REPORT OF DEPARTMENTAL COMMITTEE ON ANTHRAX IN WOOL, GOAT HAIR, & CAMEL HAIR.

MEDICAL OFFICER OF HEALTH

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO

PRECAUTIONS FOR PREVENTING DANGER OF INFECTION BY ANTHRAX IN THE MANIPULATION OF WOOL, GOAT HAIR, AND CAMEL HAIR.

VOL. I.—REPORT OF THE DISINFECTION SUB-COMMITTEE.

Presented to both Houses of Parliament by Command of His Majesty.

LONDON:
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1918.

[Cd. 9057.] *Price 1s. Net.*

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A (6)31335 Wt 6349—167 1500 5/18 E & S

REPORT.

The Right Honourable Sir George Cave, K.C., M.P.,
His Majesty's Principal Secretary of State
for the Home Department,
Home Office.

SIR, 23rd April 1918.

ON behalf of the Departmental Committee appointed to inquire as to the precautions which may be adopted for the prevention of infection by anthrax from wool, I have the honour to present the following report on an investigation by a Sub-Committee for the purpose of devising a method of disinfection for wool and hair.

The Anthrax Committee was originally appointed at the end of 1913 in order to revise the existing regulations applied under the Factory and Workshop Act in some of the branches of the worsted industry for the purpose of preventing anthrax in the processes of manufacture of certain varieties of wool, goat hair and camel hair. Subsequently they were asked to advise what precautions can be taken in warehouses at the ports and in the woollen and felt trades for the prevention of the disease

Our inquiries show that in spite of the precautions already taken the incidence of anthrax is increasing in the worsted trade, and that in warehouses at the ports and in the woollen and felt trades it is assuming somewhat alarming proportions. In the first year of its existence the Committee heard a large volume of evidence and carefully considered what further precautions can be suggested. It was found that in the worsted trade the Bradford manufacturers, acting on the advice of the Bradford Anthrax Investigation Board, had for some years carried out voluntarily certain precautions in addition to those prescribed by existing regulations. We were pressed to recommend that these should be given legal force.

After carefully considering all the evidence and every suggestion made, the Committee was forced to the conclusion that the measures already taken in the worsted trade can afford no protection to workers in warehouses at the ports or to operatives in the woollen and felt trades if applied in those occupations, and that except in minor details all the precautions it is practicable to take in factories have been in operation for a considerable time either voluntarily or in accordance with existing regulations. We think it probable that many cases of anthrax have been prevented as the result. The incidence of the disease is, however, steadily increasing, and it is clear that they cannot effectively cope with the danger.

Manufacturing processes do not kill the living organisms (anthrax spores) which cause anthrax, and the disease occurs and continues to occur in every process from the entry of the raw material into the factory to the production of the finished goods. The danger to be guarded against is different from that usually met by means of regulations applied in factories, and the Committee finally came to the conclusion that this is not a suitable or effective method of dealing with the problem, and further, that anthrax can only be prevented either by preventing the disease among animals or by the destruction of the organisms in wool and hair.

In these circumstances it was decided to endeavour to find a process by means of which anthrax spores in wool can be destroyed, and for this purpose a Sub-Committee was appointed to go into the whole question. The difficulties of disinfection of wool and hair are very great, and it was recognised that the prospects of finding a practicable process were unpromising having regard to the failure of many previous efforts to find a successful method. The Sub-Committee has, however, surmounted every difficulty successfully, and their experimental work and its results are fully described in the accompanying report.

Summary of the Sub-Committee's Report.

It is pointed out that of all disease-producing organisms anthrax spores are the most difficult to kill, that in wool and hair the difficulty is increased by the fact that the spores are protected by grease and by blood and other albuminous substances, and that wool is very easily damaged. The difficulty of killing the spores without damaging the material has hitherto proved insuperable. The inquiry was, therefore, experimental, but laboratory experiments were expressly avoided, plant being devised by means of which experiments on a small scale but on practical commercial lines could be carried out with laboratory precautions.

It is laid down that a method of disinfection of wool and hair to be practicable must comply with the following conditions:—(1) It must be capable of completely destroying anthrax spores even when protected as they are in animal fibres; (2) it must not cause damage to the material; (3) it must be practicable for use on a large commercial scale; and (4) its cost must be reasonable. In every experiment, therefore, two test materials were submitted to pre-arranged treatment: (*a*) "infected test material" consisting of bloodclots containing deeply imbedded anthrax spores, this form being chosen because it is generally agreed that spores so protected are the most difficult to destroy; (*b*) "damage test material," which consisted of raw wool or hair of one or other of the dangerous varieties supplied by manufacturers, and returned to them after treatment for examination and report as to the effect of the process.

Full details of the methods of preparation and of the behaviour of each of the test materials are given. Efficiency of disinfection is judged by cultural results of bacteriological examination of infected test material after treatment, and by animal inoculation. Disinfection is considered to be efficient only when all anthrax spores and practically all other organisms are constantly destroyed; and to be successful only when, in addition, the damage test material has suffered no deterioration.

Disinfection by means of steam is shown to be impracticable by reason of its damaging effect, and efforts were therefore concentrated on devising a chemical process. A large number of experiments was carried out, of which a full description is given, and gradually the causes of early failures were discovered and eliminated, until, finally, a successful process was evolved. Its essential features are:—(1) A preliminary process in which material is submitted to the action of a warm solution of soap in water containing a little alkali, followed by squeezing through rollers. The purpose and effect is to cause disintegration of bloodclots and the removal of all protection from the spores, and to bring the latter into a condition in which they are susceptible to the action of disinfectants. (2) The disinfecting process, in which material treated by the preliminary process is submitted to the action of a warm solution of formaldehyde in water, and again squeezed through rollers. Most of the spores are destroyed at this stage. (3) Drying, by which all the surviving spores are killed except in special circumstances. (4) Standing for a short time in order to ensure the destruction of any spores which may, when exceptionally well protected, survive stage 3. It is shown that the last two stages are largely in the nature of a safety factor.

Process

The process of disinfection occupies about one hour, and details of working (times of exposure, strength and temperature of solutions, &c.) are fully stated. Though these are somewhat complicated and expert chemical supervision is necessary, the method lends itself to continuous and rapid working on a large commercial scale by means of machinery of a type already much used in the worsted industry. The material is fed into the machine and is not again handled till it has emerged clean, dry, and disinfected.

Having devised a method apparently successful, the Sub-Committee thought it necessary to secure independent confirmation of their results. Professor Sheridan Delépine, Director of the Public Health Laboratory, University of Manchester, was, therefore, asked to undertake a critical examination of the process. He carried out many independent experiments, and asked the Sub-Committee to undertake others, for the purpose of fully testing the principles underlying the method, and finally reported (1) that the test material used in the Sub-Committee's experiments was entirely suitable, and was as resistant to disinfection as, and in many cases more resistant than, the most resistant material ordinarily found in wool and hair; (2) it is, therefore, safe to estimate on the basis of the Sub-Committee's results the effect of the process on naturally infected materials; (3) constantly good results were obtained by the method finally evolved; (4) that complete disinfection of highly infected material can be obtained by the process.

It was thought necessary to carry out experiments on a commercial scale for the purpose of proving absence of damage to the material and the practicability of the process. Arrangements were made with manufacturers in each of the branches of the wool trade (worsted, woollen, and felt) to supply a considerable quantity of each of the different varieties of dangerous materials, take it back after disinfection, manufacture it in the ordinary way alongside similar but untreated material, and report on its behaviour in each process. For these experiments commercial buildings and machinery used in the wool trade were borrowed, and altered and adapted to meet the needs of the process of disinfection. The materials treated were (1) Persian wool (representative of the class of dangerous sheep's wool used in the worsted industry); (2) mohair (representative of goat's hair); (3) alpaca (representative of the materials of the camel-hair class); (4) medium quality East Indian wool (representing the class of sheep's wool used in the woollen trade); (5) low grade East Indian wool (representing the class of materials used in the felt trade). In each case the material was selected by the manufacturers because it was of the class or quality which most easily shows damage. After treatment the materials were returned to their owners and passed through the appropriate processes in each of the four branches of trade involved, *i.e.*, the manufacture of (*a*) worsted goods, (*b*) mohair and alpaca goods, (*c*) woollens, and (*d*) felt. The reports made on their behaviour in each of the processes up to the production of the finished goods are given in full. In no case was damage observed. Small differences in behaviour, as compared with the similar but untreated material, were occasionally noted, but the manufacturers point out that these were within the ordinary range of variation of material.

The practicability of the process for use on a commercial scale is shown by the nature and results of the commercial scale experiments. It is pointed out that an incidental effect of the process is that the material is cleansed at least as effectively as by washing, which takes place in the ordinary course of manufacture, so that some advantage is offered to the trade. Formaldehyde, the disinfectant used, is already manufactured on a large scale for various purposes, so that there is no apparent difficulty in adopting the process.

In order to compute the cost, careful records were made by means of chemical analysis, and in other ways, of the loss of disinfectant in the commercial scale experiments. It is pointed out that these were wasteful owing to defects of the adapted machinery, which would be absent in machinery specially designed for disinfection. Plans and estimates of cost of machinery and buildings were obtained from machinery makers and mill erectors on the basis of disinfection being carried out in central disinfection stations. An estimate of all other working costs was also prepared and submitted to several managers of woolcombing mills whose comments are given. From these sources of information it is calculated that the capital cost of erection and equipment of a central station capable of disinfecting 10,000,000 lbs. of wool annually would be 18,000*l.*, and that the working cost of disinfection, including very liberal allowances for depreciation and sinking fund, would vary from 0·544 penny to 0·824 penny per pound of untreated material. The costs are computed at pre-war prices, and about 75 per cent. would have to be added to meet existing conditions. Manufacturers consider this to be reasonable, having regard to the object in view and the condition of the material after treatment.

The Sub-Committee recognise that there must be no ground for dispute left, and the fullest details of their work are, therefore, given. They are unanimous in putting forward the process as one the adoption of which the Departmental Committee will be completely justified in recommending to the Secretary of State as a satisfactory means of preventing anthrax among persons manipulating wool and hair. No recommendations are made, as it is pointed out that this is a question for the full Committee. It is clear, however, that the Sub-Committee strongly favour the policy of disinfection in central stations.

The evolution of a successful process of disinfection of wool and hair profoundly modifies the position in relation to the problem of preventing anthrax. The information in possession of the Committee indicates that not only does anthrax occur whenever and wherever infected material is handled after it leaves the producing districts, but also that infection may be spread during the whole time between its collection and manufacture, and even after. The Committee is, therefore, of opinion that disinfection should be carried out at the earliest stage possible in the course of the material from the producing to the consuming districts.

The Committee has adopted the Sub-Committee's report, and the measures by which disinfection can best be applied are under consideration. It was unanimously agreed, however, that the report should be presented to you without waiting for recommendations as to the manner in which disinfection of wool and hair should be brought into operation. It is necessary to issue a warning against the taking of premature action by any individual or body before the presentation of the Committee's final report. Disinfection is a highly technical process, and demands skilled scientific supervision and the use of extensive special machinery. It cannot, in our opinion, after reviewing all the circumstances, be carried out in factories in which wool or hair is manufactured. Nor can it be applied effectively by any private body.

I cannot, of course, anticipate the recommendations of the Committee, but the circumstances are such as to make it necessary for the Government themselves to organise disinfection, and it is further necessary for it to be carried out before the materials are dealt with in any way in this country. The report and recommendations are now in draft, and will be presented to you within a few weeks. Till a decision has been come to as to the steps to be taken following on those recommendations, it will be unwise for any person or body to take any action whatever on the results of the Sub-Committee's investigation.

I am, Sir,
Your obedient servant,
WM. MIDDLEBROOK,
Chairman.

G. ELMHIRST DUCKERING,
Secretary.

Report to the Chairman of the Departmental Committee on Anthrax on the Investigations of the Sub-Committee appointed to inquire as to the Practicability of Disinfection of Wool and Hair.

SIR,

WE beg to present the following report on our experimental investigation of methods of disinfection applicable to wool and hair. We regret that, owing partly to difficulties and delays resulting from the war, but principally to the success attending the experiments and the desire to submit to the most severe tests the process evolved, it has not been found possible to report sooner.

The Sub-Committee was first instructed to consider and report to the Committee on the desirability of undertaking experiments in disinfection. We reported that certain materials are imported in such a condition as to show no visible indications of infection, that during their manipulation no effective protection of the workers against anthrax can be provided, and that an efficient method of disinfection is therefore desirable. We also pointed out that no systematic experiments in chemical disinfection of wool had been carried out, while such isolated experiments as had been made indicated either damage to material or doubtful efficiency of disinfection, and we expressed the opinion that there was real necessity for an experimental investigation having for its object the working out of a method of disinfection efficient, yet harmless to material. We further made an estimate of the cost of the proposed investigation.

The Secretary of State having approved the proposal and consented to the necessary expenditure, we drew up a rough scheme of experiments, to which the Committee agreed, and the investigation was then begun.

The problem of disinfection of wool and hair is one of great difficulty and complexity. On the one hand, anthrax organisms in the form and in the environment in which they exist in wool are exceedingly resistant to, and are largely protected against direct action of all means by which living organisms may be destroyed. On the other hand, wool is an exceedingly delicate material, very easily damaged, not only by contact with chemicals, but also by heat and even by mere manipulation. The two desiderata, *i.e.*, efficient disinfection and avoidance of damage, are in a great degree opposing and mutually destructive. The need for a method of disinfection has been recognised since 1880, and many experiments (chiefly as to physical methods), have been made with a view to devising one. All have, however, failed either because they did not ensure the destruction of anthrax spores or because they resulted in damage to the matterial.

1. CONSIDERATION OF MATERIAL TO BE DISINFECTED.

In order properly to approach the question of disinfection it is necessary to understand clearly (1) the nature of the material to be disinfected, (2) the manner in which damage may be caused, (3) its treatment in the course of manufacture, and (4) the conditions under which the organism, whose destruction is desired, exists in that material.

(1) *Nature of the Material to be disinfected and* (4) *Conditions under which the Organism exists in it.*—In order fully to understand (4), it is necessary to know the manner in which and the means by which the material becomes infected. We have not, however, been able to obtain any reliable data as to this. The information in our possession is largely surmise based on what it is thought ought to or may happen in the country of origin of the material. This is discussed in the section on preparation of infected test material. Accurate knowledge of what takes place among the flocks and of the manipulations to which wool is subjected in India, Mesopotamia, Arabia, Asia Minor, Egypt, Peru, and other countries where anthrax occurs on a large scale among sheep and goats, is also really essential. Attempts to acquire this were made by obtaining evidence from persons engaged in the wool trade and living in these countries, but such statements as they could make were of the vague general type which afford ground for speculation but no firm basis on which to found conclusions. It was then proposed to send a small Sub-Committee to these countries to obtain evidence on the spot, but in the conditions created by the war no attempt could be made to do this. It is clearly dangerous to draw conclusions by analogy from the isolated cases of anthrax which occur among animals in Great Britain.

Concerning the actual condition of material as it is found in factories there is more certainty, though there are many obscurities which would probably be relieved by knowledge of conditions in which the wool is grown and treated before export. The information collected by the Bradford Anthrax Investigation Board as a result of bacteriological examination of about twelve thousand samples of various materials is of the very greatest value. Not only have we availed ourselves of this information, freely placed at our disposal by the

Board, but we have ourselves made close inquiries into and observations on the condition of materials in course of manufacture. The period occupied by our investigations coincided with one in which the incidence of anthrax was very severe amongst factory workers. Though we greatly regret the outbreak of the disease and the resulting suffering, it is unquestionable that the coincidence facilitated the collection of much valuable information. Several hundreds of samples of materials were collected by or on behalf of the Sub-Committee, principally in connection with cases of anthrax. They were examined bacteriologically by Dr. Eurich in the laboratory which the Health Committee of the Bradford Corporation has placed at the service of the Anthrax Investigation Board, and the results are published in the annual reports of the latter body.

The following is a brief summary of the information gathered:—Practically all wool, hair and animal products appear to be or are liable to be infected with anthrax spores more or less frequently, but the materials most frequently found to be infected are, in the approximate order of severity of infection, (1) East Indian goat hair, (2) East Indian wool, (3) Persian wool, (4) mohair and "other" goat hair, including cashmere, (5) Egyptian wool, (6) alpaca. These materials have different characteristics and are differently treated in the course of manufacture. This must be borne in mind in carrying out experiments in disinfection, since what may be severe damage to one class of material or to material used for certain purposes may be negligible in another material or in material used for different purposes. Consideration of the relation between disinfection and different materials or different methods of manufacture is a question for the full Committee, and has not, therefore, been dealt with by the Sub-Committee. The conditions under which infection exists (*i.e.*, the extent to, and the means by, which spores are protected) in the materials as they reach this country vary considerably. The necessity for a thorough understanding of these variations will be realised by consideration of the experimental results, and it is a matter for regret that knowledge on this point is still imperfect.

Persian wool (Bagdad, Bussorah, Bushire, Karadi, Awassi) reaches this country in press-packed bales, which may contain (1) fleeces fastened by means of a knotted wool band, (2) broken-up fleeces which are known as pieces, or (3) locks. Each fleece may also contain wrapped inside it a considerable quantity of locks not properly belonging to it, *i.e.*, the locks and the fleece have been derived from different animals. A proportion of the fleeces and pieces is skin material which may be packed in separate bales or may be mixed with shorn material. Present among the wool is a considerable number of dried bloodstains and blood-clots, the latter being frequently of large size and very hard. These are most frequent among skin wool, and pieces, though they are also present in fleece wool. They are by no means necessarily infected. In locks large blood-clots are rare, but small clots or bloodstains are frequent. The origin of the blood (*i.e.*, from healthy or sick animals) and the means by which it becomes attached to the wool are quite unknown in this country. A proportion of the bloodstains and clots is infected with anthrax, the degree of infection being sometimes scanty, sometimes abundant. In a certain consignment of Persian wool 10 per cent. of the bloodstains removed were found to be infected (Q. 4283); but there is no evidence that this figure is even approximately constant. The large bloodclots are occasionally infected, but, as far as infection in blood is concerned, the bulk of it lies in bloodstains and clots of moderate size. Apart from visible bloodstains, the wool itself (fleeces, pieces, and locks) has also been found to be infected, but the degree of infection is usually scanty. Locks free from visible blood are frequently infected.

Turkey and Cape mohair reach this country in bags, the former in "bumps," and the latter loose (*i.e.*, not in fleeces). Van mohair is usually imported in press-packed bales of tied-up fleeces. All these materials contain dried bloodclots, varying in number and size, the smaller preponderating. They are rarely as thick and hard as those found in Persian wool The bloodstains have frequently been found to be infected, often abundantly so; and material not visibly bloodstained, especially in skin mohair of each variety, has also been shown to contain anthrax spores.

East Indian wool, goat hair, and Egyptian wool are imported in bales of loose material (*i.e.*, not in fleeces), the first two being press-packed and the last not press-packed. East Indian cashmere is imported in bales of twisted ropes. A very large proportion of East Indian goat hair and of East Indian and Egyptian wool has been washed in India and Egypt, respectively. Bloodstains are rarely found, therefore, in these materials. With very few exceptions, infected samples are free from visible blood, but in some, blood has been detected by chemical tests. The degree of infection ranges from scanty to abundant.

Alpaca is sent to this country in bales, in which it is packed in fleeces, or collections of several fleeces loosely rolled up, and occasionally in twisted ropes. The proportion of blood-stained material varies greatly in different consignments, and infected clots are infrequent except in the case of what is understood to be skin alpaca. A number of samples of alpaca of good quality free from blood have been found to contain anthrax spores, but the degree of infection was always very scanty. One lot of skin alpaca proved to be highly infected.

Summarising this information, it may be said that in wool as it is found in commerce anthrax spores are to be found partly in visible bloodstains, and partly in wool free from visible blood. Most infected bloodstains are comparatively small, except in Persian wool, in which they may be of large size.

Much of these materials is greasy, and much is very dirty and contains considerable quantities of earthy matter and excrement. Though it should be clearly understood that there is good evidence that infection is by no means confined to skin wool, this class is generally the most highly infected.

(2) *Indications of Damage to Material.*—So far as the material itself is concerned, damage shows itself principally in reduction of lustre, discoloration (in the case of white materials), reduction in strength and elasticity, matting or felting of the fibres, decreased yield of top and increased yield of noil and waste (in the case of combing materials), shortening and shrivelling of the fibres, and, finally, loss of felting and spinning properties. The importance of any particular form of damage varies with different materials and the purposes to which they are put; but, generally speaking, any damage whatever tends to lower the value of the raw material and increase the cost of production of yarn.

Apart from the direct effect of any chemical on fibre, discoloration, shrivelling, and loss of spinning property may be caused by treatment at high temperatures. Felting of the fibres may result from treatment in liquid at high temperatures (over 140° F.), by absence of or excess of soap in the liquid, by certain forms of agitation, and by improper drying.

(3) *Treatment of Wool and Hair in the course of Manufacture.*—The manufacture of wool and hair (except horsehair, cow tail hair, and pig's hair) can be divided broadly into three branches—(*a*) worsted (including mohair, alpaca and goat hair), (*b*) woollen, and (*c*) felt. In each the processes are essentially different.

The distinguishing feature of the worsted branch of the trade is that the materials are combed. In the manufacture of worsted yarn, the raw material is usually (but not always) first sorted into "matchings" which are blended, sometimes shaken, and then washed in several baths of soap, alkali and water. After drying, the material is oiled, sometimes willowed, and the shorter materials generally carded on single cards and then combed. In combing, the card sliver is drawn by suitable mechanism through several rows of fine steel pins (the comb) in such a way that the long fibres are drawn off in a continuous sliver (top), and separated from the short fibre or noil, which becomes raw material for the woollen and felt trades. Preparatory to combing, and also after combing, the sliver is drawn through a series of rows of steel pins, which move with but more slowly than the sliver, in machines called gill boxes (strong boxes, finishing boxes, &c.). It is also sometimes washed and again oiled after carding. The top is then drawn, blended and, finally, spun on high-speed machines.

Longer material, instead of being carded, after drying is passed through a succession of gill boxes or preparing machines having coarse wide set rows of pins through which the material is drawn. The object, as in carding of the shorter material, is to cause the fibres to become parallel preparatory to combing.

Owing to the severity of the process of combing, in which the material is drawn several times through rows of pins, any damage resulting in lowering of the strength or elasticity of the fibres is at once indicated by an increased production of noil and a decrease in the average length of the fibres constituting the finished top. This is due to breaking of the fibres under the strain. Owing also to the fact that, in spinning, the material may be drawn out to a thread so fine as to reach the extreme limit of the power of the fibres to hold together, loss of the property of holding together is quickly shown by an increase in the number of breakages in the thread during spinning and in subsequent processes of weaving, &c. A comparatively small amount of damage, therefore, is sufficient to cause grave deterioration of material intended for use in the manufacture of worsted yarns.

In the manufacture of woollen yarn the raw material is usually shaken in a shaking machine (sometimes called a willow or shake willow), blended, again shaken, willowed (in a fearnought willow), and at the same time heavily oiled, scribbled (on a coarse carding machine), carded (on a finisher carding machine or condenser card), and finally drawn and spun on mules and the yarn then scoured. The yarn produced is thick and heavy in comparison with worsted yarn, and, partly owing to this fact, partly to the much less severe treatment, and partly to the fact that there is no necessity to separate the shorter fibres from the long, damage is much less readily shown by material used for manufacture into woollen yarns than by material used in the worsted trade.

In the manufacture of felt the raw material is shaken in a shaking machine, blended, again shaken and "devilled" or pulled apart, scribbled (on a coarse carding machine or "tummer"), again carded on a fine or finishing card, from which it passes on to a forming machine. A long, thick, wide flat sheet of wool is produced which is rolled up and transferred to a felting machine, which, by means of heat, moisture and friction, produces the felt. Damage must be severe to be indicated in the manufacture of felt, but any increase of brittleness in the fibre or reduction in felting properties (the property the fibres possess of holding together) would decrease the value of the material for felt-making.

2. CHOICE OF METHOD OF DISINFECTION.

It is clear from consideration of the materials to be disinfected that, apart from the question of damage to material, there are many factors adverse to successful disinfection. Moreover, it should be understood that disinfection of raw wool is a problem entirely different from disinfection of finished manufactured fabric. Methods and chemicals which have no practical effect on fabrics entirely spoil raw material and reduce it to a condition in which it is quite impossible to convert it into yarn of anything approaching the degree of fineness, strength, and other qualities it is usual to expect. The easiest method would be that in which the temperature of the material to be disinfected, or of the air surrounding it, is raised to a point at which all life is destroyed. Steam affords a most convenient means by which this can be carried out, but in most of the experiments in disinfection of wool made before the Committee undertook its inquiry, use has been made of this method, and invariably damage to material has been reported. Moreover, it is universally recognised in the wool trade that raw wool is damaged by high temperatures, not only in regard to strength and spinning property, &c. of fibres, but because heat above a certain degree fastens any colouring matter on the fibre, and thus causes discoloration. It appeared desirable, therefore, to investigate chemical methods first.

It is plain that in order for any chemical to act as an efficient disinfectant it must be capable of overcoming the protection afforded to the anthrax spores by grease, dried excrement and albuminous matters, above all by dried clotted blood, or the method of its application must be such as to provide an equivalent. In this connection also it should be recognised that many, if not most, chemical substances which have disinfecting properties also coagulate albumen, and render it insoluble, thus increasing the natural protection afforded to the spores as found in wool. Further, the chemical must not be destroyed or its disinfecting property reduced by substances found in wool, *e.g.*, ammonia produced by decomposition of urine, &c., lime (calcium carbonate), sodium sulphide and sodium carbonate or hydroxide, which may be left in wool in the process of removing it from the skins. Or if it be destroyed by these substances, the fact should be clearly recognised and measures taken to prevent undue decrease in the disinfecting power caused by loss of the disinfectant. Having regard to the large quantities of wool requiring disinfection, the chemical must also be capable of manufacture on a large scale, and, lastly, it must have no or very slight effect on the wool itself.

Of the better known disinfectants, there are only four which can be considered: (1) The phenol and cresol group; (2) hypochlorous acid; (3) corrosive sublimate, and (4) formaldehyde. It has been shown that the phenol and cresol disinfectants will inhibit the growth of but will not destroy naked anthrax spores in any time which would permit of their use in actual practice, while hypochlorous acid, though a powerful disinfectant, quickly and adversely affects raw wool, and corrosive sublimate is deficient in penetrative power and too poisonous for extensive use. There appeared, consequently, to be no choice but to employ formaldehyde or to make a search for a new disinfectant.

Formaldehyde is a substance which has a very bad reputation as a disinfectant owing to its alleged unreliability. It is beyond doubt that in some circumstances it will destroy resistant micro-organisms, while in others it appears to be inactive, or at all events ineffective against the same organisms. Formaldehyde itself is the product of the partial oxidation of methyl alcohol (wood spirit), and is a gas. It is a substance of enormous chemical activity, and possesses the property of condensing to a solid by combination of two or more of its own molecules. The effect of this is that it cannot be kept as a gas, and in commerce it is always sold as a solution of the gas in water, containing about 37 per cent. by weight of formaldehyde. This solution in certain circumstances (*e.g.*, low temperatures), and any solution over this strength, deposits the solid form on standing. The property of condensation probably explains the variable action of formaldehyde, since the solid form is inactive from a disinfection point of view, though by proper measures it may be reconverted into the active gaseous form. It is certain that the commercial solution of formaldehyde in water is not a simple solution of the gas. If dilute solutions be exposed freely to air for long periods (many weeks), they do not rapidly decrease in strength as would be expected in the case of a simple gaseous solution. Moreover, if a solution of formaldehyde be boiled and the vapours given off be condensed and collected, it is found that, though the first portions of the distillate are stronger than the original solution, the formaldehyde is not rapidly driven off. On the contrary, when the liquid has all evaporated, it is found that a residue of one of the solid forms of formaldehyde remains. Nevertheless, formaldehyde offers pronounced advantages as a disinfectant for wool if it can be used effectively. It is an article of commerce which is manufactured on a large scale, and, being a gas or convertible into a gas, it does not require elaborate measures for its removal from wool after the latter has been disinfected. If necessary, however, formaldehyde as such can be destroyed by simple immersion of the wool in a dilute solution of ammonia. Other advantages will be referred to later.

The Anthrax Investigation Board state in their ninth annual report that a solution of 1 per cent. formaldehyde kills naked anthrax spores in seven hours, but not in six. A 2 per cent. solution kills naked anthrax spores in four hours but not in three, while a 4 per cent. solution kills the naked spores in less than one hour. In their third annual report, however, they state that when natural infected mohair bloodclots are steeped in a 2 per cent. solution of formaldehyde for five days without interruption, the spores are not destroyed.

Mr. Ackroyd, giving evidence before the Committee, stated that he had endeavoured to disinfect Van mohair by steeping it in a bath containing a 2 per cent. solution of formaldehyde, but anthrax bacilli were subsequently cultivated from the bloodstains. He further stated that in 1914 he treated some thousands of pounds of badly infected mohair (from which the bloodclots had been removed by sorting) by steeping it in a solution containing about 2 per cent. of formaldehyde for periods up to 15 hours. It was not found possible to cultivate anthrax bacilli from samples after treatment, but the material was badly damaged. Mr. Ackroyd states, however, that in his opinion no definite conclusion can be drawn from this experiment, and he strongly advocated further investigations.

Professor Sheridan Delépine published in 1898 the results of experiments in disinfection of rooms with gaseous formaldehyde, in which anthrax spores were destroyed in twelve experiments out of nineteen.* When protected by blotting paper, which other experiments showed could be penetrated by the gas, spores dried for five months were unaffected by 48 hours' exposure. Other experiments have been made in which formaldehyde gas, produced from the solid form or from preparations of which formaldehyde is the basis, was used, and generally the results have indicated that this substance possesses power to kill anthrax spores, though its action is very uncertain. The true reasons for this uncertainty have never been ascertained nor indicated, nor even suggested, except in Professor Delépine's experiments. It appeared plain to us that formaldehyde possesses some power of destroying anthrax spores, though it seemed probable from the results of experiments briefly referred to above that comparatively slight covering of the spores by blood or other protecting substance sufficed to prevent their destruction. It seemed, however, to be worth while to endeavour to ascertain if by any means the uncertainties and apparent variability attaching to the use of formaldehyde could be controlled, and if the protection afforded to spores in wool could be annulled. We were the more inclined to take this course, as we had come to the conclusion, after considering the available recognised disinfectants, that formaldehyde seemed to be the only substance at present known which offered any chance of success as a disinfectant of wool.

3. AIMS OF THE SUB-COMMITTEE.

The objects which we carefully kept in view were the devising of a method of disinfection capable of use in practice, the defining of the principles which must be observed in, and of the limits of the process. The temptation to carry out experiments to elucidate scientific problems, which could not fail to and did reveal themselves in such an inquiry, was great, but has been strictly avoided. Many interesting points have been observed as to which laboratory experiments are desirable. These have not been pursued, since the undertaking of such inquiries would have entailed a certain diffusion of the energies of the Sub-Committee which it was desired to avoid. The experiments actually undertaken by us were more in the nature of commercial processes carried out on a small scale with laboratory precautions. We deemed this method of experimenting to be the only one suitable, having regard to our objects. The two tests, by means of which success or failure was judged, applied in all the experiments, were: (1) bacteriological examination of test material, known to be infected before treatment, in order to ascertain the effect of the treatment on the anthrax spores; and (2) examination of material in order to ascertain the effect on the wool fibre. To these may be added (3) the possibility of applying the principle of the experiment in practice.

4. GENERAL SCHEME OF THE EXPERIMENTS.

The usual method of making experiments in disinfection is one in which organisms, and particularly anthrax spores, cultivated in the laboratory, are exposed to the action of steam or of a chosen chemical, either when suspended in water or after drying on to silk threads. In other words, optimum conditions are chosen and the actual conditions, under which the organism whose destruction is attempted exists in practice, are ignored. Such experiments have only limited value from the point of view of the Committee. It was therefore decided to obtain naturally infected material, or to prepare infected material which should approximate closely to it as regards the conditions under which the spores exist, and to submit this material to the action of the disinfectant under known conditions which could be varied at will.

The apparatus used by the Sub-Committee was simple. It consisted of (*a*) a series of tanks in which the test material was submitted to the action of various solutions, and of (*b*) a drying oven. The tanks were three in number, each measuring 122 cm. by 81 cm. by 40 cm., were made of wood, and had an effective capacity of approximately 300 litres (66 gallons) each. They were arranged end to end on staging with power-driven squeezing rollers at the end of the first and second discharging into the second and third. Each tank was fitted with a frame carrying three rows of teeth projecting nearly to the bottom. The frames were carried on hinges so that they could be raised to allow of placing wool in or removing it from the tank, and they were supported on rollers running on horizontal rails. By means of

* Some experiments in disinfection of rooms by gaseous formaldehyde. By Professor Sheridan Delépine. Journal of State Medicine, 1898.

power-driven mechanism a to and fro horizontal motion could be given to these frames, so that the material in the tanks could be gently agitated. This agitating mechanism proved to be ineffective. Being a simple reciprocating motion, the wool, after a few seconds, settled into a position in which it remained with very little motion during the remainder of the experiment. For all practical purposes, therefore, treatment in all the experiments was a mere steeping, apart from the action of the rollers. The result was that the bloodclots were not mechanically broken up but were simply softened and partially dissolved. In experiments which will be described later it was clearly shown that the mechanism of an ordinary washbowl has a very much more powerful effect in aiding in the removal of the protection afforded to the spores by blood. About 20 to 40 lbs. of material could be treated at one time in each tank. It was early found that in dealing with highly infective material, such as was used in the experiments, this quantity was too large to be safely handled, and several small zinc tanks, having an effective capacity of about 24 litres (21 cm. by 46 cm. by 30 cm.), were then placed in the large tanks, the material in them being agitated by the mechanism provided for the latter. It was found that when the large tanks were filled with water at a temperature a degree or two above that required for the experiment, and were covered up, the temperature of the material in the small tanks could be maintained at any desired point for a considerable time.

The drying oven was of the type used in ascertaining the quantity of moisture in wool. It consisted of a large metal cylinder having hollow sides and bottom and a gas burner beneath it. Hot air was driven by means of a fan into the hollow space in the walls, whence it escaped through three orifices (covered with perforated sheet metal), in the inner floor of the cylinder. Over each of these orifices was closely fitted a small removable cylinder with a perforated metal bottom. Material placed in these small cylinders was thus subjected to the drying influence of a current of hot air passing constantly through it. After traversing the wool the air was drawn off through a tube at the top of the main cylinder. The temperature, indicated by a large thermometer in the cylinder, could be controlled by means of an automatic gas regulator. This arrangement was not found to be the best for the purpose in view, the drying being somewhat slow, but once the regulator was set for a given temperature it was possible to maintain the wool at that temperature for any desired period.

The first bath and first squeezing rollers were kept entirely for preliminary treatment of the material, the second bath and squeezing rollers for treatment by means of formaldehyde, and the third was kept in reserve for use as required. This division was necessary, and rigidly adhered to, because (1) the first bath and rollers became badly infected and might have conveyed infection to treated material if used in the later processes, and (2) because it was found that formaldehyde very quickly affected the bloodclots, and so might have interfered with the results if introduced into the bath used for the preliminary treatment. The whole apparatus was washed with hot water before beginning experiments, and was disinfected at the end of each day. The known infected test material (bloodclots) and a certain quantity of wool were subjected together to prearranged treatment for prearranged periods in the baths, lifted by means of small forks from the bath to the rollers, and when drying was necessary were dried together. Where it was desired to bring the action of the formaldehyde to an immediate end at any stage of the experiments the infected test material was removed and placed in a solution of ammonia, which, while destroying formaldehyde, does not affect anthrax spores. The infected test material was at the end of each experiment placed in sterilised sample bottles for removal to the laboratory. The wool or hair treated together with the infected test material was always regarded as being infected till the result of the bacteriological examination was known. The experiments were usually watched by two members of the Sub-Committee, sometimes by four. Before making any alteration in the method of treatment the suggested variation was carefully considered in relation to (1) disinfection, (2) effect on material, (3) practicability for actual use. No variation was attempted where there were good reasons for excluding it on the grounds that it was known to cause damage to material or that it could not be applied in practice.

The experiments were carried out in the Bradford City Conditioning House. We take this opportunity of placing on record the great services rendered by Mr. W. M. Jackson, Manager of the Conditioning House. But for his assistance it is doubtful if the experiments could have been carried out in the difficult circumstances created by the war. Not only did Mr. Jackson place his long experience and great knowledge of wool unreservedly at the disposal of the Committee, but when any special plant or apparatus was needed, he either had it made in his establishment or quickly secured it for us. In several cases, but for his assistance in this respect, owing to difficulties of obtaining men and material, experiments proposed would either have had to be abandoned or be carried out in a way which would have greatly reduced their value.

5. CONTROL TESTS IN CONNECTION WITH THE SUB-COMMITTEE'S WORK.

In order to prevent as far as possible any oversight as regards disinfection it was decided to ask a bacteriologist of acknowledged authority to undertake a control examination of material treated by us and to act as an outside and independent critic of the experimental work. Professor

Sims Woodhead, Professor of Pathology at the University of Cambridge, at first undertook to act in this capacity, and examined material treated in the first group of experiments; but, owing to pressure of his work in connection with the Army, he was reluctantly obliged to resign. Professor Sheridan Delépine, Professor of Pathology at the University of Manchester and Director of the Public Health Laboratory, Manchester, then undertook the work of checking the results obtained by us and of criticising our experiments. He inquired into our methods, and was present at some of our experiments. All information he desired was supplied to him, and the half of each treated sample and such other samples as he needed were placed at his disposal. Professor Delépine submitted all his material to the test of inoculation into guinea pigs, and, if the animals died, made post-mortem examinations of them (and cultures, if necessary) to ascertain the cause of death. The remaining halves of the treated samples were examined bacteriologically by Dr. Eurich by cultural methods. The results of Professor Delépine's examinations are given in the tables opposite those obtained by us in the same experiments. All criticisms and advice offered by Professor Delépine as to experimental details were carefully considered by us, but in general he fully approved of the methods of carrying out the experiments. In those cases where the animal test and the cultural test of treated material have shown different results we have attached greater weight to the result of the inoculation test, since, for our purposes, the death or survival of an animal has a more direct bearing on the danger of material.

In order to ascertain and control the effect of the disinfecting process on the material, the wool or hair after the treatment, together with the infected test material, was examined first by members of the Sub-Committee, and was as far as possible tested by Mr. Jackson's staff in the Bradford Conditioning House (*cf.* pages 9 and 10). The samples were also submitted either to Mr. George Feather or to Messrs. John Foster and Son, Ltd. (Queensbury), who are regarded as authorities on the materials which they respectively manufacture, and they were asked to criticise them and to point out any defects resulting from the treatment. Finally, materials treated on a commercial scale by the process evolved were spun or manufactured in the ordinary course and reports made on the observed result.

6. TEST MATERIALS AND METHODS OF TESTING USED IN THE EXPERIMENTS.

The two essential criteria by which the value and possibility of adoption of a method of disinfection, otherwise practicable, may be judged are (*a*) its effect on anthrax spores and (*b*) its effect on the raw material. It is, therefore, necessary in any experiments on which conclusions are to be based to submit to the treatment decided on, either separately or together, and preferably the latter, material of known infectivity and material of known characteristics. In this section these two test materials will be referred to as the "infected test material" and the "damage test material," respectively.

6A. Damage Test Material.

The principal classes of infected material for which, so far as the Committee is concerned, a method of disinfection is desirable are (1) goat hair, (2) sheep's wool, and (3) camel hair. The representatives of these classes selected as damage test material were respectively (1) mohair, (2) Persian wool, (3) East Indian wool, and (4) alpaca. Mohair, more than any other goat hair, readily betrays damage because of its characteristics (colour, lustre, strength, &c.) and the purposes for which it is used. Persian wool being a combing wool, and East Indian wool being a felting wool, easily show deterioration, while of the camel-hair group alpaca is most easily damaged on account of its length and fineness. In every experiment, therefore, the known infected test material was placed among about 2 lbs. of one or other of these and the whole treated together. After bacteriological examination of the infected test material, the damage test material, if the former proved to have been disinfected, was examined to ascertain the effect of the treatment on it.

It was recognised that in raw wool, and even in the same fleece, there are extraordinarily wide variations in the length, strength, fineness and quality of the fibres. The separation of these into collections or "matchings" is the object of the practice of sorting in Bradford. A good matching of mohair or alpaca was used in many experiments as the damage test material, and it was thought that valuable indications of the effect on the fibre would be obtained from a comparison of the results of tests as to strength and elasticity before and after treatment. Apart from expert examination of the treated material, and comparison of it with material which had not been submitted to the process of disinfection, the following method of testing was tried in the Bradford Conditioning House. A number of fibres over a certain length (5 inches) were drawn from the material and a predetermined weight of these straight, drawn fibres was placed in the jaws of a Schopper strength-testing machine, and readings taken of the strength, as indicated by the weight required to cause breakage of the stretched fibres, and of the elongation which took place before breakage occurred. In order to overcome the error which might result from a single test the average of ten tests was taken as a sufficiently accurate comparative reading. Unfortunately, this method of testing proved unreliable, as the following results from one series of tests of untreated and treated materials, typical of those obtained, will show :—

Table.—Results of Tests of Strength of Fibres from the same Matching of Mohair treated and untreated.

No. of Test.	Time of Treatment in Water at 102° F. (Minutes.)	Time of Treatment in 2¼ per cent. Solution of Formaldehyde at Air Temperature. (Hours.)	Number of Fibres over 5 inches in length required to weigh ·03 gramme. Average of ten tests.	Least.	Greatest.	Tension required to break the Fibres named in Columns 4–6. (Kilos.) Average of ten tests.	Least.	Greatest.	Elongation before Breakage occurred. (Centimetres.) Average of ten tests.	Least.	Greatest.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1	Untreated	Material	89·0	74	123	2·06	1·84	2·35	1·1	1·0	1·3
2	25	—	105·3	68	142	1·79	1·62	2·07	1·1	1·0	1·2
3	25	1	77·6	59	89	1·87	1·46	2·50	1·1	1·0	1·1
4	25	2¼	90·2	53	147	2·30	2·08	2·70	1·0	0·9	1·1
5	25	3¼	65·2	51	77	1·26	1·00	1·53	1·0	1·0	1·1
6	25	4¼	98·1	68	151	2·13	1·67	2·49	1·1	1·0	1·1

Before testing, the fibres were allowed to remain 24 hours in the air of the testing room.

If any importance is to be attached to these results, they would appear to indicate that the material treated most drastically is stronger and quite as elastic as material not treated at all (*cf.* 1, 4 and 6 in above table). The tests were repeated several times with similar but varying results. It was thought that difference in length of the fibres might account for the great variation in number of fibres required to give a certain weight, though no fibres were taken of less than 5 inches in length and it was extremely difficult to find any of over 6 inches in length. The tests were therefore repeated, care being taken to select only such fibres from the different lots as would give approximately the same number of a given weight. Similarly contradictory results were nevertheless obtained. Close examination of the material then revealed the fact that even in a matching such as that used the variation not only in length and thickness, but also in thickness in relation to length and of strength in relation to thickness, is enormous. It is obvious, in view of these facts, that tests of strength and elasticity, whether made on a number of or on single fibres, have no value whatever from our point of view.

We therefore came to the conclusion that the only reliable test of the effect of any treatment on material is the practical one of combing and spinning. Later experiments were, therefore, carried out without reference to damage to fibre, except that treated material was from time to time submitted to experts for their opinion and was compared with untreated material. It was clearly necessary, however, to test the effect of any process evolved, by treatment of such a quantity of material as could be combed and spun in the ordinary way in factories and to observe its behaviour in each of the processes of manufacture. It was always our intention to do this ultimately, but our early experience of attempting to ascertain by laboratory methods the effect of disinfection on wool leads us to say emphatically that this is the only reliable method by which the condition of material after disinfection can be judged in the absence of naked eye signs of damage.

6B. Infected Test Material.

The choice of material which could be used as the infected test material was a matter of some difficulty. It was clear from consideration of the data gathered during many years by the Bradford Anthrax Investigation Board, and from the observations of members of the Sub-Committee, that anthrax is present in the wool of commerce partly in bloodclots and bloodstains and partly in wool in which blood is not visible. It was clear also that blood, excrement, and other foreign bodies present in wool afford protection to anthrax spores, and, further, that this protection may vary in accordance with the size, thickness, density, hardness and dryness, age, and other qualities of the protecting substances. Obviously an ideal method of disinfection should be capable of overcoming the resistance opposed by the most refractory substance, which experience has conclusively shown to be blood. Another point most anxiously considered by us was the stage at which wool could be disinfected. This will be referred to later, but it may be said at once that we consider the disinfection of wool in press-packed or other bales, or even in unopened fleeces, to be impracticable.

The most perfectly protected spores appear to be those embedded in the large bloodclots of Persian wool, and eventually it was decided to regard these as the standard infected test material. In other words, we decided to take the extreme case as the standard by which to judge the effectiveness of any process. It is obvious that if the infection in the extreme case can be consistently destroyed, then the method of disinfection must be reliable. But the principle of taking extreme cases for test purposes involves certain dangers. The experience gained in the laboratory of the Bradford Anthrax Investigation Board shows that large infected clots are not very frequent. On the contrary, as before stated, infection appears to exist largely in medium-sized and small bloodclots and bloodstains, and even in wool not visibly bloodstained. If, then, it be found that these very large dense clots when used as the standard infected test material cannot be disinfected completely, a method which might be capable of destroying the bulk of infection in wool may be condemned unjustifiably as being useless. It ought to be thoroughly understood that disinfection of raw wool is extraordinarily difficult, and any process which, though not completely successful, yet destroys the greater part of the infection, is of great value, provided it does not damage the material. We were fully aware of the danger involved in taking the extreme case as our standard of infected test material; but we considered the possible advantage to outweigh the drawbacks from this point of view provided they be kept in mind.

It quickly became apparent, however, that the use of large Persian bloodclots as the infected test material was undesirable. Not only was there no knowledge as to the virulence of the anthrax spores, and this varies in different strains, but the degree of infection was found to be capricious and irregular, while the clots themselves were mixed up with earthy matter, so that one part might be infected and another not. Thus the standard would not be a fixed one and would be calculated to give variable results. Moreover, we found great difficulty in obtaining any infected natural bloodclots. Not only had every clot to be examined bacteriologically, which involved the making of cultures from a considerable number for each found to be infected, but it was thought that the cutting off of portions for examination might conceivably render disinfection easier than it would be in practice. The endeavours to find infected natural clots were therefore abandoned, and it was decided to make infected artificial bloodclots which should be not less difficult to disinfect than large Persian clots, and to use these as the standard infected test material. By doing this, anthrax spores of known origin and virulence and of approximately constant resisting power could be used, their distribution would, within reasonable limits, be regular, and the degree of infection would be intense. Furthermore, it would not be necessary to remove portions from each bloodclot for bacteriological examination, and an unlimited supply would be available. This course, nevertheless, had certain disadvantages, which are more conveniently discussed in the section of the report dealing with the preparation of the infected test material.

The bacteriological test applied to the treated infected material was twofold—(1) Cultural in the laboratory of Dr. Eurich, and sometimes also in that of Professor Delépine; and (2) animal inoculation carried out by Professor Delépine. The cultural method used by Dr. Eurich was as follows: The infected test material after treatment or at certain stages of treatment was placed in a sterilised bottle. In order to destroy any formaldehyde remaining in the wool or in contact with the spores from 40 to 60 c.c. of a 1 per cent. solution of ammonia was added either immediately after the infected test material was removed from the operation of the process or at such a time as to allow not less than half an hour to elapse before the material was actually placed on the culture plates. It is essential to adopt some measure for doing this as it is impossible to remove all formaldehyde from wool by drying, and it is difficult even to wash it out. Weeks after material has been thoroughly dried it is still possible to detect the presence of formaldehyde, and if this substance be allowed to get into the culture medium in even relatively minute quantities it will inhibit the growth of anthrax bacilli. After standing for at least half an hour in contact with ammonia solution the treated infected test material was removed on to a Petri dish, together with the liquid, in which it was teased out by means of needles or pointed knives and any remnant of bloodclot completely broken up into particles as fine as possible. The wool was then taken out and excess of liquid removed by pressure. The liquid in the dish was then brought to a neutral or, rather, faintly alkaline state by addition of dilute hydrochloric acid drop by drop from a pipette. Small pieces of litmus paper placed on filter paper were used as an indicator, a drop of the liquid after stirring being removed from time to time on the end of a glass rod and placed on one of the slips. The dish was then covered and allowed to stand till the sediment had become deposited. One cubic centimetre of the liquid and sediment (care being taken to include as many of the finely divided particles of blood as possible) was then transferred by means of a pipette to each of six test tubes containing 9 c.c. of melted peptone broth agar and well mixed. The contents of each tube was then poured into a petri dish and allowed to set. The quantity of liquid and sediment remaining in the dish after removal of the wool varied from 45 to 65 c.c., so that, roughly, from one-eighth to one-tenth of the material from the clots was taken for each test. The plates were then incubated at 37° C. and were examined daily. Unless an abundant growth of anthrax bacilli appeared incubation was continued for at least seven days.

The success or failure of the treatment was, of course, judged by the absence or presence of anthrax colonies on the plates. Wool is, however, rich in other organisms, the spores of which (*e.g.*, *bacillus mesentericus*) are even more resistant than anthrax spores to the action of agencies which destroy life. The anthrax colonies growing on the plates were counted separately, and then all colonies of all other organisms were also counted in order to afford some idea of the margin of safety allowed by the method of treatment when no anthrax bacilli could be cultivated. Too much significance should not be attached to the number of "other organisms" growing, since no effort was made to identify them (except in one or two instances), and it was sometimes impossible to avoid an uncertain and variable amount of contamination by dust organisms when preparing the material for culture. Nevertheless, the appearance of few or many "other organisms" on the culture plates does serve as a valuable, even if rough indication of the degree of efficiency of disinfection, especially in the case of natural bloodclots free from anthrax. Control cultures were made by the same method from one or more untreated clots of each series of bloodclots prepared. Professor Delépine's method of dealing with the treated infected test material is described in his report to the Sub-Committee (page 46).

7. PREPARATION OF INFECTED TEST MATERIAL.

In order to prepare artificially infected test material which shall be comparable with naturally infected wool, it is necessary to understand clearly how wool becomes infected, and the environment of the spores at the time when disinfection can be undertaken. As before stated, we have but imperfect knowledge on these points. It is beyond question that bloodclots impose the most difficult bar to disinfection, but there appears to be deplorable doubt as to the manner in which spores protected by blood have become attached to wool. Our experience indicates that it would not be difficult to prepare bloodclots artificially of such a nature and under such conditions as to make disinfection a practical impossibility (*see* pages 13 and 33 and Professor Delépine's report). One is then faced by the difficulty of knowing where to draw the line. It is a futile proceeding to make test material of such a nature as to render disinfection artificially much more difficult than would be found in the extreme case in practice, while at the same time a certain margin of difficulty over and above that found in practice is desirable in order to give, if possible, a sure margin of safety. If pressed too far, however, this principle endangers the success of any experiments. We are certainly of opinion that the test material prepared did not err on the side of leniency.

The following considerations influenced us in preparing test material. Very little appears to be known of the disease of anthrax in sheep and goats. Professor Delépine* states that in acute cases death may occur apparently without warning, but usually follows the onset of symptoms within 12 hours, and in sub-acute cases the animal may live for two or three days. Further, he says, that of sheep fed on infected clover, as many as half escape infection provided the quantity of spores present is moderate, and that those which ultimately die may live eight or ten days. The period of incubation, *i.e.*, the period between eating infected food and the first appearance of symptoms, he says, may be of importance in spreading infection, though he knows of no observations showing whether or not, at this stage of the disease, the excreta are infected. Sir Stewart Stockman stated in his evidence that in his opinion they might be infective (Q. 10,045), and that an animal might excrete infected material, and yet itself escape the disease of anthrax. Further, it has been pointed out that highly infected discharges, which may be stained with blood in greater or less degree, escape from the various openings of the body, particularly the anus, during the illness of the animal, and especially not long before or immediately after death. In this country instances occur where animals are killed for food in public abattoirs without having shown any symptoms of illness whatever and are yet discovered, after being killed, to have contracted anthrax, and to have anthrax bacilli present in quantity in the blood. One such case came to our notice in Bradford, and a sample of blood was examined by Dr. Eurich. Judging by the comparatively great quantity of blood in Persian skin wool, very many animals must be killed for food in Mesopotamia, and, having regard to the known high incidence of anthrax among sheep in the country of origin of this wool, it seems probable that sheep suffering from anthrax and having the bacilli in their blood may frequently be killed. Healthy sheep also may be killed after their wool has become infected by means of excreta or anal discharges during a period after eating infected food which has not caused them to contract the disease. The healthy blood clotting and drying on the wool might conceivably bury the spores already there. Further, it is possible that animals having died of anthrax may be skinned soon after death before decomposition has caused destruction of the anthrax bacilli, in which case the wool might become stained by the infected blood.

The blood of an animal dying from anthrax alters in character. It loses its power of clotting on escape from the body and exposure to air, and remains more or less fluid till it dries. Healthy blood, on the contrary, clots soon after it escapes from the body, *i.e.*, the fibrin separates out in a gelatinous mass, and this, after exposure to air and drying, is very difficult to dissolve. When an animal is suffering from anthrax in its advanced stages the blood contains enormous numbers of bacilli which can form spores only under certain conditions. The principal of these is the presence of an abundant supply of free oxygen, *i.e.*, the blood must be freely exposed to air. Apparently there are stages in the advance of the disease in animals when the blood still possesses the property of being able to clot on exposure to air though it contains anthrax bacilli. If an animal be killed at a time when bacilli are present in the blood, or be skinned or cut after dying of anthrax, its blood may escape on and become attached to the wool. It may or may not clot, or the clotting may be partial, depending on the stage reached by the disease, but the surface of this attached blood is exposed to air and

* Memorandum on anthrax by Professor Delépine, presented to the Diseases of Animals Committee of the County Council of the County Palatine of Chester, February 1905.

spores will form all over and immediately below the surface. Air may also be entangled and retained in the wool in the interior of the clot or mass of drying blood, and spores may thus form near any fibres of wool running through it. In the interior of the mass of blood, remote from the surface and from fibres of wool, however, the bacilli will to a large extent, owing to the absence of air, fail to form spores, and will die.

We desire it to be understood that we do not necessarily accept all the views summarised above. Our anxiety was to obtain test material which would cover every case and afford reliable indications of the power of destroying anthrax spores possessed by any process of disinfection applied to wool whatever the means by which the wool has become infected and in whatever state the infection exists in the materials of commerce. Having this object in view, we thought it desirable to consider every possibility put before us, whether or not any member dissented from it. Summing up the cases presented, which may be more or less hypothetical, it appears that (1) wool may become infected by excreta and discharges, without becoming bloodstained, in cases where the animal does not die from anthrax, and that the spores on the wool may be buried in healthy blood which becomes attached to it if the animal be killed with its wool in this state. (2) Wool may become highly infected, without blood being clearly visible, by discharge of fluid shortly before and immediately after death of an animal. (3) Highly infected blood, which may or may not be capable of clotting, may become attached to wool if an animal be killed when suffering from, or be skinned or cut shortly after dying from anthrax. To these may be added a further possibility (4) that wool of a healthy animal may become infected by earthy matter from badly infected land or by a mixture of earthy matter and animal organic matter from land on which an animal has died from anthrax or has been skinned after dying from this disease. The most difficult case, *i.e.*, the extreme case, would appear to be that in which spores attached to wool may be buried in healthy dried clotted blood. Hence, artificial bloodclots prepared by first causing anthrax spores to become attached to wool and then allowing healthy blood to clot and dry on it would represent this extreme. If, further, spores can be introduced into healthy blood before it is allowed to clot, in such a manner as to secure approximately regular distribution, and the blood so infected be allowed to clot and dry on wool, a test material would be obtained which might be more difficult to disinfect than the most refractory natural clots, since not only would live spores be in contact with the wool, and so be deeply buried by blood, but they would be distributed throughout the mass of the blood. In order to secure disinfection of such test material, penetration of the bloodclot must be complete and must be something more than surface action, and penetration along the line of fibres of wool running through the blood which might conceivably be aided by the presence of air entangled and retained by the wool fibres.

By different methods about 150 infected bloodclots were made in the course of the experiments. The methods finally used and the characteristics of the clots produced are described below. After the blood had become firmly clotted on the wool the clots were either supported on a wire grid or strung on wire and placed to dry in desiccators containing granulated calcium chloride, and having the lids raised in order to allow access of air. The desiccators were then placed on the floor in a shaded part of the laboratory and allowed to stand till the clots were quite dry and hard. This required from one to two months, depending on the time of the year, except in the case of the clots in Series E, in which drying was assisted by placing the desiccators about 3 feet in front of the gas fire used during the day for warming the laboratory. These clots, made about Christmas time, were thoroughly dry in less than four weeks. In all cases the calcium chloride became wet and was replaced by fresh twice during the drying. When dry, the clots were still kept in the desiccators over fresh calcium chloride till required. None was used within less than a month from the date of making (as in series E), the majority were at least two months old, and some were of ages varying up to ten months. From one to three clots of each series were used as controls and examined bacteriologically in order to assure ourselves of the thoroughness of infection. In every culture test, whatever the age of the clot, thousands of colonies of anthrax grew on the plates. Professor Delépine's experiments showed that the clots of the various series each contained from 520,000 to 19,200,000 spores, and that they were acutely fatal to animals. When clots had been kept for long periods, tests of each individual clot were made by separating a few fibres of bloodstained wool and making cultures from them. Age did not appear to lessen the infectivity appreciably. Bacteriological examinations were also made of samples of the fresh clotted blood after it had been infected, but before drying of the clots had begun. It was in all cases highly infected. For some clots Persian wool was used, for others mohair, but there was no observable difference in the difficulty of disinfection. In all bloodclots the spores used for infection were obtained from pure cultures on agar derived from fatal human cases of anthrax occurring in Bradford. A litre of blood was usually sufficient to make about 20 bloodclots. As a rule, the clots consisted of a mass of blood from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches thick and deep, firmly cemented to the wool. The following series of bloodcloths were prepared :—

Series A. (Prepared September 1915. Used in experiments from December 17th, 1915, to January 20th, 1916. Two used July 21st, 1916.)—Pieces of wool were prepared of a size convenient for making clots, and were placed on the bottom of a small pail. An emulsion of spores in normal saline was made from several pure cultures on agar of anthrax bacilli derived directly from material obtained from a fatal case of human anthrax. This was well shaken and poured on the wool, which was stirred till every part had become saturated. The pail containing the infected wool was taken to the abattoirs and blood allowed to run into it direct from the throat of a sheep which was being killed, the wool being gently moved the while in order to secure thorough saturation. On return to the laboratory the pieces of wool encased in clotted blood were lifted on to a large dish, rolled up, and then tied tightly with string as one would tie up a parcel. After drying, these clots formed hard masses of wool cemented by dried clotted blood. In their characteristics and in their behaviour during treatment in the experiments they closely resembled the clots most commonly found in wool, *i.e.*, they consisted of a comparatively large quantity of wool the fibres of which were glued together by dry blood. Before use the string was cut and removed, and, probably because of the large proportion of wool as compared with blood, it was found that their disintegration was not especially difficult.

Series B. (Made in January 1916. Used in experiments from March 17th to May 2nd, 1916.)—Were made by the same method, and were closely similar to clots of Series A.

Series C. (Made May 22nd, 1916. Used in experiments from June 20th to July 25th, 1916.)—An emulsion of spores, from pure cultures of anthrax bacilli grown on agar from material obtained from a fatal case of human anthrax, in a 50 c.c. of a 10 per cent. solution of sodium citrate, was placed in a flask and taken to the abattoir, where about a litre of blood from the throat of a healthy sheep was allowed to run into it. The flask was gently shaken as the blood was running into it in order to secure thorough mixing. The presence of a soluble citrate prevents the blood from clotting, and the still fluid blood was taken to the laboratory, poured into a flat dish, and pieces of wool soaked in it, rolled up, and tied as in Series A and B.

The bloodclots of Series C were made with the object of imitating those bloodclots found in wool which are formed by the escape of blood which has lost the property of clotting. When ready for use they consisted of dry blood which had not clotted, as distinguished from clots of Series A and B which consisted of dry clotted blood. They were more readily softened and disintegrated than clots made from natural healthy blood, a fact which Professor Delépine also commented on. Though the use of citrated clots in the experiments gave valuable proof of the power of the method of disinfection to destroy anthrax once the spores were exposed to the action of the disinfectant, definite conclusions could not be drawn from the results as to the efficiency of the method for securing the exposure of the spores because of the ease with which blood in the clots could be made to pass into solution.

Series D. (Made July 18th, 1916. Used in experiments from September 19th to December 15th, 1916.)—An emulsion of anthrax spores, grown on agar from material obtained from a fatal case of human anthrax, was placed in a wide-mouthed glass flask. A piece of wool of the size necessary to make a bloodclot was placed in each of a number of the paper vessels in which cream is frequently sold. The wool was carefully pressed down so that the middle portion of the fibres rested on the bottom of the vessels, and was so arranged as to pad the sides. The two ends of the lock of wool projecting from the top were turned over and held in position by an elastic band round the vessel. These, and the flask containing the spore emulsion, were taken to the abattoir, and blood from the throat of a healthy sheep run direct into the flask while it was gently shaken with a rotary motion in order to secure thorough mixing. The blood thus infected was then quickly poured on to the wool in the vessels. By this method it was found possible to make about 10 to 12 clots from half a litre of blood before clotting in the flask occurred. After the blood on the wool had clotted firmly (the clots in the vessels were allowed to stand $1\frac{1}{2}$ to 2 hours), the clots were removed and dried in the usual way.

This method of making the clots had advantages, but there were also disadvantages. There was no means of checking the quantity of blood poured into the vessel containing wool, so that some of the clots made were very large. A most important point was that the blood in every clot found some positions where there was very little wool, and, after it had dried, formed at these points a hard horny mass penetrated by comparatively few fibres of wool. In this respect they differed from natural clots in which the blood is usually penetrated by so great a number of fibres as to make them comparatively porous, and therefore correspondingly more easy to attack. The bloodclots of Series D proved difficult to disinfect, and experiments made for the purpose of comparing their behaviour with that of natural Persian and mohair clots showed that the latter are distinctly more easy to break up and disinfect.

Series E. (Made December 5th, 1916. Used in experiments from January 16th to March 16th, 1917.)—From certain points of view it is desirable to use clots prepared from wool infected with anthrax spores (preferably by spores contained in organic matter) before blood is allowed to clot upon it. In Series E, therefore, several varieties of clots were made. The general method of preparation was the same as in Series D, but in Series E 1 the wool in the vessels was saturated with spore emulsion and allowed to dry before having uninfected blood run on to it direct from the throat of a healthy sheep. Bloodclots of Series E 2 were exactly similar to those of E 1, except that, instead of uninfected healthy blood direct from the sheep's throat, blood infected as in Series D was used. Bloodclots of Series E 3 were prepared exactly in the same way as those of Series D. In the preparation of clots of Series E 4 the wool in the vessels was first saturated with infected blood serum, obtained during the preparation of bloodclots of Series E 2, and subsequently fresh clots of blood infected as in Series D were pressed into the wool till the fibres were completely surrounded. In order to hasten the drying of the bloodclots of Series E, the desiccators containing them were placed about 3 feet from a gas fire used intermittently, but frequently for long periods during the day, for warming the laboratory. They certainly became hard and dry more quickly than other clots, but, because of the high temperature to which they were raised in this method of drying, they were far more refractory than any clots, whether artificial or natural, examined in the course of the inquiry. Apart from the large size of some of them, they were all abnormally difficult to break up in the disinfecting process. After passing through it, a remnant or several remnants of blood which it was impossible to tease out in the ordinary way almost always remained, and they varied in thickness from one-eighth to half an inch. Professor Delépine has informed us that he prepared bloodclots by a method somewhat similar, and found the same difficulty. He therefore made experiments with clots dried at various temperatures, and found that the effect of heat was to render the clot quite insoluble (*see* his report). With this added testimony it appears to be beyond doubt that the peculiar refractoriness of the various varieties of the E series of clots was due to overheating. In many cases part of the clot was found to be refractory, while the remainder behaved as usual. In consequence of the method of arrangement in the desiccators some parts of the clot were protected by wool or other clots from the direct action of the fire, and no doubt these parts were more soluble than those parts exposed to direct heat. There was no observable difference in the behaviour during disinfection of the different varieties of clots in Series E nor in the results obtained. Bloodclots of the E series were very highly infected, and contained from 6,000,000 spores per clot in Series E 3 (blood only infected) to 20,000,000 spores per clot in Series E 1 (wool only infected). Since in Series E 2 and E 4 both wool and blood were infected to the same extent, and from the same sources as the wool and blood in E 1 and E 3, respectively, the spores in clots of these two sub-series must each have contained more than 20,000,000 spores.

Series F. (Made March 6th, 1917. Used in experiments from April 13th to April 17th, 1917.)—These were prepared in two varieties, clots of Series F 1 being exactly similar to those of Series D and E 3, and clots of Series F 2 being exactly similar to those of Series E 4. In behaviour they very closely resembled those of Series D.

Series G. (Made July 18th, 1916. Used October 3rd, 1916.)—This consisted of one clot only, which was made from the blood of a beast which had been killed in the Bradford Abattoir. It was apparently healthy when killed, but after death the state of certain organs caused anthrax to be suspected. A small quantity of blood was therefore sent to Dr. Eurich's laboratory for examination, and anthrax bacilli were found to be present in quantity. The blood was clotted to some extent when received (about an hour after the animal was killed) and was pressed into wool. When dried, the clot was somewhat different from the artificial clots prepared from healthy blood. A small portion of the dried clot was teased out for control purposes, and it was noticeable that the blood dissolved very much more readily than dried clotted healthy blood. It, in fact, behaved much in the same manner as the citrated blood of the clots of Series C. It was unfortunately not found possible to obtain more of this naturally infected blood.

Summing up the characteristics of the various series of artificial bloodclots as revealed by the experiments, it was found that—

Bloodclots of Series A and B consisted of a comparatively large amount of wool with correspondingly less blood, and it was comparatively easy to remove the protection afforded by the blood to the spores. They appeared to behave very much in the same way as and to be about as difficult as natural uninfected clots.

Those of Series C, made from citrated blood, also consisted of a comparatively large amount of wool, the blood was more soluble than healthy blood, and it was comparatively easy to remove the protection of the spores. They resembled natural infected clots, but were, generally speaking, easier to disinfect than any others of the bloodclots used in the experiments, and the blood could be removed from the wool more readily than from natural clots free from anthrax spores.

Bloodclots of Series D consisted of a comparatively large quantity of blood with proportionately less wool. Portions of the blood were in thick masses not penetrated by much wool, and it was difficult to remove the protection afforded to the spores, since the blood had to be wholly dissolved, and the absence of lines of penetration along wool fibres made this difficult. These clots were, generally speaking, more refractory than natural clots free from anthrax spores.

Clots of Series E were of the same type as those of Series D, but were much more horny, the blood was in larger masses with less wool fibres running through it, and they were by far the most refractory of all the bloodclots with which experiments were made. Comparative experiments with natural uninfected clots showed that it was much less difficult to remove the protection which would be given by blood in these to anthrax spores than that afforded by the blood in bloodclots of Series E. Their refractory nature was due to the method of drying them partly by radiant heat from a fire.

Bloodclots of Series F were of the same type as, and were prepared in exactly the same way as, those of Series E, except that they were not dried before the fire. The object of their preparation was to afford additional evidence of the suspicion that the clots of Series E were abnormal. In behaviour they closely resembled clots of Series D, and in some experiments they were treated together with large natural uninfected clots, the latter proving the easier to break up. Clots of Series F were much less difficult to disintegrate than those of Series E, and their behaviour strongly supported the conclusion previously arrived at that the latter were abnormal, and that the abnormality was caused by the method of drying.

Series H.—In order to obtain comparable data as to the properties of bloodclots found in the wool of commerce, a number of natural bloodclots was obtained. A few were bloodclots from alpaca, mohair, and Persian wool sent to the laboratory of the Anthrax Investigation Board for bacteriological examination, but the majority were specially selected for our use, on account of their size, from those removed by sorters from Persian wool. They were all examined bacteriologically, but very few (4 out of 125) proved to be infected. Some of them were very large, but really consisted of many moderate-sized bloodclots joined together by wool sometimes bloodstained and sometimes not. Only very rarely were they as thick as the artificial clots used. Usually the blood was spread on the wool, which was generally in such excess that the clots were more or less porous. Earthy substances and excrement were also frequently mixed with the blood. Very few of the natural clots were as refractory as those of Series D and F. None was as refractory as those of Series E.

8. CONTROL OF DISINFECTING SOLUTIONS.

In order that the results of experiments in chemical disinfection may be strictly comparable, the strength and temperature of the solutions used must be accurately known. In our experiments the temperature of the solutions was raised to the required point by immersing the baths, within about 2 inches of the top, in the large outer tanks containing a relatively large volume of water raised to a temperature about 2 degrees above that required. Thermometer readings were taken at the beginning and in the course of each experiment. The variations observed when not exceding 1 or 2 degrees, being of no practical importance, were ignored. Wider variations, which were rare, were, of course, checked by adding hot or cold water to that in the outer tanks or, in the case of the drying machine, by reducing or increasing the supply of gas to the burner.

Before use, the strength of the commercial solution of formaldehyde was obtained by accurate analysis. The baths were also roughly calibrated, so that the volume of liquid contained in them could be gauged by measuring its depth. It was then possible to calculate fairly accurately the quantlty of commercial formaldehyde solution, or of water required to bring the contents of the disinfecting bath to any desired strength. Certain substances in the material to be disinfected destroy the formaldehyde, and the introduction of damp wool which has been squeezed through rollers dilutes the solution by the addition of water equivalent in amount to from 30 to 33 per cent. of the weight of wool placed in the solution. In order, therefore, to ascertain exactly the effective strength of the solution, it was analysed at the end of each experiment, before the commencement of any series of experiments and frequently before the commencement of individual experiments. The following method of analysis, which is sufficiently accurate for dilute solutions, was employed:—Twenty cubic centimetres of the solution were first titrated with standard acid or alkali, using methyl orange as indicator, to ascertain the quantity of any base or acid which, if present, might interfere with the estimation of the formaldehyde. The disinfecting solution and the original formaldehyde solution were always very faintly alkaline. Sixteen to 17 grammes of the solution were then weighed out into a small wide-mouthed glass flask provided with a closely fitting rubber stopper. To this was added 1 gramme of solid ammonium chloride and, after it had dissolved, 8 c.c. of double normal caustic soda solution from a burette. The flask was then closed by means of the rubber stopper. After standing a short time and cooling in a stream of water, about 50 c.c. of distilled water were added, and the whole titrated with a normal solution of sulphuric acid, using methyl orange as an indicator. The ammonia liberated from the ammonium chloride on addition of caustic soda combines with formaldehyde to produce hexamethylene tetramine, which is a monacid base. The quantity of this, together with the excess of ammonia, is found by titration with normal acid, and from this the formaldehyde originally present is calculated.

9. EXPERIMENTS AND THEIR RESULTS.

In this section details of the experiments are described, and the results obtained are given. The experiments are grouped in accordance with the general method employed. Important variations of detail in any group of experiments are indicated by divisions in the tables given at the beginning of the description of each group.

Experiments of Group 1.

Table 1.

Process:—(1) Direct immersion in cold formaldehyde solution.

(2) Process stopped by placing clots in ammonia solution immediately on removal from formaldehyde bath.

No. of Experiment.	Bloodclots used.			Treatment in Formaldehyde Solution.			Time elapsing after removal from Formaldehyde Solution before Clot placed in Ammonia Solution.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clot. ∞ = Uncountable.		Time elapsing before Growth of Anthrax on Culture Plates observed.
	Series.	Nature.	Arrangement.	Strength (per Cent. by Weight of CH_2O).	Temperature. ° F.	Time. Mins.		Anthrax.	All other Organisms.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1	A	Half clots, not citrated.	Among wool in nets.	2·47	Room	60	0	∞	∞	12
2	A	"	"	2·47	"	120	0	∞	∞	12
3	A	"	"	2·47	"	180	0	∞	∞	12
4	A	"	"	2·47	"	240	0	∞	∞	24

Objects.—The objects of the experiments in Group 1 were to ascertain (*a*) how far the statement that formaldehyde cannot cause destruction of anthrax spores in bloodclots is correct, and (*b*) whether disinfection can take place without first opening the fleeces.

Treatment of Test Material.—In this group bloodclots of Series A were used. In each experiment half a clot was embedded in the centre of mohair contained in a net (one of those usually sold as onion nets) which, with a quantity of wool to be used as damage test material, was immersed in the solution of formaldehyde contained in the baths of the apparatus described in a previous section. The disinfecting solution used contained $2\frac{1}{2}$ per cent. by weight of formaldehyde, and the temperature was that of the air.

The time of exposure of the test material varied from one to four hours. At the end of the predetermined periods the clots were removed from the bath, and the formaldehyde remaining in them destroyed by the addition of a dilute solution of ammonia. Cultures were made from the treated clots the same day.

Results.—In every instance an uncountable number of colonies of anthrax bacilli and also of other organisms grew on each plate. The only difference in the four experiments was that growth of anthrax was apparently a little delayed in that in which infected test materials had been exposed to the action of the disinfecting solution for four hours, though this may have been accidental. However this may be, this group of experiments affords conclusive proof that disinfection in any practicable time by direct action of formaldehyde on bloodclots containing anthrax spores is impossible. It will be observed, however, that no experiments were carried out in which the temperature of the solution was raised above that of the air. Experiments to be described later bear on this point and indicate the correctness of the conclusion drawn, whatever the temperature of the formaldehyde solution may be.

Experiments of Group 2.

Table 2.

Process:—(1) Immersion in warm water.

(2) Immersion in cold formaldehyde solution.

(3) Process stopped by placing clot in ammonia solution immediately on removal from formaldehyde bath.

Number of Experiment.	Bloodclots used.			Treatment in Water.		Treatment in Formaldehyde Solution.			Time elapsing after removal of Clot from Formaldehyde Solution before placing in Ammonia Solution.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clot. ∞ = Uncountable.		Time elapsing before Growth of Anthrax on Culture Plates observed.
	Series.	Nature.	Arrangement.	Temperature. ° F.	Time. Mins.	Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. ° F.	Time. Mins.	Hours.	Anthrax.	All other Organisms.	Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
5	A	Half clot, not citrated.	Among wool in nets.	110	25	2·47	Room	60	0	∞	∞	24
6	A	,,	,,	110	25	2·47	,,	120	0	∞	∞	24
7	A	,,	,,	110	25	2·47	,,	180	0	Many	∞	24
8	A	,,	,,	110	25	2·47	,,	240	0	0	?	—
9	A	,,	,,	110–109	30	2·85	,,	240	0	0	?	—
10	A	,,	,,	,,	30	2·85	,,	300	0	0	?	—
11	A	,,	,,	,,	30	2·85	,,	360	0	0	?	—
12	A	Whole clot, not citrated.	,,	110–108	30	2·62	,,	240	0	1	∞	72
13	A	,,	,,	,,	30	2·62	,,	300	0	0	∞	—
14	A	,,	,,	,,	30	2·62	,,	360	0	1	∞	72
15	A	Half clot, not citrated.	,,	110–106	60	2·85	,,	120	0	0	0	—
16	A	,,	,,	,,	60	2·85	,,	180	0	0	0	—
17	A	,,	,,	,,	60	2·85	,,	240	0	0	0	—
18	A	,,	,,	,,	60	2·85	,,	300	0	0	0	—
19	A	Whole clot, not citrated.	,,	,,	60	2·62	,,	120	0	24	∞	72
20	A	,,	,,	,,	60	2·62	,,	180	0	42	∞	72
21	A	,,	,,	,,	60	2·62	,,	240	0	5	∞	72
22	A	,,	,,	,,	60	2·62	,,	300	0	0	∞	—
23	B	,,	,,	103–100	120	3·10	,,	60	0	∞	∞	
24	A	,,	,,	102	120	2·52	,,	120	0	0	10	24
25	B	,,	,,	103–100	120	3·10	,,	120	0	0	∞	—
26	B	,,	,,	,,	120	2·72	,,	120	0	0	∞	—
27	A	,,	,,	102	120	2·52	,,	180	0	0	0	—
28	B	,,	,,	103–100	120	3·10	,,	180	0	12	∞	—
29	B	,,	,,	,,	120	2·72	,,	180	0	0	300	72
30	A	,,	,,	102	120	2·52	,,	240	0	0	0	—
31	B	,,	,,	103–100	120	3·10	,,	240	0	0	∞	—
32	B	,,	,,	,,	120	2·72	,,	240	0	0	0	—
33	A	,,	,,	102	120	2·52	,,	300	0	0	65	—
34	B	,,	,,	103–100	120	3·10	,,	300	0	0	29	—

Objects.—Having satisfied ourselves of the impossibility of securing in a reasonable time by the direct action of formaldehyde the destruction of anthrax spores protected by blood, it was decided to seek a method which would render the spores more susceptible of attack. Three reasons might conjecturally be given for this failure: (*a*) dry spores existing in dried blood may be unaffected by formaldehyde; (*b*) the dried albumen surrounding the spores may be impenetrable by formaldehyde; (*c*) the action of formaldehyde may be excessively slow. Knowledge of the mechanism by which anthrax spores are destroyed would have been of great service at this point. The only reference to this, we have noted, is a statement by Dr. Rudolph Lessing* that they are killed by the hardening effect of formaldehyde upon the envelope of

* Thorpe's Dictionary of Applied Chemistry, p. 596.

the spores. The evidence on which this statement is based is, however, not given. Rough experiments showed that dried blood can be softened (*i.e.*, gelatinised) and dissolved to a greater or less extent, and with greater or less difficulty by dilute solutions of several chemical substances, *e.g.*, by caustic alkali, ammonia, sodium carbonate, hydrochloric, acetic or formic acids. Generally speaking, however, these either tend to cause damage to wool or destroy formaldehyde, or are expensive. Of those tried, sodium carbonate (washing soda) gave good results, and this substance is frequently used in the wool trade for scouring raw wool. Opinions vary as to its effect on wool fibre. Some combers state that it causes a certain amount of deterioration which others deny. It is, however, well known that anthrax bacilli are much more readily killed than spores. Arguing from this fact, we thought it possible that, if blood containing spores be placed for a period in conditions of moisture and warmth suitable for growth into bacilli, before being brought into contact with formaldehyde, a state of incipient growth might be induced in the spores, and this, aided by the softening and partial solution of the bloodclots, might shorten the time required for disinfection. The experiments of Group 2 were designed (*a*) to ascertain the correctness of this conjecture; (*b*) to indicate whether disinfection of fleeces is possible, and (*c*) to ascertain the effect on the material.

Treatment of Test Material.—The bloodclots used were those of Series A and B. In some experiments half clots, and in others whole clots, were treated. They were placed in the centre of wool contained in nets which, together with the damage test material, were gently agitated in water at temperatures approximating to either 102° F. or 110° F. After the predetermined exposure, the nets of material were taken out, the excess liquid removed by draining and gentle pressure, and they were then immersed in a cold solution of formaldehyde of a strength of 2½ to 3 per cent. After exposure for the arranged period the clots were taken out and placed in 60 c.c. of a 2 per cent. solution of ammonia contained in sterilised bottles. Cultures were made the same day. The damage test material was treated in exactly the same manner as the infected test material, except that instead of being placed in ammonia at the end of the experiment it was rinsed in clean water and dried.

Results.—These are contained in Table 2, which is divided into three sections, according to the period occupied by the preliminary treatment. In the first section this occupied half an hour, and the exposure to formaldehyde from one to six hours. Where half clots were used as the infected test material, anthrax spores survived in great quantity after exposure to the disinfecting solution for three hours, but were completely destroyed in four hours and upwards. Where whole clots were used, some spores were still alive after six hours, and the abundant growth of other organisms on the culture plates showed the disinfection to be very imperfect.

In the experiments of section 2 of Group 2, the preliminary treatment occupied one, and the disinfection treatment from two to five hours. Where whole clots were used as the infected test material, anthrax spores still survived after four hours' exposure to formaldehyde, and, though anthrax bacilli could not be cultivated from the test material after five hours, the survival of numerous other organisms indicated, as in section 1, that disinfection was certainly not thorough.

In the experiments of section 3 the period of the preliminary treatment was increased to two hours, while that of the disinfection treatment varied from one to five hours. In twelve experiments it was only found possible to cultivate anthrax bacilli twice, once after exposure to formaldehyde of 3·1 per cent. strength for one hour, and once after three hours' exposure to the same solution. The survival of many other organisms again indicated, however, that disinfection was not satisfactory.

The experiments of Group 2, especially when considered in relation to the progressive increase in the time occupied by the preliminary treatment, showed that the preliminary treatment of infected bloodclots in water at a temperature of 102–110° F. has unquestionably considerable influence in enabling formaldehyde to cause destruction of anthrax spores embedded in blood. We took no steps to ascertain the exact reason for this result, but it was undoubtedly in large part due to partial solution and gelatinising of the blood. It is one of tempting problems referred to previously, which we reluctantly felt compelled to leave unsolved. The time required to ensure disinfection by any method based on these experiments would, however, be not less than six hours (*i.e.*, a preliminary treatment of two hours, followed by disinfection treatment for four hours), which is too long to be practicable. It would also appear, from consideration of the results in section 3 of the Group 2 experiments, that the preliminary treatment is a factor in disinfection of greater importance than either an increase in the strength of or an increase in the time of exposure to formaldehyde solution, though presumably there are limits of strength and of time of exposure below which disinfection will not take place.

The damage test material treated together with the infected test material was carefully examined by experts, who reported that there was no obvious deterioration even when the preliminary immersion in warm water for two hours was followed by agitation in a cold 3 per cent. solution of formaldehyde for five hours.

Experiments of Group 3.

Table 3.

Process:—(1) Immersion in warm water.
(2) Immersion in cold formaldehyde solution.
(3) Removal of excess formaldehyde solution by whirling in a hydro extractor.
(4) Drying in current of hot air.
(5) Process stopped by placing clots in ammonia solution immediately after drying.

No. of Experiment.	Bloodclots used. Series.	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Water. Temperature. °F.	Treatment in Water. Time. Mins.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Treatment in Formaldehyde Solution. Temperature. °F.	Treatment in Formaldehyde Solution. Time. Mins.	Drying in Current of Hot Air. Arrangement of Clots in Drying Machine.	Drying in Current of Hot Air. Temperature. °F	Drying in Current of Hot Air. Time. Mins.	Time elapsing after drying before Clots placed in Ammonia Solution. Hours.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable. Anthrax.	Number of Colonies … All other Organisms.	Time elapsing before Growth of Anthrax on Culture Plates observed. Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11,	(12)	(13)	(14)	(15)	(16)
35	B	Not citrated.	Among wool in nets.	103–102	60	2·72	Room	30	Among wool in nets.	220	210	0	0	12	—
36	B	"	"	"	60	2·72	"	60	"	220	210	0	0	0	—
37	B	"	"	"	60	2·72	"	90	"	220	210	0	0	0	—
38	B	"	"	103–102	30	1·36	"	15	Loose among wool.	220	30	0	∞	∞	12
39	B	"	"	103	30	1·36	"	30	"	220	30	0	∞	∞	12
40	B	"	"	103	30	1·36	"	60	"	220	30	0	∞	∞	12
41	B	"	"	102	60	1·36	"	15	"	220	30	0	∞	∞	12
42	B	"	"	102	60	1·36	"	30	"	220	30	0	∞	∞	12
43	B	"	"	102	60	1·36	"	60	"	220	30	0	∞	∞	12

Objects.—The objects aimed at in the experiments of Group 3 were (*a*) to ascertain if disinfection by the general method of Group 2 experiments could be hastened by drying the wool without removing the formaldehyde, (*b*) to obtain an indication of the effect on the material, (*c*) to ascertain if formaldehyde solution of reduced strength be capable of causing disinfection, (*d*) to ascertain if fleeces can be disinfected without opening.

Treatment of Test Material.—Bloodclots of Series B were placed in the centre of wool contained in nets which were then agitated in water, together with damage test material, at a temperature of 102° F. (approximately). On removal the nets and their contents were drained and pressed gently in order to free them from excess of liquid. This was followed by immersion in cold formaldehyde solution. After removal, excess of liquid was removed by means of a hydro-extractor, and the material was then dried in a current of air at a temperature of 220° F.

Results.—The experiments of Group 3 are divided into three sections, in the first of which (Experiments 35–37) the infected test material was contained among wool in nets, and the strength of the formaldehyde solution was 2·7 per cent. It was at once evident that disinfection of unopened fleeces by the method employed is impracticable if only on account of the difficulty of drying wet fleeces. The nets of wool with the clots in the centre were hung in a current of air at a temperature of 220° F. for three and a half hours, but the material was then still quite wet, except on the outside. The nets of material were intended to represent infected test material in the centre of the fleeces, but each was very much smaller than an ordinary fleece. The results of experiments of Group 3 showed conclusively that it is almost, if not quite, impossible to dry them in this state. It is certainly impossible to dry unopened fleeces in any reasonable time. At the end of the period stated, the infected test material was taken out of the nets and placed in a solution of ammonia. In two of the experiments in which the exposure in the disinfecting bath was for one and one and a half hours' respectively, the clots were quite sterile after treatment, and in the third, where the exposure was for half an hour only, no anthrax spores and very few other organisms survived. The results appeared to indicate that drying of material saturated with formaldehyde solution might be a valuable aid to disinfection. It must, however, be remembered in considering these experiments that the action of the formaldehyde continued during the impracticably long period in which it was attempted unsuccessfully to dry the material.

In the remaining two sections the exposure to formaldehyde solution varied from one quarter up to one hour, and the period occupied by the preliminary treatment was half and one hour, respectively. Before drying, the damage test material and the infected test material were removed from the nets, and were placed loosely on the bottom of the perforated cylinders, in the drying machine. The materials were dry in half an hour at the temperature employed (220° F.). The strength of the formaldehyde solution was, however, only 1·3 per cent., and an uncountable number of colonies of anthrax bacilli survived the treatment in each of the experiments. This result appeared to indicate that the strength had been reduced below that which is capable of causing disinfection in a reasonable time.

Deterioration could be observed in the damage test material used in the experiments of section 1 of this group, though it was not very serious. White mohair showed distinct evidence of scorching, probably due to the long drying at a high temperature. No deterioration was observed in the remaining six experiments (sections 2 and 3).

Experiments of Group 4.

Table 4.

Process :—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in cold formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in current of hot air.
(6) Process stopped by placing clots in ammonia solution immediately after drying.

No. of Experiment.	Bloodclots used. Series.*	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Water. Temperature. ° F.	Treatment in Water. Time. Mins.	Treatment in Water. Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CHO)	Treatment in Formaldehyde Solution. Temperature. ° F.	Treatment in Formaldehyde Solution. Time. Mins.	Treatment in Formaldehyde Solution. Times squeezed through Rollers.	Drying in Current of Hot Air. Arrangement of Clots in Drying Machine.	Drying in Current of Hot Air. Temperature. ° F.	Drying in Current of Hot Air. Time. Mins.	Time elapsing after drying before Clots put in Ammonia Solution. Hours.	Number of Colonies growing on Agar at 37°C. from $\frac{1}{10}$th of Material from treated Clot. ∞ = Uncountable. Anthrax.	Number of Colonies … All other Organisms.	Time elapsing before Growth of Anthrax on Agar observed. Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
44	B	Not citrated.	Among wool in nets.	101	30	Once	2·59	Room	30	Once	Loose among wool.	206	30	0	0	137	—
45	B	,,	,,	101	30	,,	2·59	,,	60	,,	,,	180	30	0	1	∞	18
46	B	,,	,,	101	30	,,	2·59	,,	90	,,	,,	220	30	0	0	110	—
47	B	,,	,,	102	60	,,	2·59	,,	45	,,	,,	180	30	0	0	27	—
48	B	,,	,,	102	60	,,	2·59	,,	60	,,	,,	190	30	0	0	14	—
49	B	,,	,,	102	60	,,	2·59	,,	90	,,	,,	220	30	0	0	0	—

Objects.—The purposes of the experiments of group 4 were (1) to make clear the indications of the value of drying as an aid to disinfection afforded by those of Group 3; (2) to ascertain whether passing the material through rollers would aid the disinfecting process.

Treatment of Test Material.—The infected test material used consisted of whole bloodclots of series B, which were placed in the centre of wool (damage test material) contained in nets. The whole was then submitted to a preliminary treatment in water, at a temperature of 102° F. (approximately) for one half or one hour, and was then passed bodily through squeezing rollers. This was followed by exposure to the action of cold formaldehyde solution (2½ per cent.) for from half to one and a half hours, when the material in the nets was again passed bodily through the second set of squeezing rollers. The test material was then removed from the nets, placed loose in the cylinders of the drying machine, and dried for half an hour in a current of air at a temperature varying in different experiments from 180° F. to 220° F. Immediately after drying, the infected test material was placed in ammonia solution. Damage test material was treated in exactly the same way, except that no ammonia was added to it after drying.

Results.—The six experiments of Group 4 are divided in Table 4 into two sections, in the first of which the preliminary treatment occupied half an hour and in the second, one hour. The most important result is to show that drying in a current of air for half an hour of material damp with formaldehyde solution of a strength of 2½ per cent. is a valuable aid to disinfection, and one which enables the process to be shortened. In the six experiments it was only found possible to cultivate anthrax bacilli from the treated material once, and in that case the cultivation was very scanty (one colony only). The value and importance of the preliminary treatment is again emphasised. Anthrax spores in infected test material submitted to the action of warm water for half an hour were not completely destroyed by exposure to the disinfectant solution for 60 minutes, while the number of other organisms surviving in this experiment (45) was very large. With the same preliminary treatment, however, anthrax spores were completely destroyed in other experiments where the exposure to the formaldehyde solution was for half an hour and one and a half hours respectively. In the three experiments where the preliminary treatment was increased to one hour it was not found possible in any experiment to cultivate anthrax bacilli from the infected test material after treatment, while the growth of other organisms was comparatively scanty.

The beneficial effect of passing the test material through squeezing rollers was very evident, though the result so far as disinfection is concerned was imponderable at this stage. The bloodclots were, however, freed from blood to a considerably greater extent, in spite of being surrounded by close-packed wool, and the remnants of the clot were broken up much better than in former experiments.

The damage test material treated in experiments of Group 4 had suffered no apparent deterioration.

Experiments of Group 5.

Table. 5.

Process:—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in cold formaldehyde solution.
(4) Squeezing through rollers.
(5) Heating to 150° F.
(6) Drying in current of hot air.
(7) Process stopped by placing clots in ammonia solution immediately after drying.

No. of Experiment.	Bloodclots used. Series.	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Water. Temperature. ° F.	Treatment in Water. Time. Mins	Treatment in Water. Time squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Treatment in Formaldehyde Solution. Temperature. ° F.	Treatment in Formaldehyde Solution. Time. Mins.	Treatment in Formaldehyde Solution. Times squeezed through Rollers.	Heating (among Wool in Nets suspended in Heated Chamber). Temperature. ° F.	Heating (among Wool in Nets suspended in Heated Chamber). Time. Mins.	Drying in Hot Air. Arrangement in Drying Machine.	Drying in Hot Air. Temperature. ° F.	Drying in Hot Air. Time. Mins.	Time elapsing after drying before Clot placed in Ammonia Solution. Hrs.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$ of Material from treated Clots. ∞ = Uncountable. Anthrax.	Number of Colonies … All other Organisms.	Time elapsing before Growth of Anthrax on Agar observed. Hrs.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)
50	B	Not citrated.	Among wool in nets.	102	30	Twice	2·38	Room	15	Once	144	15	Loose among wool on grid.	200	15	0	7	∞	48
51	B	„	„	102	30	„	2·38	„	30	„	148	15	„	198	15	0	1	∞	48
52	B	„	„	102	30	„	2·38	„	60	„	168	15	„	220	15	0	0	212	

Objects.—Previous experiments having shown the value of drying as an aid to disinfection, it was thought that the process might be shortened by raising the damp wool to, and maintaining it at, a moderately high temperature for a short period before drying in a current of air, which, of course, causes fairly rapid loss of formaldehyde. The object of the experiments of Group 5 was to test this suggestion.

Treatment of Test Material.—Bloodclots of series B were used as the infected test material, and their treatment was exactly the same as in the experiments of Group 4, except that the nets of material were suspended in a heated chamber for quarter of an hour before being dried. The preliminary treatment consisted of steeping for half an hour in water at a temperature of 102° F., the test material in the nets being passed whole through squeezing rollers at the middle and end of this period. This was followed by exposure to cold formaldehyde solution (of somewhat less than 2½ per cent. strength) for periods, in different experiments, of one quarter, one half and one hour respectively. The material still in the nets was then passed again through squeezing rollers, and suspended in a chamber heated to a temperature 144–160° F. for 15 minutes. The test material was then removed from the nets, placed with the damage test material loose in the cylinders of the drying machine, and dried in a current of air heated to a temperature of 200–220° F. This occupied 15 minutes, after which the infected test material was placed in a solution of ammonia.

Results.—It was seen at once that mere heating of damp materials in a condition of rest is valueless as an aid to disinfection, owing to the fact that wool is an exceedingly bad conductor of heat. The material in the centre of the nets was quite cold after heating for 15 minutes at a temperature of 150° F. In experiments made for the purpose of testing the effect of heating it was found that when a mass of mohair damp with a solution of formaldehyde is heated when at rest, it requires several hours to raise the temperature at the centre of the mass to 150° F., even when it is only loosely packed. Apart from this, in the first two experiments anthrax spores still survived after a preliminary treatment of half an hour, followed by exposure to formaldehyde solution for either one quarter or half an hour, but it was not possible to cultivate anthrax bacilli from test material where the exposure to formaldehyde had been extended to one hour. The number of other organisms which escaped destruction was, however, considerable.

At this stage it appears desirable to review the results obtained. In a total of 52 experiments carried out up to this point anthrax spores in the infected test material had been apparently destroyed completely in 29. Of the 23 experiments in which the spores survived, the treatment of the bloodclots in four was by means of the direct action of formaldehyde solution without preliminary treatment, and in six the strength of the formaldehyde solution (1·36 per cent.) was apparently below the limits at which destruction of anthrax spores can be ensured in reasonable time. In these ten experiments the growth of anthrax bacilli on the culture plates was very large. Of the remaining 13 unsuccessful experiments, ten did not and three did include, as part of the process, drying without previous removal of formaldehyde from the material. In the three experiments which included drying the cultivations of anthrax bacilli were comparatively scanty, while the preliminary treatment and the exposures to the disinfectant were comparatively short. Generally speaking, long exposures gave more certain disinfection than short ones, but throughout the whole series of experiments scanty survivals of anthrax spores appeared to occur without any clear or obvious reason, and an explanation was sought. The only factor which emerged clearly was that where the treatment of clots was comparable those which had resisted disinfection contained a larger remnant of blood. This was found to be true whether survival of anthrax spores or of other organisms was taken as the index of successful disinfection. In other words, it appeared that quite a short exposure to formaldehyde solution of about 2¼ per cent. strength followed by drying is sufficient to destroy anthrax spores provided they are by the preliminary process exposed to or made susceptible to attack; but that if still protected by blood at the end of this stage their destruction is problematical even after long exposures. The conclusion drawn was that it was necessary to concentrate effort on the improvement of the preliminary process in order to ensure the breaking up and removal of blood from the wool. The experiments seemed to indicate that if this be done, not more than 30 minutes exposure to the action of 2¼ per cent. solution of formaldehyde, followed by drying in a current of hot air, is required to kill all anthrax spores. It is clear from these considerations that disinfection of wool in fleeces is impossible by this method, and that it is mere waste of time to consider the possibility of disinfection of wool in bales. A critical stage in our inquiry having been reached, and the results appearing to promise a successful conclusion to the investigation, it was decided to ask Professor Delépine to undertake the work, referred to in section 5, of examining bacteriologically samples of infected test material treated in the subsequent experiments, so that we should have a check on our results.

Experiments of Group 6.

Objects.—Previous experiments had resulted in the evolution of a process of disinfection consisting of three stages: (1) a preliminary treatment for the purpose of removing the protection afforded to the spores by blood, followed by (2) exposure of the material so treated to the action of the disinfecting solution at the ordinary temperature, after which (3) formaldehyde solution remaining in the material is driven off by means of a current of heated air. All three processes appeared to be essential, and one object of the experiments of Group 6 was to show whether the third part of the process (*i.e.*, drying) is really essential when the preliminary process is effective. Another object was to ascertain the effect, on both anthrax spores and wool, of raising the temperature of the formaldehyde solution.

Treatment of Test Material.—The infected test material used consisted of bloodclots of series A and C, and they were placed loose among damage test material in the baths. The use of nets was abandoned at this stage, as it had become quite clear that disinfection of unopened fleeces is impracticable. The preliminary treatment in water at 102° F. occupied 20 to 30 minutes, and the exposure to formaldehyde solution of a strength of 2¼ to 2½ per cent. at a temperature of 102° F., 15 to 60 minutes. The material was passed through rollers half-way through, and at the end of each part of the process, except in Experiments 56–60, in which the use of the rollers was omitted at the middle stage of the treatment with formaldehyde. Immediately after removal from the disinfecting solution any formaldehyde remaining attached to the wool was destroyed by addition of ammonia solution, and the disinfection thus brought to an end without drying the material.

Results.—Professor Delépine having agreed to undertake the work of verifying the bacteriological results, half of each clot treated in five of the eight experiments composing group 6 was sent to him for examination. Neither he nor Dr. Eurich was able to cultivate anthrax bacilli from the disinfected test material, but the number of colonies of other organisms it was found possible to cultivate (up to 12,000 per clot) indicated imperfect disinfection. Professor Delépine also inoculated guinea pigs with sediment from each of the five half clots sent to him. Of the ten animals inoculated (two for each experiment), five either died from or were killed when suffering from anthrax. The inoculation results, as reference to Table 6 will show, prove that anthrax spores survived treatment in three of the

Table 6.

DETAILS OF EXPERIMENTS AND SUB-COMMITTEE'S RESULTS.

No. of Experiment.	Bloodclots used.			Treatment in Water.			Treatment in Formaldehyde Solution.				Time elapsing after last squeezing through Rollers before Clot put in Ammonia Solution.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clot. ∞ = Uncountable.		Time elapsing before Growth of Anthrax on Agar observed.
	Series.	Nature.	Arrangement.	Temperature. °F.	Time. Mins.	Times squeezed through Rollers.	Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. °F.	Time. Mins.	Times squeezed through Rollers.	Hours.	Anthrax.	All other Organisms.	Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
53	A	Not citrated.	Loose among wool in baths.	102	20	Twice	2·25	102	20	Twice	0	0	1	—
54	C	Citrated	,,	102	20	,,	2·25	102	20	,,	0	0	2	—
55	C	,,	,,	102	20	,,	2·22	102	20	,,	0	0	430	—
56	C	,,	,,	102	30	,,	2·67	102	15	Once	0	0	278	—
57	C	,,	,,	102	30	,,	2·35	102	15	,,	0	0	228	—
58	C	,,	,,	102	30	,,	2·67	102	30	,,	0	0	750	—
59	C	,,	,,	102	30	,,	2·35	102	30	,,	0	0	18	—
60	C	,,	,,	102	30	,,	2·67	102	60	,,	0	0	10	—

PROCESS:—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Process stopped by placing clot in ammonia solution immediately after last squeezing through rollers.

eight experiments. As stated before, we, for obvious reasons, attach greater weight to these than to cultural results. Of the unsuccessful experiments, one (of a sub-group of three) included a preliminary treatment of 20 minutes and an exposure to formaldehyde solution of 20 minutes; in one (of a sub-group of two) the preliminary treatment occupied 30 minutes, followed by disinfection treatment of 15 minutes; and the remaining one (in which only one of two animals inoculated contracted anthrax) included a preliminary treatment of 30 minutes and a disinfection treatment of 30 minutes. All the bloodclots comprising the infected test material contained some undisintegrated fragments after treatment. The results appeared to indicate that it would be unsafe to regard disinfection as completed at the end of 30 minutes exposure of the material to the disinfecting solution even when its temperature is raised to 102° F. Apparently, drying is an essential part of the process of disinfection, but the issue is obscured by the question whether improvement of the preliminary process would bring about the solution or removal of all the blood and so enable the exposure to the disinfecting solution to be effective in this or less time.

EXPERIMENTS OF GROUP 7.

Objects.—The experiments of Group 6 indicated that disinfection of bloodclots is not certainly complete at the conclusion of the treatment in the warm disinfecting solution for 30 minutes. There was reason, however, for concluding from the results of these and previous experiments, that if the preliminary process could be made so effective as to ensure the solution of the whole of the blood protecting the spores, then a comparatively short exposure to a $2\frac{1}{2}$ per cent. solution of formaldehyde (this exposure appeared to be about 20 minutes)* would be sufficient to destroy all anthrax spores. The means by which the process evolved can be applied in practice were carefully considered at this stage. The method lends itself to continuous working in which the material would pass automatically through the three stages of (1) preliminary treatment, (2) disinfection treatment, and (3) drying, without any necessity for handling it. If disinfection can be aided by drying, there appears to be no reason (except from the academical point of view of finding the extreme limits of safety) for attempting to secure the destruction of all anthrax spores at the end of the second stage if this be inconvenient or difficult. From the practical point of view, it is urgently necessary to make the process of disinfection as short as possible, while it is clear that wool treated by the process will have to be dried before passing on to processes of manufacture. The reports of the wool experts indicated that there is no obvious deterioration in material treated by the preliminary process, exposed to the formaldehyde solution, and finally dried without first removing the formaldehyde remaining in the damp wool. There appeared to be no disadvantages, therefore, and obvious advantages, in making drying an essential part of the

* *See also* pages 59 and 60 of this report, in which Professor Delépine clearly demonstrates this.

Table 6—continued.

PROFESSOR DELÉPINE'S RESULTS.

No. of Experiment.	Guinea Pigs inoculated. Proportion of Total Material (Sediment) from treated Clot injected.	Guinea Pigs inoculated. Time kept under observation.	Guinea Pigs inoculated. Mode of Death.	Examination of Lesions (+ = Anthrax found; 0 = No Anthrax found; — = No special examination). Macroscopical and Microscopical. Local Lesion	Macroscopical and Microscopical. Spleen	Macroscopical and Microscopical. Blood of Heart.	By Culture. Local Lesion	By Culture. Spleen	By Culture. Blood of Heart.	Result.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{1000}$th part of Sediment from treated Clot. An-thrax.	All other Organisms.
(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)
53	½	56 days	Killed	0	0	0	0	0	0	No anthrax	—	—
	¼	11 „	Died	0	0	0	—	—	—	„	—	—
54	½	5 „	„	+	+	+	—	—	+	Anthrax, general, sub-acute.	—	—
	¼	5 „	„	+	+	+	—	—	+		—	—
55	—	—	—	—	—	—	—	—	—	—	—	—
56	¼	3 days	Died	+	+	+	—	—	+	Anthrax, general, acute.	0	6
	¼	3 „	Dying, killed	+	+	+	—	—	+			
57	—	—	—	—	—	—	—	—	—	—	—	—
58	½	4 days	Died	+	+	+	+	?	+	Anthrax, general, sub-acute.	0	0
	½	76 „	Killed	0	0	0	0	0	0	No anthrax		
59	—	—	—	—	—	—	—	—	—	—	—	—
60	¼	77 days	Killed	0	0	0	0	0	0	No anthrax	0	0
	¼	41 „	Died	0	0	0	0	0	0	„		

process, always remembering that in cases of necessity destruction of anthrax spores can be ensured by lengthening the preliminary treatment or by otherwise making it effective. It was quite clear at this stage of the experiments that the key part of the process is the preliminary treatment, and that just in the degree that this is made effective in removing the protection of blood from the spores, so can the process be shortened and made efficient. In effect, the preliminary process aims at producing optimum conditions for disinfection before the infected material is introduced into the disinfecting solution. The object of the experiments of Group 7 was, therefore, to ascertain if the process evolved—(1) treatment in water at 102° F. for 20–30 minutes with two squeezings through rollers, followed by (2) exposure for 20–30 minutes to formaldehyde solution of 2–2¼ per cent. strength at 102° F. and another squeezing through rollers, and (3) immediate drying in a current of air heated to 160–170° F., occupying 15–20 minutes—can be accepted as an efficient method of disinfection.

Treatment of Test Material.—The infected test material used consisted of bloodclots of Series A, C, and D, which included both the comparatively easily softened clots made from citrated blood and the difficult clots made from infected natural healthy blood. In some experiments they were placed in the centre of damage test material contained in nets, and in others they were placed loose among damage test material in the baths. The preliminary treatment consisted of immersion for either 20 or 30 minutes (in one experiment 10 minutes) in warm water, the material being squeezed through rollers in the middle and at the end of this period. The treatment in formaldehyde solution, the strength of which varied from 0·95 to 2·86 per cent. at 102° F., occupied 15 to 30 minutes in most experiments, but in three, one hour. Drying required from 13 to 35 minutes, but usually was complete in 15–20 minutes at temperatures varying from 157 to 170° F. Immediately on removal from the drying machine the infected test material was placed in a sterilised bottle containing 60 c.c. of a solution of ammonia of a strength of 1 per cent.

Results.—Of the 21 experiments included in Group 7, complete destruction of all anthrax spores was secured in 16, while in five some anthrax spores survived. In one of the unsuccessful experiments the strength of the formaldehyde solution was under 1 per cent., and, as before pointed out, it appears to be necessary to use solutions of higher concentration than this. One experiment in which the infected test material was placed in wool contained in nets proved unsuccessful, though the guinea pigs inoculated with the sediment extracted from the infected test material survived five and nine days, respectively. In a further unsuccessful experiment the preliminary treatment and the exposure to the formaldehyde solution each occupied ten minutes only. This experiment will be again referred to in the section dealing with experiments of Group 8. Of the remaining 18 experiments of Group 7, three included 30 minutes preliminary and 15 minutes disinfecting treatment, and all were successful (animals were inoculated with test material treated in one of these); in four, the preliminary and disinfecting treatments each occupied 30 minutes, all being successful (animals were inoculated with infected test material treated in two of these experiments); in three, the preliminary treatment occupied 30 minutes and the disinfecting treatment 60 minutes, and each was successful, animals being inoculated with test material treated in two; in two, the preliminary treatment occupied 30 minutes and the disinfecting treatment 20 minutes, both

Table 7.

DETAILS OF EXPERIMENTS AND SUB-COMMITTEE'S RESULTS.

No. of Experiment.	Bloodclots used.			Treatment in Water.			Treatment in Formaldehyde Solution.				Drying in Hot Air.			Time elapsing after drying before Clots put in Ammonia Solution.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable.		Time elapsing before Growth of Anthrax on Agar observed.
	Series.	Nature.	Arrangement.	Temperature. ° F.	Time. Mins.	Times squeezed through Rollers.	Strength of Solution (per Cent. by Weight of CH_2O.)	Temperature. ° F.	Time. Mins.	Times squeezed through Rollers.	Arrangement in Drying Machine.	Temperature. ° F.	Time. Mins.	Hrs.	Anthrax.	All other Organisms.	Hrs.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
61	C	Citrated	Among wool in nets.	102	30	Twice	2·86	102	15	Once	Loose among wool on grid.	162	25	0	0	1	—
62	C	"	"	102	30	"	2·78	101	15	"	"	170	15	0	0	∞	—
63	C	"	Loose among wool in baths.	102	30	"	2·67	102	15	"	"	162	15	0	0	17	—
64	C	"	"	102	30	"	2·35	102	15	"	"	165	20	0	0	6	—
65	C	"	Among wool in nets.	102	30	"	2·86	102	30	"	"	164	25	0	0	0	—
66	C	"	"	102	30	"	2·78	101	30	"	"	170	15	0	0	96	—
67	C	"	Loose among wool in baths.	102	30	"	2·67	102	30	"	"	162	20	0	0	11	—
68	C	"	"	102	30	"	2·35	102	30	"	"	165	15	0	0	11	—
69	C	"	Among wool in nets.	102	30	"	2·86	102	60	"	"	164	35	0	0	3	—
70	C	"	"	102	30	"	2·78	101	60	"	"	165	15	0	0	27	—
71	C	"	Loose among wool in baths.	102	30	"	2·67	102	60	"	"	170	15	0	0	3	—
72	D	Very thick; not citrated.	"	102	30	"	2·09	102	20	Twice	"	160	15	0	0	14	—
73	D	"	"	102	30	"	1·94	102	20	"	"	170	20	0	—	—	—
74	D	"	"	102	30	"	0·95	102	20	"	"	164	20	0	0	124	—
75	C	Citrated	"	102	20	"	2·25	102	20	"	"	165	17	0	0	15	—
76	C	"	"	102	20	"	2·22	102	20	"	"	157	15	0	0	37	—
77	A	Old clot; not citrated.	"	102	20	"	2·25	102	20	"	"	165	18	0	0	4	—
78	D	Very thick; not citrated.	"	102	20	"	2·09	102	20	"	"	165	15	0	13	1,200	15
79	D	"	"	102	20	"	2·48	102	20	"	"	164	20	0	0	75	—
80	D	"	"	102	20	"	2·48	102	20	"	"	165	22	0	—	—	—
81	D	"	"	102	10	"	2·09	102	10	"	"	164	15	0	∞	∞	15

PROCESS:—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in a current of hot air.
(6) Process stopped by placing clots in ammonia solution immediately after drying.

Table 7—continued.

PROFESSOR DELÉPINE'S RESULTS.

No. of Experiment.	Guinea Pigs inoculated.			Examination of Lesions. + = Anthrax found; 0 = No Anthrax found; — = No special examination.						Result.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{1000}$th part of Sediment from treated Clots.	
	Proportion of Total Material (Sediment) from treated Clot injected.	Time kept under Observation.	Mode of Death.	Macroscopical and Microscopical.			By Culture.					
				Local Lesion	Spleen	Blood of Heart.	Local Lesion	Spleen	Blood of Heart.		Anthrax.	All other Organisms.
(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)
61	1/40	5 days	Died	+	+	+	—	—	+	Anthrax, general, sub-acute.	—	—
	1/5	9 days	Died	+	+	+	—	+	+	Anthrax, general, sub-acute.	—	—
62	—	—	—	—	—	—	—	—	—	—	—	—
63	1/4	76 days	Killed	0	0	0	0	0	0	No anthrax	0	4
	1/4	76 days	Killed	0	0	0	0	0	0	No anthrax		
64	—	—	—	—	—	—	—	—	—	—	—	—
65	1/40	39 days	Killed	0	0	0	—	—	—	No anthrax	—	—
	1/5	11 days	Killed	0	0	0	—	—	0	No anthrax	—	—
66	—	—	—	—	—	—	—	—	—	—	—	—
67	1/4	76 days	Killed	0	0	0	0	0	0	No anthrax	0	2
	1/4	70 days	Killed	0	0	0	0	0	0	No anthrax		
68	—	—	—	—	—	—	—	—	—	—	—	—
69	1/40	39 days	Killed	0	0	0	—	—	0	No anthrax	—	—
	1/5	11 days	Killed	+	0	0	—	0	0	Local anthrax (chronic).	—	—
70	—	—	—	—	—	—	—	—	—	—	—	—
71	1/4	27 days	Dead	0	0	0	—	—	—	No anthrax	0	2
	1/4	77 days	Killed	0	0	0	0	0	0	No anthrax		
72	—	—	—	—	—	—	—	—	—	—	—	—
73	1/4	48 days	Killed	0	0	0	0	0	0	No anthrax	0	1
74	1/4	24 hours	Died	+	0?	0?	+	+	+	Acute anthrax, mixed infection.	30	75
75	1/2	64 days	Killed	0	0	0	0	0	0	No anthrax	—	—
	1/4	64 days	Killed	0	0	0	0	0	0	No anthrax	—	—
76	—	—	—	—	—	—	—	—	—	—	—	—
77	1/2	54 days	Killed	0	0	0	0	0	0	No anthrax	—	—
	1/4	26 days	Died	0	0	0	0	0	0	No anthrax	—	—
78	—	—	—	—	—	—	—	—	—	—	—	—
79	—	—	—	—	—	—	—	—	—	—	—	—
80	1/2	45 hours	Died	+	+	+	—	+	+	Anthrax, general, sub-acute.	30	90
81*	—	—	—	—	—	—	—	—	—	—	—	—

being successful (animals being inoculated in one). In the remaining six experiments the period allowed for both the preliminary and the disinfecting treatment was 20 minutes. Four proved successful (two of which were controlled by inoculation tests) and two were unsuccessful, failure being proved culturally in one and by inoculation in the other. Excluding those three unsuccessful experiments, in which the infected test material was placed in nets or the exposure was very short, or the strength of the disinfecting solution was very low, 16 out of 18 experiments were successful. The infected test material used in 12 of these consisted of bloodclots made from infected citrated blood (which, as previously pointed out, is less difficult to dissolve); and in four, of bloodclots made from infected natural healthy blood. In both the unsuccessful experiments test material of the latter variety was used. Apart from the destruction of anthrax spores, the growth of other organisms on the culture plates was generally less than in any previous group of experiments. In all the experiments of Group 7 careful note was made of the quantity of blood remaining in the infected test material after treatment, and it was always found that in those samples which proved to be still infected, a considerable quantity remained in small but comparatively thick masses, while in those found to be free from infection, if any remained, it was in thin layers or small comparatively thin masses. The conclusion drawn was that while the results gave promise that the method might be successful, it was necessary to find means of making it more generally effective. It was clear that when infection remained it was due to the ineffective removal of blood in the preliminary process.

Experiments of Group 8.

Table 8.

Details of Experiments and Sub-Committee's Results.

No. of Experiment.	Bloodclots used. Series.	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Water. Temperature. °F.	Treatment in Water. Time. Mins.	Treatment in Water. Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Treatment in Formaldehyde Solution. Temperature. °F.	Treatment in Formaldehyde Solution. Time. Mins.	Treatment in Formaldehyde Solution. Times squeezed through Rollers.	Drying in Hot Air. Arrangement in Drying Machine.	Drying in Hot Air. Temperature. °F.	Drying in Hot Air. Time. Mins.	Time elapsing after drying before Clots put in Ammonia Solution. Hrs.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable. Anthrax.	Number of Colonies … All other Organisms.	Time elapsing before Growth of Anthrax on Agar observed. Hrs.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
82	C	Citrated	Among wool in nets.	102	30	Twice	2·86	102	15	Once	Loose among wool on grid.	162	25	24	0	6	—
83	C	,,	,,	102	30	,,	2·78	101	15	,,	,,	165	15	24	0	6	—
84	C	,,	,,	102	30	,,	2·86	102	30	,,	,,	164	25	24	0	73	—
85	C	,,	,,	102	30	,,	2·78	101	30	,,	,,	165	15	24	0	4	—
86	C	,,	,,	102	30	,,	2·86	102	60	,,	,,	164	35	24	0	0	—
87	C	,,	,,	102	30	,,	2·78	101	60	,,	,,	180	15	24	0	335*	—
88	D	Very thick; not citrated.	Loose among wool in baths.	102	30	,,	2·09	102	20	Twice	,,	160	15	84	0	38	—
89	D	,,	,,	102	30	,,	1·94	102	20	,,	,,	170	20	48	—	—	—
90	D	,,	,,	102	30	,,	0·95	102	20	,,	,,	164	20	43	0	37	—
91	C	Made from blood of beast suffering from anthrax.	,,	102	30	,,	0·95	102	20	,,	,,	164	20	43	2	600	—
92	D	Very thick; not citrated.	,,	102	20	,,	2·09	102	20	,,	,,	165	15	77	0	35	—
93	D	,,	,,	102	20	,,	2·48	102	20	,,	,,	164	20	84	0	93†	—
94	D	,,	,,	102	20	,,	2·48	102	20	,,	,,	165	22	48	—	—	—
95	D	,,	,,	102	10	,,	2·09	102	10	,,	,,	164	15	76	0	89	—

* There was much excrement in this clot.
† This clot was carried over a mile in a paper parcel instead of in a sterilised bottle.

Process:—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in current of hot air.
(6) Action of formaldehyde left in wool allowed to continue, *i.e.*, formaldehyde not destroyed by addition of ammonia solution.

Objects.—It had been observed that damage test materials, treated and dried without first washing out the formaldehyde, retained some of this substance for many weeks, and that it gave off an odour of formaldehyde during long periods. The object of experiments of Group 8 was to ascertain if disinfection continues after the actual process has been completed by drying.

Table 8—continued.

PROFESSOR DELÉPINE'S RESULTS.

No. of Experiment.	Guinea Pigs inoculated.			Examination of Lesions. + = Anthrax found; 0 = No Anthrax found; — = No special examination.						Result.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{1000}$th part of Sediment from treated Clot.	
	Proportion of Total Material (Sediment) from Clot injected.	Time kept under Observation.	Mode of Death.	Macroscopical and Microscopical.			By Culture.					
				Local Lesion	Spleen	Blood of Heart.	Local Lesion	Spleen	Blood of Heart.		Anthrax.	All other Organisms
(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)
82 {	$\frac{1}{40}$	40 days	Killed	0	0	0	—	—	—	No anthrax	—	—
	$\frac{1}{4}$	7 days	Died	0	0	0	—	—	0	No anthrax	—	—
83	—	—	—	—	—	—	—	—	—	—	—	—
84 {	$\frac{1}{40}$	41 days	Killed	0	0	0	—	—	—	No anthrax	—	—
	$\frac{1}{2}$	11 days	Killed	0	0	0	—	0	0	No anthrax	—	—
85	—	—	—	—	—	—	—	—	—	—	—	—
86 {	$\frac{1}{80}$	37 days	Killed	0	0	0	—	—	—	No anthrax	—	—
	$1\frac{1}{4}$	11 days	Killed	0	0	0	—	0	0	No anthrax	—	—
87	—	—	—	—	—	—	—	—	—	—	—	—
88	—	—	—	—	—	—	—	—	—	—	—	—
89	$\frac{1}{4}$	38 days	Died	0	0	0	0	0	0	No anthrax	0	0
90	$\frac{1}{4}$	69 hours	Died	+	+	+	+	+	+	Anthrax, sub-acute, general.	0	1
91	—	—	—	—	—	—	—	—	—	—	—	—
92	—	—	—	—	—	—	—	—	—	—	—	—
93	—	—	—	—	—	—	—	—	—	—	—	—
94	$\frac{1}{2}$	48 days	Killed	0	0	0	0	0	0	No anthrax	0	1
95	—	—	—	—	—	—	—	—	—	—	—	—

Treatment of Test Material.—In the experiments of Group 8 the infected test material used consisted of bloodclots of Series C and D, *i.e.*, clots made both from infected citrated and from infected natural blood. They were treated in exactly the same manner as, and many were treated simultaneously with, clots in experiments of Group 7, except that the formaldehyde remaining in the material after drying was not destroyed by the addition of ammonia till the expiration of a period varying from 24 to 84 hours.

Results.—Of the 14 experiments in Group 8, total destruction of all anthrax spores was secured in 12 and anthrax spores survived in two. In both of these the strength of the formaldehyde solution was less than 1 per cent., so that the unsuccessful results, though they bear out the conclusion, previously arrived at, that this strength is too low to destroy anthrax spores with complete certainty in a reasonable time, can be dismissed in considering the success or failure of the process of disinfection. Of the 12 successful experiments, the presence or absence of living anthrax organisms was judged by both cultural methods and animal inoculation in five and by cultural methods alone in seven. The pairs of experiments detailed in the following table (Table 8A) were carried out simultaneously, *i.e.*, the infected test material either consisted of two infected bloodclots of the same series which passed through each stage of the disinfection process side by side, or a bloodclot was divided into two equal portions at the end of drying. One (or one-half in the three single-clot experiments) was put into ammonia immediately the drying was concluded, and the other (the other half in the single-clot experiments) was allowed to remain dry for varying periods before being placed in ammonia solution.

Placed in juxtaposition, the results show clearly that where the infected test material is exposed to the action of formaldehyde solution of 2–2½ per cent. strength for 20 minutes or over, following a preliminary treatment of 30 minutes (pairs 3 to 8), the continuing action of the formaldehyde after drying has little or no effect—probably because all the anthrax and most other organisms are killed when drying is completed. Where, however, the length of

Table 8A.

No. of Pair.	No. of Experiments.	Preliminary Treatment. Time occupied. Mins.	Disinfection Treatment. Strength of Formaldehyde Solution. Per Cent.	Disinfection Treatment. Time occupied. Mins.	Time occupied by drying. Mins.	Time elapsing between End of Drying and placing Test Material in Ammonia Solution. Hours.	Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material extracted from treated Test Material. ∞ = Uncountable. Anthrax.	All other Organisms.	Guinea Pigs inoculated, and Result.	Remarks.
1	61	30	2·86	15	25	0	0	1	Two. Both died from anthrax.	—
	82					24	0	6	Two. Neither contracted anthrax.	—
2	62	30	2·78	15	15	0	0	∞	—	—
	83					24	0	6	—	—
3	65	30	2·86	30	25	0	0	0	Two. Neither contracted anthrax.	—
	84					24	0	73	Do.	—
4	66	30	2·78	30	15	0	0	96	—	—
	85					24	0	4	—	—
5	69	30	2·86	60	35	0	0	3	Two. Neither contracted anthrax.	—
	86					24	0	0	Do.	—
6	70	30	2·78	60	15	0	0	27	—	—
	87					24	0	335	—	There was much excrement in this clot.
7	72	30	2·09	20	15	0	0	14	—	Halves of same clot.
	88					84	0	38	—	
8	73	30	1·94	20	20	0	0	200	One. Did not contract anthrax.	—
	89					48	0	0	Do.	—
9	74	30	0·95	20	20	0	0	124	One. Died from anthrax in 20 hours.	—
	90					43	0	37	One. Died from anthrax in 69 hours.	—
10	78	20	2·09	20	15	0	13	1,200	—	Halves of same clot.
	92					77	0	35	—	
11	79	20	2·48	20	20	0	0	75	—	—
	93					84	0	93	—	This clot was carried a mile in a paper parcel after treatment.
12	80	20	2·48	20	22	0	6,000	12,000	One. Died from anthrax in 21 hours.	—
	94					48	0	200	One. Did not contract anthrax.	—
13	81	10	2·09	10	15	0	∞	∞	—	Halves of same clot.
	95					76	0	89	—	

the preliminary treatment is reduced (pairs 10 to 13), or a weaker solution of formaldehyde is used (pair No. 9), or where the time of exposure to the disinfecting solution is shorter than 20 minutes (pairs 1, 2, and particularly pair 13), the disinfecting action of the small quantity of formaldehyde remaining in the material after drying, continues and is of pronounced value. It is also clear that if the preliminary process is sufficiently effective in breaking up, softening or dissolving the protecting blood, 20 minutes' exposure to formaldehyde solution of 2 to 2½ per cent. strength, followed by drying, is sufficient to destroy all anthrax spores in material so treated. The value of the results set forth in Tables 8 or 8A, however, lies not so much in the fact that they give data which enable the process of disinfection to be shortened, but in showing the existence of a safety factor which will render nugatory small defects in the disinfection treatment which may so easily result from momentary carelessness or other causes. Drying of wool damp with formaldehyde solution appears to cause no deterioration in the fibre, so that, besides making the process of disinfection more effective, the expense of washing out the formaldehyde is avoided, while the presence of a small amount of formaldehyde in the wool in the period before it is manufactured will undoubtedly powerfully discourage those enemies of the wool trade,—moths,—and will inhibit bacterial action (heating). The No. 13 pair of experiments is worthy of remark. The preliminary treatment of only 10 minutes left much blood in the infected test material, and there were thousands of colonies of anthrax on every culture plate made from the half of the clot placed in ammonia solution immediately after drying. In that half, allowed to stand three days, however, no anthrax and comparatively few other organisms survived although the exposure to formaldehyde solution had occupied so short a period.

Nevertheless, though the experiments of Group 8 do show that the continuing action of formaldehyde in the disinfected wool after drying may be a powerful factor in completing disinfection, the results shown in Table 8 are not altogether satisfactory, in that some of the infected test material after treatment still contained a fair number of surviving "other" organisms. The whole experience of the inquiry tended to indicate that survival of many "other" organisms pointed to danger of some anthrax spores surviving also, and the results, together with the presence of a considerable quantity of blood in some of the treated material pointed (as in experiments of Group 7) to possible inefficiency of the preliminary treatment. We, however, came to a tentative conclusion that the following method of disinfection would be effective for wool:—(1) A preliminary treatment in water at a temperature of 102° F. for two successive periods of 15 minutes, with squeezing through rollers at the end of each; (2) treatment in a 2 to $2\frac{1}{2}$ per cent. solution of formaldehyde at a temperature of 102° F. for two successive periods of 10 minutes, the material being squeezed through rollers after each; (3) drying for 15 to 20 minutes at a temperature of 160 to 170° F.; (4) a period of standing after drying.

Experiments of Group 9.

Objects.—The first eight experiments of Group 9 were simply intended as repetition experiments to prove the soundness of the method of disinfection outlined in the last paragraph. The object of the last four was to find a way out of the difficulties revealed by the first eight.

Treatment of Test Material.—The infected test material treated in these experiments consisted entirely of the various types of bloodclots of Series E. In the first eight they were placed loose among wool in the baths; the preliminary treatment consisted in immersion in water at 102° F. for two periods of 15 minutes, the clots and wool being squeezed through rollers at the end of each, followed by exposure to formaldehyde solution of approximately 2 per cent. strength for two periods of 10 minutes, with squeezing through rollers after each. The test material was then dried in a current of air at a temperature of 140–168° F., which required from 10 to 20 minutes. It was then allowed to stand for a period of 18 to 48 hours before any formaldehyde remaining was destroyed by the addition of ammonia solution. In the next three experiments the strength of the formaldehyde solution was increased to approximately $2\frac{1}{2}$ per cent., and the length of the two disinfection periods to 15 minutes each. In the last experiment, in addition, the preliminary treatment was altered to three periods of 10 minutes, with squeezing through rollers after each. In the first 10 minutes the test material was immersed in water at 102° F., in the second in soap solution at 117° F., and in the third again in water at 102° F.

Results.—In each of the first eight experiments of Group 9 cultures were made from part of the material extracted from the bloodclots after treatment, and guinea pigs were inoculated with part of the remainder. In the last four no animals were inoculated, but cultures were made from material from each of the treated clots. In Experiments 96 and 97 the drying machine was not in proper working order, so that it was not found possible to maintain the temperature higher than 140° F. during drying of infected test material, but there is no reason for thinking this to be the correct explanation of the failure to obtain disinfection. In the remaining nine experiments there was no known defect in the technique. In the first eight experiments, intended merely for repetition purposes, it was found possible to cultivate anthrax bacilli from the infected test material in six, though only in four of these six did animals inoculated with material from the treated bloodclots contract anthrax. Material treated in two of the eight experiments was completely disinfected, whether judged by the results of culture or animal inoculation. In two more the animals inoculated with sediment from the test material after treatment failed to contract anthrax, though it was found possible to cultivate anthrax bacilli from the same material (18 and 107 colonies, respectively, from one-tenth of the alkaline watery extract of the clots). As before stated, we attach greater weight to the animal results than to cultural results, but there is a possible reason for the apparently more favourable animal results. Owing to the fact that material had to be sent by post to Professor Delépine a longer period elapsed between the end of drying and the time when the known continuing action of the formaldehyde was brought to an end in the case of the half clots used for the animal test. Varying periods of 12 to 36 hours must be added to the times given in column 15 of Table 9, which apply only to half clots used for our cultural tests.

Table 9.

PROCESS:—(1) Immersion in warm water.
(2) Squeezing through rollers.
(3) Immersion in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in current of hot air.
(6) Process allowed to continue (*i.e.*, no ammonia was added to the infected test material to destroy the formaldehyde).

DETAILS OF EXPERIMENTS AND SUB-COMMITTEE'S RESULTS.

No. of Experiment.	Bloodclots used. Series.	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Water. Temperature. °F.	Treatment in Water. Time. Mins.	Treatment in Water. Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Treatment in Formaldehyde Solution. Temperature. °F.	Treatment in Formaldehyde Solution. Time. Mins.	Treatment in Formaldehyde Solution. Times squeezed through Rollers.	Drying in Hot Air. Arrangement in Drying Machine.	Drying in Hot Air. Temperature. °F.	Drying in Hot Air. Time. Mins.	Time elapsing before Clots put in Ammonia Solution.‡ Hrs.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable. Anthrax.	Number of Colonies … All other Organisms.	Time elapsing before Growth of Anthrax on Agar observed. hrs.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
96	E 3	Not citrated; very large and thick.	Loose among wool in baths.	102	30	Two	2·12	102	20	Two	Loose on grids.	140†	10	22	∞	∞	24
97	E 1	"	"	102	30	Two	2·0	102	20	Two	"	140†	15	18·5	10	49	24
98	E 3	"	"	102	30	Two	1·95	101	20	Two	"	167	20	18	0	44	—
99	E 3	"	"	101	30	Two	2·18	98	20	Two	"	163	18	47·5	18	31	24
100	E 2	"	"	101	30	Two	2·11	100	20	Two	"	168	17	47	0	10	—
101	E 2	"	"	102	30	Two	2·0	102	20	Two	"	168	19	44·5	21	36	24
102	E 4	"	"	102	30	Two	1·89	102	20	Two	"	168	19	44	18	16	24
103	E 3	"	"	100	30	Two	1·77	102	20	Two	"	168	19	44	107	39	24
104	E 3	"	"	102	30	Two	2·39	102	30	Two	"	168	20	47·5	0	77	—
105	E 4	"	"	102	30	Two	2·7	102	30	Two	"	165	20	47·5	7	47	24
106	E 3	"	"	102	30	Two	2·68	100	30	Two	"	167	20	47	∞	∞	24
107	E 3	"	"	102*	30*	Three*	2·67	103	30	Two	"	170	15	47	32	7	—

* In this experiment (107) three baths were used: (*a*) 10 minutes in water at 102° F.; (*b*) 10 minutes in soap solution at 117° F.; (*c*) 10 minutes in water at 102° F., with squeezing after each bath.

† The drying machine was out of order in these experiments (96 and 97), and the temperature fell to 140° F., at which it remained for the greater part of the time occupied in drying.

‡ The times stated in this column (15) do not apply to the samples sent to Professor Delépine.

Nevertheless, when examined in the most favourable light the results of the repetition experiments were very disappointing. If they were to be relied on, it is evident that there would be a residuum of danger in the wool treated in accordance with the method evolved. It must be understood that this residuum would not be large, even if as great as indicated by the results of experiments of Group 9, because the blood clots of the E series specially prepared for these repetition experiments were of a size, thickness, and density rarely met with in wool of commerce, and if met with, still more rarely found to be infected.

In seeking an explanation of the unfavourable results, we were at once struck by the extraordinary behaviour of the clots of the E series, the first of which was used in Experiment 96 (the first experiment of Group 9). Careful observation of the appearance of the bloodclots after treatment had been made in all the experiments, and in many previous to those of Group 9 it had been remarked that remnants of the clots remained, though always in process of obvious disintegration. The first clot of the E series used, however, showed quite different behaviour. After treatment it consisted of a hard, leathery flattened dark brown circular mass about 2 inches in diameter and three-quarters of an inch thick in the centre, and about half an inch thick at the edge. Some of the original clot had disappeared, but the remainder showed no clear indications of progressive disintegration. When cut, it showed sections as in the following sketches:—

Section through centre of whole clot after treatment.

Section through centre of half clot after treatment.

The outer deeply-shaded part of the clot consisted of a hard dark brown to black leathery substance, while the lightly-shaded central portion was of the usual red colour of unchanged blood. Immediately on putting the half clot into ammonia solution 22 hours after the end of drying the liquid became stained deep red. It was impossible to tease out the black outer portion of the clot in the ordinary way, though the central portion was soft enough. The former had to be cut up and resembled tough leather. This clot will be again referred to.

Table 9—continued.

PROFESSOR DELÉPINE'S RESULTS.

No. of Experiment.	Guinea Pigs inoculated. Proportion of Total Material (Sediment) from treated Clot injected.	Time kept under Observation.	Mode of Death.	Examination of Lesions. + = Anthrax found; 0 = No Anthrax found; – = No special examination. Macroscopical and Microscopical. Local Lesion	Spleen	Blood of Heart.	By Culture. Local Lesion	Spleen	Blood of Heart.	Result.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{1000}$th part of Sediment from treated Clot. Anthrax.	All other Organisms.
(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)
96	½	8 days	Died	+	+	+	+	+	+	Anthrax, sub-chronic, general.	—	—
	½	40 hrs.	Died	+	+	+	+	+	+	Anthrax, acute, general.	—	—
97	½	67 days	Died	0	0	0	0	0	0	No anthrax	—	—
	½	40 hrs.	Died	+	?	0	+	?	0	Anthrax, sub-acute, local.	—	—
98	½	67 days	Died	0	0	0	0	0	0	No anthrax	—	—
	½	67 days	Killed	0	0	0	0	0	0	No anthrax	—	—
99	⅓	21 days	Died	0	0	0	0	0	0	No anthrax	—	—
	⅓	66 days	Killed	0	0	0	0	0	0	No anthrax	—	—
100	⅓	65 days	Killed	0	0	0	0	0	0	No anthrax	—	—
	⅓	67 days	Killed	0	0	0	0	0	0	No anthrax	—	—
101	⅓	3 days	Died	+	+	+	+	+	+	Anthrax, sub-acute, general.	—	—
	⅓	3 days	Died	+	+	+	+	+	+	Anthrax, sub-acute, general.	—	—
102	⅓	3 days	Died	+	+	+	+	+	+	Anthrax, sub-acute, general.	—	—
	⅓	3 days	Died	+	+	+	+	+	+	Anthrax, sub-acute, general.	—	—
103	⅓	52 days	Died	0	0	0	0	0	0	No anthrax	—	—
	⅓	18 days	Died	0	0	0	0	0	0	No anthrax	—	—
104	—	—	—	—	—	—	—	—	—	—	—	—
105	—	—	—	—	—	—	—	—	—	—	—	—
106	—	—	—	—	—	—	—	—	—	—	—	—
107	—	—	—	—	—	—	—	—	—	—	—	—

At first it was thought that the blood was in some way different from blood used for making previous clots, but this view was untenable because the same blood had been used for making all the clots of the E series, and they did not all behave in the same manner. Thus, the clots used in Experiments 98 and 100 were not different in size, thickness or outward characteristics from that used in Experiment 96, yet they were both almost completely disintegrated by the preliminary treatment. In all the remaining experiments of Group 9 the clots were only partly disintegrated. In most a considerable part of the clot disappeared, leaving from one to three hard masses of blood over a quarter of an inch in thickness. A few clots behaved similarly to that used in Experiment 96, though none was quite so refractory. This difference in behaviour pointed to a cause which was not common to all or which was more effective in some than in others. The clots of Series E had been strung on wire in groups of five, each group being placed in a separate desiccator. The desiccators were then placed in front of the laboratory fire with a view to hastening the drying, which at that time of the year (Christmas) was slow. The clot used in Experiment 96 was the end clot on the wire, and as it was intended to use this lot of clots first, the desiccator containing that group was placed nearest the fire. Parts of the interior clots were shielded from direct heat by wool and other clots, and, having regard to a similar experience of Professor Delépine's and to his experiments (*see* his report), there can be very little doubt that parts of the clots became hardened and made insoluble by the heat. They were thus enabled to resist disintegration by the preliminary process in disinfection. It is not to be supposed that we came to this conclusion at once. The cause was suspected, but many experiments were made before the above-mentioned explanation was accepted.

In the second section of the Group 9 experiments (Experiments 104–106) the clots were exposed to a stronger solution of formaldehyde (approximately $2\frac{1}{2}$ per cent. as against 2 per cent.) for a longer time (two periods of 15 minutes as against two periods of 10 minutes). As was to be expected, this did not give improved results. In Experiment 106 an end clot was again used and, as in Experiment 96, this proved to be exceedingly refractory. The bacteriological results were also similar.

The results obtained in the first 11 experiments of Group 9 emphasised very strongly indeed what had already been realised, *i.e.*, that effective preliminary treatment is the key to successful disinfection of blood clots. The number of "other" organisms cultivated from material treated in many of the earlier experiments, from which it was not found possible to cultivate anthrax, had indicated that the preliminary treatment was not so effective as could be desired. We had made rough experiments as to the effect of various substances on dried clotted blood, and of those tried sodium carbonate appeared to be the most effective. We were not willing to use this unless the necessity was clearly proved, because of the division of opinion as to its effect on wool. There is, however, no objection whatever to the use of soap. On the contrary, many woolcombers are of opinion that presence of soap is advantageous whenever wool is treated by a wet process, and that it tends to prevent damage to wool. In Experiment 107 an attempt was therefore made to improve the preliminary process by using three baths, the first of which contained water at 102° F., the second soap solution (of about 1 per cent. strength) at 117° F., and the third water at 102° F., the infected test material being allowed to remain 10 minutes in each bath. The clot chosen for this experiment was an end clot in the desiccator and was exceptionally thick and hard. After treatment some undisintegrated blood still remained from which anthrax bacilli were cultivated. The increased disintegration obtained in the preliminary treatment indicated, however, that the alteration of method was an improvement.

Experiments of Group 10.

Table 10.

Process :—(1) Treatment in warm soap solution and warm water.
(2) Squeezing through rollers.
(3) Treatment in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in a current of hot air.
(6) Disinfection allowed to continue (*i.e.*, no ammonia added to test material to destroy formaldehyde).

Details of Experiments and Sub-Committee's Results.

No. of Experiment.	Blood-clots used. Series.	Nature.	Arrangement.	Treatment in Soap Solution and Water. First Bath Soap. Temperature. °F.	First Bath Soap. Time. Mins.	Second Bath Soap. Temperature. °F.	Second Bath Soap. Time. Min	Third Bath Water. Temperature. °F.	Third Bath Water. Time. Mins.	Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. °F.	Time. Mins.	Times squeezed through Rollers.	Drying in Current of Hot Air. Arrangement in Drying Machine.	Temperature. °F.	Time. Mins.	Time elapsing before Clot put in Ammonia Solution. Hrs.*	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable. Anthrax.	Other Organisms.	Time elapsing before Growth of … Hr…
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(2…
108	E 3	Very large and thick ; not citrated.	Loose among wool in baths.	115	20	115	10	115	10	3	2·69	101	30	2	Loose on grids.	160	17	45	0	6	—
109	E 3	"	"	114	20	116	10	115	10	3	2·51	101	30	2	"	162	25	69	0	3	—
110	E 4	"	"	114	20	116	10	115	10	3	2·51	101	30	2	"	160	25	69	0	4	—
111	E 3	"	"	115	20	115	10	112	10	3	2·35	99	30	2	"	165	20	70	1	20	7[illegible]
112	E 4	"	"	115	20	115	10	112	10	3	2·35	99	30	2	"	165	20	70	2	20	7[illegible]
113	E 3	Moderate size, but thick ; not citrated.	"	115	20	115	10	112	10	3	2·34	102	30	2	"	165	20	69	0	4	—
114	E 4	Very large and thick ; not citrated.	"	115	20	115	10	112	10	3	2·34	102	30	2	"	165	20	69	0	0	—
115	E 4	"	"	114	20	115	10	114	10	3	2·34	103	30	2	"	168	17	65	1	35	7[illegible]
116	E 4	"	"	114	20	115	10	114	10	3	2·34	103	30	2	"	168	17	65	7	27	3[illegible]

* The times stated in this column (19) do not apply to the samples submitted to Professor Delépine.

Objects. – At the end of the 12 experiments of Group 9 we concluded that the explanation of the failure to secure complete disinfection was that the preliminary process was not effective in removing the protection afforded to the spores by blood; and, further, that the failure of the preliminary process was due to the exceptional refractoriness of the bloodclots, caused by overheating. It was recognised, however, that many of the earlier experiments had shown the preliminary treatment to be, in a certain degree, ineffective. Probably whenever anthrax spores survive 20 minutes' exposure to a 2½ per cent. solution of formaldehyde at a temperature of 102° F. they are enabled to do so as a result of inefficient preliminary treatment. Efforts were made, therefore, to improve this stage of the process, and the object of the experiments of Group 10 was to ascertain the effect of the modifications.

Treatment of Test Material.—The test material used in the Group 10 experiments consisted entirely of the various types of exceptionally refractory clots of Series E. They were placed loose amongst damage test material in the various baths. The preliminary treatment consisted of (*a*) exposure to soap solution (strength 1 per cent.) at a temperature of 114–115° F. for 20 minutes, followed by (*b*) further immersion in the soap solution (strength one-half per cent.) at a temperature of 115–116° F. for 10 minutes, and (*c*) immersion in water at a temperature of 112–115° F. for 10 minutes. After each bath the infected and damage test materials were squeezed through rollers. They were then exposed to the action of a 2½ per cent. (approximate strength) solution of formaldehyde at a temperature of 99–102° F. for two periods of 15 minutes, each followed by squeezing through rollers. Finally, they were dried in a current of air heated to a temperature of 160–168° F. and allowed to stand for 45–70 hours before the addition of ammonia solution. In each case the clots were divided at the end of drying, and half sent to Professor Delépine; the period during which his halves were allowed to stand before the continuing action of the formaldehyde was brought to an end was considerably greater than that allowed for the halves retained by us.

Results.— Each of the clots was carefully scrutinised after disinfection, and it was at once evident that the modified preliminary treatment was far more powerful in securing disintegration of the blood. The clots still showed their refractoriness, but the blood remaining was not in thick masses, as in some of the experiments in Group 9, but consisted of comparatively thin leathery plates and layers generally not more than one-sixteenth of an inch in thickness.

In each experiment cultures were made by Dr. Eurich from half of the clot, and animals were inoculated by the Professor Delépine with material from the other half. In four out of the nine Dr. Eurich was able to obtain scanty cultivations (respectively 1, 2, 1 and 7 colonies) of anthrax, but these were weak colonies growing only after long incubation (30 hours in one instance and 77 hours in the other three). None of the animals inoculated contracted anthrax. Having regard to the similar experience in the experiments of Group 9 and to the scanty weak growth of anthrax obtained by cultural methods, it is probable that the continuing

Table 10—continued.

PROFESSOR DELÉPINE'S RESULTS.

No of Experiment.	Guinea Pigs inoculated.			Examination of Lesions + = Anthrax found; 0 = No Anthrax found; – = No special examination.						Result.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{1000}$th part of Sediment from treated Cloth.	
	Proportion of Total Material (Sediment) from treated Clot injected.	Time kept under Observation.	Mode of Death.	Macroscopical and Microscopical.			By Culture.					
				Local Lesion	Spleen	Blood of Heart.	Local Lesion	Spleen	Blood of Heart.		Anthrax.	All other Organisms.
(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	(34)	(35)
108	½	48 days	Killed	0	0	0	0	0	0	No anthrax	—	—
109	½	9 days	Died	0	0	0	0	0	0	No anthrax	—	—
110	½	9 days	Died	0	0	0	0	0	0	No anthrax	—	—
111	½	9 days	Died	0	0	0	0	0	0	No anthrax	—	—
112	½	31 days	Died	0	0	0	0	0	0	No anthrax	—	—
113	½	9 days	Died	0	0	0	0	0	0	No anthrax	—	—
114	½	25 days	Died	0	0	0	0	0	0	No anthrax	—	—
115	½	9 days	Died	0	0	0	0	0	0	No anthrax	—	—
116	½	2 days	Died	0	0	0	0	0	0	No anthrax	—	—

action of the formaldehyde during the longer period between the end of drying and the preparation of the material for inoculation was sufficient to cause the death of the spores shown by the cultural results to have survived though much weakened by the process of disinfection. We regard these results as of very great importance. In practice no doubt bloodclots will be met with of greater weight than those artificially made and used by us, but in the examination of many hundreds of natural clots found in wool we have never seen any of the density and homogeneity of the artificial clots. The former are broken up by intervening pieces of wool and by fission into many small clots; the latter always consisted of one solid mass of hard dry blood. Further, it is rare to find natural clots infected to anything approaching the degree and uniformity of the artificial clots, if, indeed, they exist at all. Nor have we ever seen natural clots so refractory. Still, the possibility must be taken into account that in hot countries some clots may have been exposed to direct sunlight and may thus have become overheated and hardened to a degree approaching that of the clots of Series E. At the worst, however, the amount of infection remaining after disinfection would be infinitesimal, and it is very doubtful if the spores would then be sufficiently virulent to cause anthrax in human beings. The importance, however, of the difference between the results of animal inoculation and of cultivation lies in this—that the progressive action of the formaldehyde which has penetrated into and remains in the remnant of blood appears to cause ultimately the death of the few weakened surviving spores.

Differences of refractoriness were again observed in clots of the E series used in the Group 10 experiments exactly similar to those noted in experiments of Group 9. The clot used in Experiment 116 (an end clot again) closely resembled in appearance and behaviour that used in Experiment 96. The superior disintegrating power of the preliminary process in the former experiment was shown by the much greater reduction in size and thickness of the clot as compared with that used in Experiment 96.

Experiments of Group 11.

Table 11.

Process:—(1) Treatment in warm soap solution.
(2) Squeezing through rollers.
(3) Treatment in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in a current of hot air.
(6) Disinfection allowed to continue (*i.e.*, no ammonia added to test material to destroy formaldehyde).

Details of Experiments and Sub-Committee's Results.

No. of Experiment.	Bloodclots used. Series.	Nature.	Arrangement.	Treatment in Soap Solution. Temperature. ° F	Time. Mins.	Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. ° F.	Time. Mins.	Times squeezed through Rollers.	Drying in Hot Air. Arrangement in Drying Machine.	Temperature. ° F.	Time. Mins.	Time elapsing before Clots put in Ammonia Solution. Hours.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{15}$ of Material from treated Clots. ∞ = Uncountable. Anthrax.	All other Organisms.	Time elapsing before Growth of Anthrax on Agar observed. Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
117	F 1	Very large and thick; not citrated.	Loose among wool in baths.	110	30	2	2·72	102	30	2	Loose on grids.	168	20	70	0	1	—
118	F 1	"	"	110	30	2	2·72	102	30	2	"	168	20	70	0	4	—
119	F 1	"	"	110	30	2	2·62	102	20	2	"	158	20	68	0	1	—
120	F 1	"	"	110	30	2	2·62	102	20	2	"	158	20	68	0	1	—
121	F 1	"	Loose among large natural Persian bloodclots in baths.*	110	30	2	2·49	102	20	2	"	162	20	51	0	4	—
122	F 1	"	"	110	30	2	2·49	102	20	2	"	162	20	51	0	2	—
123	F 2	"	"	110	30	2	2·40	103	20	2	"	163	20	48	0	7	—
124	F 2	"	"	110	30	2	2·40	103	20	2	"	163	20	48	0	4	—

* *See* Table 13 for results of experiments with these natural clots.

Objects.—As soon as it was realised that the difficulties met with in disinfecting bloodclots of Series E were probably due to overheating and consequent abnormal chemical changes in the blood, a fresh series (F) of bloodclots was made in exactly the same manner as those of Series E, but care was taken that they were never placed less than 6 feet from the laboratory fire. The objects of experiments of Group 11 were to obtain additional evidence (*a*) as to the abnormality of clots of Series E, and (*b*) as to the improvement effected in the preliminary process in relation to normal clots.

Treatment of Test Material.—Assuming the correctness of the view that overheating was the cause of the refractory nature of the clots of Series E, it was argued that the clots of Series F ought to be disintegrated by a preliminary treatment much shorter than that used in experiments of Group 10. In those of Group 11, therefore, this stage consisted of immersion in soap solution at a temperature of 110° F. for two periods of 15 minutes, the test materials being squeezed through rollers after each. The disinfection treatment included two periods of 10 minutes each (in two experiments of 15 minutes each) of immersion in formaldehyde solution of approximately 2½ per cent. strength, at a temperature of 102–103° F., followed by drying in a current of air at a temperature of 158–168° F. The treated infected test material was then allowed to stand for 48–70 hours before being placed in ammonia solution.

Results.—In some of the experiments the bloodclots were almost freed from blood, but in most there remained one or more thin remnants of blood less than $\frac{1}{16}$ inch thick. No anthrax bacilli and very few colonies of other organisms could be cultivated from any. The test material was, in fact, practically sterilised by the treatment, and the results of Group 11 experiments, therefore, strongly support the view that clots of the E series were abnormal. Throughout the whole group the results were uniformly good, and if comparison be made with earlier experiments (*e.g.*, with those of Group 8) none of the disconcerting high counts of other organisms (which point to inefficiency of treatment) are to be found. There was no known or observable difference between the bloodclots used in Group 8 and those used in Group 11 experiments. The better results were, therefore, in all probability due to the greater efficiency of the preliminary treatment.

EXPERIMENTS OF GROUP 12.

Table 12.—Experiments with Natural Bloodclots.

PROCESS:—(1) Treatment in warm water.
(2) Squeezing through rollers.
(3) Treatment in cold or warm formaldehyde solution.
(4) Drying in a current of hot air.

No. of Experiment.	Bloodclots used.		Treatment in Water.			Treatment in Formaldehyde Solution.				Drying in Current of Hot Air.			Time elapsing after drying before Clots put in Ammonia Solution.	Numbers of Colonies growing on Agar at 37° C. from $\frac{1}{10}$th of Material from treated Clots. ∞ = Uncountable.	
	Nature.	Arrangement.	Temperature. °F.	Time. Mins.	Times squeezed through Rollers.	Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. °F	Time. Mins.	Times squeezed through Rollers.	Arrangement of Clots in Drying Machine.	Temperature. °F.	Time. Mins.	Hours.	Anthrax.	All other Organisms. Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
125	Large natural Bussorah clot; not infected.	In nets among wool in baths.	104	35	2	2·38	Room.	15	1	In nets.	212	15	0	—	∞
126	,,	,,	104	35	2	2·38	,,	15	1	,,	212	15	0	—	∞
127	,,	,,	102	30	2	2·78	101	15	1	Loose on grids.	165	15	0	—	∞
128	,,	,,	102	30	2	2·78	101	15	1	,,	165	15	24	—	440
129	,,	,,	102	30	2	2·78	101	30	1	,,	165	20	0	—	33
130	,,	,,	102	30	2	2·78	101	30	1	,,	165	20	24	—	39
131	,,	,,	102	30	2	2·78	101	60	1	,,	180	15	0	—	39
132	,,	,,	102	30	2	2·78	101	60	1	,,	180	15	24	—	357
133	,,	Loose among wool in baths.	102	20	2	2·22	102	20	2	,,	157	15	0	—	550
134	,,	,,	102	20	2	2·22	102	20	2	Not dried.*				—	294

* This clot was placed in ammonia solution immediately after the treatment in formaldehyde.

Objects.—At intervals natural clots were used in the experiments in order to obtain a comparison with the artificial clots. The comparison is not quite just, because the former contain mud, excrement, and foreign matters, and were usually much larger besides containing no anthrax spores. In the ten experiments of Group 12 none of the clots used was infected with anthrax, and most originated from Bussorah skin wool. They were all very large.

Treatment of Test Material.—In eight of the earlier experiments the natural clots were placed among wool in nets, which were put among loose wool in the baths. The preliminary treatment was divided into two periods of 15 minutes, during which the test material was immersed in water at a temperature of 102–104° F. and squeezed through rollers at the end of each period. The disinfection treatment consisted of immersion in a $2\frac{1}{2}$ per cent. solution of formaldehyde at temperatures ranging from that of air (in two experiments) to 101° F. (in six experiments). The duration of this stage was 15 minutes in four, 30 minutes in two, and 60 minutes also in two experiments. The test material was squeezed through rollers at the end of these periods, and then dried in a current of air at temperatures of 165–212° F.

In the remaining two experiments of Group 12 the clots were placed loose among wool in the baths and the periods of the preliminary treatment in water were reduced to 10 minutes each. The disinfection part of the process consisted of immersion for two periods of 10 minutes each in a solution of formaldehyde of $2\frac{1}{2}$ per cent. strength at a temperature of 102° F. In both stages the material was squeezed through rollers at the end of each period. In one experiment the test material was dried at 157° F., and in the other it was not dried.

Results.—The results of these experiments can only be judged by the condition of the clots after treatment and by the number of organisms other than anthrax it was possible to cultivate from them. The condition of those clots placed among wool in nets for treatment was very unsatisfactory, as there were often masses of other substances as well as of blood only partially disintegrated. The number of organisms surviving the treatment was large in five out of the eight experiments in which this course was followed.

Excluding these, however, and considering only the two experiments in which the clots were placed loose in the baths, the number of organisms which survived the treatment was as great as in the experiments of Group 8, in which artificial clots were used. The experiments of Group 12 showed, in fact, exactly the same defect in the preliminary treatment as was indicated in the first eight groups.

Experiments of Group 13.

Table 13.—Experiments with Natural Bloodclots.

Process:—(1) Treatment in warm soap solution.
(2) Squeezing through rollers.
(3) Treatment in warm formaldehyde solution.
(4) Squeezing through rollers.
(5) Drying in a current of hot air.
(6) Disinfection allowed to continue (*i.e.*, ammonia solution not added to test material to destroy formaldehyde).

No. of Experiment.	Bloodclots used. Nature.	Bloodclots used. Arrangement.	Treatment in Soap Solution. Temperature. °F.	Treatment in Soap Solution. Time. Mins.	Treatment in Soap Solution. Times squeezed through Rollers.	Treatment in Formaldehyde Solution. Strength of Solution (per Cent. by Weight of CH_2O).	Treatment in Formaldehyde Solution. Temperature. °F.	Treatment in Formaldehyde Solution. Time. Mins.	Treatment in Formaldehyde Solution. Times squeezed through Rollers.	Drying in Current of Hot Air. Arrangement in Drying Machine.	Drying in Current of Hot Air. Temperature. °F.	Drying in Current of Hot Air. Time. Mins.	Time elapsing before Clots put in Ammonia Solution. Hours.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{16}$ of Material from treated Clots. Anthrax.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{16}$ of Material from treated Clots. All other Organisms.	Time elapsing before Growth of Anthrax observed. Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
135	Half of a natural very heavily bloodstained Bagdad skin fleece; not infected.	Loose in baths together with other clots (natural).	110	40	3	2·51	102	20	2	Loose on grids.	156	45	142	—	0	—
136	Large, thick mohair clot picked out by sorters; not infected.		110	40	3	2·51	102	20	2	"	156	45	142	—	0	—
137	Large natural *infected* bloodclot picked out of Bagdad skin wool.		115	40	3	2·29	98	20	2	"	166	23	69	0	1	—
138	"	Together in baths loose with other clots (natural).	115	40	3	2·29	98	20	2	"	166	23	69	0	1	—
139	Large natural bloodclot picked out of Bagdad skin wool; not infected.		115	40	3	2·29	98	20	2	"	166	23	69	—	1	—
140	"		115	40	3	2·29	98	20	2	"	166	23	69	—	1	—

Table 13—continued.

No. of Experiment.	Bloodclots used.		Treatment in Soap Solution.			Treatment in Formaldehyde Solution.				Drying in Current of Hot Air.			Time elapsing before Clots put in Ammonia Solution.	Number of Colonies growing on Agar at 37° C. from $\frac{1}{10}$ of Material from treated Clots.		Time elapsing before Growth of Anthrax observed.
	Nature.	Arrangement.	Temperature. ° F.	Time. Mins.	Times squeezed through Rollers.	Strength of Solution (per Cent. by Weight of CH_2O).	Temperature. ° F.	Time. Mins.	Times squeezed through Rollers.	Arrangement in Drying Machine.	Temperature. ° F.	Time. Mins.	Hours.	Anthrax.	All other Organisms.	Hours.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
141	Large Cape mohair bloodclot picked out by sorters; not infected.	Loose in baths with other natural bloodclots.	115	40	3	2·29	98	20	2	Loose on grids.	166	23	69	—	1	—
142	Two large natural bloodclots, weighing together over 3 lbs., picked out of Bagdad skin wool; not infected.	Loose in baths together with artificial clot of Expt. 121* and other bloodclots (natural).	110	30	2	2·49	102	20	2	"	162	20	51	0	6	—
143	" (but weight about 2 lbs.)		110	30	2	2·49	102	20	2	"	162	20	51	0	153	—
144	Two very large natural clots picked out of Bagdad skin wool; not infected.	Loose in baths together with artificial clot of Expt. 123* and other natural bloodclots.	110	30	2	2·40	103	20	2	"	163	20	48	0	13	—
145	"		110	30	2	2·40	103	20	2	"	163	20	48	0	0	—

* *See* Table 11 for results of examination of these artificial clots.

Objects.—The object of the experiments of Group 13 was twofold: (*a*) to examine the effect on natural bloodclots of the preliminary process improved as a result of the difficulties met with in treatment of artificial clots of Series E; and (*b*) to compare the behaviour of natural clots with that of exceptionally refractory artificial clots of this series and with that of ordinary artificial clots of Series F.

Treatment of Test Material.—A further endeavour to find infected natural bloodclots was made for the purpose of Group 13 experiments. The sorters at two large commission combing works were instructed to pick out the largest and thickest clots. Those treated in experiments of Group 13 were the thickest and largest of those (over 100) so selected by the sorters. Out of over 100 examined, however, only two were found to be infected. These were treated (Experiments 137 and 138), although they were not quite so large as the others.

The experiments of Group 13 are divided into two sections: in the first of which (seven experiments) the treatment was exactly the same as in that of the artificial clots (Series E) of Group 10 (except that the third bath in the preliminary treatment contained a little soap and the treatment in formaldehyde solution was reduced to two periods of 10 minutes each instead of two of 15 minutes each). The preliminary treatment, therefore, consisted of immersion in soap solution at a temperature of 110–115° F. for 40 minutes, with three squeezings through rollers at the end of periods of 20, 10, and 10 minutes respectively. The disinfection treatment consisted of immersion in a $2\frac{1}{4}$–$2\frac{1}{2}$ per cent. solution of formaldehyde at a temperature of 98–102° F. for two periods of 10 minutes, the materials being squeezed through rollers at the end of each. This was followed by drying in a current of air heated to a temperature of 156–166° F., and the dried treated clots were allowed to stand 69–142 hours before being placed in ammonia solution. In all the experiments a number of other natural clots were treated with the test clots, the former taking the place of damage test material. The object was to make the conditions as to presence of blood and dirt as bad as possible, and worse than anything which is likely to be met with in practice.

In the four experiments of the second section of Group 13 the treatment of the infected test material was exactly the same as that of artificial clots in experiments of Group 11. The difference from the treatment of the clots of the first section of Group 13 was that the time occupied by the preliminary treatment was reduced to two periods of 15 minutes (as against 20, 10 and 10 minutes), the squeezings through rollers being consequently reduced from three to two. Instead of damage test material, a number of other natural clots was treated together with the test material, which consisted of both natural and artificial clots (*see* Experiments 121–124).

Results.—Having regard to the objects of the experiments of Group 13, the results were noteworthy. Considering Section 1 first, after the first bath of the improved preliminary treatment, the blood was almost entirely softened, and no hard masses could be found. There were, however, many pultaceous masses of blood enclosing wool. At this stage, the ordinary artificial clots had always shown one or more masses of hard and unattacked blood, while the most refractory clots of the E Series had only just begun to be soft on the outside. On completion of the disinfection process, the mohair clot of Experiment 136 was still bloodstained at the ends of the staples, but there was no hard blood remaining; the mohair clot of Experiment 141 was absolutely free from blood; while the Persian clots, including the two infected, showed here and there a few bloodstains on thickly matted wool (but no masses of blood), and they also contained a few small lumps of a white earthy substance (clay). The wool was, however, quite clean.

After treatment, the wool, freed from the contractive power of the dried blood, swelled up producing a mass very much greater in volume than the original clot. On account of the quantity it was not possible to make cultures from the whole of this material. Besides, as pointed out above, before treatment these comparatively large masses of wool, cemented together by hard dry blood, really consisted of from two to twelve separate bloodclots held together by wool more or less bloodstained. For cultural purposes, therefore, the most heavily bloodstained remnants of these natural clots were cut off, including some of the limy or clayey lumps found in Persian wool.

The total quantity of material thus taken from each natural clot or combination of clots was at least equal to, and was frequently greater than, the total bulk of an artificial clot after treatment; and while in the former it consisted entirely of wool enclosed in blood remnants, in the latter it was composed largely of wool from which the protective substances had been removed. *A priori*, therefore, a greater number of organisms would be expected to appear in the cultures from natural clots than in those from artificial clots, yet this proved not to be so. In Section 1 of Group 3 the bacteriological results showed that the treated natural clots (including those two found to be infected with anthrax before treatment) were practically sterile. In Experiments 135 and 136, in which the material stood an exceptionally long period (six days) after drying before addition of ammonia, the treated materials were quite sterile. In each of the remaining five experiments, one colony only (not anthrax) could be grown in the part of the material (one-tenth of the total) taken for culture. The results, both of scrutiny of the clots after treatment and of bacteriological examination, clearly indicated (*a*) that effective disinfection of natural bloodclots can be secured by the method evolved; (*b*) that natural clots are much less difficult to disintegrate and disinfect than the refractory clots of Series E. Assuming that the organisms, not anthrax, present in the natural clots, are of approximately the same resisting power as those (not anthrax) in the artificial clots, the more favourable results of treatment of the natural clots would appear to be explained by their greater permeability and porosity, the admixture with the blood of sand and wool or hair, and the resulting greater susceptibility to disintegration.

The essential differences in treatment of the clots in Section 1, and in the four experiments of Section 2 of Group 13, were that in the latter (*a*) the preliminary treatment was shorter, and (*b*) the treated clots were allowed to stand a considerably shorter time after drying before addition of ammonia. In each experiment, two large masses of bloodstained wool, each containing at least seven ordinary sized clots joined together by wool, were treated, and the largest remnants of blood from six of the individual clots were cut off after treatment to supply material for culture. The culture material was therefore very concentrated. Outward examination showed that a very large proportion of the blood had disappeared, but there were many flat plates of dark brown leathery blood about $\frac{1}{16}$ inch thick remaining after treatment, all of which had been completely penetrated by formaldehyde.

Though these natural clots and highly infected artificial clots were treated together, we failed to cultivate anthrax from any, while in three out of four experiments very few other organisms survived. In Experiment 143, however, in which the blood remnants were larger than in any other, the number (153) of other organisms (chiefly *bacillus mesentericus*) it was found possible to cultivate from one-tenth of the material prepared for culture was distinctly higher than we regard as desirable. Apart from this experiment, the results were quite as favourable as those obtained by similar treatment of ordinary artificial clots (*i.e.*, clots not over-hardened by heat) in experiments of Group 11.

10. EFFICIENCY OF MECHANISM USED IN EXPERIMENTS.

Having shown the supreme importance of the preliminary treatment of material in securing effective disinfection of wool, it is necessary to consider at this stage the efficiency of the mechanism used in our experiments. The efficiency of the preliminary treatment in causing disintegration of dried bloodclots and the removal of protective substances depends on factors partly chemical, partly physical, and partly mechanical. The chemical effect of substances like sodium carbonate and alkalies generally is very considerable in converting the blood to a condition in which it can pass into solution, the gelatinising of blood (*i.e.*, the penetration of water into the blood albumen), the emulsifying and lubricating power of soap and the solvent action of water are important physical effects; while the loosening of fibres passing through the blood, the constant bringing of fresh water or chemical solutions in contact with protecting substances and the constant exposure of fresh surfaces to the action of the solvents are important mechanical effects of agitation. The effect of squeezing in causing the removal of partly dissolved and partially disintegrated blood and so exposing fresh portions to attack is also important mechanically. The mechanism by means of which wool is in practice washed and cleansed consists essentially of a long, narrow trough containing the washing liquid through which the wool in a comparatively thin layer is caused by means of rakes to pass in a series of short, rapid, intermittent rushes. The effect is as if a rapid current of water were sent intermittently through the wool, while during the periods of rest the fibres spread and diffuse in the liquid. The rakes tend to pull apart the fibres of wool, and constantly new surfaces are exposed in the rushes through the water. In the experimental apparatus it was not only impossible to use a similar arrangement, but at the time the apparatus was devised the importance of the preliminary treatment was only very dimly realised. As before stated, the apparatus consisted of small tanks in which the test material surrounded by wool was immersed as a large mass. The agitating mechanism was a simple and very gentle forward and reverse motion which, after the first few movements, caused the wool to settle into a more or less fixed position. Mechanically, therefore, the treatment of the test material in the experiments was bad. Not only was there failure to obtain any pulling apart of the fibres, but there was no scouring effect, repeated at short intervals, caused by the sharp, rapid thrusting of the wool through liquid, while the renewal of liquid immediately surrounding the clots was at best slow and irregular, and fresh surfaces were not constantly being exposed.

Two rough experiments were made with natural clots in which experimental conditions were similar to those in Section 2 of Group 13, save that the wool was kept in fairly rapid movement by forks manipulated by hand. The effect in causing more rapid and thorough removal of blood was pronounced.

Another series of experiments was made in which five of the specially large brown Persian clots were successively allowed to pass through an ordinary wool scouring machine at the time being used for washing white wool. The washing liquid consisted of an alkaline solution of soap in water, at a temperature of 125–130° F., contained in three bowls. The time occupied from the moment of immersion of the clots to their passage into the drying machine, including squeezing through three sets of rollers, was $5\frac{1}{2}$ minutes, while passing through the drying machine occupied 16 minutes.

Four of the five clots after this treatment were almost free from obvious blood though after complete drying much of the wool was stiff, indicating that some of the albumen remained. The remaining clot still contained a quantity of undisintegrated blood, estimated to be about one-quarter of the original. The results of these experiments clearly showed that by using proper mechanism the preliminary treatment could be made much more efficient, or, what comes to the same thing, the period occupied by it could be materially reduced, at all events from that of the experiments of Group 10. We do not, of course, suggest that five and half minutes is sufficiently long for effective preliminary treatment.

11. EFFECT OF FORMALDEHYDE ON BLOODCLOTS.

As the experimental results indicate, some portions of the bloodclots may escape disintegration in the conditions of our experiments in which inefficient machinery was used. The question of penetration of bloodclots by whatever disinfectant is used is, therefore, one of importance. Our earliest experiments showed that perfectly dry clots are penetrated by formaldehyde solution, but that the action is very slow. The period required for disinfection of dry clots by direct treatment was not ascertained, but is lengthy.

In the case of treated clots, in some of the experiments it was easy to trace the extent of penetration, because the blood is altered by the action of the formaldehyde. In the preliminary treatment the blood behaves like gelatine, *i.e.*, before disintegration takes place the water penetrates and the mass swells up, becomes soft, and in appearance resembles red gelatine containing a considerable quantity of water. When a bloodclot or blood which has not been in contact with formaldehyde is placed in a solution of ammonia, it dissolves and disintegrates on being teased out. If the clot has first been softened in water (*i.e.*, by the preliminary treatment) the red gelatine-like masses disappear in ammonia solution, and a brown or red liquid is obtained, which deposits a heavy precipitate on addition of excess of hydrochloric acid. If the remnants of bloodclots containing, after the preliminary treatment, many of the gelatine-like masses are placed in a $2\frac{1}{2}$ per cent. solution of formaldehyde, the masses shrink very considerably, become darker in colour and, if they be cut, the extent of the penetration of formaldehyde can, roughly, be gauged by the difference in colour. If the exposure to formaldehyde solution be short (not more than 20 minutes) the blood masses, on being placed immediately in ammonia solution, regain in a large degree their bright red colour, and dissolve and disintegrate when teased out. If, after exposure to formaldehyde solution, the clots be dried at a temperature of 160° F. (71·1° C.) for 15–20 minutes, the portions penetrated by formaldehyde are almost black, but if they be placed in ammonia solution at once they regain to some extent their bright red colour, and swell up, but are no longer soluble and do not disintegrate. The red gelatine-like masses are quite soft and can be cut and broken up, but they are, nevertheless, tough, and resist crushing or other methods of disintegration. The liquid in which they are teased out may be brown, and may give a considerable precipitate on acidification. If the clot, after short exposure to formaldehyde solution and drying, be kept 48–72 hours before being placed in ammonia, the blood masses will not regain their red colour nor swell up, but will form exceedingly tough dark brown or nearly black masses which, in toughness, texture, and behaviour, resemble new leather. The ammonia solution at most becomes straw-coloured, and gives little, if any, precipitate on acidifying. If they be small, so that the complete penetration by formaldehyde has been rapid, or if the exposure to formaldehyde be made longer or the period of standing after drying be extended, the blood masses after drying and standing are, on being placed in ammonia solution, no longer like new leather, but are hard, brittle, and cindery. They do not stain the solution, and the latter gives no precipitate when acidified. These phenomena appear to represent stages in the progressive action of formaldehyde and can be taken as a rough guide to the advance of disinfection. Tough red gelatine-like masses almost always contain surviving anthrax spores, which appear as separate and detached colonies in the culture medium. The tough, brown leathery masses may contain a red or reddish brown centre, and these also frequently contain surviving anthrax spores, which appear as detached colonies in the culture medium. If, however, the penetration by the formaldehyde has been sufficiently complete (either because the blood masses are small, or as the result of long standing, provided they are not too large), and the blood masses are apparently homogeneous, but have not reached the brittle stage, then surviving anthrax spores are rarely found. It is sometimes possible, however, if care be taken to chop the leathery substance up sufficiently fine and to get some of the small particles into the culture medium, to find anthrax colonies after more or less prolonged incubation growing out from the particles, though detached colonies do not appear. For this reason, in all except the very early experiments, care was taken to get as many fine particles of blood as possible into the culture medium. When the action of the formaldehyde has progressed sufficiently far for the blood masses to assume the hard cindery stage, anthrax spores apparently do not survive.

In the pair of Experiments 78 and 92 (*see* p. 30, Table 8A, Pair No. 10)—20 minutes' preliminary and 20 minutes' disinfection treatment—one clot was treated and equally divided after drying, one-half being placed in ammonia solution at once and cultures made the same day. The remaining half was kept standing for three days before being placed in ammonia solution. In each half a number of blood masses approximately one-eighth of an inch thick remained, and in that placed at once in ammonia they assumed the bright red gelatine-like form. From one-tenth of the material extracted from this half 13 anthrax and 1,200 other colonies were cultivated. In the half allowed to stand for three days after drying, the blood masses when placed in ammonia solution assumed the tough leathery and (in this case) rather brittle form. No anthrax bacilli and only 35 other colonies could be cultivated from one-tenth of the material extracted from this half. Apparently, the formaldehyde had penetrated the blood masses completely, but had not been in sufficient strength or had not had sufficient time to cause destruction of anthrax spores by the end of drying, though its action had been able to progress sufficiently far in the three days of standing to cause destruction of all surviving anthrax spores and of most other organisms.

In the pair of Experiments 81 and 95 (p. 30, Table 8A, Pair No. 13; 10 minutes' preliminary and 10 minutes' disinfection treatment) one clot also was treated, and this was divided equally after drying, one-half being placed at once and the other standing for three days before being put in ammonia solution. The remaining blood masses were fully a quarter of an inch thick, and in the half placed at once in ammonia solution they assumed the bright red tough gelatine-like form from which it was found possible to cultivate hundreds of colonies of anthrax bacilli and of other organisms. In the half put into ammonia solution after three days' standing, the blood masses assumed the hard leathery (almost cindery) form, and they contained no surviving anthrax spores, though 89 colonies of other organisms were cultivated from one-tenth of the material extracted from the half clot. Apparently, the blood masses were penetrated by the formaldehyde at the end of drying, but a period of standing was necessary to enable the progressive action of the formaldehyde to destroy the surviving anthrax spores. The short exposure to formaldehyde solution in this pair of experiments is worthy of note.

The behaviour of the clots of the E Series has already been described. In the most refractory of these there usually remained one large solid remnant of blood which was from a quarter to half an inch thick. In the less refractory, where any blood remained, it was in masses the size of which varied from that of a pea to that of a marble. The large blood remnants of the very refractory clots usually consisted after treatment and standing of a tough brown leathery envelope of about one-eighth of an inch in thickness, surrounding a mass of soft powdery red blood. In other words, the formaldehyde had penetrated the blood to a depth of one-eighth of an inch, leaving a quantity in the centre untouched. The size of this untouched central portion varied from that of a pin's head upwards, but it was always possible to cultivate anthrax where it was observed. It was constantly noted that where the thickness of the remnant was less than a quarter of an inch (6 millimetres), the formaldehyde had penetrated to the centre, the whole had been converted to a tough leathery substance, and all anthrax spores were destroyed. In some cases, where the thickness of the remnant was about a quarter of an inch (6¼ millimetres) or slightly over, it was found possible to cause one or two isolated colonies to grow out of minute particles of the tough leathery changed blood in the culture medium after prolonged incubation. When the thickness of the remnant appreciably exceeded a quarter of an inch, it was possible to discern a red centre, and detached colonies of anthrax appeared in the culture medium.

Three things are clear: (1) That formaldehyde possesses fairly considerable powers of penetration into the blood which remains after the preliminary part of the disinfection process. Penetration takes place during immersion in the formaldehyde solution, but whether it is continued in the drying process we made no experiments to ascertain (but see Professor Delepine's report to the Sub-Committee, pp. 60 to 65 below). In the time and under the conditions of the experiments the distance the formaldehyde penetrates into the blood measured from the outer surface is approximately one-eighth of an inch (3 mm.); so that remnants of bloodclots of less than one-quarter of an inch (6¼ mm.) in thickness are completely penetrated. (2) In remnants of bloodclots a quarter of an inch thick or more the formaldehyde is not in sufficient strength or (more probably) has not, owing to the time necessary for penetration, had sufficient time to cause destruction of all anthrax spores at the end of drying. (3) The action of formaldehyde which has penetrated into blood is progressive and does not cease with drying, so that if the penetrated blood be allowed to stand, all anthrax spores surviving at the end of drying are in time destroyed. The limit of time necessary to permit of the destruction of the surviving spores was not ascertained, but it is apparently less than three days in most cases. This clearly depends, however, on the thoroughness with which penetration has taken place. There were indications that remnants of clots somewhat larger than those referred to above might contain a few surviving spores after three days' standing, but none after four or five days. This might be the interpretation of the results obtained in Experiments 111, 112, 115 and 116, in which by cultivation after 65–70 hours' standing a few surviving spores were found, while after a further 48 hours' standing Professor Delépine was unable to find surviving infection by animal inoculation.

The penetrative and progressive action of formaldehyde and its effect on blood are of the greatest importance. The complete removal of all protection from the spores must be aimed at in the preliminary process, yet it is possible that some fragments of blood may escape. If not too large, these will be penetrated completely by formaldehyde and will be converted from the friable, easily broken up clot into tough leathery masses in which, after a few days, the surviving spores will perish owing to the slow but eventually fatal action of the formaldehyde. In other words, a safety factor of considerable value is provided.

12. OTHER EXPERIMENTS.

In addition to the experiments already discussed and experiments on the commercial scale to be presently described, numerous others were carried out. Of these, the following are of importance:—

(a) *Experiment* 146.—In order to gain some idea of the degree of infection remaining in the bloodclots after the preliminary treatment, a bloodclot of series C (citrated blood) was treated for three periods of 15 minutes in water at 102° F., each period being followed by squeezing through rollers. The wool was then practically free from blood, and was placed in ammonia solution and cultures made the same day. The number of colonies of anthrax bacilli which developed on the culture plates was enormous, and the result indicated that the wool after washing, even when freed from blood, may still be very highly infected. This was to be expected, but the demonstration of the fact is worthy of being placed on record, as it incidentally affords a complete explanation of the abundance in which anthrax bacilli may occasionally be grown from certain raw materials, such as East Indian goat hair, entirely free from blood.

The Sub-Committee was approached by the proprietors of "bacterol," a disinfecting preparation of which formaldehyde is a constituent, with a view to making experiments with this substance by means of the apparatus and according to the method advocated by them. It was claimed that "bacterol" when so used has great powers of penetration, whereby the complete destruction of anthrax spores, even when embedded in hard dry blood, could be ensured. Anxious to try any method offering prospects of success, we arranged that Messrs. Bacterol, Ltd., should send their representative to Bradford with their apparatus. This they did, and the following experiments were carried out by him. The apparatus consisted of a chamber having four shelves of perforated metal, each capable of holding about 40 lbs. of mohair. To the outside of the chamber a vaporiser was fitted, consisting of a strongly heated coil, through which the bacterol (a liquid) flowed, under pressure, from a container. The vapour was admitted to the chamber through two pipes, one entering below the centre of the bottom shelf and one at the middle of one side, below the second shelf from the top.

(*b*) *Experiment* 147.—On each of the two lower shelves of the chamber were placed 40 lbs. of mohair, and on the third from the bottom 12 lbs. of cross-bred laps, while the top shelf was left empty. A bloodclot of the D Series was placed at the point furthest from the vapour inlet in the middle of the layer of mohair, at the corner of the second shelf from the bottom. In order to reach this clot the vapour would have to penetrate a layer of mohair about 4 inches thick. A second clot of the D Series was placed in the centre of the empty top shelf, being lightly covered by about half an ounce of cross-bred laps to prevent direct condensation of liquid on it. The vapour rising through the perforated metal shelf would impinge directly on this clot. The time required to vaporise two litres of bacterol, the quantity considered necessary by Messrs. Bacterol, Ltd., was 70 minutes, and the action of the vapour in the chamber was allowed to continue a further 50 minutes. At the expiration of this period, *i.e.*, two hours from the commencement of vaporisation, the clots were removed and placed in ammonia solution. The maximum temperature reached in the vicinity of the clot which was buried in mohair was 78° F. Cultures were made the same day. The number of colonies of anthrax bacilli and of other organisms obtained in 16 hours from each clot was enormous.

(*c*) *Experiment* 148.—Bacterol having thus been shown to be ineffective, we desired to ascertain if the method of application was of value when pure formaldehyde solution was used. The conditions in this experiment were exactly similar to those of Experiment 147, except that the three lower shelves were filled with cross-bred laps. The clots were placed in the same positions, and relatively under the same conditions. Instead of using bacterol, two litres of a 37 per cent. (by weight) solution of formaldehyde was used. Vaporisation required 54 minutes, and the action of the vapour in the chamber was allowed to continue for a further 66 minutes, *i.e.*, the period of action was two hours from the commencement of vaporisation. The clots were treated in exactly the same way as those in Experiment 147, and the result of culture was similar, *i.e.*, there was an enormous growth of colonies of anthrax bacilli on the culture plates from each clot.

In order to give the method the most complete trial, a further experiment was carried out.

(*d*) *Experiment* 149.—In this experiment the chamber was kept empty and a bloodclot of the D Series was placed on a very little mohair in the centre of the third shelf from the bottom. A little mohair was also placed on the clot to prevent direct condensation on it, but the vapour would have to penetrate at most but half an inch of material in order to reach the infected blood. Two litres of bacterol were vaporised, 50 minutes being required for this, and the vapour in the chamber was allowed to act for a further 70 minutes (in all, two hours from commencement of vaporisation). The maximum temperature reached in the vicinity of the clot was 120° F., and on opening the chamber, the walls, shelves, the mohair, and the bloodclot were found to be quite wet from condensed bacterol. The clot was placed in ammonia at once. Cultures were made the same day and resulted in the growth of an uncountable number of colonies of anthrax bacilli and of other organisms.

The results of these experiments showed emphatically that neither bacterol nor formaldehyde in the form of vapour can in any reasonable time penetrate dry blood and destroy anthrax spores protected by it. Whether or not the use of vapour instead of a solution of formaldehyde might offer advantages in the disinfection of wool after it has been treated by the preliminary process, or whether any possible advantages would outweigh obvious disadvantages in the use of vapour for this purpose, we made no experiments to ascertain.

(*e*) In certain of the experiments separate bacteriological examination was made of the wool free from blood, but forming part of the bloodclots after treatment. The object was to ascertain if any power of infection remained in the wool from which the infected blood had been removed, as distinguished from the remnants of blood. In no case could anthrax be cultivated, even when the blood remnant attached to it still contained surviving anthrax spores.

(*f*) Professor Delépine carried out certain experiments in our presence, in which currents of steam at atmospheric pressure and high velocity were used to bring about disinfection. The disinfecting power of steam was not in question, but it was desired to ascertain if disinfection by steam in the short time made possible by our preliminary treatment would cause damage to the material. It was found that, though the damage was less severe than in previous experiments made by the Bradford Anthrax Investigation Board, the wool was still gravely affected.

These experiments served a very useful purpose. Our experiments have shown that anthrax spores treated by our preliminary process are much more susceptible to attack by agencies which destroy life. It appeared to be an open question, therefore, whether or not wool would be damaged by exposure to steam for the short time necessary to secure destruction of anthrax spores in material which has been thus treated. The exposures to steam at temperatures of 212°–214° F. given in the experiments carried out by Professor Delépine were for 5–8 minutes. During drying the materials gave off the objectionable odour usually associated with strongly heated wool, and, when dry, all the varieties treated showed very evident indications of damage. We are, therefore, satisfied that, under present conditions and probably under any conditions, the use of a method of disinfection of wool by means of steam is impracticable on account of the resulting deterioration of the material. This is of importance in view of the regulations proposed by the United States Government, in which exposure of possibly infected wool to a temperature of 212° F. for at least 15 minutes is required.

13. INDEPENDENT EXAMINATION OF THE PROCESS DEVISED BY THE SUB-COMMITTEE.

(PROFESSOR DELÉPINE'S REPORT.)

In a matter of such importance to an industry of the dimensions of the worsted, woollen and felt trades, we deemed it expedient to secure an independent but weighty and decisive report on the effectiveness of the process of disinfection devised by us. We therefore asked Professor Delépine to consider the whole of our experimental work, and to make a critical survey of it. He had intimate knowledge of the test material used by us, and for comparative purposes he was supplied with a quantity of natural bloodclots found in mohair, Persian wool and alpaca, and of material not bloodstained. These were sent to us by Mr. George Feather, Messrs. John Foster & Son, Ltd., Messrs. Campbell & Harrison, Ltd., and Messrs. John Cure & Co., Ltd., and were transmitted to Professsr Delépine exactly as we received them.

We consider his report to be of the greatest importance and value, for not only was he in a position to use the method of animal inoculation for testing the infected material after treatment (a method which Dr. Eurich was precluded from using for want of the requisite licence), but he also carried out laboratory experiments to prove the soundness of the different stages of our process. These included independent experiments as to (1) the effectiveness of preliminary treatment of artificial and natural clots; (2) the time of exposure to formaldehyde solution necessary for destruction of anthrax spores so treated; (3) penetration of formaldehyde solution and vapour into clotted blood; (4) effect of drying on the treated spores; and (5) the progressive action of formaldehyde remaining in the wool after drying, and its effect on spores. The essential features of our process were thus submitted to critical examination. His conclusions are entirely confirmatory of those arrived at by us, and we think it desirable to adopt and include his report as an integral part of ours. It is as follows:—

REPORT BY PROFESSOR SHERIDAN DELÉPINE, DIRECTOR OF THE PUBLIC HEALTH LABORATORY, UNIVERSITY OF MANCHESTER, UPON WOOL INFECTED WITH SPORES OF ANTHRAX BACILLI AND AFTERWARDS TREATED BY FORMALDEHYDE ACCORDING TO THE METHODS INVESTIGATED AT BRADFORD BY THE DISINFECTION SUB-COMMITTEE OF THE ANTHRAX COMMITTEE.

On the 23rd of May 1916 I was informed by Dr. T. M. Legge that the Disinfection Sub-Committee of the Anthrax Committee wished me to assist in the control of experiments conducted at Bradford for the purpose of finding a method for the disinfection on a commercial scale of wool infected with anthrax.

This was followed by a letter (dated June 8th, 1916) from Mr. G. Elmhirst Duckering, who informed me that the Committee wished me to—

> "undertake the work of advising on and checking the experiments being made by the Sub-Committee of the Anthrax Committee appointed to inquire as to the possibility of disinfection of wool."

On June 21st Mr. Duckering supplied me with information regarding the work which had been done up to then by Dr. Eurich and himself in Bradford. We discussed fully the experimental work, and made arrangements for its continuation under similar and new conditions.

I was present at the Conditioning House, Bradford, on July 4th, 1916, while a set of experiments was carried out, and discussed with Mr. Duckering and Dr. Eurich the value of the various stages of the process under investigation.

Many experiments were conducted at Bradford, and some 22 specimens were sent to me in connection with five sets of experiments conducted between the months of June and October 1916.

I sent an interim report on August 14th, which I supplemented by an addendum on November 9th, 1916.

On November 20th I attended, at the Conditioning House, a meeting of the Sub-Committee, at which Dr. Legge was present. The results already obtained were discussed, and the methods used up to date fully criticised.

Other methods of disinfection were briefly considered, and arrangements were made to continue the tests with and without certain modifications in order to control more fully previous results and to estimate the value of certain improvements which appeared to be desirable.

Arrangements were also made to carry out at the Public Health Laboratory some experiments to test the effects upon wool of rapid currents of saturated steam at atmospheric pressure, which is an effective, rapid and cheap method of disinfection, but in the opinion of the manufacturers this method is unsuitable on account of the effects which the temperature of steam has upon wool.

These experiments were carried out at the laboratory on the 23rd of January 1917, in the presence of the members of the Sub-Committee, and the results confirmed the members familiar with manufacturing processes in their previous opinion.

This finding is of great importance in view of the recent United States Regulations.*

These do not specify that steam is to be used, but they certainly demand exposure to the temperature of steam at atmospheric pressure for 15 minutes. Unless steam is used this means an exposure for more than 15 minutes to temperatures higher than that considered in Bradford to be the maximum allowable.

Since January, 17 treated samples corresponding to three new sets of experiments have been sent to me.

In addition to these samples, I have received from Mr. Duckering infected clots forming part of batches of clots used in four of the sets of the Bradford experiments in which I was interested; I wanted these clots for purposes of control. Mr. Duckering also sent me a large number of samples of wool with and without natural clots. These were particularly useful for investigating the effects upon the clot and wool of the treatment at its various stages.

In accordance with the original and subsequent instructions, and the indications which Mr. Duckering has kindly given me regarding the information which the Committee expected from me, I propose to deal in the report with the following points:—

1. Methods used at the laboratory to ascertain whether the infected material treated at Bradford had lost the power of conveying anthrax.
2. Tabulated account of the results of the laboratory tests.
3. Comments upon effects of treatment in the light of laboratory tests.
4. Laboratory experiments bearing upon the effects of the agitation of artificial and natural clots in water and also in acid and alkaline solutions.
5. Laboratory experiments bearing upon the action upon anthrax spores of watery solutions of formaldehyde and of the vapours arising from such solutions.
6. Laboratory experiments bearing upon the rate of penetration of formaldehyde solution and vapours into wet and dry clots.
7. Comments upon the value of the method adopted by the Bradford Committee; general conclusions.

Section I.—Methods.

Samples of wool contaminated with dry infected blood are termed "clots" for shortness sake. Clots treated in various ways at Bradford were sent to the laboratory in stoppered bottles; each bottle had a label, on which Mr. Duckering had entered full particulars regarding the nature of the clot and of the treatment to which it had been submitted.

Some of the clots were dry and some were immersed in a solution of ammonia (the object of this immersion being to arrest the action of formaldehyde at definite times). On arrival at the laboratory each clot was transferred to a sterilised bottle containing sterilised water, and shaken violently for half an hour in a shaking machine. (In the first set of experiments the quantity of water used for washing each clot was 1,000 c.c.; in all the subsequent sets 200 c.c. only was used. The larger amount of water did not act better than the smaller, and it was easier to obtain rapidly complete sedimentation when the smaller amount of water was used. This unimportant alteration in my technique is the only one which I permitted myself during the whole course of the experiments.)

*Regulations governing the Certification and Disinfection of Hides, Fleshings, Hide Cuttings, Parings, and Glue Stock, Sheepskins and Goatskins and Parts thereof, Hair, Wool, and other Animal By-products, Hay, Straw, Forage, or similar Material offered for Entry into the United States.

United States Treasury Department and Department of Agriculture.

Joint Order No. 1. Effective January 1, 1917.

At page 4, Regulation V., Section 2, after defining the kind of declaration which will satisfy the authority as to the freedom from anthrax infection of picked or pulled wool imported into the United States, the following passage occurs:—

"If such wool or hair, when offered for entry, is unaccompanied by the above-mentioned declaration, its entry will be permitted upon the condition that the consignee or owner thereof or his agent files a satisfactory bond or agreement assuring proper facilities for disinfection at the establishment to which the shipment is consigned, and that all of such wool or hair will be disinfected or sterilised by proper exposure to a temperature of not less than 212° F. for at least 15 minutes prior to any transfer or reshipment from such establishment."

I am informed by Mr. Duckering that the coming into force of these regulations has been postponed.

The contents of each bottle in which a clot had been shaken were then poured into a sterilised cylinder through a piece of sterilised gauze on which the wool remained. The fluid retained by the wool was afterwards squeezed out of the wool and added to the other fluid.

The fluid was then centrifugalised to separate the suspended matter.

The fractions used for inoculation purposes are indicated in the tables of results. The number of bacteria, when given, has been calculated for the whole clot.

The state of the wool on arrival, and after it had been shaken in water, as well as the character of the sediment, was generally noted. It would have been difficult to measure accurately the amount of sediment obtainable in each case, as this would have interfered with the inoculation tests without giving results capable of strict comparison.

The notes relating to these points are given in the discussion of the general table of results.

At least two guinea pigs were inoculated, each with a definite fraction of the sediment obtainable from each of the clots received up to the end of January 1917; after that date the scarcity of animals made it necessary for me to use only one guinea pig for each test.

All the inoculations were performed in the same way. The fraction of sediment was mixed with enough sterilised water to produce $\frac{1}{2}$ to $\frac{3}{4}$ c.c. of material. This was injected subcutaneously in the inner aspect of the lower part of the thigh of a healthy guinea pig, the skin at and around the seat of inoculation being previously disinfected.

The animals inoculated with the sediment from one clot were placed in a separate sterilised cage and not allowed to mix with any other animal. They were kept under close observation.

Those that died were dissected as rapidly as possible. After their death notes were taken in each case of the naked eye lesions at the seat of inoculation, and of the state of all the viscera and of the blood.

Microscopical preparations were made of material taken from the seat of inoculation, and also of the spleen pulp and of the heart blood, in all cases in which any lesions were observed.

This was also done in many cases in which no lesion was observable.

In all cases in which the microscopical and macroscopical findings left room for any doubt, cultures were made from material taken from the seat of inoculation, from the spleen and from the heart blood.

In a large proportion of obviously positive or negative cases culture tests were also made.

The final conclusions as to the presence or absence of anthrax infection were always based upon a complete examination.

Animals which did not die spontaneously were allowed to live for several weeks. They were ultimately killed and examined *post mortem*. The number of days each animal (whether infected or not) was kept under observation is given in the table, as well as the parts in which anthrax bacilli were found in those animals that had contracted anthrax.

The reference number given to each experiment in Mr. Duckering's final tables is given in each case next to my inoculation book reference number. For the purpose of recording experimental results in my tables, I have followed the order of dates. In discussing these results the experiments are grouped according to the method of treatment.

This grouping has also been adopted by Mr. Duckering in his final tables, in which the experiments have been rearranged and numbered accordingly. This is undoubtedly advantageous, and facilitates the discussion of methods. It is, however, also desirable to have a record of experiments arranged in chronological order. This is of assistance in estimating the value of the experimental test and comparing the results obtained at various stages of investigation.

SECTION II.—TABLE I. (*See* pages 48 and 49.)

Discussion of Table I.

In the first four sets of experiments controlled by inoculation, the clots used were all made with citrated infected blood, with the exception of two (Experiments 53 and 77). From October 1916 onward no citrated artificial clot was used. It appears unnecessary to describe in detail the state of each sample of wool infected with citrated blood, and which had been treated at Bradford before reaching the laboratory, (Experiments 82, 84, 86, 61, 65, 69, 56, 63, 58, 67, 60, 71, 54, 75). These numbers are given in the order in which the specimens reached the laboratory. For convenience sake, Mr. Duckering's new numbers as given in his final tables have been used instead of my laboratory book numbers.

A common feature of these samples (citrated blood) was that the treated wool (as it reached the laboratory) was not matted, or very slightly matted, and that no formed clot could be seen or felt; the only exception to this being in the case of Experiment 84, in which a slight trace of clot was noticed, and in the case of Experiment 54, in which there were some remnants of clots, and the wool was much matted and not so clean as usual. All these samples were in ammonia when they reached the laboratory. The amount of sediment obtainable from them was comparatively large and of a greyish or reddish brown colour. In some cases the sediment obtained was heavy and gritty (Experiments 56, 63, 71); this probably indicated that the wool itself was dirty before being infected with the citrated blood. The effects of agitation of citrated clots in water is dealt

SECTION II. TABLE I.—TABULATED RECORD OF SAMPLES INVESTIGATED, AND OF THE RESULTS OF THE LABORATORY TESTS, IN CONSECUTIVE ORDER.

			Treatment in Bradford.												Results of Laboratory Tests.								
			Nature of Clot.			Stirring in Water.			Treatment by Formal. Temp. 38·3 to 38·8° C.			Exposure to Hot Air in Drying Machine.						Examination of Lesions.					
Date.	Inoculation Book No.	No. of Experiment.	Citrated = +. Not citrated = 0.	Blood infected = +. Not infected = 0.	Wool infected = +. Not infected = 0.	Temperature.	Time.	Rolling, Number of Times.	Strength.	Time.	Rolling, Number of Times.	Temperature.	Time.	Interval after Last Operation before placed in Ammonia Solution.	Fraction of Sediment used for Inoculation.	Time Guinea Pig kept under Observation.	Mode of Death or Effect of Inoculation.	Local Lesion.	Spleen.	Blood of Heart.	Production of Anthrax.	Remarks.	Approximate Number of Colonies per Clot. T = Total. A = Typical Anthrax.
						° C.	Mins.		Per cent.	Mins.		° C.	Mins.	Hours.									
24.6.16	2657	82	+	+	0	38·8	30	2	2·86	15	1	72·2	25	24	1/10	40 days	Killed	0	0	0	None.		
27.6.16	2666	82													1/4	7 days	Dead	0	0	0	None	Death not due to anthrax.	
24.6.16	2658	84	+	+	0	38·8	30	2	2·86	30	1	73·3	25	24	1/10	41 days	Killed	0	0	0	None.		
27.6.16	2667	84													1/4	11 days	Killed	0	0	0	None.		
24.6.16	2659	86	+	+	0	38·8	30	2	2·86	60	1	73·3	35	24	1/10	37 days	Killed	0	0	0	None.		
27.6.16	2668	86													1/4	11 days	Killed	0	0	0	None.		
24.6.16	2660	61	+	+	0	38·8	30	2	2·86	15	1	72·2	25	0	1/10	5 days	Dead	+	+	+	Sub-acute, general.		
27.6.16	2669	61													1/4	9 days	Dead	+	+	+	Sub-acute, general.		
24.6.16	2661	65	+	+	0	38·8	30	2	2·86	30	1	73·3	25	0	1/10	39 days	Killed	0	0	0	None.		
27.6.16	2670	65													1/4	11 days	Killed	0	0	0	None.		
24.6.16	2662	69	+	+	0	38·8	30	2	2·86	60	1	73·3	35	0	1/10	39 days	Killed	0	0	0	None.		
27.6.16	2671	69													1/4	11 days	Killed	+	0	0	Chronic, local.		
6.7.16	2677 A	56	+	+	0	38·8	30	2	2·67	15	1	—	—	0	1/4	3 days	Dead	+	+	+	Acute, general.		T = 12,000.
	B	56													1/4	3 days	Dying, killed.	+	+	+	Acute, general.		
6.7.16	2678 A	63	+	+	0	38·8	30	2	2·67	15	1	72·2	15	0	1/4	76 days	Killed	0	0	0	None.		T = 8,000.
	B	63													1/4	76 days	Killed	0	0	0	None.		
6.7.16	2679 A	58	+	+	0	38·8	30	2	2·67	30	1	—	—	0	1/4	4 days	Dead	+	+	+	Sub-acute, general.		T = 0.
	B	58													1/4	76 days	Killed	0	0	0	None.		
6.7.16	2680 A	67	+	+	0	38·8	30	2	2·67	30	1	72·2	20	0	1/4	76 days	Killed	0	0	0	None.		T = 4,000.
	B	67													1/4	70 days	Killed	0	0	0	None.		
6.7.16	2681 A	60	+	+	0	38·8	30	2	2·67	60	1	—	—	0	1/4	77 days	Killed	0	0	0	None.		T = 0.
	B	60													1/4	41 days	Dead	0	0	0	None	Death not due to anthrax.	
6.7.16	2682 A	71	+	+	0	38·8	30	2	2·67	60	1	76·6	15	0	1/4	27 days	Dead	0	0	0	None	Ditto	T = 4,000.
	B	71													1/4	77 days	Killed	0	0	0	None.		
21.7.16	2686 A	53	0	+	0	38·8	20	2	2·25	20	2	—	—	0	1/4	56 days	Killed	0	0	0	None.		
	B	53													1/4	11 days	Dead	0	0	0	None	Death not due to anthrax.	
21.7.16	2687 A	77	0	+	0	38·8	20	2	2·25	20	2	73·8	18	0	1/4	54 days	Killed	0	0	0	None.		
	B	77													1/4	26 days	Dead	0	0	0	None	Death not due to anthrax.	
21.7.16	2688 A	54	+	+	0	38·8	20	2	2·25	20	2	—	—	0	1/4	5 days	Dead	+	+	+	Sub-acute, general.		
	B	54													1/4	5 days	Dead	+	+	+	Sub-acute, general.		
21.7.16	2689 A	75	+	+	0	38·8	20	2	2·25	20	2	73·8	17	0	1/4	64 days	Killed	0	0	0	None.		
	B	75													1/4	64 days	Killed	0	0	0	None.		

Date.	Laboratory No.	No. of Experiment.	Nature of Clot. Citrated = +. Not citrated = 0.	Blood infected = +. Not infected = 0.	Wool infected = +. Not infected = 0.	Stirring in Water. Temperature.	Time.	Rolling, Number of Times.	Treatment by Formal. Temp. 38·3 to 38·8° C. Strength	Time.	Rolling, Number of Times.	Exposure to Hot Air in Drying Machine. Temperature.	Time.	Interval after Last Operation before placed in Ammonia Solution. §	Fraction of Sediment used for Inoculation.	Time Guinea Pig kept under Observation.	Mode of Death or Effect of Inoculation.	Examination of Lesions. Local Lesion.	Spleen.	Blood of Heart.	Production of Anthrax Infection.	Remarks.	Approximate Number of Colonies per Clot. T = Total. A = Typical Anthrax. *
						° C.	Mins.		Per cent.	Mins.		° C.	Mins.	Hours.									
6.10.16	2705 A	80	0	+	0	38·8	20	2	2·48	20	2	73·8	22	0	¼	45 hours	Dead	+	+	+	Sub-acute, general.		T = 180,000 A = 60,000.
6.10.16	2705 B	94	0	+	0	38·8	20	2	2·48	20	2	73·8	22	—	½	48 days	Killed	0	0	0	None.		
6.10.16	2706 A	73	0	+	0	38·8	30	2	1·94	20	2	76·6	20	0	½	48 days	Killed	0	0	0	None.		
6.10.16	2706 B	89	0	+	0	38·8	30	2	1·94	20	2	76·6	20	—	½	38 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
6.10.16	2707 A	74	0	+	0	38·8	30	2	0·95	20	2	73·3	20	0	¼	24 hours	Dead	+	+	+	Acute, mixed infection.		T = 150,000 A = 60,040.
6.10.16	2707 B	90	0	+	0	38·8	30	2	0·95	20	2	73·3	20	—	¼	69 hours	Dead	+	+	+	Sub-acute, general.		
18.1.17	2740 A	96	0	+	0	38·8	30	2	2·12	20	2	63·8	10	—	½	8 days	Dead	+	+	+	Sub-chronic, general		
	B	96													½	40 hours	Dead	+	+	+	Acute, general.		
18.1.17	2741 A	97	0	0	+	38·8	30	2	2·00	20	2	63·8	15	—	½	67 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
	B	97													½	40 hours	Dead	+	?	0	Sub-acute, local.		
18.1.17	2742 A	98	0	+	0	38·8	30	2	1·95	20	2	75·0	20	—	½	67 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
	B	98													½	67 days	Killed	0	0	0	None.		
6.2.17	2755 A	99	0	+	0	38·3	30	2	2·18	20	2	72·7	18	—	½	21 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
	B	99													½	66 days	Killed	0	0	0	None.		
6.2.17	2756 A	100	0	+	+	38·3	30	2	2·11	20	2	75·5	17	—	½	65 days	Killed	0	0	0	None.		
	B	100													½	67 days	Killed	0	0	0	None.		
6.2.17	2757 A	101	0	+	+	38·8	30	2	2·00	20	2	75·5	19	—	½	3 days	Dead	+	+	+	Sub-acute, general.		
	B	101													½	3 days	Dead	+	+	+	Sub-acute, general.		
6.2.17	2758 A	102	0	+	+	38·8	30	2	1·89	20	2	75·5	19	—	½	3 days	Dead	+	+	+	Sub-acute, general.		
	B	102													½	3 days	Dead	+	+	+	Sub-acute, general.		
6.2.17	2759 A	103	0	+	0	37·7	30	2	1·77	20	2	75·5	19	—	½	52 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
	B	103													½	18 days	Dead	0	0	0	None - - -	Ditto.	
						Soapy water, 20 and 10 mins. Water, 10 mins.																	
23.3.17	2776	108	0	+	0	46·1	40	3	2·69	30	2	71·1	17	—	½	48 days	Killed	0	0	0	None.		
23.3.17	2777	109	0	+	0	45·5 to 46·6	40	3	2·51	30	2	72·2	25	—	½	9 days	Dead	0	0	0	None - - -	Death not due to anthrax.	
23.3.17	2778	110	0	+	+	45·5 to 46·6	40	3	2·51	30	2	71·1	25	—	½	9 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2779	111	0	+	0	44·4 to 46·1	40	3	2·35	30	2	73·8	20	—	½	9 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2780	112	0	+	+	44·4 to 46·1	40	3	2·35	30	2	73·8	20	—	½	31 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2781	113	0	+	0	44·4 to 46·1	40	3	2·34	30	2	73·8	20	—	½	9 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2782	114	0	+	+	44·4 to 46·1	40	3	2·34	30	2	73·8	20	—	½	25 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2783	115	0	+	+	45·5 to 46·1	40	3	2·34	30	2	75·5	17	—	½	9 days	Dead	0	0	0	None - - -	Ditto.	
23.3.17	2784	116	0	+	+	45·5 to 46·1	40	3	2·34	30	2	75·5	17	—	½	2 days	Dead	0	0	0	None - - -	Ditto.	

* These estimates are based on cultivation of $\frac{1}{2000}$ part of the sediment, and are, therefore, liable to serious errors unless the numbers are large. When no entry is made it does not mean that there was no bacteria, but none in the quantity examined.

§ When ammonia was used to stop the action of formaldehyde immediately at the end of the operations indicated under the head of "Treatment at Bradford," no interval, therefore, being allowed, this is indicated by "0." Any interval is indicated by giving the number of hours. When the clot was not treated by ammonia at all before arriving at the laboratory, this is indicated by the sign "—." In Mr. Duckering's tables some of the references to the ammonia treatment apply only to the samples handed over to Dr. Eurich.

with at pages 54 and 55 of this report. Two of the untreated clots belonging to batches used in this group of experiments were found, on cultivation and inoculation, to be highly infected (*see* pages 56 and 57, Table II. of Controls).

Of the treated clots, five out of fourteen (61, 69, 56, 58, 54) were found still infectious, but it must be remembered that at the time when these clots were used the method of treatment was not so thorough as in later experiments.

In the last four sets of experiment, the clots used were made with non-citrated blood, generally infected by admixture with spores as it flowed from the sheep's throat. The blood was afterwards allowed to dry. I am informed that a certain proportion of the clots were dried in front of the fire. This may account for some cases of extreme resistance of the clot to the process of washing. I found experimentally that clots dried at a temperature below 40° C. were more readily softened in water than clots dried at a higher temperature, and also that when the temperature rose above 70° or 80° C., and, still more, when it approached the temperature of boiling water, the clots were only slightly affected by water, which is what could be expected. It is possible that clots dried before a fire were sometimes brought to a temperature much in excess of what was intended. For the purpose of making experimental clots it does not seem desirable to raise the temperature of the blood beyond 50° C., which is certainly above the temperature to which blood among hair and hides is likely to reach in nature. (The clots themselves are probably seldom exposed to direct sunlight.)

In a certain number of cases, in addition to the blood being infected, the wool had previously been infected with an emulsion of spores which had been allowed to dry upon the hair. In six cases (Experiments 102, 110, 112, 114, 115 and 116) the infected blood was added to the wool by kneading into it clots of infected blood. In all these clots made with non-citrated blood the blood was distinctly more difficult to remove from the wool than in the case of citrated clots, and the treated wool on arrival at the laboratory still contained distinct clots on several occasions. This was specially the case in Experiments 80, 89, 74, 96, 98, 108, 109 and 114; in all these cases the further shaking in water in the laboratory failed to clean the wool from these remnants of clots. The worst cases were 74, in which several clots remained; 80, in which a large clot was left; 96, in which a hard flattened clot, which appeared not to have been affected at all, was present. It appears, therefore, that in nine out of twenty-five non-citrated clots the clot had not been entirely removed by the agitation of the wool in water, and four of these remained infective.

In the remaining 16 cases the samples of wool were comparatively clean and free from clots, three out of these remaining infectious.

SECTION III.—COMMENTS UPON THE EFFECT OF TREATMENT IN THE LIGHT OF LABORATORY TESTS.

It will be a matter of convenience to group together the samples which have passed through similar stages of treatment. I will, therefore, refer to the group of experiments as they occur in Mr. Duckering's final tables. The tables and experiment numbers mentioned in this section are those given in Mr. Duckering's tables.

In the following remarks I will use the word "formal," for short, instead of formaldehyde solution.

All the temperatures in my experiments are given in the Centigrade scale, and those given in the Fahrenheit scale in Mr. Duckering's statement have been reduced to the Centigrade scale. This is a matter of great convenience, as in all the classical works on anthrax certain critical temperatures are referred to frequently, and these are always given in the Centigrade scale.

The experiments recorded in Mr. Duckering's first five tables need not be discussed in detail.

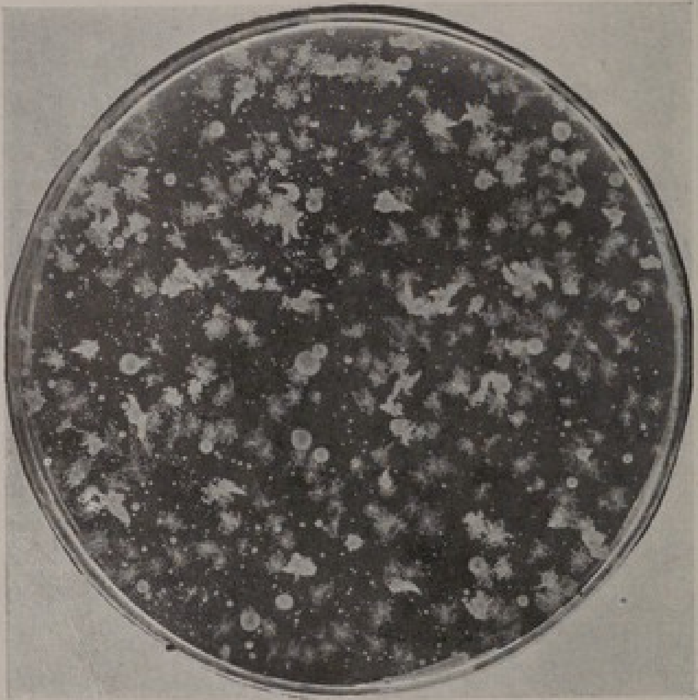
Tables 1 to 5.—The results of the first group of 52 experiments, summarised in Mr. Duckering's Tables 1 to 5, inclusive, indicate that—

I. Infected wool which has previously been soaked and agitated in water at blood temperature may be disinfected by immersion and agitation in cold formal when the strength of the solution is 2·47 per cent. and the exposure is four hours in duration (Experiment 8), or the strength of the solution is 2·72 per cent. and the exposure is two hours in duration (Experiment 26). (Without previous soaking of the clot an exposure to 2·47 per cent. formal for four hours is insufficient (Experiment 4).)

Some irregularities were, however, observed; thus, a 3·10 per cent. solution failed to disinfect in one experiment after an exposure of three hours (Experiment 28); and a similar failure was observed in the case of a 2·62 per cent. solution after an exposure of four hours (Experiment 21).

II. When, after the exposure to formaldehyde, the action of the disinfectant is allowed to continue 3½ hours while the wool is exposed to a current of hot air, immersion for half an hour to one hour in 2·72 per cent. formal was found to be sufficient (Experiments 35 to 37).

III. Preliminary breaking up of the clot by passing between rollers seemed to be beneficial (Experiments 44 to 49). In interpreting the above results it must be remembered—



Exp. 80.—Not citrated blood clot treated by agitation in warm water, passage between rollers, immersion in 2·48 per cent. formal. Passage between rollers, drying at 73·8° C. for 22 minutes, and placed *immediately in ammonia*. Numerous colonies of Anthrax bacilli. The superficial colonies are denser and more opaque than the deep colonies. Both kinds are typical. (*See* Table I., section II.)

(i) That during treatment the clots were enclosed in nets, which probably interfered with the effects of agitation of the fluids.
(ii) That all the clots were not absolutely comparable.*
(iii) That the effects of the treatment were tested by culture methods only.

In Tables 6 to 10, inclusive, the results of Experiments 53 to 103 (most of which were controlled by inoculation experiments) are given.

These experiments are not comparable with any of the previous ones, because warm formal was used instead of cold formal. The disinfecting and penetrating power of formal is considerably increased by heat (*see* Section IV., page 53 *et seq.*).

A. In Experiments 53 to 60, inclusive (Table 6), there was agitation in warm water (38·5° C.) and warm formaldehyde (38·5° C.), and squeezing of the clots during both these parts of the process. The action of formal was stopped by ammonia immediately after the end of the treatment by formal. The results were not quite concordant. Thus:—

With 2·25 per cent. formal for 20 minutes disinfection succeeded once (Experiment 53) and failed once (Experiment 54).
With 2·67 per cent. formal for 15 minutes there was failure of disinfection (Experiment 56).
With 2·67 formal for 30 minutes there was failure once (Experiment 58).
With 2·67 per cent. formal for 60 minutes there was disinfection (Experiment 60).

B. In the following set of experiments (Table 7) the treated clots were kept in a current of hot air for a length of time varying between 15 minutes and 25 minutes (35 minutes in one case), after which the action of formal was stopped by ammonia. The clot had been treated previously as in set A. The temperature of the water and of the formal ranged between 38° and 39° C. The duration of the bath in water varied between 20 minutes and 30 minutes, being generally 30 minutes.

The most important variations were in the strength of the formal and in the duration of the immersion in formal. The results will be considered in relation to these two factors.

No. of Experiment.	Strength of Formal. Temp. 38°—39° C.	Duration of Exposure.	Result.	Nature of Clot.	Exposure to Hot Air.	
					Temperature.	Time.
		Minutes.			°C.	Minutes.
74	0·95	20	No disinfection	Very thick; not citrated.	73·3	20
73	1·94	20	Disinfection	Very thick; not citrated.	76·6	20
75	2·25	20	Disinfection	Citrated	73·8	17
77	2·25	20	Disinfection	Not citrated	73·8	18
80§	2·48	20	No disinfection	Very thick; not citrated.	73·8	22
63	2·67	15	Disinfection	Citrated	72·2	15
67	2·67	30	Disinfection	Citrated	72·2	20
71	2·67	60	Disinfection	Citrated	76·6	15
61	2·86	15	No disinfection	Citrated	72·2	25
65	2·86	30	Disinfection	Citrated	73·3	25
69	2·86	60	Disinfection	Citrated	73·3	35

§ *See* photograph.

From these experiments it is difficult to estimate the effect which drying in hot air had. If, however, Experiment 67 is compared with Experiment 58 (*see* A), it will be seen that an immersion of 30 minutes in 2·67 per cent. formal at 38·5° C. was insufficient when there was no subsequent exposure to hot air, and sufficient when hot air was used, other things being equal.

Under the conditions of this set of experiments, it would appear that 30 minutes' exposure to 2·67 per cent. formal, followed by a passage of hot air (72° C.), was sufficient to insure the disinfection of wool which had been previously soaked in warm water (67). A shorter exposure to 2·86 per cent. formal was insufficient (61). It must, however, be remembered that in most cases of successful disinfection citrated clots had been used.

C. Table 8 deals with experiments conducted as those summed up in Table 7 up to the end of the exposure to hot air, but after this the disinfecting action of formal was not stopped immediately, but allowed to continue at ordinary temperature for from 24 to 48 hours before the formaldehyde was neutralised by ammonia.

Complete disinfection was obtained in Experiments 82, 84, 86, 89 and 94. The only failure was in connection with Experiment 90.

This failure is probably attributable to the fact that the strength of the formal was only 0·95 per cent., in addition to which the clot treated was very thick and not citrated, but a clot

* The difference between the clots is to a certain extent indicated by the differences in the number and kinds of bacteria other than anthrax found by cultivation in the treated clots.

of the same type was disinfected by treatment with 1·94 per cent. formal for the same length of time and at the same temperature. There were other slight differences, which, I think, of no importance. In successful experiments the strength and temperature of the formal solution and the times of exposure were as follows :—

Experiment 89 - - - - - -	1·94 per cent.	38·8° C.	for 20 minutes.
„ 94 - - - - - -	2·48 „	„	for 20 „
„ 82 - - - - - -	2·86 „	„	for 15 „
„ 84 - - - - - -	2·86 „	„	for 30 „
„ 86 - - - - - -	2·86 „	„	for 60 „

The temperature of the hot air used for heating the wool varied between 72·2° and 76·6° C., the duration of the exposure varying between 20 minutes and 35 minutes.

It would appear, therefore, that disinfection may be obtained when formal continues to act for 24 hours to 48 hours, after the wool treated by formal of suitable strength has been exposed to a current of air at 72° C., for some 25 minutes.

Under those conditions, immersion for 20 minutes in 1·95 per cent. formal at 38·8° C. appeared to be sufficient to secure the disinfection of a thick non-citrated clot (89).

D. The set of experiments recorded in Table 9 was intended to test the reliability of the results given in Table 8 by submitting eight different samples of clots prepared in various ways to the process carried out in the way which had given good results in previous experiments.

Of these eight experiments, two (96 and 97) must be excluded because, owing to the drying machine being out of order, the temperature of the air to which the clot was exposed after removal from formal fell to a little below 60° C. In addition to this, the exposure to hot air in the drying machine was shorter than in all the other experiments, and the after action of the formaldehyde was stopped after 18 hours and 22 hours, while in all the other experiments but one (98) the action was allowed to go on for 44 hours to 47 hours. In both these experiments the disinfection was not complete.

The six remaining experiments must be divided into two groups :—

In the first group (Experiments 98, 99 and 103) the clots used had been prepared by pouring infected blood upon the wool and allowing the infected blood to dry hard. In all these cases disinfection was complete.

In the second group (Experiments 100, 101, 102) the wool was infected first by pouring upon it an emulsion of anthrax spores, allowing this to dry upon the wool, and then pouring infected blood upon this infected wool and allowing the clot to dry hard. In two of these experiments (Experiments 101 and 102) the wool was not disinfected. In one of these (Experiment 101) there had been an exposure of 20 minutes duration to 2 per cent. formal at 38·8° C., exposure to hot air (75·5° C.) for 19 minutes, and the action of formal had been allowed to continue for 44 hours. It would appear, therefore, that the failure was possibly due to the fact that a large number of spores were contained in the film which had been made to dry on the surface of the wool previously to the embedding of the wool in the clot. Some of this highly infected hair deeply embedded in the blood probably remained beyond the reach of the disinfectant. When the blood alone is infected the proportion of spores in the most central part of the clot is, in all probability, much smaller. The difficulty of sterilising wool containing clots is not due to the fact that the spores are always brought to the wool by infected blood. In a large proportion of cases the wool is infected independently of the clots which are apparent. Nevertheless, these clots are important because in an infected wool containing clots the spores are protected by various thicknesses of dried blood and other products which prevent the free access of the disinfectant to the spores. Anything that tends to break up the clots or reduce their resistance to penetration must, therefore, promote the action of the disinfectant. It should be remembered that the clots used in Experiments 96–116, inclusive, had been dried before a fire and were highly resistant.

Agitation in warm water until the clot is quite soft favours the penetration of formaldehyde; the breaking up of the clot by passing it between rollers reduces the thickness of the obstacle and is beneficial even when the clot is not entirely disintegrated.

Artificial clots may remain hard and almost unaltered after being shaken for many hours in warm water, and when passed between rollers they may be only flattened or split up in fairly large fragments. (*See* effects of overheating artificial clots in the discussion following Table I., Section II.) When the water is rendered alkaline by the addition of some soda, old clots soften more readily. These considerations led to a modification of the process of treatment.

E. In the experiments summarised in Table 10 a warm soap solution was substituted for plain water, in the preliminary treatment, which was also more thorough than in any of the previous experiments.

Thus, the wool was soaked twice in succession in warm soap solution, and after each soaking it was pressed between rollers, and was then soaked in warm water and rolled again.

In this set of experiments the strength of the formal was never less than 2·34 per cent. to 2·69 per cent., the temperature of the formal ranged between 37·2 and 39·4° C., the duration of the exposure was 30 minutes (with two passages between rollers).

After this the wool was exposed to hot air in the drying machine for from 17 minutes to 25 minutes. The action of the disinfectant was not stopped by ammonia in the case of the clots used for inoculation tests. The action was allowed to continue slowly for 24 days in one case (108), 14 days (109 and 110), and seven days in the remaining five cases.

In every respect, therefore, and at all the steps, particularly the first and last, the conditions in these nine experiments were more favourable to disinfection than in the previous sets.

The artificial clots were made in two ways:—

(a) The blood was infected with spores as it ran from the sheep's neck (Experiments 108, 109, 111, 113).

(b) The wool was soaked with blood serum infected with spores, and then infected clotted blood was kneaded into it (Experiments 110, 112, 114, 115, 116). Most of these clots were large and thick.

None of the animals inoculated with half of the sediment obtainable from each of the treated clots contracted anthrax. For practical purposes, disinfection had been obtained in each case.

Section IV.—Some Experiments bearing upon the Effects of soaking Natural and Artificial "Clots" in Water, Alkaline or Acid Solutions, and also upon the Effect of squeezing the Soaked Wool between Rollers.

These experiments were conducted during the month of July 1916, *i.e.*, after I had tested the first set of samples of treated wool sent to me by Mr. Duckering. My object was to estimate the relative value of the various steps of the process of treatment adopted up to that time in the Bradford experiments. For this purpose I constructed a small agitator driven by a dynamo, and in which I could agitate and actually beat clots in a definite amount of water kept at the desired temperature by a regulated water bath. My agitator was probably more efficient in its action than the larger ones used in Bradford, but as all my experiments were conducted under the same very definite conditions, the results are comparable among themselves.

In most experiments the clot, after being washed in the agitator, was passed between india-rubber rollers similar to those used in the Bradford experiments.

The apparatus was arranged so as to permit the water and the blood and other products squeezed out of the wool to be collected. This water was added to that used in the agitator to estimate the amount of blood and dirt removed from the wool by the process.

Note was also taken of the state of the wool and clots.

For the purpose of these experiments I used samples of natural non-infected "clots" and some samples of artificial infected clots which Mr. Duckering kindly supplied me with at my request.

These experiments may be grouped under four heads:—

(1) Non-infected natural clots treated with water only.
(2) Non-infected natural clots treated with acidified and alkalinised water.
(3) Infected artificial non-citrated clot treated with water only.
(4) Infected artificial citrated clot treated by water.

Group 1.—*Non-infected Natural Clots treated with Water only.*

Experiment i.—Persian wool with natural clot, dense, hard and dry. Weight, 11 grammes:—

A. 15 minutes in agitator containing 1,000 c.c. of soft tap water at 40° C. Clot hardly affected; water very slightly coloured.

B. Passed twice between rollers. Clot only partly crushed; water squeezed out reddened by small débris of blood clot; very little blood pigment in solution.

C. 15 minutes in agitator, with same water as in A. More clot separates, but some of the clot remains fairly hard and apparently not softened.

D. Passed twice between rollers. Clot distinctly crushed; water squeezed out brownish red containing a large number of small clot débris.

E. Wool dried at 40° C. Weight, 8 grammes.

The moist sediment separated from wash-water, including water squeezed out by rollers, measures about 8 to 10 c.c., is coarsely granular, and greyish brown in colour.

The wool is partly matted, and contains fairly large remnants of the clot.

Experiment ii.—Alpaca with dense natural clot, hard and dry. Weight, 8 grammes :—

A. 120 minutes in agitator containing 1,000 c.c. of soft tap water at 42° C. Clot still hard.
B. 12 hours soaking in 1,000 c.c. of soft tap water at 42° C.
C. 240 minutes in agitator, in same water at 42° C. No rolling. Wool dried at 40° C. Weight over 4·1 grammes.

The water contains bulky fragments of clot. The wool is in part matted, and contains numerous small hard clots, in addition to a large hard clot.

The importance of crushing the clot between rollers is clearly indicated in these two experiments. The result of the treatment of natural clots should also be compared with the effects of the same treatment upon artificial clots.

Group 2.—*Non-infected Natural Clots with Alkaline and Acid Solution.*

Experiment iii.—Persian wool with natural clot, dense, hard and dry. Weight over 12 grammes :—

A. 15 minutes in agitator containing 1,000 c.c. of $\frac{1}{500}$ solution of carbonate of sodium in water at 40° C. Some parts of clot remain in wool, much blood has passed into the water, which is deeply coloured.
B. Passed twice between rollers. Large fragments of partly softened clot squeezed out, with deeply-stained water.
C. 15 minutes in agitator, with same water as in A. (40°). Wool still lumpy.
D. Passed twice between rollers. Some lumps of softened clot squeezed out.
E. Wool dried at 40° C. Weight, 4·6 grammes. Moist sediment bulky; wash-water deeply bloodstained. Wool slightly matted; free from hard clots.

Experiment iv.—Persian wool with natural, dense, hard dry clot. Weight, 11 grammes :—

A. 15 minutes in agitator with 1,000 c.c. of $\frac{1}{250}$ solution of caustic soda at 40° C. Clot swollen, gelatinous, large fragments of which pass into the water, which is deeply coloured. Much clot remains in the wool.
B. Passage between rollers. Ineffective on account of the slipperiness of the clot, which is hardly overcome by placing the wool between layers of cotton cloth.
C. 15 minutes in agitator. Clot remains in the same state, and cannot be passed between the rollers. The fluid removed from the agitator contains a very bulky sediment of softened bloodclots, and has a dark blood colour.
D. The wool is placed again in the agitator with 1,000 c.c. of ordinary water at 40° C.
E. Passed twice between rollers. All the fluid collected is deeply coloured and very bulky gelatinous sediment separates from it (about 20 c.c. in the moist state).
F. Wool dried at 40°. Weight, 3·8 grammes. Wool still matted and containing small débris of clot.

Experiment v.—Alpaca with natural clot, dry and hard. Weight, 4·5 grammes :—

A. 30 minutes in agitator with 1,000 c.c. of $\frac{1}{250}$ hydrochloric acid solution at 50° C. Wash-water reddish yellow.
B. Passed twice between rollers. Only small parts of clot came off; water reddish yellow.
C. 60 minutes in agitator, with same fluid as in A at 50° C.
D. Passed twice between rollers.
E. 120 minutes in agitator with 1,000 c.c. of ordinary water at 42° C. Total sediment separated from wool moderately abundant, dense, granular, reddish brown. Wash-water moderately stained reddish yellow.
F. Wool dried at 40°. Weight, 2·2 grammes. Slightly matted. No clearly distinct clot left.

Group 3.—*Two Samples of Wool from artificial infected non-citrated Clots.*

Treated at Bradford by agitation in warm water for 20 minutes, with two passages between rollers, and treatment with formaldehyde for 20 minutes and two passages between rollers, followed by drying. Wool received in ammonia.

Experiments vi. and vii. (53, 77).—30 minutes shaken violently in shaking machine with 200 c.c. water at ordinary temperature. Fluid brownish yellow, not distinctly blood-coloured. Sediment finely granular, dense brownish grey, not blood-coloured. The total sediment is very scanty as compared with the sediment obtained from a clot not previously treated at Bradford. The wool after drying appears free from clot.

Group 4.—Samples of Wool from artificial infected citrated Clots.

Experiments viii. and ix. (54, 75).—Two samples of wool from artificial infected citrated clots. Treated at Bradford as in Experiments vi. and vii. 30 minutes shaken violently in shaking machine with 200 c.c. of water at ordinary temperature. Fluid reddish brown, distinctly blood-stained. Sediment finely granular, reddish brown, about twice as bulky as sediment in Experiments vi. and vii.

Experiment x. (to compare with Experiment i.).—Wool with artificial infected citrated clot (prepared in Bradford, but not treated there, and used at the Public Health Laboratory for control purposes). Weight, 9½ grammes :—

A. 15 minutes in agitator with 1,000 c.c. of sterilised tap water at 40° C. Water deeply blood-stained.
B. Passed twice between rollers. Much deeply blood-stained fluid squeezed out, but no formed clots.
C. 10 minutes in agitator with the same water as that used in A (40°).
D. Passed twice between rollers. Same result as under B.
E. Wool dried at 40° C. Weight, 4½ grammes. All fluid used for washing and squeezing out by rollers allowed to sediment.

The moist sediment, very bulky, ill-defined, flocculent, condensing slowly, measures about 50 c.c. and is dark blood-red in colour. After addition of formal the supernatant fluid becomes slowly almost clear and colourless, and the sediment contracts to about half of its original bulk, but remains soft and gelatinous.

The wool is apparently clean, not matted and free from clot. (The wool and wash-water were used for control experiments made for estimating the extent of infection (*see* page 57).

Other experiments made with citrated clot yielded similar results (*see* 2664, page 57) without formaldehyde.

The effects of the various methods of treatment may be approximately estimated by the reduction in the weight of the treated wool in conjunction with the state of the wool after treatment, as has been done in the following table :—

Fluid at 40° C. used for washing in Agitator.	Duration of Treatment.	No. of Passages between Rollers.	Weight of Dry Wool and Clot before washing.	Weight of Wool after washing.	Loss of Weight.
Natural clots :—	Minutes.		Grammes.	Grammes.	Per cent.
Experiment i. Soft tap water - -	30	4	11	8	23·7
„ ii. ditto - -	360*	0	8	4·1	49·0
„ iii. $\frac{1}{800}$ carbonate of sodium solution.	30	4	12	4·6	61·7
„ iv. $\frac{1}{250}$ caustic soda solution.	30	4	11	3·8	65·5
„ v. $\frac{1}{250}$ hydrochloric acid solution.	90	4	4·5	2·2	51·2
Artificial citrated clot :—					
Experiment x. Soft tap water - -	25	4	9·5	4·5	52·7

* 12 hours' soaking in water between the first and second agitation.

(Experiments vi., vii., viii. and ix., which are not comparable with the others, have been excluded.)

The percentage reduction in the weight of the wool indicates the amount of blood and other products contaminating the wool which have been removed by treatment. As the original amount of blood and dirt in the wool was only approximately the same, this method of measurement is not absolutely accurate, but the differences in the final weights are so considerable as to compensate for this source of error.

General Summary.

1. Citrated blood is much more easily removed from the wool than natural blood clot (compare Experiments i. and x.). Experiments made with citrated clots are, therefore, not fully comparable with those with ordinary clots.

2. Water is less effective for washing purposes than water acidified with hydrochloric acid.

3. Acidified water is much less efficient than alkalinised water.

4. Water rendered alkaline by the addition of a comparatively small amount of carbonate of sodium is almost as effective as the more alkaline solution of caustic soda, and is more suitable.

5. The stronger caustic soda solution which renders the clot slimy and slippery is much less suitable than the weak solution of carbonate of sodium which does not render the clot slippery to the same extent.

6. Squeezing the clot by passing it between rollers assists considerably the freeing of the wool from clot.

Effect of Treatment by Formal of Clot unsoftened and unbroken by previous agitation in Water and passage between Rollers.

Experiment 96 (2740).—Among the treated clots, one which I received from Mr. Duckering on the 16th January 1917 deserves special notice. This clot had been prepared by impregnating wool with blood infected with anthrax spores as it flowed on to the wool. It had been agitated in water at 38° C. for 30 minutes and passed twice between rollers. It was then treated by 2·12 per cent. formal at 38° C. for 20 minutes, and passed between rollers at the end of each 10 minutes. Finally, it was dried for 10 minutes by a current of air at 60° C.

On arrival at the laboratory this clot was unbroken and formed a dense, hard, flattened mass. It was placed in a large bottle of water with 100 c.c. of sterile tap water and shaken violently in a shaking machine for 1 hour.

The clot remained unbroken, the wash-water was moderately turbid, not blood-stained and not frothy.

After this first treatment the clot was transferred to 100 c.c. of a 1·7 per cent. watery solution of ammonia, in which it remained for 12 hours.

At the end of this time the clot was still hard, but the ammoniacal solution was blood-stained.

The clot was then teased by means of forceps, and was found to be composed of an external hard layer about $\frac{1}{8}$ inch thick and of a central mass of soft bloodclot, the pigment of which diffused readily into the fluid.

This broken up clot was then shaken with the ammonia solution for one hour. Parts of the clot remained unbroken, the wash-water had a deep red colour and was very frothy, resembling in those respects the wash-water of untreated clots.

One-half of the sediment obtained from the water of the first washing was used to inoculate a guinea pig. This animal died in eight days of typical anthrax of a sub-chronic type.

One-half of the sediment obtained from the ammoniacal water used for the second washing was used to inoculate another guinea pig which died in less than 40 hours of acute general anthrax. (The sediment had been thoroughly washed in water previous to inoculation to remove ammonia.)

The whole clot was, therefore, infectious, but the central part was considerably more so than the superficial parts.

This experiment shows the great importance of thoroughly breaking up the clots. Where this is not done and the clot is sufficiently large, the superficial parts of the clot are rendered tough and insoluble by formal.

Experimental Testing of the Infectiousness of Clots used in the Bradford Experiments and of the Effect of the Preliminary Treatment upon the Infectiousness of the Wool before exposure to Formaldehyde.

In order to control the inoculation tests and at the same time to gain some information regarding the effects of various stages of the treatment, I obtained from time to time from Mr. Duckering samples of the infected wool and clots used in the Bradford experiments.

Two control clots were tested respectively during the months of June and July 1916, that is, at the beginning of my part of the investigation. (These clots were made with citrated blood.)

Two more control clots were tested during the month of January 1917, *i.e.*, during the last stages of the investigation. (These clots were not citrated.) The results of the tests are summed up in Table II. on the next page.

These results show that—

(1) The clots, whether citrated or not, were all heavily infected with anthrax spores (generally not less than 1,000,000 spores per clot). In all probability the number of spores was much greater than that revealed by culture. Animals inoculated with small fractions of the sediment obtained from the water used to wash the clots all contracted typical anthrax, which in three cases was complicated owing to the presence of anærobic bacilli.

(2) The wool, after being agitated twice in water and twice passed between rollers, was still highly infectious (*see* Experiment 2674), so that the subsequent treatment by formaldehyde is essential.

(3) The number of spores which pass with the blood into the wash-water render that fluid highly infectious. This water would undoubtedly have to be sterilised carefully before it was discharged into drains, streams, &c.

(4) Experiment 2685 shows the disinfecting effect of a short exposure of the washed infected wool to current steam. This experiment is given only for purposes of comparison, since it appears that steam damages wool.

Section IV. Table II.—Result of the Examination of untreated Clots (Controls).

Date.	I B No.	Experiment No.	Nature of Clot. Citrated or not citrated.	Nature of Clot. Blood infected.	Nature of Clot. Wool infected.	Treatment at the Laboratory.	Fraction of Sediment used for Inoculation.	Time Guinea Pig kept under Observation.	Mode of Death or Effect of Inoculation.	Examination of Lesion. Local Lesion.	Examination of Lesion. Spleen.	Examination of Lesion. Blood of Heart.	Production of Anthrax Infection.	Remarks.	Approximate Number of Colonies per Clot.
21.6.16	2663	Control I.	+	+	0	¼ clot + 50 c.c. of 5°/₀ ammonia. Shaken 30 minutes in 1,000 c.c. of water. Sediment not heated.	1/40	33 hours	Dead	+	—	+	Acute, general	Wash-water, brownish red.	
27.6.16	2672	"	+	+	0	Ditto ditto heated - - -	1/8	51 hours	Dead	+	—	+	General, complicated	Ditto.	
21.6.16	2664	"	+	+	0	¼ clot + 50 c.c. of sterilised water. Shaken 33 minutes in 1,000 c.c. of water. Sediment not heated.	1/40	48 hours	Dead	+	—	+	Acute, general	Wash water, purplish red.	Total bacteria innumerable; anthrax, 800,000 to 1,000,000.
27.6.16	2673	"	+	+	0	Ditto ditto heated - -	1/8	30 hours	Dead	+	—	0	Acute, local	Ditto.	
24.6.16	2665 A	"	+	+	0	Small particle of clot on point of knife.	Knife infected.	3 days	Dead	+	—	+	General, sub-acute.		
24.6.16	B	"	+	+	0	Ditto ditto - - -	"	17 days	Killed	0	0	0	None.		
27.6.16	2674	"	+	+	0	½ clot treated, as in Bradford, with water and rollers, no formal, then shaken for 30 minutes with 200 c.c. of water. Centrifuged.	1/4	28 hours	Dead	+	—	0	Local, complicated	Death caused by anærobic bacillus.	
18.7.16	2683 A	Control II.	+	+	0	¼ clot shaken in 1,000 c.c. of water. Centrifuged. Sediment diluted.	1/4	44 hours	Dead	+	+	+	General, acute		Total bacteria innumerable; anthrax, 520,000.
	B	"	+	+	0	Ditto ditto ditto - - -	1/200	68 hours	Dead	+	+	+	General, sub-acute		
18.7.16	2684 A	"	+	+	0	¼ clot shaken in 1,000 c.c. of water. Wash-water.	1/40	4 days	Dead	+	+	+	General, sub-acute		Total bacteria innumerable; anthrax, 1,100,000.
	B	"	+	+	0	Ditto ditto ditto - - -	1/2000	3 days	Dead	+	—	+	General, sub-acute		
18.7.16	2685 A	"	+	+	0	Washed wool (in above) exposed to current steam for 8 minutes. Shaken for 30 minutes in 1,000 c.c. of water. Centrifuged. Sediment diluted.	1/4	65 days	Killed	0	0	0	None		Anthrax, 0.
	B	"	+	+	0		1/200	65 days	Killed	0	0	0	None		
18.1.17	2743 A	Control III.	0	+	0	½ clot shaken for 1 hour with 100 c.c. of water. Centrifuged. Sediment diluted.	1/1000	40 hours	Dead	+	+	+	General, acute		Anthrax, 6,000,000.
	B	"	0	+	0		1/100	40 hours	Dead	+	?	?	Local, complicated		
18.1.17	2744 A	Control IV.	0	+	+	½ clot shaken for 1 hour with 100 c.c. of water. Centrifuged. Sediment diluted.	1/1000	40 hours	Dead	+	+	+	General, acute		Anthrax, 19,200,000.
	B	"	0	+	+		1/100	40 hours	Dead	+	+	+	General, acute		

SECTION V.—LETHAL ACTION OF WATERY FORMALDEHYDE SOLUTIONS AND OF MIXTURES OF FORMALDEHYDE GAS AND WATER VAPOUR AT VARIOUS TEMPERATURES UPON ANTHRAX SPORES.

A few experiments, some of which were performed as far back as 1898* are summarised here to supply certain data which are of use in interpreting the results of the Bradford experiments.

The object of these experiments was to estimate the time required by formaldehyde either in the gaseous state or in watery solutions for killing anthrax spores.

Silk threads or small strips of porous paper of constant size dipped in thick emulsions of fully formed anthrax spores, and thoroughly dried, were used in all my experiments.

The spores were, therefore, practically speaking, bare and not embedded in blood or any material amount of other protecting organic product.

It is obvious that under these conditions it was possible to estimate the minimum duration of the exposure necessary to bring about disinfection of an article infected with anthrax spores. The presence of any associated material capable of protecting the spores would lengthen the time necessary to obtain a lethal action. The weight of spores adhering to the surface of the threads which I use (silk thread ½ mm. thick, 2 cm. long) is, on an average, 0·00038 gramme and never exceeds 0·0005 gramme.

The mother solution of formaldehyde which I used was commercial formalin reputed to contain 40 per cent. formaldehyde.

This was diluted with water so as to make solutions which, according to the reputed value of the formalin, should have contained 1, 2, 2·5, 3 and 4 per cent. of formaldehyde by volume.

To make my observations comparable with the Bradford experiments, I repeated some of them with solutions of which I sent part to Mr. Duckering, who kindly estimated their strength by the method used by him in connection with the Bradford experiments.

His estimates were as follows :—

Reputed strength, 40 per cent. by volume ; actual strength, 35·33 per cent. by weight = 38 to 39 by volume.
" " 4 " " " " " strength, 3·88 per cent. by weight = 4·1 by volume.
" " 2 " " " " " strength, 1·94 per cent. by weight = 2·05 per cent. by volume.

In the following account of my experiments I will, therefore, give the strength of my solutions on the basis of the reputed strength of the commercial formalin, as this will simplify the figures without introducing any material error.

In order to estimate as accurately as possible the effect of temperature, covered capsules containing 10 c.c. of formal each were left in incubators at various temperatures for at least two hours before the threads were placed in the solution. The actual temperature of the fluid was actually observed in each case.

To observe the action of mixtures of formaldehyde gas and water vapour, open capsules containing formal of known strength were placed under a small airtight bell jar in the incubator, note being taken of the temperature of the air and of the fluid. The threads were placed upon filter paper supported by a glass plate at a height of about 1 to 2 inches.

The action of formal was arrested in each case by transferring the threads from the formal solution to 10 c.c. of 1·7 per cent. ammonia.

It will be noticed—

(i) That the amount of formal used to disinfect the threads was greatly in excess of the amount of material to be disinfected.

(ii) That the amount of ammonia used was greatly in excess of that necessary to neutralise the small amount of formaldehyde retained by the threads by the production of Hexamethylene tetramine, which has no bactericidal properties in an alkaline solution.

The experiments which bear on the Bradford investigation may be summed up as follows :—

Effect of Temperature on the action of Formal upon Anthrax Spores. (See photograph opposite.)

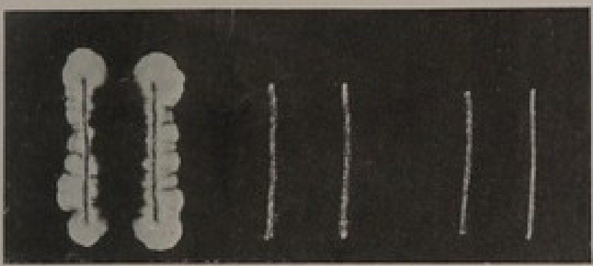
Duration of immersion in 2·50 per Cent. Formal.		Temperature of Formal (° C.).				
Hours.	Minutes.	0° to 2° C.	20° C.	30° C.	40° C.	50 C.
⅛	7½	4	4	3	1	0
¼	15	4	4	3	0	0
½	30	4	3	2	0	0
1	60	3	2	0	0	0
2	120	4	2	0	0	0
4	240	4	2	0	0	0
8	480	3	2	0	0	0
24	1,440	1	1	0	0	0

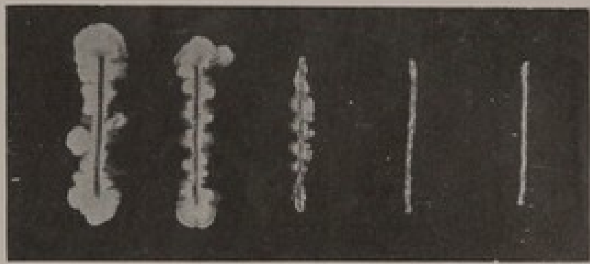
* Some experiments on disinfection of rooms by gaseous formaldehyde. Journal of State Medicine, 1898.

Effect of temperature upon the lethal action of formal as tested by the thread method. (Tables on pp. 58 and 59.) Photographs of threads after 86 hours' growth on peptone bouillon gelose.

2·5 per Cent. Formal.

Duration 15′ 30′

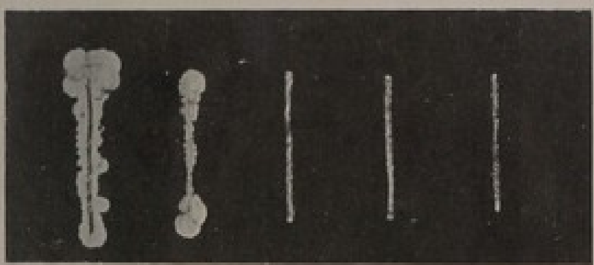




Temp. C° 30 40 50 2 20 30 40 50

2·5 per Cent. Formal.

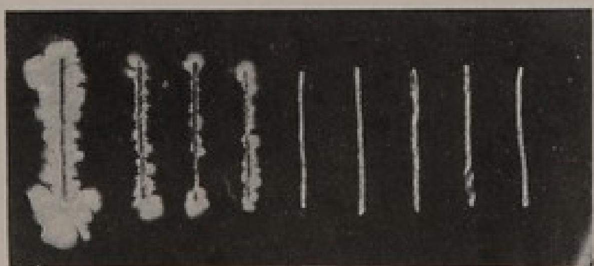
Duration 60′ 120′ 240′



Temp. C° 2 20 30 40 50 2 20 30 2 20 30

NH_3 Control. | 1 per Cent. Formal.

Duration 120′ | 5′ 10′ 15′ 20′ 30′ 40′ 60′ 120′



Temp. C° 40

Note :—The amount of growth is indicated in the above table as follows :—

4 means abundant growth, apparently more abundant than the growth from control threads after four days.
3, growth about equal to that of control.
2, growth distinctly less than that of control.
1, slight growth.
0, no growth. (*See* photograph on previous page.)

These results show that at temperatures under 30 °C. 2·5 per cent. formal acts too slowly for practical purposes.

At 30° C. a solution of that strength is not fully lethal in half an hour, but is efficient in one hour.

At 40° C. an exposure of 15 minutes and at 50° C. an exposure of $7\frac{1}{2}$ minutes are sufficient to bring about the death of anthrax spores not protected by associated material.

It would appear, therefore, that 2·5 per cent. formal at temperatures under 40° C. does not act rapidly enough to ensure complete disinfection of wool in 20 minutes.

The following table gives the result of several sets of experiments made to test the action of formal of three different strengths at approximately the same temperature (39° to 44° C.):—

Effect of dilution on the action of Formal upon Anthrax Spores.

Duration.	1 per Cent. Formal at 40° C.*	2·5 per Cent. Formal at 44° C.§	4 per Cent. Formal at 39° C.
1 minute	3	2	2
5 minutes	2	2	0
10 ,,	2	1	0
15 ,,	2	—	0
20 ,,	0	0	—
30 ,,	0	0	0
40 ,,	0	0	0
60 ,,	0	0	0
120 ,,	0	0	—
300 ,,	0	—	—
Control in water at 40° C.	4	4	—
Control in water at 40° C. dipped 3·4 per cent. ammonia.	4	4	4

For explanation of figures *see* note to previous table; — means no observation.

* *See* photograph on previous page. § *See* photograph opposite page 60.

These results taken in conjunction with those given in the previous table show, within certain limits, that temperature is of greater importance than the strength of solution of formal as regards lethal action.

To obtain fuller information upon this point, experiments with shorter exposure were made.

Lethal action of 1 per cent., 2·5 per cent., and 4 per cent. Solution of Formaldehyde at 40° C.

Duration of Exposure.	Control. No Formal.	Formal, 1 per Cent.	Formal, 2·5 per Cent.	Formal, 4 per Cent.
0	4 4			
0	4 4			
1 minute		3	2	2
2 minutes		1	0	0
3 ,,		0	0	0
4 ,,		0	0	0
5 ,,		0	0	0

Consistent as these results appear to be, they cannot be accepted as proving the absolute efficacy of short exposures (*see* previous table). Thus, in a series of experiments, in which the exposures were made at 50° C., the following results were obtained with a 1 per cent. formal :—

1 minute	3
2 minutes	2
3 ,,	1
4 ,,	0
5 ,,	0
Controls	4 and 3

The irregularities observed in short exposures are probably due to the presence of air in or on the surface of the silk, preventing the rapid and uniform access of the disinfectant.

Effect of a Minimal Quantity of Formal at a Temperature of 62° C.

In the previous experiments an excess of formal was always present. In the following experiments anthrax threads were simply dipped in the solution and left in a moist chamber in which the temperature of the air was above 60° C. This experiment was made chiefly to ascertain the effect which exposure to hot air after treatment by formaldehyde had upon anthrax spores. In the Bradford experiments the infected wool after passage through the formal bath was usually dried in a current of air at a temperature generally exceeding 60° C.

Anthrax threads dipped in 2 per cent. formal, placed immediately under a bell jar containing moist air at 62° C. and left there for five hours, were completely sterilised.

Anthrax threads not dipped in formal and left for the same time in moist air at 62° C. were not affected, and yielded an abundant and typical growth of anthrax bacilli.

In another experiment a number of anthrax threads were left in cold 4 per cent. solution of formal for five minutes, then laid on filter paper to absorb any excess of solution, and left for various lengths of time in air at a temperature ranging between 69° C. and 73° C. At the end of the exposure to hot air each thread was placed in 1·7 per cent. ammonia.

The results of cultivation of these threads were as follows:—

Duration of Exposure to Hot Air after 5 minutes in Cold 4 per Cent. Formal.	Growth after 48 Hours.	Growth after 6 Days.
7 minutes - - - - - - - -	3	3
15 " - - - - - - - -	2	3
120 " - - - - - - - -	0	0
150 " - - - - - - - -	0	0
No exposure to formal or hot air. Controls - - - - - - - -	4	4

A solution of formal exposed to a temperature of 40° to 60° gives off vapours having a very pungent smell of formaldehyde. These vapours are probably composed of water vapour and gaseous formaldehyde. The following experiment had for object to ascertain whether the formaldehyde liberated from comparatively weak solution of the gas would be capable at a temperature above 60° to kill anthrax spores rapidly.

A small dish containing 4 per cent. formal was placed under a bell jar above which there was a glass plate covered with a damp filter paper. When the temperature of the air in the jar had reached 62° C. several anthrax threads were laid upon the filter paper and allowed to remain there two hours, after which they were immersed in 1·7 per cent. ammonia. The threads were afterwards incubated in peptone bouillon and were kept under observation for six days. No growth was observed. (From untreated anthrax threads exposed in air at the same temperature abundant growth was obtained in 24 hours.)

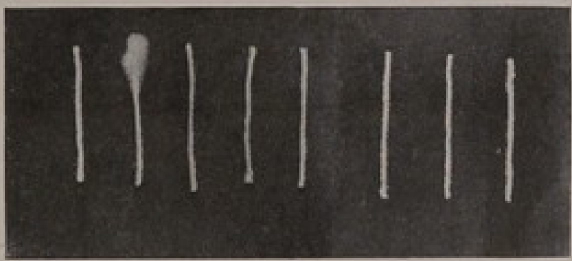
In another experiment, part of which has already been referred to anthrax threads were exposed to vapours from a 2·5 per cent. formaldehyde solution in which anthrax threads were also immersed. Threads exposed to vapours and threads immersed in the solution were removed at intervals, left for two hours in ammonia, and then transferred to culture media, with the following results:—

Effect on Anthrax Spores of Immersion in 2·5 per cent. Formal and of Exposure to Air saturated with Vapours from the same Solution at a Temperature of 44° C. (See photograph opposite.)

Duration of Exposure.	Growth from Threads immersed in Solution.	Growth from Threads exposed to Vapours from the same Solution.
5 minutes - - - - - - -	2	—
10 " - - - - - - -	1	—
20 " - - - - - - -	0	3
30 " - - - - - - -	0	2
40 " - - - - - - -	0	0
50 " - - - - - - -	0	1
60 " - - - - - - -	0	0
120 " - - - - - - -	0	0
260 " - - - - - - -	0	0
Controls six hours in 3·4 per cent. ammonia, after immersion in water or exposure to water vapour at 40° C.	4	4

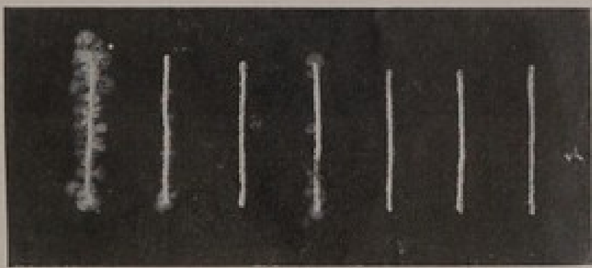
Lethal action of 2·5 per cent. formal at 44° C., and of vapours given off by 2·5 per cent. formal at 44° C. upon Anthrax spores as tested by the thread method. (*See* tables on pp. 59, 60, and A. B. C. on p. 62.) Photographs taken after 72 hours' incubation of threads on peptone bouillon gelose.

A.—2·5 PER CENT. FORMALDEHYDE SOLUTION AT 44° C.



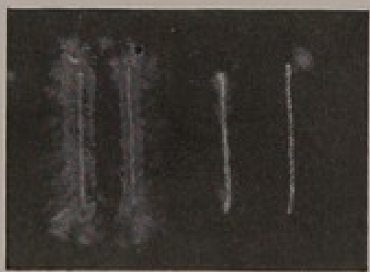
Duration 5′ 10′ 20′ 30′ 40′ 50′ 60′ 120′

B.—VAPOURS FROM 2·5 PER CENT. FORMAL AT 44° C.



Duration 20′ 30′ 40′ 50′ 60′ 120′ 240′

C.—NH_3 CONTROL. | A.—2·5 PER CENT. FORMAL AT 44° C. REPEAT.



Duration 120′ 5′ 10′

In the cases in which the spores survived, their growth was much delayed. The amount of growth recorded in this and other tables was estimated after 72 hours' incubation.

In order to obtain some direct evidence of the extent of the diffusion of formaldehyde from a watery solution at a temperature of 50° C., I made the following experiment :—

A bell jar of 2,000 c.c. capacity was luted with vaseline clay to a plate so as to close it hermetically. Before closing the jar, a glass capsule containing 20 c.c. of 31·92 per cent. formal was placed at the bottom of the jar. The capsule was 9 cm. in diameter. At a height of 3 inches above this capsule a second capsule of the same diameter, containing 20 c.c. of distilled water, free from formaldehyde, was placed. The whole apparatus was then transferred to an incubator at 50° C., in which it was left for 22 hours. At the end of that time the fluid in each capsule was measured and the amount of formaldehyde estimated.

—	Beginning of Experiment.		End of Experiment.	
	Quantity of Fluid.	Amount of Formaldehyde.	Quantity of Fluid.	Amount of Formaldehyde.
Upper capsule - - -	20 c.c.	0	18·5 c.c.	2·4 per cent.
Lower capsule - - -	20 c.c.	31·92 per cent.	21·0 c.c.	24·0 " "

There was some water of condensation at the bottom of the jar upon which there was also a distinct whitish deposit.

The bottom of the jar was slightly colder than the upper part. There had been slow distillation from the upper to the lower dish.

The amount of formaldehyde in the solution at the beginning of the experiment was 6·38 grammes in one capsule, and at the end, 5·48 distributed between the two capsules. The remaining 0·90 gramme was (1) mixed with water vapour in the air of the jar, (2) dissolved in the water of condensation at the bottom of the jar, and (3) polymerised. When the jar was opened while it was quite hot, the smell of formaldehyde was overpowering; there must, therefore, have been a large proportion of the gas not in solution.

It will be noticed that the solution of formaldehyde in the upper capsule was strong enough to cause the death of anthrax spores in a few minutes at the temperature of 50° C. It is, therefore, clear that when wool which is still damp and impregnated with formal is heated to 60° to 70° C. in a drying machine, disinfection goes on not only in the parts which have been thoroughly impregnated with formal, but also in those which may have retained an excess of the first wash-water or which may not have been thoroughly wetted.

Results similar to those obtained with infected silk threads were observed when infected wool was used.

Some mohair was heavily infected with anthrax spores by immersing and kneading it in blood serum containing a very large number of highly-resistant anthrax spores. The wool was then dried along with the infected serum covering it.

Several small tangled masses of infected wool (approximately equal to half the Bradford experimental clots) were prepared in this way, and kept dry and in the dark for over one month.

To test whether the wool was fairly uniformly infected, 12 hairs were pulled out of the tangled mass and incubated in bouillon. An abundant typical growth of anthrax bacilli was obtained in each case.

Each infected mass, wrapped up in muslin, was placed in water at 40° C. for 25 minutes, after which the excess of water was squeezed out. One set was then dipped into 2 per cent. formal, and immediately after was squeezed so as to express the excess of formal.

A second set was not dipped in formal. Both sets were then placed in a small hot-air chamber at 62° C., in which there was a small capsule containing 2 per cent. formal.

After remaining in the hot chamber for 30 minutes, the wool was transferred to a large excess of 1·7 per cent. ammonia to stop the action of the formaldehyde.

The excess of ammonia having been removed by washing in sterile water, each sample of wool (with the exception of a small portion) was then spread over the bottom of a plating dish, covered with peptone bouillon gelose, incubated at 37° C., and kept under observation for five days. The small portion removed from each mass was transferred to peptone bouillon, incubated at 37° C., and kept under observation for five days.

For control purposes one of the masses of infected wool was, after the immersion in warm water and squeezing, placed in a moist chamber at 62° C. free from formaldehyde. At the end of 30 minutes, plates and bouillon cultures were prepared as in the case of wool treated by formal.

The results of these experiments were in agreement with those obtained with infected silk threads.

The wool exposed to vapours at 62° C. arising from 2 per cent. formal was free from living anthrax spores, no growth being observed either in the fluid or solid media in which it had been incubated. The wool which had been immersed in formal before being placed in the hot chamber did not give better results. In one of the gelose plates a few doubtful colonies were observed, but no growth whatever was obtained in bouillon.

In the plates made with the control wool (not treated with formaldehyde) an immense number of typical colonies of anthrax bacilli were already visible in less than 24 hours' incubation.

Photographs (opposite page) were made after five days' incubation, and although anthrax colonies in the control plate are not so distinct in the photograph as they were in the actual plate, it is easy to see that the medium is crowded with an immense number of anthrax colonies which had remained small on account of their number.

The results of the experiments on the lethal action of formaldehyde upon bare or nearly bare anthrax spores may be summed up as follows:—

A.—Exposures to 2·5 per cent. Watery Solution of Formaldehyde.

Anthrax spores may survive for 24 hours' exposure at temperatures not exceeding 20° C. (warm room).

At 30° C. they do not resist an exposure of one hour duration.

At 40° C. (slightly above normal blood temperature) an exposure of 15 minutes is fatal.

B.—Exposure to Formaldehyde Watery Solution of various Strengths at 40° to 44° C.

Anthrax spores are killed in	20	minutes by	1	per cent.	solution.
" " " "	15-20	"	" 2·5	"	"	"
" " " "	2	"	" 4	"	"	"

The use of stronger solution does not appear to result in a saving of time, which from a practical point of view would be very material.

C.—Exposures to Mixtures of Water Vapour and Formaldehyde Gas at 44° C. to 62° C.

Anthrax spores may be killed by a 40 minutes' exposure to formaldehyde vapour at 44° C. given off by 2·5 per cent. formal at the same temperature. (Some spores, however, may resist for 50 minutes). A 60 minutes' exposure appears to be necessary to provide for the presence of highly resistant or protected spores. (In the solution itself the spores are killed in 20 minutes.)

Wool infected with anthrax spores was sterilised by a 30 minutes' exposure to the vapours given off at 62° C. by 2 per cent. formal.

It is obvious that spores embedded in bloodclot would not be killed as rapidly as the bare or almost bare spores used in the experiments dealt with in this section.

Section VI.—Experiments bearing upon the Penetration of Wet and Dry Clots by Formaldehyde.

In most of the previous laboratory experiments formal had direct or almost direct access to anthrax spores, but in infected wool a fairly large proportion of spores may be more or less deeply embedded in clotted blood, mixed with soil, excreta, and other dirt.

Clotted blood is penetrated very slowly by most, and only to a very slight extent by some, disinfectants.

Spores embedded in clot are necessarily killed by disinfectants more slowly than bare spores, and the delay must be influenced by the thickness and state of the clot. If clots were capable of forming dense homogeneous unbroken dry masses of considerable thickness, they might offer an insurmountable obstacle to disinfectants. Homogeneous clots small enough to dry entirely before undergoing putrefaction are seldom more than 2 or 3 cm. in thickness when fresh. Such clots when they are dried in the air at summer's temperature (20° to 30° C.) shrink considerably, and become so fissured and brittle that it is difficult to find in the dry clot solid pieces measuring more than 2 to 5 mm. in thickness.

The natural clots found in Persian wools are generally broken up in small fragments, mixed with much granular débris derived from the soil, excreta, plants, vermin, &c.

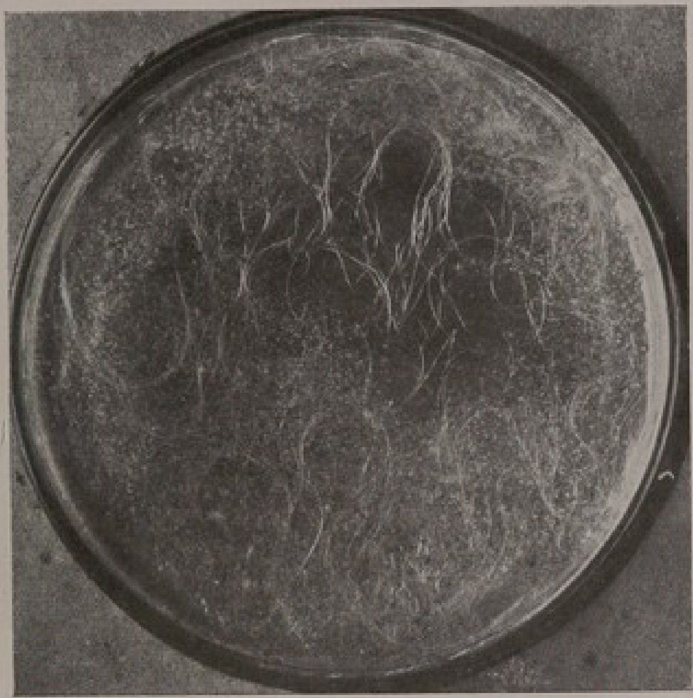
Some of these natural clots when placed in water behave like almost pure dry blood clots, yielding readily an abundance of blood pigment which gives to the water a deep red colour.

Other clots, so called, contain comparatively little blood and yield little pigment to the water in which they are immersed.

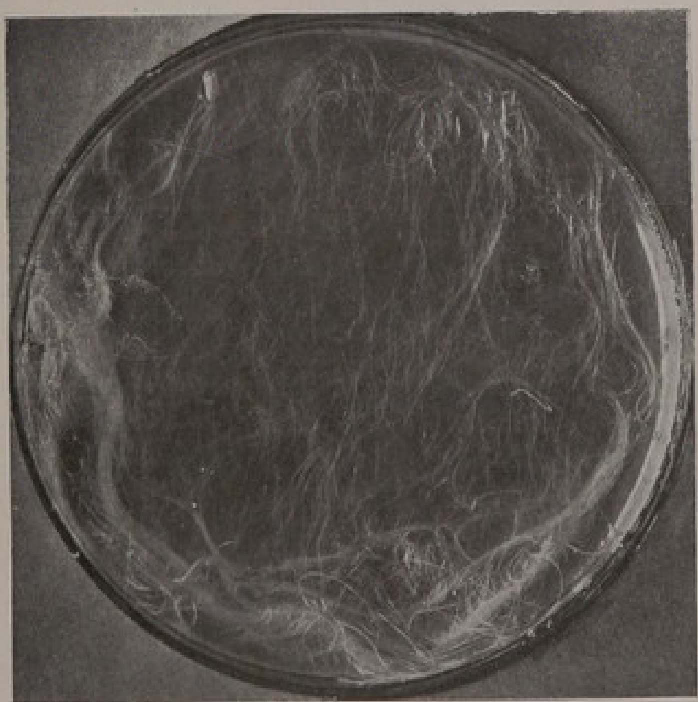
When a bloodclot, recent or dry, is immersed in a 4 per cent. watery solution of formaldehyde for a sufficient time, the blood pigment becomes insoluble, so that when the clot is placed in water the fluid remains practically colourless.

When a fresh clot is immersed in a 4 per cent. watery solution of formaldehyde at the ordinary temperature of the air, the formaldehyde penetrates into the clot slowly. The parts which have been penetrated are fixed, become stiff and assume a dark brown colour. The parts which have not been penetrated retain their normal colour, and are soft. If such a clot is

[To face page 62.



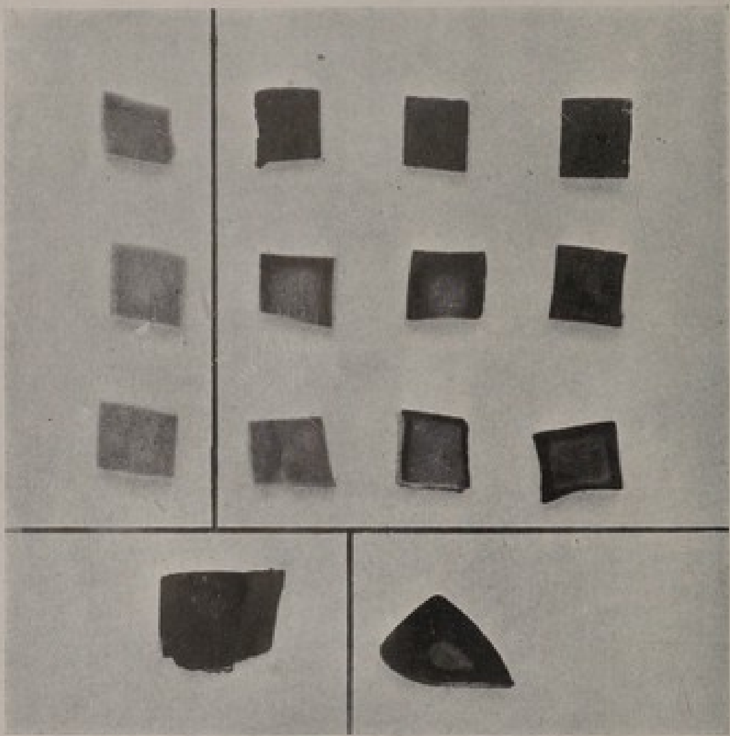
Control I.—Wool infected with Anthrax spores, washed in water at 40° C. for 30 minutes, rolled, transferred to ammonia, photographed after six days' incubation, innumerable colonies of Anthrax remaining small on account of their number. (*See* Report, pp. 61 and 62.)



Wool infected with Anthrax spores, washed in water at 40° C. for half an hour, rolled, and exposed to 2 per cent. formal vapours at 70° C. for half an hour, and transferred to ammonia. No growth observed. Photograph six days after incubation (other half of same clot used for control, *see* above). (*See* Report, pp. 61 and 62.)

20° C. 50° C.

1 per cent. 1 per cent. 2 per cent. 4 per cent



18 hours.

4 hours.

2 hours.

18 hours.

A. —2·5 per cent. solution.

B.—Vapours from 2·5 per cent. solution.

50° C.

Penetration of formaldehyde into cubes of well-contracted fresh clot (vol. about 1 c.c.). The parts which have been penetrated are dark grey in colour; the parts not penetrated are pale grey. Normal size. (Section VI., pp. 62–65.)

placed in water, no appreciable amount of red blood pigment is given off by the fixed parts. A brownish or yellowish pigment issues from the partly fixed part. More or less altered hæmoglobin is given off by the parts which have not been acted upon, and imparts to the water a scarlet or purplish red colour.

After a time the latter parts are decolorised by water and assume a pale buff white colour. It is, therefore, easy to determine to what depth formal has penetrated into a clot immersed in that fluid.

Some determinations of this kind were made in the following way:—

Two litres of ox blood was allowed to clot. After 48 hours, when the clot had become firm, it was cut into cubical masses measuring approximately 1, 3 and 8 cubic centimetres. Some of the smaller cubes were placed in formal and formal vapours of various strengths at different temperatures. Some of the larger cubes were dried slowly in air at 20° C., and others were dried more rapidly at 50° C. The cubes which had been exposed in the fresh state to formal and formal vapour for various lengths of time were then transferred to water after being cut into three slices to expose their central parts to the direct action of water. The colour of the water and the various parts of each clot were noted, and the thickness of the fixed parts of the clot measured as exactly as possible.

The results of these experiments are given in the following table:—

Penetration of Formaldehyde into fresh, well-contracted Blood Clots (Volume, 1 c.c.) immersed in 20 c.c. of 1, 2, and 4 per Cent. Formal at 50° C. and 20° C.

Temperature.	Strength of Formal.	Duration of the Exposure.			—
		2 hours.	4 hours.	18 hours.	
50° C.	4 per cent.	2 mm.	4 to 5 mm.	5 to 6 mm.	Depth of penetration.
		Yellowish red.	Yellowish.	Colourless.	Colour of the water.
	2 per cent.	1 mm.	3 to 4 mm.	5 to 6 mm.	Depth of penetration.
		Orange red.	Yellowish red.	Colourless.	Colour of the water.
	1 per cent.	½ mm.	1 to 1½ mm.	4 to 5 mm.	Depth of penetration.
		Scarlet, slight orange tint.	Orange red.	Yellowish.	Colour of the water.
20° C.	1 per cent.	0 ?	0	1½ to 1 mm.	Depth of penetration.
		Scarlet blood colour.	Scarlet blood colour.	Orange red.	Colour of the water

Penetration of Formaldehyde into fresh, well-contracted Blood Clots (Volume, 3 c.c.)

A. Immersed in 2·5 per cent. formal.

B. Exposed to vapours from 2·5 per cent. formal at 50° C. for 18 hours.

Temperature.	Strength of Formal.	A. Formal Solution. (18 hours).	B. Formal Vapour. (18 hours).
50° C.	2·5 per cent.	6 to 7 mm.	4 to 5 mm.

These experiments show that the rate of penetration is considerably influenced by the strength and temperature of the solution, and that although a clot immersed in formal is more rapidly penetrated than one exposed to the vapours from the same solution, the vapours have a power of penetration which is quite material for practical purposes. (*See* photograph opposite.)

The next experiments had for object to ascertain to what extent dry clots would be penetrated when immersed in formal or exposed to its vapours.

A number of fragments of the clot used in the previous experiment, and dried as explained above, were placed under the bell jar, part of them immersed in 1 per cent. formal and another part in a capsule placed about 2 inches above the capsule containing the formal. The jar, after being hermetically sealed, was placed in an incubator at 50° C.

As usual, the solid fragments of dry clot were small, none measuring more than 4 mm. in thickness; some of those used in these experiments measured in their smallest dimension 3 mm., the others were smaller.

The fragments which had been immersed in formal for two hours were hard and tough. They were not brittle and were not easily crushed. These small fragments macerated in water for several days did not alter, and the water remained colourless and clear.

The fragments which had been exposed to formal vapour for two hours had remained brittle, and were more easily crushed. The crushed clots when placed in water gave off slowly a material amount of orange red pigment.

Fragments which had not been immersed in formal or exposed to formal vapour were very easily crushed, and yielded rapidly a much larger amount of scarlet red pigment.

A dry natural clot composed of fragments measuring about 3 mm. may, therefore, be entirely penetrated by formaldehyde after an immersion of two hours in 1 per cent. formal at 50° C. Exposure to vapours arising from the same solution had only a partial effect on the clot.

This experiment was repeated with larger fragments of dry clot. The thickness of some of these fragments was more than 4 mm.; some measured over 10 mm. in length. Several of these fragments had a volume of 200 to 300 cubic mm.

The experiment was conducted as the previous one, but 4 per cent. formal was used, and the effects of the exposure were tested at various intervals. For comparative purposes, some clots were immersed in the 4 per cent. formal, and others were placed in the vapours after their surface had been wetted with the solution, the excess of fluid being removed with filter paper.

Some of the clots exposed to the vapours were, therefore, quite dry and placed on the upper part of the chamber where condensation of water was not taking place; other clots were exposed to the same vapours after their surface had been damped. To compare accurately the effects of exposure, 0·5 gramme of each treated clot was ground to a fine powder and treated by 75 c.c. of distilled water for 24 hours, after which the amount of pigment in the water and the degree of decoloration of the treated blood powder were noted. The results of these sets of experiments are given in the following table:—

Action of 4 per Cent. Formal at 50° C. upon Dry Clots immersed in it compared with the action of the Vapours arising from the Solution at 50° C. upon Dry Clots the surface of which remains dry, and upon Dry Clots the surface of which is damp.

Duration of Exposure.	Clots exposed to Vapours.		Clots immersed in Formal.
	Clots quite dry.	Clots damped with Formal.	
3 hours - - - - - -	83·3	20	17
5 " - - - - - -	50	17	12·5
8 " - - - - - -	—	10	—
12 " - - - - - -	—	—	0 to 1
17 " - - - - - -	25	—	—
24 " - - - - - -	20	—	0 to 1

The figures indicate the amount of more or less modified hæmoglobin present in the water estimated colorimetrically by comparing the colour of the water used to wash the treated clot with water which had acted for the same time, and in the same proportion as to quantity, upon a portion of the dry clot which had not been treated. The coloration observed in this control solution is taken as 100; — means no observation made.

To ascertain whether these experiments on artificial clots were applicable to natural clots, I took one of the large natural clots supplied to me by Mr. Duckering, and divided it into two parts, which were placed in water. Blood pigment issued at once from the clot and stained the water.

One-half was removed after a few minutes and immersed in 2 per cent. formal at 20° C. The stained water retained in the wet cloth imparted some colour to the formal. The other half of the clot was left in water.

Three hours later the appearance of the fluid in both cases was as follows:—

Clot treated by ordinary water	- Water deeply blood-stained; turbid.
Clot treated by 2 per cent. formal	- Water brownish yellow. The pigment which at first had passed into solution formed a brown sediment.

The clots were then removed from the water and formal, respectively, placed in beakers containing equal amounts of water and kept under observation for four days. At the end of that time the appearances were as follows:—

Clot treated by ordinary water	- Water deeply blood-stained; turbid.
Clot treated by 2 per cent. formal	- Water clear; very pale yellow.

A second natural clot was used to study the effect of exposure to vapour arising from a 2 per cent. formal solution at 50° C., the apparatus used being the same as in previous vapour experiments. For control purposes the clot was divided into two equal parts, one part being exposed to vapour arising from formal at 50° C., the other half to vapours arising from ordinary water at 50° C. (The wool was slightly moist at the beginning of these experiments.)

After an exposure of 3½ hours to vapour, each half of the clot was immersed in 200 c.c. of distilled water, with the following results:—

Clot exposed to water vapour at 50° C.	Water is rapidly stained by blood, is very turbid, and froths on shaking.
Clot exposed to formal vapour at 50° C.	Water pale brownish yellow, slightly turbid; does not froth on shaking.

The clots were transferred to fresh water and thoroughly shaken. After 48 hours the appearances of the water were as follows:—

Clot exposed to water vapour at 50° C.	Water dark brownish red, turbid, frothing on shaking.
Clot exposed to formal vapour at 50° C.	Water pale yellow, clear; does not froth on shaking.

From these two sets of experiments it would appear that natural clots in wool are more easily penetrated by formal than the experimental clot which I have used to estimate the penetration power of formal.

SECTION VII.—A. COMMENTS UPON THE VALUE OF THE METHOD INVESTIGATED BY THE ANTHRAX COMMITTEE.

The complete disinfection of highly-infected wool containing clots can be effected by the method elaborated at Bradford by the Sub-Committee.

Constantly good results were obtained when the wool was treated according to the method used in the nine experiments performed in February and March 1917 (Experiments 108 to 116, inclusive).

The procedure finally adopted by Mr. Duckering is as follows:—

1. A. Treatment in warm (46° C.) soap solution	20	minutes.
B. Passage between rollers.		
C. Treatment in warm soap solution	10	"
D. Passage between rollers.		
E. Treatment in warm water	10	"
F. Passage between rollers.		
2. G. Treatment in warm (38° to 39° C.) formaldehyde (2·34 to 2·69 per cent.) solution	15	"
H. Passage between rollers		
J. Treatment in warm formaldehyde solution	15	"
K. Passage between rollers.		
3. L. Drying in a current of hot air (71° to 75° C.)	17 to 25	"
4. M. Storage for several days before distribution.		

The time occupied by the actual treatment (without counting the delays which may be caused by five passages between rollers) must therefore be about 1½ hours, during which some 11 operations have to be carried out. Provision must also be made for the storage of the treated wool during a period of at least 48 hours.

The multiplicity of steps is not in itself so objectionable as it might appear, because the method lends itself to continuous treatment carried out automatically by machinery of a simple character and easily managed.

There are very few efficient disinfecting methods which can be applied to wool without damaging it more or less. Steam at atmospheric pressure, which provides a simple, rapid and efficient method, is condemned by practical men on account of the deteriorating effects which exposure to a temperature above 80° C. has upon wool. On the other hand, they are satisfied that formaldehyde does not damage wool and does not render it unsuitable for the various manufacturing processes to which it has to be submitted.

Disinfection of wool imported from certain countries is attended with serious difficulties owing to the fact that the material is often very dirty, matted by various products, such as excreta and blood, which sometimes form fairly large masses, termed "clots" in this report.

These "clots" render disinfection by any process difficult to carry out. The importance of the "clots" is not due to the fact that they are the only parts infected with anthrax spores, but to the difficulty which most chemical disinfectants have of penetrating into them before they can reach the spores which these clots contain or cover.

Thus, although there are consignments of infected wool which contain few or no clots, it is absolutely necessary to provide for wool containing clots. A method efficient in the case of wool containing clots can be relied upon for the treatment of wool free from clots.

For the purpose of their investigation the Sub-Committee used artificial clots. Some of these, though probably more highly infected than most natural clots, were, in my opinion, not suitable for the purpose on account of the ease with which wool can be freed from citrated blood by a simple water treatment. In the later experiments, which include all the crucial ones, the Committee used artificial clots made with non-citrated blood which were entirely suitable for the purpose, and which I have found to be as resistant, and sometimes more resistant, than the most resistant natural clots I have had the opportunity to investigate. From the information given to me by Mr. Duckering, these natural clots were of the worst type (*see* discussion of Table I., and Section IV., page 53).

I am of opinion, therefore, that it is safe to estimate, on the basis of the experimental work conducted at Bradford, the effects which the method investigated would have upon naturally infected wool.

With regard to the utility of the various steps in the treatment, both the failures and successes point to the fact that each one of the operations carried out in the final experiments is useful and necessary to final success in the time and under the conditions previously stated.

The experimental results which I have detailed in Sections IV., V. and VI. of my report show the importance of the operations forming part of the wet process adopted by the Committee.

The use of each step may be summed up as follows:—

1. Washing and agitating in warm soap solution brings about softening and complete, or almost complete, removal of clots and dirt, as well as general warming of the wool and clots which is favourable to the rapid action of the formaldehyde. A slightly alkaline or soap solution is preferable to pure water (*see* pages 54 and 55 of report).

Repeated passage between rollers helps in the breaking up of the clots and favours the penetration of water, softening and removal of the clots.

At the end of this part of the process the local infection due to the presence of spores in clots is reduced, but the general infection of the wool is increased. The spores have, however, become more generally accessible (*see* Section IV. of report).

2. *Treatment by warm Formal.*—The strength and temperature specified both promote disinfection (*see* Section V. of report).

The passages between rollers help to remove more clot and to redistribute the solution. The final rolling prepares the wool for the hot air treatment and causes the excess of solution which is still capable of action to return to the formal bath.

3. Even after the formal bath some of the spores escape the action of the formaldehyde.

The action of the formaldehyde is continued and increased during the treatment by hot air.

4. During the whole course of the investigation it has been found that when the action of formaldehyde was arrested immediately after the short treatment by hot air, the disinfection of some of the clots was incomplete. On the other hand, complete disinfection was obtained when the action of the disinfectant was not arrested previous to the storing of the dried wool. The best results were obtained when the wool had been stored up for some 48 hours or longer.

B. *Conclusions.*

1. The rapid treatment of large quantities of wool by agitation in warm water necessarily demands a fairly extensive machinery and the use of a large amount of fuel and water.

If, however, all these things have to be provided for the usual purpose of scouring, no material objection can be offered to this part of the process except as regards the disposal of the infected wash-water.

In a well populated and cultivated district the discharging of this infected water into the sea, lakes, streams, drains or sewers, or upon land or filter beds, could not be tolerated unless the wash-water had been thoroughly disinfected. The cost of the treatment of the wash-water should therefore be taken into consideration. This is equally true, however, in the case of water used for wool scouring at the present time.

2. The process is applicable only after the bales of wool have been opened. It offers no protection to the workmen in charge of this work. In this respect it is not different from other methods of disinfection which might possibly be adopted.

3. To be effective it must be carried out thoroughly. The strength of the disinfectant and the temperature at various stages of the process must be under constant and accurate scientific control. The results should be submitted frequently to searching tests with the object of detecting the occurrence of defects that might otherwise escape detection.

(Signed) SHERIDAN DELÉPINE.

June 15th, 1917.

14. EFFECT OF THE PROCESS ON MATERIAL.

One of the most difficult problems in disinfection of wool and hair is that of avoiding damage to the material, and it was the subject of most anxious consideration by us. The method followed in the earlier experiments in order to ascertain the effect on the fibre has been described in section 6A. Briefly, it consisted, after the failure of the attempt to judge the condition of the treated material by tests of the strength and elasticity of fibres, in submitting samples of the various materials (alpaca, mohair, and Persian wool) used as damage test material to experts in each variety. This was sufficient to show that the damage could not be very serious, but it was always our expressed intention to carry out experiments on a large scale as soon as we were satisfied that a method had been evolved which secured effective disinfection while avoiding obvious serious damage to wool and hair. We proposed to treat not less than 1,000 lbs. of each of several varieties of wool and hair, and to have this combed, spun, woven, and dyed under close observation by firms who could be trusted to observe and report fairly on the behaviour of the material.

Mr. George Feather,* Director of the firm of Messrs. John Feather & Son, Ltd., had examined several samples of Persian wool used as damage test material in the various experiments, and was so impressed by the apparent absence of adverse effect on this material that he approached us and offered, on behalf of his firm, to place at our disposal 5,000 lbs. of Persian wool (or more if necessary) for an experiment in disinfection on a commercial scale. He suggested that half should be treated by our process, and combed by a comber selected by us, and half should be combed by the same comber untreated. He undertook to run all the risks of damage to the material and to pay all the costs of combing. The only stipulation he made was that all tops, noil, and waste produced should be returned to him (except such samples as we might desire to retain), but he also undertook to sell the products at their proper value to any spinner with whom we might make arrangements or to allow us to make the sale. There was necessarily a time limit on the offer, as the wool was then being combed. Our experiments were not complete, though the general principles of the method of disinfection were worked out, and it was clear that it would be successful in greater or less degree. We decided, therefore, to endeavour to take advantage of Mr. Feather's offer, and at the same time to carry out experiments on the commercial scale with other materials. Messrs. John Foster & Son, Ltd., of Queensbury, undertook to supply 1,000 lbs. of a mohair and 1,000 lbs. of an alpaca matching, and to comb, spin, weave, dye, and finish the materials after disinfection. Similarly Messrs. James Walker & Sons, Ltd., Mirfield, undertook to supply the Sub-Committee with 600 lbs. of East Indian wool and to manufacture the treated material into blankets; while Mr. L. H. Clegg, on behalf of Messrs. The Bury Felt Manufacturing Co., Ltd., undertook to supply 90 lbs. of East Indian felting wool and to manufacture it, after treatment, into felt. We cannot express too highly our appreciation of the public-spirited and generous action of these gentlemen and the firms they represent.

The question of obtaining the plant necessary for the process was one of great difficulty. It had been decided to borrow and use an existing scouring plant and to adapt it to the needs of the method of disinfection. Such a plant usually consists of three long tanks or washbowls, each having a pair of squeezing rollers at the delivery end. The wool is fed continuously into the machine, passed forward by means of rakes through soap solution contained in the tanks, and delivered by a travelling lattice from one tank or bowl to the next, and finally into a drying machine. The great difficulty was the dearth of scouring machines, those installed in factories being more than fully employed. Eventually the Chairman of the Bradford Education Committee, Mr. Squire Deighton, was approached and asked to give us the loan of the scouring and drying plant forming part of the machinery for technical instruction at the Bradford Technical College. This he did, and we desire to take this opportunity of recording our thanks to him and to those members of the Staff of the College who were put to much inconvenience by the demands made upon them, but who whole-heartedly endeavoured to meet the unusual requirements of the Sub-Committee. To Mr. James, the Electrical Engineer, especially, thanks are due.

The scouring plant in question consists of three scouring bowls and a detached drying machine. The water in the scouring bowls is heated by the admission of steam in the usual way. The drying machine consisted of several chambers, separated by rollers through which the wool could pass, and into which a blast of hot air could be projected, which impinged directly on the wool as it entered through the rollers and carried it over a bridge into the nip of the succeeding pair of rollers. The time occupied by the wool in going through the whole of the bowls in the ordinary process of scouring was about four minutes, and about two minutes were required for it to pass through the drying machine. The process of disinfection necessitated the wool remaining in water for at least 20 minutes, and in formaldehyde solution also for 20 minutes, while drying should extend to 15 minutes. Further, it was recognised that it would be impossible for men to work in a room in which was an open vessel containing several hundred gallons of a warm solution of formaldehyde. The fact that the drying machine was detached from the scouring bowls, thus rendering it necessary to convey the wool in trucks from the end of the formaldehyde bowl to the feed lattice of the drier, was also a difficulty. Finally, it was decided to use the first and second bowls for

* Mr. Feather has since been appointed a member of the Committee.

the preliminary process and the third for the disinfection process, and to cover or box in the third bowl (in which it was intended to place the formaldehyde solution) by means of a wooden erection enclosing all the mechanism of the bowl except the driving pulley and rollers. There still remained the difficulty of conveying the material damp with warm formaldehyde solution from the bowl to the drying machine, but no way of avoiding this could be devised. In order to slow down the machinery to the rate desired a countershaft was put down and alterations made to the pulleys and in the supply of electric current. In order to control the temperature of drying, a thermometer was fixed in the blast of air in the first chamber of the drier in such a position that readings could be taken through a small glass window from outside the machine. When the necessary alterations had been decided on, it was found impossible, or at all events extremely difficult, to get men to carry them out, and eventually Mr. Jackson (the manager of the Bradford Conditioning House) came to our help and supplied the necessary mechanic and carpenter. The alterations were then made partly by these men and partly by members of the Sub-Committee themselves, aided by members of the College Staff. When the machinery was finally adapted, the material required the following times for its passage through it:—

Wool passing through first bowl from immersion to nip of rollers required -	15 minutes.
Wool passing through second bowl from immersion to nip of rollers required - - - - - - - - -	8 minutes.
Wool passing through third bowl from immersion to nip of rollers required	17 minutes.
Wool passing through drying machine from first nip of rollers to emergence	12 minutes.

It was arranged that the first two bowls should be devoted to the preliminary process, and the time occupied by wool in passing through these from the moment of immersion to entering the third bowl was 25 minutes, including two minutes spent on the travelling lattice from the rollers to the immersing mechanism. The third bowl, of which the capacity is 700 gallons, was used for the disinfection treatment, and the time occupied by wool in passing through it from the moment of immersion to falling into the truck below the delivery lattice was 18 minutes. In addition, there was a period of waiting of over 10 minutes, on the average, before it could be placed on the feeding lattice of the drying machine, so that the total time of exposure to the formaldehyde solution before drying was about 30 minutes when the machinery was working properly. Owing to breakdowns the time was often extended (sometimes several hours), so that, in fact, the materials or portions of them were exposed to the action of formaldehyde solution for periods greatly in excess of that necessary for disinfection.

Having adapted the machinery as well as possible to our requirements, we were again faced by the impossibility of obtaining men. Mr. Jackson lent two unskilled men for trucking the material from the third bowl to the drier, and for packing the wool, but it was impossible to get a skilled washbowl minder, or even a man who was capable of feeding the machine. Eventually Mr. Mackinder (a member of the Committee) undertook the feeding of the machine, a position of some danger, as part of the material used was Persian wool containing many locks from which bloodstains had not been removed. Mr. Duckering supervised the general working of the process, while Mr. C. E. Biggin (Manager of Messrs. John Cure & Co., Ltd.,) kindly undertook to give assistance and advice in the management of a scouring machine, and his help in the first experiment, in which the machinery almost refused to work, was invaluable. It is obvious that in such experiments, whose only object was to indicate the effect of the treatment on the material, we ran a considerable risk of failure, at all events in the earlier ones, owing to our inexperience in the management of the machinery as adapted, since bad scouring alone can damage wool to a very considerable extent. It was difficult to adopt any other course, however, since experienced men were not available, and even if obtained would have been inexperienced in the process of disinfection. On this account we were prepared to urge that an adverse effect on the material, if small, should be discounted, and judgment suspended till experience in the working of the process on a commercial scale had been acquired.

The scouring and drying machinery was, of course, made to run very much more slowly than the speed for which it was designed, with the result that very great difficulties were experienced in making it work. Moreover, the third washbowl, *i.e.*, the smallest of the three, was made to run relatively more slowly than the first two, so that there was a considerable degree of congestion of the wool in this bowl. The effect of the slow speed of the mechanism of the first and second bowls, and of the relatively slower speed still of that of the third bowl, was that when a slightly increased supply of wool reached the rollers, especially those of the third or formaldehyde bowl, the machinery stopped, either because one or more of the belts slipped or broke or came off the pulleys. Further, owing to wool having become jammed in the rollers of the drying machine, the chains driving them broke repeatedly till the cause was discovered and removed. There were thus frequent delays—some of several hours—during which the wool remained immersed in formaldehyde solution or in water. The effect on the material should, therefore, be a maximum, and much greater in these test experiments than it would be in actual practice where properly designed machinery would be used. Moreover, when the wool jammed in the rollers of the formaldehyde bowl, the only method of relieving the block was to remove the material, saturated with formaldehyde solution, by hand, and throw it on the floor at the side of the machine. Not only did the wool become tangled in consequence, but the atmosphere became heavily charged with the pungent, irritating vapour of formaldehyde, and was almost irrespirable. We wish to express appreciation of the conduct of the workmen in continuing their work under these conditions. There was in consequence also considerable waste of formaldehyde solution, but the experience gained in the use of large quantities of formaldehyde solution should prove of value if the process be ultimately applied in practice. The necessity for trucking the damp wool from the end of the disinfection bowl to the detached dryer was also a possible source of slight damage to the wool, since damp wool is easily caused to felt.

The details of the experiments are as follows :—

(a) Experiments with Persian Wool.

Experiment 1.—The material supplied to us by Messrs. John Feather & Son, Ltd., for use in this experiment consisted of three unopened bales of brown Bagdad wool, part of which was greasy. They were placed at the side of the feed lattice of the first bowl, broken open, and the fleeces opened and placed on the feed lattice. Most of the fleeces contained a considerable quantity of locks foreign to them, and most of the wool composing the fleeces was distinctly greasy. The following are the details of the experiment :—

Time of passage of the wool through water in first two bowls (preliminary treatment) - - - - - - -	29 minutes.
Temperature of water in first two bowls - - - - -	99°–103° F.
Time of passage of wool through formaldehyde solution in third bowl (disinfection treatment) - - - - -	19 minutes.
Temperature of formaldehyde solution in third bowl - -	102° F.
Strength of formaldehyde solution (per cent. by weight) - -	2·81, falling to 2·49.
Average time between discharge from disinfection bowl and feeding into drying machine - - - - - - -	12 minutes.
Temperature of air passing into drying machine - - -	160° F.
Time of passage of wool through drying machine - - -	12 minutes.

The above times are those observed when the machinery was working properly. Breakdowns were, however, frequent, and were for periods varying from a few minutes to three hours. During the stops the wool had to remain at the point it had reached, whether in the preliminary process or in the formaldehyde solution, or in the drying machine. Some of the stops were caused by jamming of the wool in the rollers of the formaldehyde bowl. The material causing the block had then to be pulled out by hand and thrown on the floor without squeezing. In the course of the experiment a considerable heap collected, and the whole had to be placed on the feed lattice leading to the disinfection bowl, since it could not be put through the drier in its saturated state, and it was impossible to feed it into the rollers except indirectly by passage through the disinfection bowl. This quantity was therefore treated twice.

The treated material and three unopened bales from the same lots of Bagdad wool were sent for combing. At the combers the untreated material was opened, and the bloodstains sorted out. It then became clear that there was great variation in the wool composing the bales, and also in the quantity of locks inside the fleeces. With the exception that the untreated material was sorted, the two lots were treated in exactly the same way, being scoured, willowed (fearnought), carded, combed and finished on the same machines. No difference was observed in the working of the material, though both the comber and his carder were of opinion that the treated material had a softer handle than the untreated. The results of combing were as follows :—

Product.	Treated Material.		Untreated Material.	
	Weight (Pounds).	Per Cent.	Weight (Pounds).	Per Cent.
Top - - - - - - - - - -	447	44·52	497	48·11
Noil - - - - - - - - - -	115	11·46	94	9·10
Waste - - - - - - - - - -	17	1·69	6	0·58
Sinkage (Loss). In Disinfection - - - - -	202	20·12	—	—
Sinkage (Loss). In Combing - - - - -	223	22·21	436	42·21
Sinkage (Loss). Total - - - - - -	425	42·33	436	42·21
Raw wool - - - - - - - - -	1,004	100·00	1,033	100·00
Tear, *i.e.*, ratio $\frac{\text{Top}}{\text{Noil}}$ - - - - - -	3·88		5·29	

The value of raw material is judged principally by the yield of top and noil together, partly by the proportion between the various products of combing, and partly by the quality of the main products (tops and noils). The tops and noils were examined by several experts, none of whom could detect any difference in the quality, although all expressed a preference for the treated top, but solely on the ground that it contained less grey hair. Judged by the combing results the untreated material gave a better yield of top, and a better total yield of top and noil than the disinfected material, while the latter gave a higher yield of noil. The loss in combing was practically the same in the two cases. This would be generally taken to mean that the former was a better and more valuable combing material than the treated material. Mr. Feather, however, in considering the result, pointed out that the proportion of top to noil in the untreated material was much above the average, and that the yield of top from the treated material was also higher than the average which was being obtained from the bulk lot from which it was taken. He also stated that in his opinion there was no difference in the value of the products. The question was further complicated by the facts that small lots almost invariably give results which are not comparable, and that in using raw material from bales of greasy Persian wool, it is impossible to ensure that two successive portions are even approximately similar (a fact which will be appreciated readily by combers and top-makers). He therefore suggested that another experiment should be carried out.

Experiment 2.—In this experiment the wool composing three bales of the same lots of Persian wool as that used in Experiment 1 was first sorted and bloodstains removed. It was then thrown on a heap which was divided into two parts, one of which was disinfected and combed, while the remaining part was combed without being disinfected. Careful observation of the material was made, and it was remarked that the portion taken for disinfection appeared to contain many more locks than that part which was combed only. The details of the disinfection treatment are as follows :—

Time occupied by preliminary treatment of wool - - -	28 minutes.
Temperature of water in preliminary treatment of wool - -	102° F.
Time occupied by disinfection treatment of wool - - -	19 minutes.
Temperature of formaldehyde solution in disinfection treatment -	103° F.
Strength of formaldehyde solution in disinfection treatment (per cent. by weight of formaldehyde) - - - -	2·45, falling to 2·28 per cent.
Average time between discharge from disinfection bowl and feeding into drying machine - - - - - -	12 minutes.
Time occupied in passing through drying machine - -	12 minutes.
Temperature of air passing through wool in drying machine -	155° F. to 165° F.

In this experiment there were a few short stops owing to difficulties with the machinery, but the longest occupied only a few minutes. In the various processes of combing the two portions were treated in exactly the same way. No difference in behaviour was observed, but it was again noticed that the treated material was a little softer than the untreated. The combing results from the two lots were as follows :—

Product.	Treated portion of Material.		Portion of Material not disinfected.	
	Weight (Pounds).	Per Cent.	Weight (Pounds).	Per Cent.
Tops - - - - - - - - - -	249	48·92	216	48·21
Noils - - - - - - - - - -	56	11·00	37	8·26
Shoddy - - - - - - - - -	3·5	0·69	3·5	0·78
Sinkage (Loss). In Disinfection - - - - -	183	35·95	—	—
Sinkage (Loss). In Combing - - - - -	17·5	3·44	191·5	42·75
Sinkage (Loss). Total - - - - - - -	200·5	39·39	191·5	42·75
Raw wool - - - - - - - - -	509	100·00	448	100·00
Tear, *i.e.*, ratio $\frac{\text{Top}}{\text{Noil}}$ - - - - - -	4·45 to 1		5·84 to 1	

The result of this experiment, judging by the combing results, was that the disinfected part of the material gave an appreciably higher yield of both top and noil than the part not treated, while the latter had a correspondingly higher loss or sinkage in combing. In spite of the fact that the proportion of top to noil is lower in the disinfected material than in that not disinfected, the former would, on the combing result, be regarded as the more valuable combing material. Again, there was no apparent difference in the products of combing, and Mr. Feather stated that in his opinion the process had no effect whatever on the wool, but that the result was still ambiguous, since the treatment could not be expected to improve the material and cause it to give a higher yield. He therefore suggested that we should treat a third quantity of Persian wool which should be taken from his main blend of sorted material then awaiting combing. It was anticipated that this course would obviate the chance of error inseparable from the use of raw material direct from the bale.

Experiment 3.—In this experiment 2,000 lbs. of Persian wool was pulled from a very large blend of sorted material and made into a small pile, which was then divided into two equal parts. One of these was disinfected and combed, and the other was combed on the same machines, and was treated exactly in the same way except that it was not disinfected. The details of the disinfection treatment are as follows:—

Time occupied by preliminary treatment of wool - - -	33 minutes.
Temperature of water in preliminary treatment of wool - -	102° F.
Time occupied by disinfection treatment of wool - - -	20 minutes.
Temperature of formaldehyde solution in disinfection treatment -	102° F.
Strength of formaldehyde solution in disinfection treatment -	2·35, falling to 1·91 per cent.
Average time between discharge from disinfecting machine and feeding into drier - - - - - -	12 minutes.
Time occupied by wool in passing through drying machine -	12 minutes.
Temperature of air passing through wool in drying machine -	155° F. to 168° F.

During Experiment 3 there were two stops of half an hour each and several shorter ones, owing to breakdowns of the machinery. No difference was observed in the behaviour of the treated and untreated material during combing, though the comber expressed the opinion that the treated material was inclined to be stringy after treatment and before combing. This defect is usually the result of faulty manipulation, which was unavoidable with the adapted machinery. One of the experts who examined the tops produced thought that the treated material was a little less lustrous than the untreated, and another thought the former slightly harsher to the touch than the latter, but otherwise no difference was observed. All the experts agreed that there was no difference in value. The results of combing were as follows:—

Product.	Treated Portion. Weight (Pounds).	Treated Portion. Per Cent.	Untreated Portion. Weight (Pounds)	Untreated Portion. Per Cent.
Tops	476	47·60	504	50·40
Noils	153	15·30	150	15·00
Shoddy	13	1·30	21	2·10
Sinkage (Loss). In Disinfection	206	20·60	—	—
Sinkage (Loss). In Combing	152	15·20	325	32·50
Sinkage (Loss). Total	358	35·80	325	32·50
Raw wool	1,000	100·00	1,000	100·00
Tear, *i.e.*, ratio $\frac{\text{Top}}{\text{Noil}}$	3·11		3·36	

Allowing for the difficulty of obtaining comparable results from small lots, partly due to the fact that there is not time to adjust accurately the supply of oil and water in the machines by which these are added to the wool, the results of combing the treated and untreated material are very closely similar.

The tops produced in Experiments 1 and 3 were supplied in the ordinary way of business, at ordinary market prices, to Messrs. W. Atkinson & Son, Ltd., St. Peg Mills, Cleckheaton, who expressed their willingness to take the risk of greater difficulties in spinning than usual. The firm observed closely the behaviour of the tops during drawing and spinning into yarn of three fold 14 in count, but could detect no difference whatever in comparison with the tops from the untreated material. Their report is as follows:—

St. Peg Mills, Cleckheaton,
7th December 1916.

"Dear Sir,

"In accordance with your wishes, we have taken very careful note of the two lots of brown Persian tops, 'treated' and 'untreated,' which you supplied to us for special observation.

"In our opinion, there is no material difference between these two lots, either in regard to spin or in the life of the material itself. Whatever process you may have passed this material through does not appear to us to have been in any way detrimental to the fibre.

"We are, &c.,
"For W. Atkinson & Son, Ltd.
"(Signed) H. Walker, Director."

"To the Secretary of the
"Departmental Committee on Anthrax."

The two lots of tops—treated and untreated—produced in Experiment 2 were sent out accidentally from the warehouse of Messrs. John Feather & Son, Ltd., in supplying an order from an old customer, and this was not discovered till after they had been spun. Inquiries were then made as to the spinning, to which the customer replied that the tops had spun well, and that no difference had been observed either between the treated and untreated tops or between the former and tops usually supplied by the firm. This was, of course, a result eminently satisfactory to us, since the spinner had no knowledge of the special treatment to which the material had been submitted, and if any difficulties had been met with, inquiries would have been addressed in the ordinary course to the top maker.

The yarn spun from material treated in Experiments 1 and 3 was supplied to Messrs. R. Walker & Sons, Ltd., Rutland Road, Leicester, for knitting into Cardigan jackets. Their report on the behaviour of the yarn is as follows:—

Leicester,
May 21st, 1917.

"Dear Sir,

"Referring to your letter, under date May 14th, we certainly had a quantity of yarn from Messrs. Atkinson, of St. Peg Mill, Cleckheaton, of their O.K. quality, which we understood they had spun from tops which had been treated by you with a special method of disinfection for the purpose of destroying anthrax in wool.

"From a manufacfuring point of view, we did not notice any special difference from the yarn that we were in the habit of having from Messrs. Atkinson, that is to say, we could work it all right, but in our opinion the treatment did not leave the yarn quite so full, and we had difficulty in getting our goods quite up to normal weight.

"This difficulty could be easily overcome by spinning the yarn half a count stouter.

"Trusting this information will be of service, and if you would like to have one of the garments we will gladly send one.

"We are, &c.,
"For R. Walker & Sons, Ltd.,
"(Signed) W. Brendle,
"Director."

"The Secretary of the
"Departmental Committee on Anthrax."

It is extremely unlikely that the want of weight and stoutness in the yarn could have been caused by the disinfection treatment of the raw wool, and this criticism applied both to the yarn made from treated and that spun from untreated material. Messrs. Walker & Son, Ltd., kindly sent us a Cardigan jacket made from each yarn, and these were submitted to experts for examination. No difference could be detected.

Messrs. John Feather & Son, Ltd., made the following report on the effect of the treatment on the material:—

" Wade Street, Bradford,
May 23rd, 1917.

"Dear Sir,

"*Disinfection of Persian Wool.*

"At various times in the course of 1916 you asked us to examine small quantities of Persian and other wools which you had treated by an experimental process of disinfection. These, in our opinion and that of others well acquainted with the characteristics of the materials, showed no obvious signs of damage or alteration in character. From our point of view, however, as top makers, it was essential, in order to enable us to form a correct judgment of the effect of the process on the fibre, that the treated material should pass through all the processes of manufacture and be under close observation during that time. With this end in view we supplied to you a quantity of Persian wool (from a large consignment we then had in combing) in three separate lots, half of each of which was treated by your process and combed and half was combed without treatment.

"We are aware of the fact that the disinfection treatment was carried out by means of machinery, not in itself quite suitable for the process, which had to be altered and adapted to meet the needs of the method of disinfection. In our opinion the effect of the alterations on the working of the machinery was such as to involve some risk of injury to the wool apart from the effects of the process altogether, though we recognise that the use of this machinery was unavoidable in the circumstances.

"*Lot* 1.—The first lot of wool we supplied to you consisted of 2,037 lbs. of Persian fleeces in bales as purchased, the majority of the fleeces containing locks and part of it being greasy. Of this quantity, 1,004 lbs. was treated by the process before combing and 1,033 lbs. was combed without treatment. No difficulty nor any difference whatever was observed in the behaviour of the two parts of the lot in any process of combing. When the tops were calculated to standard condition, the yield of top and noil was slightly higher from the treated than from the untreated material, though the 'tear' was lower in the case of the former than in that of the latter. Neither we nor others to whom the tops were shown could detect any deterioration in quality. This led us to seek some further reason than the effect of the process to explain the difference in 'tear.' Apart from the difficulty of securing strictly comparable results from the combing of such small lots, it is, of course, entirely impossible to say that the wool in unopened bales is quite similar throughout the whole of six bales, particularly because of the presence of greasy fleeces and fleeces containing locks, and it appeared to us that the difference in 'tear' could more adequately be explained by want of evenness in the wool than by the effect of the process, since the quality of the product was not affected.

"*Lot* 2.—The second lot supplied consisted of 957 lbs. of Persian wool in bales, entirely similar in character to those of Lot 1, which were opened in the ordinary way, sorted for blood and the wool thrown on a heap about half of which was taken for treatment and the remainder for combing without treatment. No difficulty was observed in combing, but the yield and 'tear' were much the same as in the first lot, *i.e.*, the yield was slightly higher and the 'tear' lower in the treated than in the untreated material. Again we could detect no difference in the tops produced, and there was still strong reason to think that the difference in combing results was more likely to be due to dissimilarity between the portions combed after treatment and combed without treatment than to the process itself.

"*Lot* 3.—In order to avoid the difficulty due to possible differences in the raw material, the third lot we supplied consisted of 2,000 lbs. of material taken from the large blend of sorted Persian wool we then had in combing. This quantity was carefully blended and divided into two equal parts, one of which was combed after treatment, the other without treatment by your process. As we expected, there were in this experiment only slight differences in the yield from, and the 'tear' of, the treated and untreated material, and the combing results were very closely comparable, the variations being only such as would be looked for in the combing of small lots consisting partly of greasy wool.

"The tops from lots 1 and 3 were sold at market prices to a spinner, to whom a careful explanation of the treatment was given, and he was asked to make careful observations on their behaviour in the course of drawing and spinning. This he undertook to do, and he has informed us that he can detect no difference whatever between the tops from the treated and those from the untreated portions of the two lots.

"The tops from lot 2 were accidentally sold in the ordinary course of business, and it was not till they were being spun that it was discovered they had left the warehouse. Inquiries of the spinner then elicited the reply that the treated and untreated portions of the lot had been spun in the ordinary way without any modifications, and that no unusual feature or difficulty had been observed.

"We are satisfied that the tops produced from raw material which has been treated by the process of disinfection in question are not in any way deteriorated and that its adoption as a means of preventing anthrax will not affect the uses to which the wool can be put. We are also of the opinion that the process itself does not affect the combing. There were certainly differences between the treated and untreated wool in the first two experiments, but the last one in which our blended wool was used appears to indicate conclusively that these were due to differences in the material itself and not to the effect of the treatment.

"Yours faithfully,

"For John Feather & Son, Limited,

"(Signed) Geo. H. Feather, Director.

"The Secretary of the Departmental Committee on Anthrax."

Results of Combing disinfected Persian Wool.

Samples of the tops and noils produced were examined in the Bradford Conditioning House, with the following results :—

Lot 1.—Return made by Combers.

——	Disinfected Part.		Part not disinfected.	
	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	447	44·52	497	48·11
Noil	115	11·46	94	9·10
Waste	17	1·69	6	0·58
Sinkage :—				
(*a*) In disinfection	202	20·12	—	—
(*b*) In combing	223	22·21	436	42·21
(*c*) Total sinkage	425	42·23	436	42·21
Raw wool	1,004	100·00	1,033	100·00
Tear	3·88	to 1.	5·29	to 1.

Results of Examination at the Conditioning House of Samples only.

(*a*) Tops.

	Per Cent.	Per Cent.
Dry weight of wool	86·25	84·37
19 per cent. regain	16·39	16·03
	102·64	100·40

Tops contain 2·64 per cent. less moisture than standard condition.

Tops contain 0·40 less moisture than standard condition.

	Per Cent.	Per Cent.
Gross loss in scouring	3·35	4·55
Oil and fat	2·64	3·10

(b) Noils.

	Per Cent.	Per Cent.
Dry weight of wool	86·72	87·19
14 per cent. regain	12·14	12·21
	98·86	99·40

Noils contain 1·14 per cent. more moisture than standard condition.

Noils contain 0·60 per cent. more moisture than standard condition.

	Per Cent.	Per Cent.
Gross loss in scouring	12·49	16·19
Oil and fats	4·10	5·88

Results of Combing when Tops calculated to Standard Condition and as clean scoured.

	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	443·4	44·16	476·3	46·11
Noils	115·0	11·46	94·0	9·10
Waste	17·0	1·69	6·0	0·58
Sinkage :—				
(a) In disinfection	202·0	20·12	—	—
(b) In combing	226·6	22·57	456·7	44·21
(c) Total	428·6	42·69	456·7	44·21
Raw wool	1,004·0	100·00	1,033·0	100·00
Tear	3·86	to 1.	5·07	to 1.

Lot 2.—Return made by Combers.

	Disinfected Part.		Part not disinfected.	
	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	249·0	48·92	216·0	48·21
Noils	56·0	11·00	37·0	8·26
Waste	3·5	0·69	3·5	0·78
Sinkage :—				
(a) In disinfection	183·0	35·95	—	—
(b) In combing	17·5	3·44	191·5	42·75
(c) Total	200·5	39·39	191·5	42·75
Raw wool	509·0	100·00	448·0	100·00
Tear	4·45	to 1.	5·84	to 1.

Results of Examination at the Conditioning House of Samples only.

(a) Tops.

	Per Cent.	Per Cent.
Dry weight of wool	80·90	85·00
19 per cent. regain	15·37	16·15
	96·27	101·15

Sample of tops contains 3·73 per cent. more moisture than is allowed for standard condition.

Sample contains 1·15 per cent. less moisture than is allowed for standard condition.

	Per Cent.	Per Cent.
Gross loss in scouring	5·07	5·21
Oils and fat (by ether extraction)	2·77	3·34

(b) Noils.

	Per Cent.	Per Cent.
Dry weight of wool	89·76	89·22
14 per cent. regain	12·57	12·49
	102·33	101·71

Sample of noils contains 2·33 per cent. less moisture than is allowed for standard condition.

Sample contains 1·71 per cent. less moisture than is allowed for standard condition.

	Per Cent.	Per Cent.
Gross loss on scouring	13·51	15·82
Oil and fats (by ether extraction)	5·37	5·53

Results of Combing when Tops calculated to Standard Condition and as clean scoured.

	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	226·5	44·50	207·2	46·25
Noils	56·0	11·00	37·0	8·26
Waste	3·5	0·69	3·5	0·78
Sinkage:—				
(a) In disinfection	183·0	35·95	—	—
(b) In combing	40·0	7·86	200·3	44·71
(c) Total sinkage	223·0	43·81	200·3	44·71
Raw wool	509·0	100·00	448·0	100·00
Tear	4·05	to 1.	5·59	to 1.

Lot 3.—Return made by Combers.

—	Disinfected Part.		Part not disinfected.	
	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	476·0	47·60	504·0	50·40
Noils	153·0	15·30	150·0	15·00
Shoddy	13·0	1·30	21·0	2·10
Sinkage:—				
(a) In disinfection	206·0	20·60	—	—
(b) In combing	152·0	15·20	325·0	32·50
(c) Total sinkage	358·0	35·80	325·0	32·50
Raw wool	1,000·0	100·00	1,000·0	100·00
Tear	3·11	to 1.	3·36	to 1.

Results of Examination of Samples only at the Conditioning House.

(a) Tops.

	Per Cent.	Per Cent.
Dry weight of 100 lbs. of tops	86·09	84·73
19 per cent. regain	16·36	16·10
	102·45	100·83

Sample of tops contained 2·45 per cent. less moisture than is allowed for standard condition.

Sample of tops contained 0·83 per cent. less moisture than is allowed for standard condition.

	Per Cent.	Per Cent.
Gross loss in scouring	3·62	3·84
Oil and fats (by ether extraction)	2·16	1·98

(b) Noils—Not tested.

Results of Combing when Tops calculated to Standard Condition and as clean scoured.

	Pounds.	Per Cent.	Pounds.	Per Cent.
Tops	470·2	47·02	488·7	48·87
Noils	153·0	15·30	150·0	15·00
Shoddy	13·0	1·30	21·0	2·10
Sinkage:—				
(a) In disinfection	206·0	20·60	—	—
(b) In combing	157·8	15·78	340·3	34·03
(c) Total sinkage	363·8	36·38	340·3	34·03
Raw wool	1,000·0	100·00	1,000·0	100·00
Tear	3·07	to 1.	3·25	to 1.

Experiments with Mohair and Alpaca.

Experiment 4.—The material used in this experiment consisted of 1,042 lbs. of ordinary quality mohair matching of preparing length blended with a little wool. It had been sorted in the usual way, and was supplied to the Committee in sheets. The details of treatment are as follows:—

Time occupied by preliminary treatment of mohair in water	29 minutes.
Temperature of water in preliminary treatment of mohair	102° F.
Time occupied by disinfection of mohair in formaldehyde solution	19 minutes.
Temperature of formaldehyde solution	102° F.
Strength of formaldehyde solution (by weight)	2·08 per cent., falling to 1·91 per cent.
Average time between discharge of wool from disinfection bowl and feeding into drying machine	12 minutes.
Time occupied by mohair in passing through drying machine	12 minutes.
Temperature of air passing through mohair in drying machine	168°–170° F.

During treatment of the mohair there were a few involuntary stops, due to machinery difficulties, none of which was of long duration.

Experiment with Alpaca.

Experiment 5.—In this experiment 1,025 lbs. of an ordinary quality matching of alpaca blended with a little wool was used. It had been sorted in the usual way, and was delivered to the Sub-Committee in sheets. The details of its treatment are as follows:—

Time occupied by preliminary treatment of alpaca in water	29 minutes.
Temperature of water in preliminary treatment of alpaca	102° F.
Time occupied by disinfection treatment of alpaca in formaldehyde solution	19 minutes.
Temperature of formaldehyde solution	102° F.
Strength of formaldehyde solution (by weight)	2·54 per cent., falling to 2·08 per cent.
Average time between discharge of wool from disinfection bowl to feeding into drying machine	12 minutes.
Time occupied by alpaca in passing through drying machine	12 minutes.
Temperature of air passing through alpaca in drying machine	160° F.

In the course of this experiment there were several very lengthy stops due to machinery defects. Mr. H. J. Foster was present during part of the experiment. He expressed the opinion that the material was being dried too strongly.

After treatment the materials (mohair and alpaca) were returned to Messrs. John Foster & Son, Ltd., and were combed at once. Both were combed and spun in the usual way, part of each being spun to fine counts having regard to the qualities (mohair to a count of 24 and alpaca to a count of 36), and part to coarse counts (each to a count of 12). Members of the Sub-Committee saw each material passing through every stage of manufacture. No difficulty whatever was observed in combing; in drawing, the mohair rovings produced were rougher than desirable, but no defect was observed in the drawing of the alpaca tops; in spinning of mohair no defect developed, but in the spinning of the alpaca more ends came down than in the spinning for comparison on the opposite side of the same frame of an untreated lot; in weaving no difference was observed. It was pointed out to us that the roughness of the mohair in drawing might be due to the short time allowed to the tops for maturing. It was also stated that the treated alpaca was spinning quite up to the average for this quality and count, and that the untreated comparative lot of alpaca was spinning exceptionally well. We can add nothing to, and we think no comment is necessary on, the following report made by Messrs. John Foster & Son, Ltd.:—

"Dear Sir, Queensbury, June 27th, 1917.

"In August 1916 we supplied to you 1,042 lbs. of our ordinary average mohair matching and 1,025 lbs. of our ordinary average alpaca matching for treatment by the experimental process of disinfection then being investigated by the Departmental Committee on Anthrax. The object was to ascertain how far the material is affected by the process from a manufacturing point of view. I saw the material in process of treatment on August 10th, and after treatment it was returned to us for manufacture. The following is the result of observations made as to the behaviour of the treated material in the various processes:—

"*Condition after Treatment.*—The process being a wet one, the material was dried after treatment, and in our opinion the drying had been too thorough, or at least the material was much drier than we think advantageous. Otherwise, there was no apparent alteration or effect on either the mohair or the alpaca.

"*Combing.* — Both materials were willowed, scoured, dried, prepared, and combed on August 26th. No difficulty whatever was observed in any of these processes, and there was no apparent difference in the behaviour of the treated as compared with the ordinary untreated material. The results of combing were as follows, the average result for the previous year being also given for purpose of comparison. In comparing the two sets of figures it should be understood that the annual average includes in each case a number of lots of material of quality above the average, while the treated material was an ordinary lot :—

—	Treated Mohair.	Average Results for Year of untreated Mohair (including some lots of super quality).	Treated Alpaca.	Average Results for Year of untreated Alpaca (including some lots of super quality).
	Per Cent.	Per Cent.	Per Cent.	Per Cent
Tops	60·65	62·80	75·65	79·70
Noils	23·75	21·25	19·05	14·05
Loss	15·60	15·95	5·30	6·25
	100·00	100·00	100·00	100·00

"We regard the results of combing as good, the yields of top and noil comparing favourably with those usually obtained from material of this quality. The mohair tops produced from the treated material were a little whiter and fuller than those from untreated mohair being combed at the same time, but this was the only observable difference in any of the products of combing.

"*Drawing.*—The two materials were drawn on September 8th. We could detect no difference whatever during drawing in the behaviour of treated and untreated alpaca. The treated mohair drew looser and rougher than untreated mohair drawn at the same time, and it appeared to be too dry. The untreated mohair had been in warehouse since the end of June, while the treated had been in store less than a fortnight. This may possibly account for the difference noted. Apart from the hairiness, there was no observable difference between the treated and untreated material.

"*Spinning.*—The materials were spun on October 3rd to 6th. Part of the alpaca was spun to a count of 36 and part to a count of 12. The mohair was spun partly to a count of 24 and partly to a count of 12. In order to obtain a comparison, one side of a frame* was used for treated material and the other for untreated material, and the broken ends and snarls were counted during five doffings. The treated and untreated materials were not part of the same matching, but otherwise the comparison was as just as it is possible to make it. The dates of previous processes were as follows :—

—	Date disinfected.	Date combed.	Date drawn.	Date of Spinning.
Mohair Treated	August 11th	August 26th	September 8th	October 3rd–6th
Mohair Untreated	—	End June	" 11th	Do.
Alpaca Treated	August 10th	August 26th	" 8th	Do.
Alpaca Untreated	—	September 1st	" 11th	Do.

"In the spinning of the coarser count no difference whatever could be observed in the behaviour of the treated and untreated materials, either alpaca or mohair. In the spinning of the finer count, the breakages and snarls occurring in the period under observation were as follows :—

—	Counts.	Period under Observation.		Broken Ends.		Snarls.	
		Doffings.	Time. (Hours).	Total.	Average per Hour.	Total.	Average per Hour.
Mohair Treated	24	5	5	37	7·4	39	7·8
Mohair Untreated	24	5	5	21	4·2	89	17·8
Alpaca Treated	36	5	8·75	166	18·9	27	3·0
Alpaca Untreated	36	5	8·75	36	4·1	23	2·6

"The behaviour of the treated mohair compared favourably with that of the untreated, but the yarn produced was rougher, as was to be expected from its

* In each case 80 spindles.

behaviour in drawing. The spinning of the treated alpaca was up to the average, but the broken ends were considerably in excess of those occurring in the spinning of the untreated material. The latter was, however, spinning exceptionally well. We could observe no difference whatever in the yarn produced. On the whole, the spinning properties of the treated material compared favourably with that of average untreated material of the same quality.

"*Weaving, Dyeing, and Finishing.*—The yarn produced was woven into pieces at various dates between January 1917 and the present time. No difference whatever could be observed between the behaviour of the treated and untreated material in weaving in the case of either the coarse or fine yarns, and there was no observable difference in the pieces produced. The latter were dyed black, and, when finished, they compared favourably with those made from untreated material. They were sent to customers in the ordinary way of business, and no complaints or comments whatever have reached us.

"In order to compare the dyeing of treated and untreated yarn we dyed some hanks of treated and untreated mohair yarn in the same baths, of various colours The yarns were, of course, not of the same drawings. In the case of blacks no difference could be observed, but in blues, khaki and cerise the untreated material absorbed the dye faster than the treated, so that when the baths were exhausted the treated material was of a lighter shade than the untreated. When dyed in separate baths the colours were the same (though the treated yarns were, perhaps, a little brighter), but the treated material required a little longer to exhaust the dye liquor.

"The process of disinfection through which the raw material passed does not appear to cause deterioration. The small differences observed in the course of manufacture are all within the ordinary variations of the material, and, in our opinion and so far as our experience of the two lots of treated material goes, the method of disinfection could be used without causing serious manufacturing difficulties.

"Yours truly,

"JOHN FOSTER & SON, LTD.,

"(Signed) HAROLD J. FOSTER, Director.

"The Secretary of the
Departmental Committee on Anthrax."

EAST INDIAN WOOL.

Experiment 6.—The material treated in Experiment 6 consisted of 600 lbs. of a blend of two-thirds East Indian wool of medium quality and one-third of mohair noils (greasy). It had been blended and willowed by Messrs. James Walker & Sons, Ltd., who supplied it to us in sheets. The following are details of the treatment:—

Time occupied by preliminary treatment of wool in water	22 minutes.
Temperature of water in preliminary treatment of wool in water	102° F.
Time occupied by disinfection treatment of wool in formaldehyde solution	18 minutes.
Temperature of formaldehyde solution	102° F.
Strength of formaldehyde solution (by weight)	1·91 per cent., falling to 1·79 per cent.
Average time between discharge from formaldehyde bowl and feeding into drying machine	12 minutes.
Time occupied by wool in passing through drying machine	11 minutes.
Temperature of air passing through wool in drying machine	145–165° F.

There were no stops of any considerable length in the course of this experiment. The material lost 33 lbs. in weight (5·5 per cent.) during disinfection, this being partly due to removal of dust and partly to removal of oil from the mohair noils. Being a woollen material, it was neither scoured nor combed after return to Messrs. Walker & Sons, Ltd., but after being blended with cotton, was at once carded, spun on mules and manufactured into blankets. Mr. Samuel Walker, who examined the treated material, could detect no deterioration in it, and no defect showed itself in either carding, spinning, weaving or finishing, either absolutely or in comparison with the part of the blend which had not been treated. When finished the blankets were examined by several persons, but no material difference could be observed between those made from the treated and those made from the untreated material, except that the former were a little whiter, which was probably due to small differences in milling. The following is the report made by Messrs. James Walker & Sons, Ltd.:—

"Holme Bank Mills, Mirfield.
"December 20th, 1916.

"DEAR SIR,

"Some time ago we sent you two sheets of wool blend to be specially treated for the extermination of anthrax germs. (The blend was composed of East India wool and mohair noils.)

"The material was returned to us in a nice, clean condition, and quite 'free' to work in the machines. We noticed no difference in its drawing and spinning capacity, and the blankets, when finished, were the same as, or similar to, our regular production.

"We do not know the cost of treatment, but, apart from this, we consider the experiment a success.

"Yours truly,
"JAMES WALKER & SONS, LTD.,
"(Signed) SAMUEL WALKER, Director.

"The Secretary of the
"Departmental Committee on Anthrax."

Experiment 7.—East Indian wool is the principal material for, and is used on a large scale in the manufacture of felt as well as in that of blanket and carpet yarns. It was stated to us that wool shows damage more readily in the felting process than in spinning, and it was, therefore, considered necessary to carry out an experiment in which a sufficient quantity of East Indian wool was treated by the process of disinfection and afterwards manufactured into felt. The machinery used in the commercial scale experiments had been dismantled when this need became clear, and the small experimental apparatus had, therefore, to be used. This was inconvenient and difficult, as only about 30 lbs. of material could be treated at one time. The absence of mechanism for removing the material from the baths and the consequent necessity for forking it out by hand also resulted in a more lengthy exposure to the solutions than necessary, while drying occupied more time than it should have done, and there was much delay after the material was removed from the formaldehyde bath before drying could be commenced.

Messrs. The Bury Felt Manufacturing Company, Ltd., supplied us with 90 lbs. of a blend of East Indian wool and noils (this is the smallest quantity which can be manufactured into felt satisfactorily). The firm purposely supplied the lowest-grade felting material it is considered possible to manufacture into felt. The lower-grade materials more easily show damage than those of higher quality, and the argument of the firm was that if material of low felting quality betray no defects after treatment by the process of disinfection, then higher grade materials will certainly not be deteriorated.

The following are the details of the experiment. Average times of exposure are stated because it is impossible to give exact times owing to (1) the splitting up of the total quantity into three portions for treatment, (2) the absence of mechanism for automatically removing the material from the baths, and (3) the splitting up of the material into small quantities of about 1 lb. each for drying :—

Total weight of material treated - - - - -	90 lbs.
Quantity of material treated at one time - - - -	30 lbs.
Average period of immersion of material in soap solution—preliminary treatment - - - - - -	40 minutes.
Temperature of soap solution in preliminary treatment - -	108° F.
Average period of immersion in formaldehyde solution—disinfection treatment - - - - - -	30 minutes.
Temperature of formaldehyde solution - - - -	102° F.
Strength of formaldehyde solution - - - -	2·32 per cent., falling to 2·00 per cent.
Average time of standing between disinfection treatment and drying - - - - - - - -	50 minutes.
Average time occupied by drying - - - -	75 minutes.
Temperature of current of air passing through material in drying	160°–180° F.
Loss of weight in treatment - - - - -	16 per cent.

After treatment the material was returned to the firm for manufacture into felt. It was carefully watched through each process by Mr. Clegg. Owing to the removal of dirt and dust in the disinfection process, it was not considered necessary to willow it, and it was therefore scribbled, carded, felted, milled and dyed. No dust was thrown into the air in carding. No defect was observed in any of the processes of manufacture, and the following report was made to us by the firm, who also sent us a piece of the finished felt, together with a piece made from similar untreated material at the same time. It is pointed out that the piece of felt made from the treated material is perfect, and defies criticism, having regard to the low-grade materials from which it was made :—

"Hudcar Mill, Bury,
"November 5th, 1917.

"DEAR SIR,

"*Report on Wool treated for prevention of Anthrax.*

"The growing knowledge of the peril to which all workers engaged in the woollen industry are exposed in consequence of the germs of this deadly disease lurking in the wool added a human touch to the visit of Mr. Duckering to our mills to secure a practical demonstration of the treated wool in the processes of manufacture, and to ascertain if the theories of the laboratory were borne out in the practical realities of the workshop.

"Starting from the point that a piece of felt made on the very basis of the law of felting, *i.e.*, the proportion of *bonâ fide* wool fibres being at a minimum to secure a compact piece under the old dispensation, and using a maximum of by-product or waste fibres, we forwarded the necessary weight of wool to be chemically treated. The raw material used for felting consisted of 40 lbs. of East Indian wool, 20 lbs. of noils, and 30 lbs. of waste—a total weight of 90 lbs., which produced 70 lbs. of felt in the piece. The waste was not treated by the disinfection process, but was added during carding of the treated material.

"The piece made on this principle would rule out any subsequent objection that wool had been specially chosen, and that when inferior felts were to be made difficulties would arise. The piece has been made metaphorically 'on the edge of the precipice,' and if at this perilous point success is achieved it can be taken for granted that the general business would be on a sound basis, as pieces made solely from wool of good breed, character and known natural qualities would be beyond cavil or criticism.

"The material having been returned to us, we hastened to make our practical test. As first impressions are deep and lasting, the writer must admit the handling of the clean, wholesome material was a real thing of beauty, and would lead to the perpetual joy of our workpeople if we were to work such material in the coming future. The dusty atmosphere would be consigned to the limbo of 'a dark age,' and health would be more assured to the worker, and his monotony would not be aggravated by the uncongenial surroundings of his or her labours. The use of this hygienic material would conserve the vitality which is rapidly sapped under the old dispensation notwithstanding the full use of the latest scientific means of ventilation and dust extraction.

"We carded the wool in the usual way, adding the necessary proportion of waste, to start at the bottom rung of the ladder (as previously explained). The material carded beautifully, yes, let me add, faultlessly, and did not show a sign of breaking as the sliver left the doffer on to the forming frame. When completed, the laps bore the lustre and brilliance of the clean material we had used, and evoked the time-worn adage, 'Cleanliness is next to godliness,' which in its modern application in the manufacturing of textile fabrics is also the synonym of good workmanship.

"We placed the lap on the hardener to approach its test under the first process of felting. The materials all combined together in an uniform mass, and a beautifully hardened lap was the result.

"In the milling process which followed we milled along with a lap made from similar material (untreated), and 'the key' to the treated material, having lost none of its felting properties, was revealed in the real test, the chemically treated lap milled in a shorter period of time, proving the chemical operation, whilst sterilising the wool, had not impaired the fibres, but, on the contrary, the removal of the deleterious matter had given each fibre its own freedom to assert its characteristics, viz., its natural affinity for another, and become a beautifully felted whole.

"The harmony of the success was 'coloured' in the dyeing process which followed in the usual course. The lap stood the test of dyeing without the slightest disintegration, and each colour combined on the piece with brilliant effect. The dye has a richer cast and an even body; and levelness of dyeing will undoubtedly be facilitated by the adoption of the treated material.

"The summing up is the piece in its entirety, and no words at my command are so eloquent of the real practicability of this treated material as the piece made from wool which has been 'under fire.' The manufactured felt is its best tribute even as virtue is its own reward.

"The author of the chemical combination which removes from the woollen industry its 'hidden foe' will be remembered in the pages of historical industrialism as 'one of the benefactors of mankind.'

"(Signed) L. H. Clegg.

"The Secretary of the
"Departmental Committee on Anthrax."

15. COMMERCIAL ASPECTS OF DISINFECTION.

Having devised a satisfactory method of disinfection for wool and hair which can be used without causing damage to the material, it remains to consider the purely commercial part of the problem. The two questions, apart from the effect on material, naturally asked by all concerned commercially with the wool trade are: (1) Can the process be applied in practice? (2) What is its cost? We have carefully considered these two questions.

15A. APPLICABILITY OF THE PROCESS.

At the commencement of the experiments we asked ourselves what would constitute a practical method of disinfection? Mr. Ackroyd stated in his evidence that a method requiring treatment of wool for six hours might be capable of use. The question of applicability, of course, depends to a great extent on the quantity of wool it is deemed necessary to disinfect. Consideration of the large amount of wool and hair which may be infected (60,000,000 lbs. of East Indian wool, 30 to 40,000,000 lbs. of mohair, 6,000,000 lbs. of alpaca, 10,000,000 lbs. of Persian wool, and large quantities of camel hair, goat hair, Egyptian wool, &c.) suggests at once that a process requiring six hours becomes almost impracticable by reason only of the enormous amount of plant and space necessary to put it into operation if all wool which may be infected is to be treated. Having this in view, it is clear that two of the most important of the desiderata for a method of disinfection are that it should be rapid, and that it should be capable of being applied as a continuous process. The efforts of the Sub-Committee were directed towards securing at least these two objects. The method adopted in the experiments on the commercial scale suggests the method of application of the process of disinfection, and these experiments were partly intended to afford some experience as to the applicability of the method and to provide data on which to base a calculation of its cost.

It has been pointed out that the process consists of three stages: (1) the preliminary treatment, by means of which the protective substances present in wool are removed, the anthrax spores laid bare and brought to a condition favourable to attack; (2) the disinfection treatment, in which the material and the spores already made susceptible are brought into contact with the agent used to cause the destruction of the latter; (3), drying, in which action of the disinfectant is, as far as possible, hastened and completed. The experiments indicate that the protection afforded to the spores by the various substances present in wool can be removed partly by solution, partly by mechanical agitation, and partly by the action of squeezing the material through rollers. Apart from any action in making anthrax spores more susceptible to the effect of contact with formaldehyde, the preliminary treatment in the disinfection process is essentially a cleansing and washing process. Scouring is, of course, an ordinary process of woolcombing, but the method of scouring in general use is not sufficient as a preliminary treatment for the purposes of disinfection (*see* experiments on the effect of scouring on bloodclots described at the end of section 9 of this report). This is due to the fact that the breaking up of bloodclots is not merely a case of solution, but is also largely a process by which the albuminous constituents of blood become gelatinous and softened, in which state they can be broken up by agitation and squeezed off the wool by means of the rollers. This gelatinising takes place only slowly, and the time required is apparently proportionate to the thickness and hardness (not necessarily the size) of the bloodclot. It is obvious, therefore, that the time necessary for the preliminary treatment is governed by the thickness of the thickest clots in the wool and might vary for different materials. The time required for the complete and sufficient breaking up of bloodclots in the preliminary treatment varies to some extent also with the efficiency of the agitating mechanism, but the necessity of avoiding excessive and violent agitation of wool, which might result in grave deterioration of the material, limits the extent to which it can be applied. After careful consideration we are agreed that the method and machinery of scouring now in use is, with necessary adaptations, the best means by which the disinfection process can be applied satisfactorily. We have also come to the conclusion after considering all the data available that 20 minutes' exposure to the action of soap solution under proper conditions is sufficient to remove the protection afforded to the spores by the largest and thickest bloodclots usually found in wool. An additional safeguard would be provided by removing any very large clots observed in feeding the machines and exposing them for a longer period. No skill in the recognition of bloodclots would be needed for this, since anything large and hard to the touch could be taken out. We do not suggest this as being a necessary proceeding, but it could be used in unusual or exceptional circumstances.

The machinery necessary for the preliminary treatment would consist of two bowls or baths fitted with mechanism for causing the wool to pass through the liquid in them, and with squeezing rollers at the end of each. They should be of the same general construction and arrangement as an ordinary scouring bowl, or the acid treatment bowls of a carbonising plant. Each bowl would be fitted with means for admission of steam into the liquid of such construction as to be capable of maintaining the latter at a temperature of 110° F., or of raising it rapidly to boiling point, in order, when necessary, to sterilise it. The two baths would be arranged so that the first discharges into the second and the second into the first formaldehyde bath. At the feeding end of the machine it would be necessary to have an exhaust screen and other arrangements requisite for removing dust produced in opening the fleeces and placing them on the feed lattice, as the danger from anthrax at this point will be the same as in existing factories during opening. The speed at which the wool is caused to pass through each bowl should be capable of adjustment, and should be such that the wool remains not less than ten minutes in the liquid contained in each bowl. This liquid should be a solution of soap in water, and might also contain such other substances (*e.g.*, a small amount of sodium carbonate) as are found by experience to aid in causing the removal of blood, or in the cleansing of wool without causing damage. It should be maintained at a temperature of 102° F. to 110° F. during treatment of the wool.

The part of the plant used for disinfection proper would be exactly similar to that used for the preliminary treatment, and it would be so arranged that the wool emerging from the last pair of rollers would pass direct into a drying machine. The liquid contained in each of the two bowls of this part of the plant would be a solution of formaldehyde maintained at a strength of between 2 and $2\frac{1}{2}$ per cent. by weight, and at a temperature of 102° F.

The drier would consist of an ordinary wool-drying machine, which slowly dries the wool in a current of air at a temperature of about 160° F., the time required being about twenty minutes.

The whole plant would therefore consist of four vessels of equal size, and a drying machine arranged end to end, so that the wool passes automatically from one to the next, and finally into the drying machine, and so constructed that the material remains in each vessel for at least ten minutes and in the drying machine for twenty minutes. The whole process of disinfection will thus occupy not less than an hour. The raw wool will be fed into one end of the machinery and will emerge from the other dry, disinfected, clean and free from grease. There is nothing difficult about such a plant. It is merely a modification of machinery already regularly in use (*e.g.*, a scouring or a carbonising plant), and would be capable of dealing with approximately 1,000 lbs. of fleece wool per hour.* All the four vessels would require to be completely closed in—those used for the preliminary treatment because the liquid contained in them becomes highly infected, and must therefore be sterilised by being raised to boiling point by means of steam driven into it (or by other means), and those used for the disinfection proper, because it is impossible for men to work in an atmosphere charged with the irritating vapour of formaldehyde. The plant used in the commercial experiment was closed in in the manner suggested, and no difficulty in working resulted from this. We therefore see no difficulty in the application of the process so far as plant, &c., is concerned.

There will be a certain amount of risk of infection to persons employed in opening the bales and fleeces and feeding the disinfecting machine. This is unavoidable, but the incidence of anthrax in factories indicates that danger of anthrax at this stage is not great, either absolutely or relatively. Since all the risk will be at this point, extraordinary measures can be taken, by means of exhaust ventilation and in other ways, to reduce it. This is a matter as to which the Committee may think it desirable to make recommendations.

15B. COST OF THE PROCESS.

It is exceedingly difficult to arrive at an accurate estimate of the cost of the process, since this will depend so much on the manner in which and by whom disinfection is eventually carried out, *i.e.*, whether it be done in each factory using dangerous materials, or in separate factories on a commission basis, or in a State or municipal central disinfection station, or otherwise. In any event, however, the cost will be made up of four factors: (1) the cost of disinfectant; (2) the ordinary cost of scouring or washing, with necessary modifications; (3) standing, establishment and capital charges; and (4) cost of sterilisation of the liquid used in the preliminary treatment. For all practical purposes the wool is scoured in the process of disinfection, so that, from the really practical point of view, the only part of the cost which will be an added burden to manufacturing costs is that of the disinfectant and that of the sterilisation of the liquid used in the preliminary treatment (always remembering, however, that the machinery required for disinfection will entail a capital cost higher than that of scouring machinery, though considerably less than that of carbonising plant).

The quantity of disinfectant used depends on four factors: (1) the amount removed from the bowls by the wool, (2) loss by evaporation, (3) loss by chemical action with substances normally contained in wool, and (4) loss by oxidation or other chemical changes. Throughout the whole inquiry careful observations have been made on these points. As before stated, in the small scale experiments chemical analysis of the formaldehyde solution was made after each experiment, and frequently at the beginning of an experiment. It was also made at the beginning and end of several periods during which the formaldehyde was standing in the uncovered small tanks immersed in water contained in the large covered tank. If wet wool be squeezed through rollers before going into the formaldehyde solution and again after being taken out, it introduces as much liquid into the solution as it removes from it, but water is introduced while the solution is removed. The effect, therefore, if both sets of rollers are efficient and the squeezed out liquid is returned to the bath, is that the volume of solution remains the same but its strength is reduced. Chemical analysis, therefore, before and after an experiment will give with sufficient accuracy a measure of all the losses which take place as a result of treatment of the weight of wool used, whether these be due to oxidation, evaporation, chemical action with substances in wool, or to direct loss by removal on the wool.

The loss due to oxidation may be found by ascertaining by chemical means the increase in the quantity of acid in the formaldehyde solution, since the oxidation product of formaldehyde is formic acid; that resulting from evaporation, by analysis of the solution at the beginning and end of a period, and by observing at the same time the reduction in volume of the liquid; the loss due to removal of solution on wool can be calculated by drying a known weight of damp wool and ascertaining the loss; and, finally, any difference between the sum of the individual losses and the total loss must be put down to chemical interaction of the formaldehyde with substances present in the wool.

It was, of course, recognised that the cost of the process would depend mainly on the loss

* The machinery makers estimate upwards of 1,000 lbs. per hour.

of disinfectant, and it was essential to gain an approximately accurate conception of the means by which any occurs. It was feared that losses by evaporation and oxidation would be serious, but, happily, these fears proved unfounded. On all occasions when the strength of the formaldehyde solution was estimated the liquid was titrated to ascertain the quantity of formic acid present. On no occasion was the solution found to be acid. On the contrary, the original solution was, when purchased, very faintly alkaline, and no variation was found during the experiments, even after the experimental solution had been used many times and had been exposed to the air for some months (except that the alkalinity increased to a slight extent after long use, probably on account of absorption of ammonia). The danger of loss by oxidation is therefore negligible. Nor is the loss from evaporation serious. It is, of course, to be understood that the solution, if freely exposed to air, would in time evaporate entirely, though even then a large part of the formaldehyde would remain behind as a solid. The decrease in strength of the solution (*i.e.*, the escape of the formaldehyde from the solution) is, however, very small provided the vessel containing it be kept covered. The following experiment indicates that formaldehyde does not freely escape from the solution :—

One hundred cubic centimetres of a solution containing 1·86 per cent. by weight of formaldehyde was distilled, and the distillation stopped immediately 30 c.c. of the distillate had collected. The residue was cooled by holding the flask in a stream of cold water, and it was then found to contain 1·29 per cent. of its weight of formaldehyde, while the distillate contained 2·86 per cent. In the experiment about 95 per cent. of the formaldehyde originally present was accounted for either in the residue or in the distillate. Formaldehyde is, therefore, only slowly driven off even by boiling.

It is not necessary to give all the results of analysis of the various solutions of formaldehyde, but the following examples of tests of solutions used in several successive experiments with intervals between and without addition of formaldehyde afford indications of the losses which occurred in the experiments on a small scale. They are selected from a large number, and are typical of the whole :—

(*a*) Where water only was used in preliminary treatment and 2 lbs. of mohair was used as damage test material. Total volume of formaldehyde solution = 24 litres.

	Per Cent.
1. Winter :—	
Strength of solution of formaldehyde—	
Before experiment	2·63
After experiment lasting six hours	2·61
After standing 12 days (January 7th to January 19th)	2·57
Solution was then faintly alkaline.	
2. Summer :—	
Strength of solution of formaldehyde—	
On June 26th, before experiment	2·82
After standing 24 hours and use in experiment	2·78
After standing six days (June 27th to July 3rd)	2·70
After use in a further experiment	2·67
After standing seven more days (July 4th to July 11th)	2·63

(*b*) Using soap solution for preliminary treatment and about 2 lbs. of Persian wool as damage test material. Volume of formaldehyde solution, 15 litres.

	Per Cent.
Strength of formaldehyde solution—	
On February 17th at commencement	2·70
After use in an experiment	2·68
After standing seven days (February 17th to February 24th)	2·67
After use in another experiment	2·68
After standing three days more (February 24th to February 27th)	2·64
After use in another experiment	2·59
After standing a further ten days (February 27th to March 9th) and use in two more experiments	2·51
After standing five days further (to March 14th) and use in two more experiments in which the damage test material consisted of badly blood-stained Persian skin fleeces	2·51
Loss in strength after use in seven experiments and standing 25 days	0·19

(*c*) Using soap solution for preliminary treatment and about 3 to 4 lbs. of badly blood-stained Persian skin wool as damage test material in each experiment. Volume of formaldehyde solution was about 20 litres.

	Per Cent.
Strength of formaldehyde solution—	
March 16th at commencement	2·35
After use in four experiments	2·34
After standing seven days (March 16th to March 23rd) and use in two more experiments	2·29
Loss in strength after use in six experiments with very dirty material and standing seven days	0·06

In all the experiments in which the above solutions were used, the wool, after the preliminary treatment, was squeezed through rollers, and was similarly treated after immersion in the solution of formaldehyde, the excess of the latter being allowed to run back into the bath. The material used consisted of test bloodclots, with either about 2 lbs. of raw mohair or Persian wool or (in later experiments) 3 to 4 lbs. of badly blood-stained Persian skin wool. It is impossible, of course, to make any calculation of the cost without knowing the weight of material used, and the volume as well as the strength of formaldehyde solution. The decrease in strength of the formaldehyde solution is partly dependent on the relation between the volume of solution and the weight of wool used, since after squeezing through rollers wool retains from 30 to 33 per cent. of its weight of liquid. Accurate measurements of the quantity of solution and weight of wool used in the experiments on a small scale were not made, partly because the errors due to accidental losses caused by constant manipulation of the baths and apparatus were considerable, but principally because it was intended to work out the cost from experiments on a commercial scale. The results given do indicate, however, that the losses due to evaporation and oxidation are small. The total losses are greater than can be accounted for by removal of solution on the wool, and there is probably destruction of formaldehyde by substances present in wool. There was distinctly less loss of formaldehyde in those experiments where soap solution was used in the preliminary treatment, *i.e.*, where the wool was comparatively clean when it entered the formaldehyde bath. Some of the losses were, however, purely accidental, and were inevitable in experiments on so small a scale. The most valuable information gained is that a solution of formaldehyde can be used repeatedly without loss of efficiency, provided the amount of the disinfectant abstracted by wool be made good. The same solution was used for many experiments, in some instances for as long as six months, its strength being kept up by addition of strong formaldehyde solution as occasion required. Neither chemically nor bacteriologically were there any indications of loss of efficiency. On the contrary, there were distinct indications that, from a bacteriological point of view, a solution of formaldehyde, after use in several experiments and standing for some time, is more active as a disinfectant than one freshly made. The only reason against repeated use of the same solution is that it becomes dirty. This objection largely disappears when soap solution is used in the preliminary treatment, and the wool is effectively cleansed before it enters the disinfecting bath.

In order to acquire reasonably accurate data as to the cost of the disinfection process due to loss of disinfectant, observations were made in the experiments on a commercial scale. The observations were as accurate as possible under the circumstances in which they were made, but in considering the data obtained it is necessary to bear in mind certain adverse factors, all of which can be avoided in the use of a properly organised plant. As previously stated, the plant used in these experiments was a scouring machine altered to meet the needs of the process. As the last bowl, containing the formaldehyde, was made to work more slowly than those supplying wool to it, this part of the machinery became congested. The effect was to cause an intermittent blocking of the formaldehyde squeezing rollers, which then ceased work and allowed the wool to accumulate in front of them. As the only means of relieving this block was to throw the accumulated wool out on to the floor before it had been squeezed, there was a very considerable loss of formaldehyde. Another effect of the congestion, even when the rollers were working, was to cause the wool to pass into them in masses instead of in an even flow, with the result that some of it was imperfectly squeezed; further, it was found impossible to work the rollers at their correct pressure. Much formaldehyde solution thus passed into the drier with the wool. Similar but less accentuated difficulties were encountered in connection with the rollers delivering wool to the formaldehyde bowl, whereby the amount of water conveyed into the formaldehyde solution was greater than it should have been. The result was a very high loss of formaldehyde, with correspondingly increased dilution, both of which are avoidable. Further, though a wooden cover was placed over the whole of the formaldehyde bowl, it was found necessary to leave openings of very considerable size at various points in this cover, *e.g.*, at the point of entrance of wool, at the rollers, &c., where the solution was in a state of rapid motion (due to the action of rollers and pumps). Evaporation and escape of formaldehyde was, consequently, higher than it should have been. Difficulties were also met with in connection with the pump belonging to the formaldehyde bowl, with the result that a considerable loss occurred from leakage. It must, therefore, be understood that the costs worked out below are those of exceedingly inefficient working such as could and would not be tolerated for a day in any well conducted factory. The only experiments which were at all free from difficulties were those in which mohair and East Indian wool were treated, and the second experiment with Persian wool. The costs due to loss of formaldehyde in these are by far the lowest of any, and it is to be expected that with efficient machinery and normal smooth working they would be still further reduced. One other circumstance calls for remark. As before pointed out, the commercial experiments were undertaken before the process was fully worked out in order to take advantage of Mr. Feather's offer of wool. At this stage, water only had been used in the preliminary treatment, and water was also used in the preliminary treatment of wool in the commercial experiments. Soap solution would now be used instead, and the loss of formaldehyde would thereby probably be reduced very considerably owing to the fact that the wool is clean when it enters the disinfecting bath.

The method followed in ascertaining the costs due to loss of formaldehyde was as follows:—

The bowl which contained the formaldehyde solution is of the wash-out McNaught scouring machine type (wet nip), which consists of a tank through which the wool is caused, by means of moving rakes to pass in a trough of perforated metal. After passing through the bowl it is forced by rakes, over the end of the trough down an inclined plane into the nip of the rollers, carrying with it a quantity of liquid. An escape pipe, with an adjustable top, maintains the liquid at a constant level in this bowl. The liquid entering this overflow pipe, and that escaping with or squeezed out of the wool by the rollers, flows into a side tank from which it is pumped back into the main bowl. The only point, therefore, at which variations in the volume of liquid is shown is in the overflow tank. A mark was, therefore, made on the inside of this tank after the solution for the first experiment was made up, and the machinery worked for some time with the liquid at the correct temperature. The tank was also calibrated roughly, and the volume for each inch of depth calculated. The same solution was used in all the experiments, the strength being adjusted by the addition of strong formaldehyde solution, and the volume then corrected to the mark in the overflow tank. After each experiment the variation of volume in the formaldehyde solution was measured by the variation of the level of the liquid in relation to the mark. In two experiments the volume was very slightly increased, and in the remainder it did not alter materially. In no instance was there any variation which would substantially affect the results. The decrease in strength of the solution, therefore, gave a complete approximate measure of the loss of formaldehyde. Analyses were made at the beginning and end of each experiment, whether or not these were completed on the day of commencement (some occupied parts of two successive days), and the difference, therefore, included all losses, whether due to evaporation, oxidation, chemical action of substances present in wool, or to mechanical removal on wool. Knowing the volume occupied by the experimental formaldehyde solution, the quantity of strong formaldehyde it was necessary to add to restore the solution to its original strength can be calculated from the difference between the strength at the beginning and end of the experiment. If to the quantity so arrived at there be added the quantity of strong formaldehyde solution placed in the experimental solution during any experiment, the loss caused by treatment of the known weight of wool can be obtained with reasonable accuracy. It is thus possible to ascertain the cost, per pound of material treated, accounted for by loss of formaldehyde.

The normal volume occupied by the liquid in the bowl used for the formaldehyde solution as calculated by the staff of the Bradford Technical College (the proprietors of the machine) is 700 gallons. In order to avoid danger of escape through the overflow pipe in the overflow tank the mark in the latter by which the volume was adjusted was placed so as to give a volume, calculated from the normal volume, of 674 gallons of formaldehyde solution. Calculated from the strength of the solution made by adding 51 gallons of formaldehyde of accurately known strength to water in the bowl and finally bringing up to the mark when the machinery was working, the volume was 672 gallons, which indicated that the volume taken (674 gallons) is sufficiently accurate.

In the following calculations of cost due to loss of formaldehyde data known or assumed to be correct are:—

Strength (by analysis) of original formaldehyde solution = 37 per cent. (by weight).
Volume occupied by experimental formaldehyde solution = 674 gallons.
Cost of original formaldehyde (*i.e.*, price paid by Sub-Committee) = 9*s.* per gallon.
Cost of original formaldehyde (pre-war price quoted to Sub-Committee) = 4·5*s.* per gallon.

The data on which are calculated the costs, and the cost per pound of the material treated, of losses of formaldehyde are given in the following table:—

COST OF DISINFECTION DUE TO LOSSES OF FORMALDEHYDE.

—	Persian Wool.			Mohair.	Alpaca.	East Indian Wool.	
	Expt. 1.	Expt. 2.	Expt. 3.	Expt. 4.	Expt. 5.	Expt. 6.	Expt. 7.*
Strength (per cent. by weight of formaldehyde) of experimental solution at beginning of experiment.	2·81	2·45	2·35	2·08	2·54	1·91	2·32
Strength (per cent. by weight of formaldehyde) of experimental solution at end of experiment.	2·54	2·28	1·91	1·91	2·08	1·79	2·00
Loss (per cent. by weight of formaldehyde) in experiment.	0·27	0·17	0·44	0·17	0·46	0·12	0·32
Volume of formaldehyde (37 per cent.) necessary to restore original strength (gallons).	4·9	3·1	8·0	3·1	8·4	2·2	0·5
Volume of formaldehyde (37 per cent.) added in course of experiment (gallons).	3·0	—	—	—	—	—	—

* This experiment (No. 7) was carried out in the small experimental apparatus.

—	Persian Wool.			Mohair.	Alpaca.	East Indian Wool.	
	Expt. 1.	Expt. 2.	Expt. 3.	Expt. 4.	Expt. 5.	Expt. 6.	Expt. 7.*
Total volume of formaldehyde required to restore original strength (gallons)	7·9	3·1	8·0	3·1	8·4	2·2	0·5
Weight of raw material treated (pounds)	1,004	507	1,000	1,042	1,025	600	90
Cost, in pence per pound of raw material treated, of loss of formaldehyde (war price of formaldehyde).	0·85	0·66	0·86	0·32	0·88	0·40	0·60
Cost, in pence per pound of raw material treated, of loss of formaldehyde (pre-war price of formaldehyde).	0·43	0·33	0·43	0·16	0·44	0·20	0·30

* This experiment (No. 7) was carried out in the small experimental apparatus.

It would appear from the results given that alpaca and Persian wool cost more to disinfect than either mohair or East Indian wool, but this is possibly accidental owing either to difficulties met with in the experiments which resulted in loss of formaldehyde or to a greater loss of formaldehyde due to chemical action with substances present in wool. It is noteworthy that in those experiments where the working was comparatively free from difficulty (no experiment went quite smoothly) the costs are decidedly lower, *e.g.*, in the mohair and East Indian wool experiments and in Experiment 2 with Persian wool. The average cost per pound of material treated in all the experiments is 0·68 penny at the war price of formaldehyde and 0·34 penny at the pre-war price.

The finer varieties of wool remove more liquid than the coarser kinds owing to the greater surface available, but it is worth while calculating the cost of disinfection due to losses of formaldehyde by direct mechanical removal on wool. From data supplied by Mr. Walter Leach, the chemist of Messrs. Woolcombers, Ltd., it appears that merino wool (a fine variety of wool) after passing through squeezing rollers from a scouring bowl contains 30–33 per cent. of its weight of water. Assuming that raw material loses 40 per cent. in scouring, 1,000 lbs. of raw wool would remove approximately 20 gallons of solution from the formaldehyde bath. If this has a strength of 2½ per cent., and disregarding the fact that the removal is gradual and at gradually lowering strength, the cost of treatment due to loss of formaldehyde by mechanical removal on wool would not exceed 0·15 penny per pound of raw material at war prices of formaldehyde, or 0·07 penny at pre-war prices. The lowest cost at the present price of formaldehyde shown in the experiments was 0·32 penny per pound of raw mohair (0·16 penny at pre-war price) and the highest 0·88 penny per pound of raw alpaca (0·44 penny at pre-war price). Whether this difference from the theoretical cost be due to accidental losses resulting from the makeshift character of the experimental machinery used or to chemical action with substances present in wool, it can probably be avoided in practice, since by the method finally worked out the wool is clean when it enters the formaldehyde bath. (It should be remembered that in the commercial experiments the wool was not clean at this stage.)

In order to obtain a complete idea of the cost of disinfection on the lines outlined the makers of wool-scouring machinery were consulted, and the proposed method of disinfection and the times required for the material to pass through each stage of the process carefully explained. They were asked to prepare estimates of the cost of machinery and of buildings necessary for a central disinfecting station. The basis adopted was that of a unit central station capable of dealing with about 10,000,000 lbs. of raw wool per year, and complete provisional plans for such a station and of machinery necessary were prepared. Considerable economies will be possible where a station consisting of several such units is erected.

The question of the basis of price to be adopted in the estimates was considered, as it was pointed out that present war prices are liable to considerable fluctuations. Finally, it was decided that all estimates should be given on the basis of pre-war prices since it is always possible to add the necessary percentage to bring these prices up to those in force at any given time. In the following estimates, therefore, all the prices stated are those in force immediately before the war. At the moment of writing it is necessary to increase them by about 55 to 65 per cent. in order to convert them into prices in existence at the present time.

The following estimate of the capital cost of a unit central disinfecting station is that prepared by one of the leading wool-scouring machinery makers and mill erectors. Where it is considered for any reason that additional expense may be incurred, a sum has been added by us, but these additions are clearly indicated. The estimate has been submitted to the managers of several of the factories of Messrs. Woolcombers, Ltd., in which dangerous materials are treated, and their comments are appended. It is necessary to bear in mind that their remarks are based on experience of scouring the materials requiring disinfection. They are, therefore, of general application, and are extremely valuable, but the practice in disinfection will be somewhat different from that in scouring.

ESTIMATE OF THE CAPITAL COST OF A CENTRAL DISINFECTING STATION CAPABLE OF DEALING WITH 10,000,000 LBS. OF RAW WOOL PER YEAR.

In their estimate and plans the machinery makers propose machinery capable of treating 1,000 lbs. of raw material per hour per machine, and it is assumed that two machines would be working 100 hours per week and 50 weeks per year. This would permit of exactly 10,000,000 lbs. of raw wool being disinfected annually.

Two comments were made on this by woolcombing managers: (*a*) that it would be difficult to maintain this figure if there are many stoppages for cleaning the machines and changing from one lot of wool to another; (*b*) that with the machines proposed it should be easily possible to deal with the quantity of wool estimated. In a central station it should be possible to avoid many changes.

(N.B.—In any event, it must be recognised that it is impossible to run off the formaldehyde solution, as this is too valuable to lose.)

Item.	Material, &c.	Cost estimated.	
		£ s. d.	£ s. d.
1	Two sets of disinfecting machines, each capable of disinfecting 1,000 lbs. of raw material per hour.	3,976 0 0	
2	Two wool-drying machines, each capable of completely drying 1,000 lbs. of wool per hour at 160° F.	1,000 0 0	
3	Additional sum for drying machines added by Sub-Committee -	250 0 0	
4	Shafting, hangers, pedestals, pulleys, &c., as shown in plans -	480 0 0	
5	Ropes, belting, &c. -	200 0 0	
6	Compound horizontal steam engine of about 60 indicated horse-power	600 0 0	
7	Two steel boilers, each 30 feet × 8 feet -	1,100 0 0	
8	Two economisers of 100 pipes each -	250 0 0	
9	The necessary wrought-iron steam pipes and cast-iron water pipes -	240 0 0	
	Total capital cost of machinery -	-	8,096 0 0
10	Building covering 2,400 square yards of land, including engine foundation, boiler seating, chimney, drainage, lighting fittings, &c., in accordance with plan.	4,800 0 0	
11	Sum added by Sub-Committee for provision of more warehouse room, &c.	1,000 0 0	
12	Stores, scales, soap and alkali pans, trolleys, tools, &c. -	500 0 0	
13	Office furniture, &c. -	200 0 0	
14	Land—4,000 square yards at 3*s.* 6*d.* per square yard -	700 0 0	
	Total capital cost of land, buildings, &c. -	-	7,200 0 0
	Added by Sub-Committee for contingencies -	-	2,710 0 0
	Total estimated capital cost -	-	18,000 0 0

The comments by practical woolcombers were as follows:—

Item 2.—The price quoted for wool-drying machines appears to be very low. To meet this the Sub-Committee has added a sum of 250*l.* to the estimate.

Item 7.—(*a*) Two boilers would probably be unnecessary, though a single boiler might sometimes have to be pressed. (*b*) One boiler would probably be sufficient.

Item 10.—The warehouse room provided in the plans (two warehouses, each 76 feet by 43 feet) may prove to be too small. To meet this possibility, the Sub-Committee has added 1,000*l.* to the estimated cost of the building to cover contingencies of this kind.

Item 14.—It is impossible to estimate the cost of land till the situation of the station is known.

Having obtained estimates of the capital cost of the machinery, buildings, &c., necessary for a unit central disinfecting station, and of the quantity of material which can be disinfected annually in that unit station, it is possible to estimate the working expenses. The following estimate of the working costs has been prepared in consultation with the machinery makers, and, as in the case of the estimate of the capital cost, has been submitted for criticism to the managers of Commission woolcombing factories:—

ESTIMATE OF THE WEEKLY WORKING COSTS OF A CENTRAL DISINFECTING STATION CAPABLE OF DISINFECTING ABOUT 10,000,000 LBS. OF WOOL PER YEAR.

Item.	Material, &c., or Labour.	Estimated Cost.
		£ s. d.
1	Coal for two boilers working night and day—60 tons weekly at 12s. per ton -	36 0 0
2	Soap and alkali (calculated that on the average the materials being disinfected will require soap and alkali equivalent to 2s. per pack of 240 lbs.).	80 0 0
3	Roller wrapping, calculated at 2d. per hour per roller - - - - -	8 0 0
4	Oil, brushes, buckets, boiler composition, stores, &c. - - - - -	25 0 0
5	Water—60,000 to 100,000 gallons per week - - - - - -	6 0 0
	Total weekly estimated cost of materials - - -	155 0 0
	Wages.	
6	Warehousemen and packers—12 at 25s. per week each - - - -	15 0 0
7	Machine feeders—two day feeders at 23s. and two night feeders at 26s. per week each.	4 18 0
8	Machine minders—two day at 27s. and two night at 29s. per week each - -	5 12 0
9	Driermen—two day at 25s. and two night at 27s. 6d. per week each - -	5 5 0
10	Engineer and engineer mechanic at 2l. per week each - - - - -	4 0 0
11	Firemen—two at 26s. per week each - - - - - -	2 12 0
12	Overlooker at 3l. per week, clerk at 2l., typist at 1l., office boy at 1l. per week -	7 0 0
	Total weekly wages - - - - - - -	44 7 0

The comments on this estimate of working costs are as follows:—

Item 1.—(*a*) Coal consumption and price are both estimated at too high a figure. (*b*) Coal consumption and price of coal both on the high side.

Item 2.—(*a*) Soap and alkali estimated at too high a figure. For the materials requiring disinfection 1s. 4d. per pack for soft soap and 10d. per pack for hard soap is ample. (*b*) Approximately correct if soft olive soap be used. Might not be sufficient for alpaca alone.

Item 3.—(*a*) Roller wrapping is estimated at too high a figure. Actual consumption is nearer 1½d. per roller per hour, and would be less for new machines. (*b*) Approximately correct unless very bad material is treated and machine minding is defective.

Item 4.—(*a*) Much too high. (*b*) Expenses of oil and stores should not exceed 4l. to 5l. per week.

Item 5.—(*a*) Cost depends on rate; consumption is correct. (*b*) Consumption is correct, but rate seems high.

Item 6.—(*a*) Number of warehousemen estimated for seems high for simple handling of material; otherwise labour estimate seems correct. (*b*) Labour estimate appears reasonable, but warehousemen will not be too many for receiving and packing 10,000,000 lbs. of wool per year.

SUMMARY OF ESTIMATED YEARLY WORKING COSTS AT PRE-WAR PRICES.

	£ s. d.
Yearly cost of materials at 155l. per week - - -	8,060 0 0
Yearly cost of wages at 44l. 7s. per week - - -	2,306 0 0
Interest on 18,000l. capital at 5 per cent. per year - -	900 0 0
Sinking fund and depreciation on capital of 18,000l. at 10 per cent. per annum - - - - - -	1,800 0 0
Rates and taxes - - - - - - -	350 0 0
Total estimated yearly cost - - - - -	13,416 0 0
Sum added by the Sub-Committee to meet the possible cost of additional labour and other contingencies - - - - - -	2,584 0 0
Total estimated annual working cost of the unit central disinfecting station at pre-war prices -	16,000 0 0

The cost of disinfecting 10,000,000 lbs. of material, estimated on a liberal basis, would, therefore, be 16,000l., including an allowance of 50l. per week, over the anticipated weekly working cost of 200l. per week, to meet contingencies. Apart from the cost of disinfectant, this is equivalent to a cost of 0·384 penny per pound of raw material disinfected.

The cost of disinfectant as worked out in the commercial scale experiments allows nothing for loss of disinfectant, except that which takes place during the passage of material through the disinfecting bowls. In other words, it is assumed that if the solution be kept up to the proper strength by addition of strong formaldehyde solution to meet the wastage during treatment, the liquid in the baths could be kept permanently in use. In practice this cannot, of course, be done because it becomes dirty. It will be necessary, therefore, to incur some expense for filtering the disinfecting solution, and it is intended that this shall be a charge on the margin of working costs allowed in the above estimate. The necessary filters will also be a charge on the margin of capital cost allowed in the estimate.

Excluding these filtering costs, which will not be large, the following are estimates of the cost of disinfection per pound of material of different varieties treated at pre-war prices :—

	Cost of Treatment, per pound of untreated material. (Fractions of a penny.)
Persian wool :—	
Working cost of treatment	0·384
Cost of disinfectant	0·408
Total	0·792
Mohair :—	
Working cost of treatment	0·384
Cost of disinfectant	0·16
Total	0·544
Alpaca :—	
Working cost of treatment	0·384
Cost of disinfectant	0·44
Total	0·824
East Indian wool :—	
Working cost of treatment	0·384
Cost of disinfectant	0·212
Total	0·596

The quantities of materials known to be liable to be infected reach this country, roughly, in the following proportions :—East Indian wool 60, mohair 30, Persian wool 10, alpaca 6, camel hair 6, Egyptian wool 4. Those which can be most cheaply disinfected, therefore, form by far the greater proportion of the whole, but assuming the ultimate cost of disinfection is that of the material which apparently causes the greatest loss of disinfectant in treatment (*i.e.*, alpaca), the cost of disinfection per pound of material treated will be 0·824 penny. Taking the average cost due to loss of disinfectant in the commercial scale experiments for all the materials treated as 0·34 penny, the average cost of disinfecting all materials will be 0·724 penny per pound of material disinfected. These costs are, as before stated, reckoned at pre-war prices. At the moment of writing about 55 to 65 per cent. must be added to them in order to estimate costs at present prices. For this sum the material is not only rendered free from danger from anthrax, but it is made at least as clean as it is after scouring as usually carried out in the worsted trade at the present time.

16. SUMMARY AND CONCLUSIONS.

Throughout our inquiry we have carefully examined the problem of disinfection from the widely different aspects of (1) the destruction of anthrax spores, (2) effect on material, (3) applicability in practice of the process evolved, and (4) cost. Under these heads we may summarise our work and conclusions as follows :—

(1) *Destruction of Anthrax Spores.*—In all our experiments we used dried bloodclots as infected test material, because it appeared to us that if we could find a method by which anthrax spores can be destroyed in these, the complete disinfection of wool can be ensured. The bloodclots used were made artificially in such a way that they contained a large number of spores, known to be of high virulence, deeply buried in hard dried blood. We compared these artificial clots with the thickest and heaviest natural bloodclots found in wool, by means of experiments in which the two kinds of clots were treated side by side. We are satisfied

that the test material was more highly infected than any material found in wool of commerce, and that the protection afforded to the spores was at least as great as that given by the most resistant substances found in wool.

Apart from the test material, the conditions of our experiments were purposely arranged so as to be not more favourable to disinfection than they would be in practice. Thus, the infected test material was never exposed directly to the action of the liquids used, either in the preliminary or in the disinfecting part of the process; it was always placed between layers of wool, and it was also dried among wool, and not alone. The machinery actually used was certainly less efficient and less favourable to disinfection than would be used in practice.

In the bacteriological examinations of material the most careful precautions were taken and sources of error excluded, wherever possible, by means of control tests. Further control was provided by the results of Professor Delépine's independent examinations of either parallel samples or portions of the same material tested by us. We are, therefore, satisfied that the experimental results are reliable.

We attempted to find a method by means of which fleeces of wool could be disinfected without opening. Although the possibility of disinfection is not definitely disproved, we are satisfied that such a method is not applicable in practice, because the fleeces cannot be dried, after disinfection, in any reasonable time. It follows that it is equally impossible to disinfect material in unopened bales, whether in fleeces or not.

Attempts were also made in the early experiments to secure disinfection by direct action of formaldehyde solution. These failed, and the results of the whole inquiry conclusively prove that the destruction of anthrax spores when well protected by dried blood is impracticable by this method in such time as would permit its use in pactice. We attempted also to make use of formaldehyde vapour by direct action, but in this again we failed. We are, therefore, satisfied that disinfection of wool containing dry bloodclots is impracticable by direct means, and that the protection afforded to anthrax spores by various substances in wool must be removed before disinfection can take place.

It is possible that a disinfectant may be discovered which will have both a disintegrating and disinfecting action. Most of the disinfectants at present known, however, penetrate hard dried blood very slowly, act chemically on the blood albumen and coagulate it, thus increasing the obstacles to further penetration and disinfection of the interior.

Our later experiments were therefore, directed towards finding a method by which the environment of anthrax spores in wool can be so modified as to permit of disinfection. We found that hard dried blood is capable of disintegration by water, and that this can be hastened and made more effective by (*a*) addition of certain substances to the water, *e.g.*, soap, sodium carbonate, &c., (*b*) raising the temperature of the water to about 110° F., (*c*) agitation, and (*d*) by squeezing the material through rollers. Finally, we concluded that where blood enclosing the spores had not been overheated, *i.e.*, when it had dried at ordinary temperatures, the protection afforded to the spores is sufficiently removed by these means in 20 minutes if efficient machinery be used. Throughout the report we have referred to this method of exposure of the spores as the preliminary treatment, and it constitutes the first stage in the process of disinfection. After this treatment the material is still very highly infected even when all blood and other protecting substances have been entirely removed. The anthrax spores, though their vitality is in nowise diminished, are then accessible. There is also some reason for thinking that they are more susceptible to the action of disinfectants. However that may be, they can be quickly destroyed if the material be immediately immersed in a solution containing 2–2½ per cent. of formaldehyde at a temperature of 102° F. We are satisfied that 20 minutes' exposure in this solution is sufficient to ensure destruction of all anthrax spores in wool provided the preliminary process has been effective. If any doubt were possible, it is removed by Professor Delépine's experiments bearing on this point. This constitutes the second stage of the disinfection process, and we have termed it the disinfecting treatment.

It is also clear from the results of our experiments that rapidity of disinfection is very greatly affected by the temperature of the formaldehyde solution. When this is at air temperatures disinfection of bloodclots after treatment in the preliminary process requires four to six hours, which is too long to be of use in practice. We further found that the time required for disinfection is greatly increased if the strength of the formaldehyde solution is allowed to fall much below 2 per cent. There does not appear to be any decided advantage, however, in raising the strength above 2½ per cent.

In certain circumstances we found that blood may be more resistant to disintegration in the preliminary process, or, at all events, may escape complete disintegration. In this event disinfection may, if the remnants are sufficiently large, be incomplete at the end of the disinfecting treatment, though spores survive only in the blood remnants by which they are protected.

We further found that if bloodclots treated by, but not completely disintegrated by, the preliminary treatment then pass through the disinfecting treatment, and are afterwards dried in a current of air heated to a temperature of about 160° F., then the remnants of blood, if not too thick, are completely penetrated by formaldehyde. We also found that occasionally in some bloodclot remnants a few spores after drying, though greatly weakened, may still survive. We found that the action of the formaldehyde is progressive, and that if the material be allowed to stand a few days all the spores have perished.

We are agreed that a process of disinfection can be based on the above facts, and must consist of four stages, as follows:—

Stage 1.—*Preliminary treatment*, consisting of agitation (by means of rakes which thrust the wool through liquid as in scouring machinery) for 20 minutes in a solution of soap in water (preferably also containing an alkali like sodium or potassium carbonate) at a temperature of 102° to 110° F., assisted by squeezing through rollers. The protection afforded to the spores is by this means removed, the spores are rendered susceptible to the action of disinfectants and the wool is cleansed.

Stage 2.—*Disinfecting treatment* in which the material is agitated by similar means for 20 minutes in a 2–2½ per cent. solution of formaldehyde in water at a temperature of 102° F., assisted by squeezing through rollers. In this stage the bulk of the anthrax spores is destroyed, those only surviving which are imbedded in remnants of bloodclots which in a few instances may have escaped complete disintegration during stage 1, but which become saturated with formaldehyde solution.

Stage 3.—*Drying* in a current of air heated to 160° F. The moisture in the wool is driven off, and nearly all the surviving spores in any blood remnants are destroyed.

Stage 4.—Standing for some days to ensure by the progressive action of the formaldehyde which remains in the blood remnants the complete destruction of the few weakened spores which have survived stage 3.

We are convinced that the key to successful disinfection is the efficiency of the preliminary treatment. Providing this is entirely effective in removing all protection to the spores, stages 3 and 4 are unnecessary so far as disinfection itself is concerned, though for commercial reasons drying is usually a necessity. We were not able in our experiments to make the first stage so efficient as to bring about with absolute certainty complete disintegration or solution of all protecting substances, except by very prolonged treatment, because we were compelled by the circumstances under which it was possible to carry out such an investigation to use inefficient machinery. We satisfied ourselves, however, by experiments with natural clots, that all blood can be removed from wool, and that scouring machinery is much more efficient for this purpose than the apparatus we used. Nevertheless, the possibility is always present that some small remnants may escape, and we therefore think stages 3 and 4 should be regarded as integral parts of the process of disinfection, which are in the nature of safety factors.

We took, in the course of our inquiry, every possible step to safeguard ourselves against the oversight of any factor which might prevent the successful disinfection of wool by our process in practice. From this point of view we consider the experiments and report of Professor Delépine, an expert critic outside of and entirely independent of the Committee, to be invaluable in enabling us to draw confident conclusions, confirming, as they do, the whole of our work. It is impossible to say that in no conceivable circumstances will anthrax spores escape destruction. On the contrary, it is possible that in rare instances traces of infection may remain in wool treated by the process. This applies to all methods of disinfection. We are, however, satisfied that anthrax among persons manipulating wool disinfected by our process will be a very rare disease.

(2) *Effect on Material.*—Throughout the whole of our inquiry we kept the troublesome question of effect on the material prominently before us. A quantity of one or other of the varieties requiring disinfection was treated together with the infected test material in every experiment. The damage test material so treated was submitted to experts for examination. We are satisfied that when wool or hair is disinfected by means of steam there is distinct and obvious deterioration in colour, strength, and spinning properties. In only one instance, however, was any deterioration detected in material treated by the formaldehyde process above described. In that case mohair had been treated by the preliminary process, and allowed then to remain for 14 days in a 2½ per cent. solution of formaldehyde. The only comment made by the experts who examined it was that it had deteriorated in colour and lustre. In all other experiments no deterioration could be detected.

In order to place this matter beyond doubt, we carried out under great difficulties a series of experiments on a commercial scale, in which the materials (Persian wool, East Indian wool, mohair and alpaca) were treated by the process of disinfection, and were then returned to the owners in order to be carefully watched through every process of manufacture. In these experiments the machinery we were compelled to use was not suitable for the purpose, and this and other unfavourable conditions involved faults of manipulation impossible to avoid, but calculated to produce small defects in the material from a manufacturing point of view. The method we adopted of asking the manufacturers to report on the behaviour of the material at every stage in the course of manufacture, from the raw wool to the finished cloth or other goods, together with the fact that the various products of manufacture (tops, yarn, cloth, blankets, Cardigan jackets, and felt) were put on the market and sold in the ordinary way of business, is one which we think should remove any doubts in the minds of those engaged in the various branches of the wool trade to whom this question is of paramount importance.

The reports we received revealed no defect of serious importance in the treated material. Reference was made to one or two small minor defects, but even these were only doubtfully due to the treatment. As both Messrs. John Foster and Son, Ltd., and Messrs. John Feather and Son, Ltd., point out, the differences observed in the treated and untreated materials are within the range of ordinary variations in the materials. We are satisfied that no damage or deterioration of any moment to either wool or hair results from the treatment.

As pointed out in section 1, pages 4 and 5, the effect of the process of disinfection on the material might appear differently in accordance with the use to which the latter is put, *i.e.*, whether it be used for (1) combing and spinning into worsted yarn, (2) spinning into woollen yarn, or (3) manufacture into felt. The materials treated in the commercial scale experiments for the purpose of demonstrating the effect of the process on the material were chosen not only to represent the different classes of dangerous wool and hair imported into this country, but also with a view to ascertaining the effect of the process on those of their qualities which make them valuable for use respectively in the three great branches of wool manufacture. Materials were supplied respectively by members of (1) the worsted trade, (2) the mohair and alpaca piece trade, (3) the blanket trade, and (4) the felt trade. After treatment they were returned and manufactured respectively into (1) worsted hosiery (after combing), (2) mohair and alpaca pieces (after combing), (3) woollen blankets, and (4) felt. The effect of the process can, therefore, be judged from the special standpoint of each of the great sub-divisions of the manufacture of wool and hair. In no case was any defect observed which would decrease the value of the materials for use in any of these branches of manufacture.

(3) *Applicability in Practice.*—The application of the method in actual practice was also a question we kept always before us, and in every experiment our aim was to work out a process which would be eminently capable of practical application. The method finally evolved is one which can be worked continuously by means of machinery of a type already in use in every worsted and many woollen manufactories. Modifications will, of course, be necessary, but they present no great difficulty. Formaldehyde is a substance already manufactured on a large scale, and used for a variety of purposes in many industries. We are, therefore, satisfied that no serious practical difficulty in the application of the process can arise.

(4) *Cost.*—It is impossible to state definitely what the costs of disinfection will ultimately be, as so much depends on the method by which any requirement of compulsory disinfection of wool and hair is brought into force. The capital and working costs have been worked out for a unit central disinfecting station, but we wish to guard against any assumption that we are making any recommendation in this report that this should be the policy adopted by the Committee. A unit central station, so far as this report is concerned, merely affords a convenient means for arriving at an idea of the cost of disinfection. We think the costs have been so stated as to afford a margin for contingencies, but it must be remembered that there is no experience save that of wool scouring and of the commercial scale experiments on which an estimate can be based. With this proviso, the estimate we are able to make, after careful consideration, would seem to show that some materials can be disinfected more cheaply than others, and that the cost will vary between 0·544 penny and 0·824 penny per pound of material treated. The materials capable of being treated most cheaply form the greatest proportion of the whole of the materials liable to be infected, and, allowing for all the circumstances, the bare cost of disinfection, together with interest on capital, &c., ought not, at pre-war prices, to exceed 0·8 penny per pound of raw material disinfected.

After disinfection, the material is at least as clean as it is after ordinary scouring. In fact, the preliminary process is in effect a scouring process, though it is an essential part of the disinfection process. In our estimate of costs we have kept the cost of disinfectant distinct from other costs, and this should be regarded as the real cost of disinfection, since a large part of the remaining costs will be saved by the comber or owner of the material after treatment. This applies with equal force whether it be intended to use the material for the manufacture of worsted, woollen or felt goods. Much of the cost of scouring will be avoided in the worsted trade, and the whole cost of preliminary shaking will be avoided in the woollen and felt trades.

17. CONCLUDING REMARKS.

From each of the points of view discussed above we are unanimous that the process of disinfection we have been able to elaborate is one the adoption of which the Committee will be completely justified in recommending to the Secretary of State as a means for preventing anthrax among persons manipulating wool and hair. The recommendation of the exact measures for bringing the process into operation is a question for the Committee, on which we offer no opinion in this report. We desire to point out, however, (1) that the scouring liquids at present used in Bradford are certainly and frequently highly infected. They are now allowed to pass into the drainage system (and possibly the anthrax spores they contain may be there destroyed by the action of other bacteria). The liquids used in the preliminary treatment of wool in the disinfection process will be infected in exactly the same degree. We think it highly undesirable that any liquids which have become infective, whether in the process of disinfection of wool or in the scouring of wool, should be allowed to pass into the drains without previous sterilisation. The cost of this is a charge which, if the Committee agree with us, would properly be borne as a normal expense in the scouring of wool, and one, therefore, which should not be specially added to the cost of disinfection. (2) There will still be a certain, though limited, degree of risk during manipulation of material (such as in opening, &c.) before it passes into the disinfection machinery. Very stringent measures should be taken to reduce this risk as much as possible. (3) The method of disinfection proposed is a chemical process which should be carried out only under expert supervision. It is highly technical, somewhat complicated, and is distinctly not a process calculated to yield certain results in the hands of the ordinary person, who may not realise the importance of or the necessity for the different operations.

Disinfection Sub-Committee.
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NOVEMBER 23RD, 1917.

Printed under the authority of His Majesty's Stationery Office
By EYRE and SPOTTISWOODE, LTD., East Harding Street, E.C.4,
Printers to the King's most Excellent Majesty.

DEPARTMENTAL COMMITTEE ON ANTHRAX.

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO

PRECAUTIONS FOR PREVENTING DANGER OF INFECTION FROM ANTHRAX IN THE MANIPULATION OF WOOL, GOAT HAIR, AND CAMEL HAIR.

VOL. II.—REPORT OF THE COMMITTEE.

Presented to Parliament by Command of His Majesty.

LONDON:
PUBLISHED BY HIS MAJESTY'S STATIONERY OFFICE.

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1918.

[Cd. 9171.] *Price 6d. Net.*

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Volume I. [Cd. 9057] of this Report contains the Report of the Disinfection Sub-Committee on the experimental investigation of disinfection of wool and hair.

Volume III. [Cd. 9172] of this Report contains a Summary of Evidence heard by the Committee, and Appendices to the Report.

DEPARTMENTAL COMMITTEE ON ANTHRAX.

TERMS OF REFERENCE, WARRANTS OF APPOINTMENT, &c.

(1.)

I HEREBY APPOINT—

The Right Hon. Sir THOMAS P. WHITTAKER, M.P. ;
W. BARBER, Esq., Secretary to the Bradford Trades and Labour Council ;
F. W. EURICH, Esq., M.D. ;
Alderman JOHN EDWARD FAWCETT, J.P., President of the Bradford Chamber of Commerce and Chairman of the Anthrax Investigation Board ;
Colonel EDWARD H. FOSTER ;
T. GRUNDY, Esq., Secretary of the National Union of Woolsorters ;
THOMAS MORISON LEGGE, Esq., M.D., His Majesty's Medical Inspector of Factories ;
ERNEST MARSH, Esq. ; and
SAM PARKER, Esq., Secretary of the Bradford and District Wool, Top and Noil Warehousemen's Union

to be a Committee to inquire into the dangers from infection by anthrax in the processes of sorting, willeying, washing and combing, and carding wool, goat hair and camel hair, and in the processes incidental thereto ; and to consider and report whether any, and, if so, what, amendments are desirable in the Regulations for these processes made under section 79 of the Factory and Workshop Act, 1901.

AND I FURTHER APPOINT Sir THOMAS WHITTAKER to be Chairman, and Mr. GEORGE ELMHIRST DUCKERING, one of His Majesty's Inspectors of Factories, Secretary of the Committee.

(Signed) R. McKENNA.

Whitehall, 4th November 1913.

(2.)

I HEREBY APPOINT Mr. W. MIDDLEBROOK, M.P.,* to be Chairman of the Committee in place of Sir THOMAS WHITTAKER, M.P., who has resigned.

AND I FURTHER APPOINT Mr. A. H. ILLINGWORTH, Ex-President of the Bradford Chamber of Commerce, and Mr. HERBERT MORAN, Secretary of the National Society of Machine Woolcombers, to be members of the Committee.

(Signed) R. McKENNA.

Whitehall, 18th December 1913.

(3.)

I HEREBY APPOINT Mr. WILLIAM MACKINDER, Secretary of the Bradford and District Wool, Top and Noil Warehousemen's Society, a member of the Departmental Committee to inquire into the dangers from infection by anthrax in woolsorting and other processes, in place of Mr. S. PARKER, who has resigned.

(Signed) R. McKENNA.

Home Office, 6th July 1914.

(4.)

I HEREBY APPOINT Mr. WILLIAM MORTON JACKSON to be an additional member of the Committee appointed on the 4th November 1913 to inquire into the dangers arising from infection by anthrax.

(Signed) JOHN SIMON.

Home Office, 5th October 1915.

* Now Sir William Middlebrook, M.P.

m (6)31339 1250 10/18 E & S

(5.)

Home Office, Whitehall,
22nd August 1916.

SIR,

I AM directed by the Secretary of State to forward to you the enclosed copies of a question put by Mr. Strauss, M.P., and of the reply, and to say that he would be much obliged if the Departmental Committee on Anthrax would inquire into the precautions which should be adopted to diminish the dangers from infection by anthrax in the case of persons employed in warehouses at wharves, &c., so far, at any rate, as regards the dangers from wool, goat hair and camel hair.

The Secretary of State understands that the Committee are already making inquiries in connection with the dangers from these materials when stored in warehouses at factories.

I am, &c.,
(Signed) MALCOLM DELEVINGNE.

W. Middlebrook, Esq., M.P.

Copy of Question and Reply.

Daily Debates, 10th July 1916.

Written Answer.

ANTHRAX.

Mr. E. STRAUSS asked the Home Secretary whether his attention had been called to the inquest held at the Coroner's Court, Southwark, on the 29th June 1916, upon the body of Benjamin Morgan, aged 51 years, a waterside labourer, who died in Guy's Hospital from cutaneous anthrax contracted during his work at the New Hibernia Wharf, or Hay's Wharf, Southwark, while handling infected Persian or China wool from bales; and, if so, and in view of the fact that several deaths have recently been caused by this deadly disease in and around London, will he take such action, by legislation or otherwise, so that the provisions of the Factory and Workshops Act can be extended or enlarged so as to apply to wharves and warehouses and other places where foreign or suspect wool, hides, skins, horse and goat hair, pigs' bristles, and other material liable to be infected with anthrax are handled and dealt with, and that the preventive regulations, including placards in picture form, issued by the Home Office should be compulsorily exhibited and enforced for the information and well-being of the workers in such wharves and warehouses.

Mr. BRACE: The Home Office has received a letter from the Coroner drawing attention to the proceedings at the inquest on this case. The danger of anthrax in connection with the handling of wool bales at wharves and warehouses has recently come into prominence, and the question of the steps to be taken to protect persons employed in such premises has been under the consideration of the Department. I propose asking the Departmental Committee, which is now considering the question of anthrax in the wool industry, to make inquiry into this subject, and pending the receipt of a report from them, I am arranging for a circular to be issued to the occupiers of such premises calling their attention to the danger, and recommending the adoption of certain precautionary measures which will include the posting of the picture-placard to which the Hon. Member refers. In a number of instances the placard in question has already been issued to the occupiers of wharves and warehouses.

(6.)

Home Office, Whitehall,
19th September 1917.

SIR,

I AM directed by the Secretary of State to say that he has received an application from the General Union of Textile Workers (15, Talbot Street, Batley) asking him to appoint a committee to hold a special inquiry into the numerous cases of anthrax arising in the Dewsbury, Batley, and Spen Valley textile mills.

As you will be aware from the previous correspondence, when the Committee of which you are Chairman was set up it was originally intended that the Committee, after completing its inquiry into the incidence of anthrax in the worsted industry, should be reconstituted for the purpose of extending the investigation to the woollen trades. The Secretary of State understands, however, that you are of the opinion that the conclusions reached by the present Committee as a result of their recent experiments will be applicable not only to the worsted, but also to the woollen sections, and that a separate inquiry in regard to the woollen trades will accordingly be unnecessary, provided the representatives of these trades are prepared to give their adherence to the scheme formulated by the Committee.

In these circumstances, the Secretary of State would be much obliged if you would undertake to meet representatives of the employers and employed in the woollen trades, including representatives of the General Union of Textile Workers, with a view to explain the whole situation and obtain their concurrence in the application of the scheme to their section of the industry.

A copy of the Secretary of State's reply to the application of the General Union of Textile Workers is enclosed for your information.

I am, &c.,
(Signed) MALCOLM DELEVINGNE.

Sir W. MIDDLEBROOK, M.P.,
Chairman of the Departmental
Committee on Anthrax.

(7.)

I HEREBY APPOINT Mr. GEORGE H. FEATHER to be a member of the Committee appointed on the 4th November 1913 to inquire into the dangers arising from infection by anthrax, in the place of Mr. A. H. ILLINGWORTH.

(Signed) GEO. CAVE.

Whitehall, 5th October 1917.

(8.)

I HEREBY APPOINT Mr. SAMUEL WALKER to be a member of the Departmental Committee appointed to inquire into the dangers of infection by anthrax in the processes of sorting, willeying, washing, combing and carding wool, goat hair and camel hair, and in the processes incidental thereto, in the place of Mr. ERNEST MARSH, who has resigned.

(Signed) GEO. CAVE.

Whitehall, 3rd June 1918.

REPORT.

The Right Honourable Sir George Cave, K.C., M.P.,
His Majesty's Principal Secretary of State
for the Home Department,
Home Office.

SIR,

1. WE have the honour to submit the following Report on our investigations of the dangers to persons manipulating wool, goat hair, and camel hair of infection from anthrax. The Committee has met on 116 days, visited 13 representative works and examined 49 witnesses.* Our work has been greatly hampered by difficulties directly attributable to the war. In the difficult conditions obtaining since August 1914 much of the detail work has been carried on by means of conferences between the Chairman, Secretary, and members of the Committee, and employers, operatives, and others engaged in or having knowledge of the trade in wool or having knowledge of anthrax. A very large number of these conferences has been held in addition to the meetings of the Committee, and they have absorbed much time.

2. While this Report has been under final consideration, we deeply regret to have lost, by death, one of our members—Mr. J. E. Fawcett—who brought both experience and knowledge to our deliberations. Mr. Fawcett before illness incapacitated him had, as a member, signed the report of the Sub-Committee on Disinfection.

3. Our investigation divides itself naturally into two periods, during the first of which evidence was taken and the application of regulations examined and considered. The more important second period of our labours was devoted to the carrying out of an extensive experimental investigation for the purpose of devising a method of disinfection of wool and hair, and, after the evolution of a successful process, to consideration of the most effective means by which it could be applied for the protection from anthrax of persons working among these materials.

TERMS OF REFERENCE AND SCOPE OF THE REPORT.

1. Shortly after we began our investigation it was explained in correspondence with the Home Office that the Committee was constituted in order to deal, in the first instance, with the question of anthrax in the worsted industry; and that, on the completion of this investigation, it was intended to reconstruct the Committee for the purpose of investigating the dangers of anthrax in the woollen industry and in other branches of the wool trade. In 1916 an outbreak of anthrax among persons employed in those dock warehouses in which wool is stored for examination for sale purposes at the ports, directed increased attention to this phase of the general danger of infection, and we were asked to inquire as to precautions which should be adopted for preventing anthrax in these premises.

2. During 1916 and 1917 incidence of anthrax was, as compared with that in previous years, heavy among operatives employed in the woollen and felt trades, with the result that the Home Office consulted us with reference to a request for a special inquiry. The Chairman pointed out that danger of infection is more a question of the material used than of the manner of its use; that the Committee had succeeded in finding a practicable method of disinfection applicable in all branches of the trade in wool, whether the product manufactured be worsted, woollen or felt; and that, in consequence, the situation was so modified as to make unnecessary further separate inquiry as to the precautions necessary in different branches of the trade. The Chairman was then requested by the Home Office to meet the employers and operatives in the woollen trades, explain the position, and ask them if they were prepared to agree to the scheme of disinfection to be formulated by the Committee.

3. A meeting in Liverpool, thoroughly representative of those branches of trade outside the scope of the Committee's original terms of reference, was, therefore, convened by the East Indian Wool Joint Committee and the Liverpool Woolbrokers' Association, at which the wool importers, wool brokers, woollen trade, felt trade, wool merchants, top makers, wool trade organisations, and others, were represented. The Chairman placed before this meeting the results obtained and the conclusions arrived at, and outlined the proposals for a scheme of disinfection. It was then agreed that action was needed, that there is no apparent advantage in having an additional separate inquiry, and that the trades concerned are prepared to accept the proposals to be made by us. The principle of disinfection at a point as near as possible to the source from which dangerous materials are obtained was very strongly supported by the woollen and felt manufacturers.

* *See* Summary of Evidence—Witnesses.

4. The General Union of Textile Workers arranged a meeting with representatives of the operatives, to whom the position was similarly explained. They pointed out that (1) incidence of anthrax had recently been very severe in the woollen trade, (2) alarm was felt, (3) action was urgently necessary. It was agreed that disinfection is the only means for *preventing* anthrax, and that our recommendations would be accepted without separate inquiry into their branches of the trade. They stipulated, however, that prompt action should be taken.

5. We were thus finally charged with the duty of making recommendations covering the manipulation of wool and hair (other than horsehair) in dock warehouses and in the worsted, woollen and felt trades. Had it been proposed to recommend regulations for controlling the processes in these different branches of the manufacture of wool, we should have felt the task to be impossible without some reorganisation of the Committee, but given a successful method of disinfection, the prevention of anthrax becomes much more a question of materials used than of the processes which those materials undergo in the course of manufacture.

6. The ultimate intentions as to inquiry into the dangers of anthrax in other branches of the trade in wool being known to us, the experimental investigation into disinfection had been so directed as to include within the scope of the experiments the varieties of dangerous materials used in each of the worsted, woollen and felt branches of the wool trade. We further carried out experiments to test the effect of the process on the material as judged by the requirements and necessities of each section of the trade, and our Report and Recommendations have been considered and drafted with due regard to them.

7. The salient points in connection with each branch of the trade, and the considerations, based on the evidence placed before us, which influenced us finally to attempt to find a method of disinfection, are, first, briefly reviewed. We then state the method of disinfection devised by the Sub-Committee which carried out the experimental investigation (the Report* itself having been published separately), and, finally, we put forward the scheme by means of which we think disinfection can be most effectively brought into operation. A summary of the evidence under appropriate heads is given as an appendix to the Report. References to the evidence in the body of the Report are, therefore, only brief.

THE TRADE IN, AND THE MANUFACTURE OF, WOOL.

1. The manufacture of wool and hair into articles for domestic use is divided into three distinct divisions, known as (1) the worsted trade, (2) the woollen or heavy woollen trade, and (3) the felt trade. Behind these manufacturing industries is a vast organisation of trade engaged in the production, collection, transport, and supply of wool and hair of cattle, sheep, goats, and camels, all the varieties of which are used in one or other of the three manufacturing industries. Some or all of the kinds of animals named above exist in every country in the world. In some countries the production of wool or hair is highly organised, in others it is unorganised. This distinction is fundamental since anthrax is primarily a disease of animals which can, by proper organisation, be controlled.

2. Wool and hair are imported into Great Britain from practically all the countries in which they are produced on any considerable scale. We endeavoured to obtain evidence of the methods followed in the production, collection, packing and transport of the different varieties, particularly of those known to be liable to convey infection. Complete information on these points would have assisted us when considering measures of prevention of anthrax, but that tendered was meagre and vague, especially in regard to those countries from which the most dangerous materials are obtained.

3. All wool and hair can be divided into two classes: (1) that produced in the ordinary way by shearing or other method of removal from the body of the live animal, *i.e.*, fleece material; and (2) that removed from the body or skin of animals after death, *i.e.*, skin material. Material of the latter class is removed either by the farmers or graziers who own the animals, or by fellmongers who purchase the skins. In countries where the production and trade in wool is a highly organised industry, shorn fleece wool and wool removed from bodies or pelts of dead animals are regarded as different articles of commerce and are rarely mixed even by the producers. In countries where the industry is less highly organised fleece and skin materials are frequently mixed by the farmers or merchants, and sold in this state.

4. Wool and hair of all grades are usually collected by local merchants (except where they are produced on a large scale in highly organised States, *e.g.*, Australia, New Zealand, &c.) at centres where they are sometimes roughly graded, mixed and packed. Passing by way of trade through the hands of various dealers, they are frequently collected at larger centres or ports and sold to, or placed in charge of, importers in this country who arrange for their transport and for sale here. Many merchants and some manufacturers also buy direct at the foreign centres, and themselves arrange for transport to this country. In countries like Asia, where transport over long land routes is necessary, the route followed depends on many factors, so that sometimes materials from a particular district appear at one centre and sometimes at another, and in these instances the same material is frequently described by different names

* *See* footnote on page 29.

according to the route by which it is transported. Wool and hair are mostly bought and sold by direct examination of the bulk offered for sale. Purchase by sample does take place, but usually the purchaser examines each bale of the lot offered.

5. On arrival in this country, materials are dealt with in various ways. Those bought direct by manufacturers go, naturally, to the mills; those bought and imported by wool merchants go to the warehouses of their owner, where he may sort them into qualities or "matchings" and repack for sale to his usual customers or sell them by private treaty without opening. The materials brought to this country by importers* are usually put into the hands of wool-brokers for sale, either by private treaty or by public auction.

WOOL WAREHOUSES AT THE PORTS.

1. The great bulk of imported wool and hair enters this country in normal times through the ports of London and Liverpool. On arrival, the materials are removed from the ships to large warehouses under the control of the Port of London Authority and the Mersey Docks and Harbour Board respectively, which are used for the storage and exhibition of wool and hair. If intended for sale by brokers at the public auction sales the bales of each lot are arranged in the order in which they are catalogued for sale. Intending purchasers make their examination, in order to value the materials, one or two days before the sale is announced to take place. After the sales are completed the open ends of the bales are closed up and each lot despatched to the place designated by the purchaser. The wool which falls on the floor during the examination is also collected, and in Liverpool is sold separately. In the portions of the warehouses devoted to storage and examination of certain varieties of materials anthrax occurs among intending purchasers and persons employed. Smaller quantities of wool and hair are landed at Hull, and possibly at other places, and are usually for private trade.

THE WORSTED INDUSTRY.

1. Worsted yarn is generally understood to be a yarn made from *wool* from which the bulk of the short fibre has been removed. For the purpose of this Report, however, the manufacture of similar yarns from mohair, alpaca, camel hair and goat hair is included under the general head of the worsted industry. The essential feature in the manufacture of worsted is the combing process, by which the short fibres are separated from the long. Generally speaking, only raw materials over 3 inches in length are suitable for use in this industry. Any quality of material can be used, but the combing process is severe and tends to breakage of weak fibres.

2. Certain of the materials, *e.g.*, the better qualities of certain sheeps' wool and of mohair and alpaca, are usually, while cashmere and camel hair are occasionally, sorted. This is done principally in merchants' warehouses, which thus become workshops under the Factory and Workshops Act, and in spinning factories, but partly also in factories devoted to topmaking (combing). Certain other materials, including the lower qualities of mohair and alpaca, goat hair, Persian wool, East Indian wool, &c. are sometimes, but not frequently, sorted. The term "*sorting*" was much used in evidence laid before us, and in its usual sense describes the separation of the wool composing fleeces into portions or "matchings" the individual fibres of which have approximately the same characteristics, *e.g.*, length, strength, degree of fineness, colour, &c. Of recent years, however, the separation of bloodstains from wool has become a definite process which resembles sorting, and is often included in that term.

3. The matchings after sorting, or the raw materials if unsorted, are blended, occasionally willowed or shaken, scoured or washed by machinery in successive baths containing a solution of soap and (sometimes) sodium carbonate at a temperature of 100–140° F., dried in a current of air at a temperature of 160–170° F., and sprinkled with oil. The next process depends principally on the length of the fibres of the material, the longer materials being "prepared" in machines (preparing boxes) by drawing them through rows of spikes or coarse pins which travel with, but move more slowly, than the wool. The shorter are carded on carding machines (consisting of a series of revolving cylinders covered with pointed wires projecting from the surface). In either case the product is a sliver (a long strip or band of loosely clinging fibres) in which the fibres are roughly parallel.

4. The sliver is sometimes washed and dried in machines named back-washers (back-washing), and, whether backwashed or not, is combed, in which process it is drawn through several rows of steel pins in such a way as to separate the short fibres from the long. The latter, in the form of a sliver, is passed through a gill box (finishing box) in which the wool is

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* In considering the trade in wool it is necessary to draw a distinction between importers and wool merchants. *Importers* are persons or firms who import produce generally from various parts of the world, of whose business the trade in wool forms part only, though it may possibly be a considerable part. They also, in some instances, finance the movement from one part of the world to another, and arrange for the sale by wool brokers of wool which is not their actual property. *Wool merchants* buy and sell wool only. Usually they purchase in the producing districts and sell to consumers. They frequently grade or otherwise handle the material in their own warehouses and supply a particular branch of the trade. They are experts in the particular variety of material in which they deal.

sprinkled with water, in order to bring it to a standard condition for spinning purposes, and made up into balls. The final product so obtained is known as "Tops." This is the first definite product of worsted manufacture and is an article of commerce.

5. The short fibre or "Noil" produced in combing, and the waste short fibre produced in carding (known as card waste), are sold as raw materials for the woollen and felt trades. The dust and debris separated from the waste material is sold to waste dealers, who further separate a proportion of very short fibre (sold as "flock" for making mattresses, &c.) from the dust, which is disposed of for use as manure.

6. The production of tops is not confined to spinning and combing factories in which the materials treated belong to the owners of the factories. There is in addition a class known as "Commission Combing Factories," the owner of which combs material belonging to other people, and produces tops for a fixed remuneration or commission. Since the occupiers of many factories of this class are prepared to comb any material (within certain limits) sent to them, the variety of material dealt with is considerable. Not only is this so, but the lowest grade and most dangerous materials are frequently sent to be combed in commission factories on account of their condition. In consequence, the incidence of anthrax in some of these establishments is relatively high.

7. The tops produced may be blended and are spun into yarn either on mules or, more usually, on high-speed spinning frames. Worsted yarn is also an article of commerce, and is, of course, used for weaving (or knitting) into worsted fabrics, *e.g.*, cloth, hosiery (including in that term socks, underwear, cardigan jackets, &c.), and carpets. Waste material produced in spinning and weaving processes is sold—usually to woollen manufacturers—and again worked up. Most of the worsted spinning is done in Bradford and the immediate neighbourhood, but worsted spinning factories are also scattered throughout the country.

THE WOOLLEN INDUSTRY.

1. Some kinds of raw materials are used in all three branches of the manufacture of wool, notably certain kinds of East Indian wool and Egyptian wool. The number of varieties used in the woollen industry is, however, much greater than in the production of worsted yarns. Practically any wool or hair of about 5 inches in length or less can be and is used. The waste materials produced in worsted combing, spinning, and weaving, the by-product of combing (noils), the waste clippings produced in manufacture of clothing and other articles of wear (hosiery, cardigan jackets, &c.), and shoddy (*i.e.*, torn up worn-out clothing and rags) are also used.

2. The first process in manufacture of woollen yarn is willowing or shaking (of raw materials), by which dust is removed. The materials are then blended most carefully and the blend "pulled" in such a way that a homogeneous mixture is obtained. After having been again shaken the blended materials are heavily oiled, passed through a "fearnought" willow, and carded twice (on a scribbling or coarse carding, and a finisher or fine carding machine [condenser] respectively). The product of carding is a thick thread or condenser roving of loosely adherent fibres, which is at once spun on mules (very rarely on high-speed flyer frames). The yarn produced may then be scoured in soap and water, and is ready for dyeing or for weaving (or knitting) into woollen goods, *e.g.*, cloth, blankets, rugs, carpets, hosiery, &c. The waste materials produced in the course of manufacture are cleaned and used over again. The dust separated from the raw materials in the manufacture of woollen yarns is sold and used as manure. Woollen manufacture is carried on in various parts of the country, *e.g.*, the West Riding of Yorkshire, parts of Scotland, Witney, Gloucestershire, Wales, Kidderminster, &c.

THE FELT INDUSTRY.

1. As in the woollen industry a great variety of raw materials is used in the manufacture of felt, consisting not only of raw wools, but also of the waste and by-products of both the worsted and woollen industries. The process of manufacture is the same as that of woollen yarns up to the second carding, except that no oil is applied to the materials. The second or finishing card is not fitted with condensing mechanism, but the sliver passes in a broad band the same width as the card between the sheets of a forming machine, from which it is finally removed as a thick broad sheet or "lap" or "bat" of wool, rolled up, and transferred to a hardening machine where, by means of heat, pressure, and friction, the fibres of wool are caused to felt together into a fabric. The dust and other waste materials produced in the manufacture of felt are sold for use as manure. The principal felt-producing district is the Rossendale Valley in Lancashire, but there are smaller centres in other parts of the country.

PREVIOUS ENQUIRIES.

1. The danger of anthrax in the different branches of the wool trade has formed the subject of numerous enquiries since 1879, when Dr. J. H. Bell, of Bradford, first established the fact that the disease then known in Bradford as "Woolsorters disease" is, in truth,

anthrax. In 1880 Mr. John Spear, one of the medical inspectors of the Local Government Board, made an enquiry in Bradford as to the existence of the disease.*

2. A code of voluntary rules was drawn up by representatives of employers, woolsorters, and the Factory Department of the Home Office, revised in 1884, and issued by a Joint Committee of Representatives of Employers, Woolsorters, and the Sanitary Committee of the Bradford Town Council.

3. In 1896 the Departmental Committee, appointed by the Home Office in 1895 to inquire generally into the danger of anthrax, made recommendations for a code of special rules for woolsorting which was brought into legal operation in 1897. The report of this Committee describes the various enquiries and voluntary regulations made up to that time and renders it unnecessary here to detail them.

4. In 1899 the Bradford Chamber of Commerce and the Bradford and District Trades and Labour Council jointly asked for a code of special rules to be applied to woolcombing as distinguished from woolsorting, and made recommendations which, after conferences between these bodies and the Factory Department, were embodied in a code established in 1901.

5. Continued heavy incidence of anthrax led to joint issue in 1903 of a circular by the Chambers of Commerce of Bradford, Halifax, Keighley and Kidderminster dealing with the unsatisfactory condition in which Persian wool is imported. In the same year a Joint Committee of the Bradford Chamber of Commerce, the Bradford and District Trades and Labour Council, the National Union of Woolsorters, the Bradford Woolcombers' Association, and the Bradford Wool, Top and Noil Warehousemen's Association submitted proposals to the Secretary of State for amendment of the two codes of special rules in force, and the Factory Department suggested their consolidation into one code of regulations. The combined code applying to woolsorting and woolcombing, which resulted from these suggestions, was brought into force in 1905 and is still in operation. The Bradford and District Anthrax Investigation Board was constituted in the same year and their inquiries have continued up to the present time, the results being published yearly in their Annual Reports.

6. Incidence of anthrax in the woollen trade (which began to attract attention in 1900) led in 1906 to inquiry by the Factory Department, and the suggestion that the woolcombing code of regulations should be applied in factories where East Indian wool was used. In 1907, at conferences between the Home Office, the woollen manufacturers and wool brokers, exception to the suggestion of risk of anthrax from this material was taken and, eventually, a code of regulations was applied ostensibly for the purpose of suppressing the very dusty conditions in its manufacture. Since that time, recurring outbreaks of anthrax in Bradford, Kilmarnock, the West Riding, Lancashire, &c. have formed the subject of enquiries by the Factory Department, particularly by Mr. Verney and Mr. Allen Taylor, His Majesty's Inspectors of Factories, and by the Anthrax Investigation Board.

7. In 1912 an International Sub-Committee of the International Society of Labour Legislation was appointed to consider the danger of anthrax and draw up regulations aiming at its prevention.

8. The question is thus shown to be one which, for over 40 years, has caused continually recurring anxiety to the authorities, employers, and operatives, and one on which much labour and thought have been expended.

PERSONS EMPLOYED IN THE WOOL INDUSTRIES.

1. The number of persons employed in the various branches of manufacture of wool (including hosiery) is, roundly, 260,000 according to the return of persons employed, made to the Home Office in 1907. Of these, roughly, 110,000 are females. Persons employed in felt-making are not separately mentioned, but, in the return of 1901, it is stated that, roundly, 1,700 persons (400 females) are employed in felt, flock, and waste processes not for re-spinning. This number has not since materially altered. In 1907 the persons employed in the worsted and woollen trades were distributed as follows (in addition to 25,048 persons employed in finishing processes) :—

—	Worsted.			Woollen.		
	M.	F.	Total.	M.	F.	Total.
Sorting and combing	9,920	4,415	14,335	—	—	—
Spinning and incidental processes	19,491	45,845	65,336	21,036	12,092	33,128
Weaving and incidental processes	19,273	31,925	51,198	21,541	47,361	68,902
Totals	48,684	82,185	130,869	42,577	59,453	102,030

* Supplement to the 10th Annual Report of the Local Government Board, containing the Report of the Medical Officer, 1880, Appendix A8.

2. Though no variety of wool or hair can be considered entirely free from infection many varieties are practically free. There is no means of ascertaining what proportion of the persons employed in the worsted trade is exposed to danger of infection, or what number is engaged in the manipulation of varieties of material likely to convey infection in a dangerous degree, but, as will be seen later, no process of manufacture removes the danger from the material. Further, it is impossible to compute the number of persons exposed to the danger of anthrax because infection of wool is not constant. Many consignments and qualities of even dangerous varieties are probably quite free from infection, and particular varieties may be heavily infected in one season and but slightly infected in another.

3. Still less is it possible to form any idea of the number of persons exposed to danger of anthrax in the woollen branch of the trade, owing to the extremely varied character of the materials used. In the manufacture of felt a very large proportion of the total number employed is exposed to risk. We have no knowledge of the number of persons employed in public and private warehouses and in transport.

4. In transport and in port warehouses males only are employed. In factory warehouses females are occasionally employed in the worsted branch, but warehouse work in each of the three branches of the trade is usually done by males. Sorting is usually a worsted process only, and all skilled sorters are males, but women are occasionally employed for rough sorting and removal of bloodstains. Women are employed in blending and willowing in the woollen trade in certain parts of the country, but usually the process is carried on by males in each of the three branches. Scouring, both of raw wool and of woollen yarn, is almost entirely done by males. The carding of wool in all branches of the wool trade is done principally by females working under the direction of card jobbers, who are males, but the cards are fettled (cleaned) and ground by males. Both males and females are employed in preparing, but combing, spinning, and weaving are carried on principally by females working under foremen.

INCIDENCE OF ANTHRAX.

1. Section 73 of the Factory and Workshop Act, 1901, requires every medical practitioner attending on or called in to visit a patient whom he believes to be suffering from anthrax contracted in a factory or workshop to notify the case to the Chief Inspector of Factories, and the occupier is required to report every case to the District Inspector of Factories and the certifying surgeon. Evidence clearly indicates that recognition of external anthrax by medical practitioners is sometimes, and of internal anthrax is always, difficult; and that, in consequence, some cases are not recognised and, therefore, fail to be notified. Nevertheless, the incidence may be sufficiently gauged from the statistics, collected as a result of the notifications, published annually in the reports of the Medical Inspector of Factories. In the period 1896–1917 inclusive, 594 cases (457 males and 137 females) occurring in the manipulation of wool, goat hair and camel hair (including one of a plasterer using goat hair) were reported on. The distribution of these cases year by year in the different branches of the trade is shown in the following table:—

(Small figures refer to fatal cases.)

—	Year.											
	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.
Transport	—	—	—	—	—	—	1	2	—	—	1^{1}	—
Warehouses at the ports	—	—	—	—	—	1^{1}	—	—	2^{1}	—	1	4
Wool merchants	—	—	—	1	—	—	—	—	—	1	—	—
Worsted trade:—												
Mohair merchants	—	—	—	3^{1}	—	1^{1}	—	4^{1}	—	—	—	1
Commission woolcombers.	—	—	—	6^{2}	5^{2}	2^{2}	2	7	3	18^{10}	13^{6}	7
Woolcombers other than commission woolcombers.	—	—	—	7^{2}	—	—	—	—	1^{1}	—	—	2^{2}
Mohair, alpaca, and worsted spinning and manufacturing.	—	—	—	1	3	2^{1}	6^{2}	8^{4}	7	11^{2}	5^{1}	5^{1}
Total in worsted trade.	3	9	13^{3}	17^{5}	8^{2}	5^{4}	8^{2}	19^{5}	11^{1}	29^{12}	18^{7}	15^{3}
Woollen trade	—	—	—	—	2	2	3	1	3	2	6^{1}	4
Felt trade	—	—	—	—	—	—	1	3^{1}	—	2	3	1
Wool waste dealers	—	—	—	—	—	—	—	—	—	—	—	—
Rag and waste pullers	—	—	—	—	—	—	—	1^{1}	—	1^{1}	1	—
Total handling wool	3	9	16^{3}	18^{5}	10^{2}	8^{5}	13^{2}	26^{7}	16^{2}	35^{13}	30^{9}	24^{3}

(Continued on page 12)

	Year.										
	1908.	1909.	1910.	1911.	1912.	1913.	1914.	1915.	1916.	1917.	Total.
Transport - - -	—	1	—	—	—	—	—	—	—	—	5^{1}
Warehouses at the ports	1	1	1	1^{1}	1	—	—	—	10^{3}	2	25^{6}
Wool merchants - -	—	1	1	1	1	—	—	—	1	1	8
Worsted trade:—											
Mohair merchants -	—	—	1	—	1	—	1	—	—	—	12^{3}
Commission wool-combers.	6^{3}	13^{2}	9^{2}	12^{6}	9^{3}	13^{2}	7^{2}	5^{1}	20^{6}	9^{4}	166^{33}
Woolcombers other than commission woolcombers,	—	—	2	1	1	3	1	—	2	3^{1}	23^{6}
Mohair, alpaca, and worsted spinning and manufacturing.	2	6^{1}	4^{1}	6^{3}	3^{1}	6^{1}	4	5^{1}	9^{1}	8^{1}	101^{21}
Total in worsted trade.	8^{3}	19^{3}	16^{3}	19^{9}	14^{4}	22^{3}	13^{2}	10^{2}	31^{7}	20^{6}	327^{88}
Woollen trade - -	4	3	6	12	11^{1}	14^{1}	10^{3}	14	33	37^{4}	167^{16}
Felt trade - - - -	6	2	4	2	3	6^{1}	5	1	5^{2}	4^{1}	48^{5}
Wool waste dealers -	—	1	—	—	1^{1}	1	1	1	—	1	6^{1}
Rag and waste pullers -	—	1	—	—	—	—	—	—	—	—	4^{2}
Total handling wool	19^{3}	29^{3}	28^{3}	35^{10}	31^{6}	43^{5}	29^{5}	26^{2}	80^{12}	65^{11}	593^{113}

2. "Transport" includes cases reported in unloading wool from ships, carting it, and carrying it by rail, &c. Such cases do not come within the terms of section 73 of the Factory and Workshop Act, 1901, so that the record is probably incomplete. "Warehouses at the ports" means warehouses like those of the Mersey Docks and Harbour Board in Liverpool, where wool is stored and exhibited for sale. Cases of anthrax in other warehouses are not reportable, and, though some have occurred, there is no definite record of cases occurring in warehouses except in large public establishments.

3. Leaving out those occupations like transport, wool merchant, and waste dealers, in which the records are necessarily incomplete, and considering only the main branches of the trade, *i.e.*, dock warehouses, worsted, woollen and felt, there is no indication of any tendency in any branch towards a reduction of the incidence. Fluctuations in incidence in the worsted trade are considerable, but avoiding the effect of this, by dividing the time covered by the records into periods of five years dating from 1896, the following result is obtained:—

	Cases of Anthrax in the Period.				
	1896–1900.	1901–5.	1906–10.	1911–15.	1916–17 (two years).
Total cases - - - -	56	98	130	164	145
„ fatal internal cases - -	6	10	*11	13	15
„ „ external cases - -	6	19	10	15	8
Warehouses at the ports:—					
Total cases - - - -	—	3	8	2	12
Fatal internal cases - - -	—	—	—	—	1
„ external cases - - -	—	2	—	1	2
The worsted trade:—					
Total cases - - - -	50	72	76	78	51
Fatal internal cases - - -	6	10	*11	13	11
„ external cases - - -	6	14	8	7	2
The woollen trade:—					
Total cases - - - -	2	11	23	61	70
Fatal internal cases - - -	—	—	—	—	2
„ external cases - - -	—	—	1	5	2
The felt trade:—					
Total cases - - - -	—	6	16	17	9
Fatal internal cases - - -	—	—	—	—	1
„ external cases - - -	—	1	—	1	2

* In addition one internal case resulted in recovery.

4. In the worsted branch of the trade (if the strong rise in 1916–1917 be excluded) there is a distinct, though not great, tendency for the incidence to increase. In the years 1916 and 1917, in spite of the fact that there has been no supply of Turkey mohair, which is one of the most dangerous materials used in the combing (worsted) trade, there has been a notable increase, more cases having occurred in 1916 than in any previous year. Incidence of fatal cases also shows a tendency to rise, though not sharply. The proportion of fatal cases to

total cases remains nearly the same in each of the five periods—almost exactly 25 per cent. except in the second, in which it was 33 per cent.—in spite of the fact that, as will be seen later, the fatality of external anthrax has decreased. In warehouses, in the woollen trade, and in the felt trade there has been a strongly marked increase, especially in 1916 and 1917.

5. In considering measures for prevention of anthrax the form taken by the disease, *i.e.*, whether internal or external, is of importance. The following table (*see also* the preceding table) gives the number of cases of both forms occurring in each year and in each period of five years dating from 1896:—

—	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.
Internal cases -	—	—	3^{3}	2^{2}	1^{1}	1^{1}	1^{1}	—	1^{1}	7^{7}	6^{5}	1^{1}	2^{2}	2^{2}	1^{1}
			6^{6}					10^{10}					12^{11}		
External cases -	3	9	13^{2}	16^{3}	9^{1}	7^{4}	12^{1}	26^{7}	15^{1}	28^{6}	24^{4}	23^{2}	17^{1}	27^{1}	27^{2}
			50^{6}					88^{19}					118^{10}		

—	1911.	1912.	1913.	1914.	1915.	1916.	1917.	Total.
Internal cases -	7^{7}	3^{3}	1^{1}	—	2^{2}	7^{7}	8^{8}	56^{55}
			13^{13}			15^{15}		
External cases -	28^{3}	28^{3}	42^{4}	29^{5}	24	73^{5}	57^{3}	537^{58}
			151^{15}			130^8 (Two years.)		

More internal cases have been recorded in the two years 1916–1917 than in any previous period of five years dating from 1896. The number recorded in the period 1913–1917 is three times and the total number of cases four and a half times that recorded in the period 1896–1900.

6. All except four of the internal cases have occurred in the worsted branch of the trade. Two occurred in the woollen trade, and one each in the felt trade and in a warehouse. Increase of external anthrax is much greater, both relatively and absolutely, than of internal, but the incidence of the latter form shows in the period up to 1915 a gradual, and in 1916 and 1917 a sharp, rise. The fatal cases are almost equally divided between the two forms of the disease, but whereas practically all internal cases are fatal, only eight per cent. of the external form are. The fatality from the latter form appears to be decreasing relatively to the number of cases.

7. In order to obtain a complete picture it is necessary to know the occupations in which the cases have occurred. The following tables give this for the period 1899–1917 (details for the years 1896–1898 are not available):—

WORSTED TRADE.

Branch of the Worsted Trade.	Factory warehouse.	Opening and skilled sorting.	Blending and pulling.	Shake willowing.	Scouring.	Driermen.	Fearnought willowing.	Card-room. Carding.	Card-room. Card jobbing, grinding, and fettling.	Preparing.	Comb-room. Combing.	Comb-room. Finishing and balling tops.	Waste willowing.	Top and noil packing.	Spinning and handling yarn.	Sweeping, &c.	Occupiers, mechanics, &c.	Member of family of employed person.
Mohair merchants - (5 premises.)	–	11^{8}	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Commission woolcombing - (13 factories.)	17^{7}	5^{1}	4^{3}	7^{3}	24^{6}	3	13^{2}	31^{11}	20^{7}	2	16^{6}	11^{6}	5^{2}	4^{2}	–	–	3	1
Woolcombing (other than Commission woolcombing. (4 factories.)	2^{1}	1^{1}	–	2	5^{2}	–	1	–	5^{1}	–	2^{1}	2	1	1	–	1	–	–
Mohair, alpaca, and worsted spinning and manufacturing. (27 factories.)	13^{2}	31^{11}	2	3^{1}	2^{1}	–	1	7	3	1	6^{2}	1	–	–	*22^{2}	1^{1}	6^{1}	2
Total cases -	32^{10}	48^{28}	6^{3}	12^{4}	31^{9}	3	15^{2}	38^{11}	28^{8}	3	24^{7}	14^{6}	6^{3}	5^{2}	*22^{2}	2^{1}	10^{1}	3
			129^{61}							158^{39}								
Internal cases -	7^{7}	7^{7}	3^{3}	3^{3}	5^{5}	–	2^{2}	8^{8}	4^{4}	–	3^{3}	5^{5}	1^{1}	–	–	1^{1}	–	–
			25^{25}							23^{22}								

* One weaver.

WOOLLEN TRADE.

Factory warehouse, blending and willowing	57^{5*}
Scouring	1
Card room :—	
Carding	23^{1}
Card fettling, grinding, &c.	11
Spinning, doubling, &c.	24
Yarn scouring and dyeing	6
Yarn hanking, winding, &c.	19^{1}
Weaving	14^{1}
Removing dust from chambers	1
Waste willowing	4^{1}
Occupier, buyer, mechanic, &c.	5^{1*}
Member of family of employed person	2

FELT TRADE.

Factory warehouse, blending, willowing, &c.	24^{4*}
Carding	18^{1}
Card fettling, grinding, &c.	3
Felting and finishing processes	3

OTHER OCCUPATIONS.

Warehouses at the ports	25^{6*}
Transport	5^{1}
Wool merchants	8
Waste dealers	6^{1}
Rag and waste	4^{2}

* One fatal internal case.

8. These tables show that anthrax occurs in every process in which dangerous materials are handled. In the worsted trade the number of cases recorded in occupations previous to scouring (washing) is 129 (42 fatal, 25 internal), and in occupations after scouring is 158 (39 fatal, 23 internal). Having regard to the smaller number of persons employed in processes before than in processes after washing, and leaving out of account such factors as the degree of contact with the material, unwashed materials are apparently more dangerous than washed. More cases occur, however, in the manufacturing processes after washing than in the warehouse processes, including the feeding of the scouring machine, before washing, the proportions being respectively 52·3 and 42·7 per cent. of the total cases recorded.

9. The proportional distribution of cases, fatal cases, and internal cases in the worsted trade in the period 1899–1917 is as follows:—

Processes.	All cases (per cent. of total cases).	Fatal cases (per cent. of total fatal cases).	Internal cases (per cent. of total internal cases).
Warehouse processes, including sorting, blending, pulling, and willowing.	32·5	39·8	40·8
Scouring	10·3	10·8	10·2
Drying	1·0	—	—
Carding processes, including fearnought willowing	26·8	25·3	28·6
Preparing processes	1·0	—	—
Combing processes, including top and noil packing	14·2	18·1	16·3
Spinning processes*	7·3	2·4	—
Waste willowing, sweeping, &c.	2·6	2·4	4·1
Occupiers, mechanics, members of operative's family.	4·3	1·2	—
Total	100·0	100·0	100·0

* One case in weaving included.

The similarity in the proportions of all cases, fatal cases, and internal cases recorded in each group of processes is remarkable.

10. In the woollen trade the number of cases of anthrax occurring in warehouse processes, in the processes of carding (including card fettling and grinding), in spinning, in yarn finishing, &c., and in weaving, are respectively 34·1, 20·3, 14·3, 13·7, and 8·3 per cent. of the total cases reported in this industry between 1900 (when the first case occurred) and 1917. In the manufacture of felt half the reported cases have occurred in warehouse processes, 43·7 per cent. in carding and 6·3 per cent. in finishing processes.

11. The incidence of fatal cases is much higher in the worsted branch of the industry than in any other, a fact for which it is not easy to account. The accidental discovery of fatal cases of internal anthrax in the past two years in the woollen and felt trade, coupled with the evidence placed before us as to the difficulty of detecting these cases even in Bradford, suggests that they have occurred in these trades but have not been recognised and reported, but this does not appear sufficient to account for the difference in incidence. Most

of the materials used in the woollen and felt trades are either washed abroad or are by-products of the worsted trade, and this, together with the different methods of manufacture, may, in part, account for the difference in incidence of fatal cases in the worsted and in the woollen and felt trades, but the incidence of fatal cases is also much higher in worsted processes after washing than in the woollen and felt trades, and we have not been able to find any really satisfactory explanation.

12. The report of the Departmental Committee of 1897 states that recorded outbreaks of anthrax are confined to the worsted branch of the wool industry, and that it is in the earlier processes of worsted manufacture, principally, that detriment to health has been recognised. In consequence they recommended precautions only in the worsted process of sorting. Dr. Legge in his evidence outlined the apparent gradual spread of anthrax through all other processes of manufacture of worsted yarns, through those of woollen and felt manufacture, in warehouses at the ports and elsewhere. The fact that formerly in Bradford internal anthrax was much more commonly recorded than external was also much commented on in evidence.

13. The tables given above show that (1) more cases of anthrax are now reported in the woollen than in the worsted trade, (2) a high proportion both of fatal and non-fatal cases now occurs in all the later processes up to and including spinning in the worsted trade and weaving in the woollen trade; (3) external anthrax is, at the present time, much more often reported than the internal form; and (4) the incidence of both forms is steadily increasing, slowly in the case of internal anthrax and more rapidly in the case of external. It would appear that the conditions, as generally understood prior to 1897 have been completely reversed.

14. Much evidence was given in explanation of these facts. Speaking of the worsted branch of the trade, sorters of experience before 1896 stated that internal anthrax was then more common than external, but cases were not confined to sorters, although attention was so concentrated on this occupation as to cause other cases to be lost sight of. The incomplete notes, covering the period 1878–1896, left by Dr. Bell, include records of 13 fatal cases among persons manipulating washed materials, showing that the disease was not confined to wool-sorters in that period (Q. 8,714–28). Mr. Spear's report, referred to on page 10, also speaks of non-fatal cases in processes after washing.

15. Prior to 1906 no cases had been recognised in a certain commission combing works, in existence since 1878, yet, in the period 1906–1913, no fewer than 18 were notified, of which only one occurred in wool-sorting. No change in method or in materials used had been made, but about 1905 the packing of locks* (short material, frequently derived from bodies of animals dying or killed before the wool reaches shearing length) inside fleeces of Persian wool notably increased, and, as locks appear to be highly infected, the increase in this practice probably accounts for the increased incidence, especially in later processes (Q. 5,791–849). Other witnesses suggested as the cause of the apparent change: (1) the effect of washing in bringing the spores to a condition favourable to development, (2) more dusty conditions than formerly, (3) speeding up of manufacturing processes and consequent carelessness and greater production of dust, (4) hurried and, therefore, careless removal of bloodstains, (5) greater use of Persian wool, (6) improved reporting of cases, (7) the fact that practicable remedies and the regulations are inadequate to cope with the danger.

16. After carefully considering the evidence, we conclude that (1) the occurrence of anthrax in processes after sorting and after washing is not a new development; (2) the cases occurring in later processes form now a relatively higher proportion of the total reported cases than before 1896; (3) possibly as an effect of the operation of the existing regulations (first voluntarily brought into force in 1884), especially the requirement of downward exhaust and ventilation in sorting, the incidence of anthrax, and especially of fatal internal anthrax, in woolsorting has been reduced much below that indicated in Mr. Spear's report in 1880; (4) an increase, which more than counterbalances the decrease in sorting, has occurred in the total number of cases recorded in later processes.

17. The cause of the increase of the reported cases in the later processes cannot be stated definitely. Appendix 3, however, gives a summary of the occupations in each case of anthrax occurring during manipulation of each variety of material, which shows that in manipulation of mohair, particularly of Turkey mohair (excluding Van mohair, which in method of collection, district of production, route followed in transport, treatment in manufacture, &c., is much more akin to Persian wool than mohair) cases in sorting and warehouse processes account for a very high proportion of the whole; while in manipulation of Persian and similar wools the proportion in these processes is low, and in the later manufacturing processes correspondingly high. The increase in later processes may have been brought about, therefore, by greater infectivity and increased use of materials of the type of Persian wool. The increasing knowledge of the requirement of notification, and better recognition of cases of anthrax, without doubt, also account for a part of the increase.

18. The last factors and the increased infectivity, and greater use, of materials of the type (in regard to district of origin, methods of collection and packing, &c.) of Persian and

* The packing, inside fleeces, of inferior material not derived from the same animal as the fleece is known as "False packing." This practice is peculiarly dangerous, because skin locks or short material derived from animals which have died from disease can thus conveniently be hidden and disposed of.

East Indian wool also explain satisfactorily the development of anthrax in the woollen and felt trades and in warehouses. The consumption of East Indian wool in these trades has nearly doubled in the last 20 years, and it appears now to be constantly and heavily infected. Egyptian wool, Syrian wool, and noils from Persian wool and other worsted materials are also used extensively in the woollen and felt trade.

THE DISEASE OF ANTHRAX AND THE MODE BY WHICH INFECTION IS CONVEYED.

1. Anthrax is a germ disease due to the activity in the tissues of a low form of vegetable life, viz., a bacillus. It is world-wide in its distribution, and probably no class among the mammalia is completely immune to it. The Ungulates (hoofed animals), however, possess a susceptibility above the average, and, because of their relation to man, the disease as it befalls these animals is of importance both economically and pathologically. In seeking means for prevention of industrial anthrax its consideration is, indeed, of paramount importance.

2. Anthrax in animals is practically never external nor pulmonary, but almost always gastro-intestinal, the result of eating infected food—pastures in some countries and districts, grain and cake food in others. The period of obvious illness is short; in sheep and goats it may escape observation and the animals be found dead, while in the larger animals death often takes place so suddenly as to be ascribed by farmers and others to "apoplexy." The blood of animals dead from anthrax is generally crowded with the specific bacilli, and may impart the infection to all discharges from the nostrils, mouth, urinary bladder, or bowel, especially to those from the last when acute diarrhœa is a symptom of the illness. Though in slaughtering or skinning animals anthrax is sometimes contracted, mere contact of the healthy with the sick, be they animals or human beings, rarely, if ever, leads to infection. Infection almost always takes place through intermediary channels. These are, so far as man is concerned, animal products, such as skins and hides, wool, hair, and bristles.

3. Under certain conditions, the most important of which is the presence of free oxygen, anthrax bacilli can produce spores. These are a means to ensure the preservation of the species, for they may remain alive for many years, and are able to offer to the process of drying, to changes of temperature, and to chemical influences a resistance far beyond the power of the vegetative form, *i.e.*, the bacillus, but they do not themselves multiply. The conditions necessary for spore formation are usually present immediately the blood or discharges referred to come in contact with air. In this way wool, hair and bristles, which they happen to touch, and even the soil into which they soak may become carriers of anthrax spores. A further suggestion was made by Sir Stewart Stockman and is also referred to by Professor Delépine in a report to the Cheshire County Authorities, *i.e.*, that spores in infected food eaten by animals may possibly develop into bacilli and multiply in the stomach, without necessarily causing the disease, and may be excreted. Both, however, point out that proofs are wanting.

4. Workers in wool and hair may contract anthrax in one of several ways:—(*a*) the virus may be introduced into the skin and there produce its immediate effects, *i.e.*, cutaneous anthrax; (*b*) it may be inhaled and cause pulmonary anthrax ("woolsorters disease," "internal anthrax"); and (*c*) it may be passed into the stomach or bowels, giving rise to the second internal form, *i.e.*, gastro-intestinal anthrax. The last-mentioned mode of infection has always been rare. The time between the introduction of the infecting agent and the earliest evidence of the disease, *i.e.*, the stage of incubation, is *said* to vary from one day to ten. Instances are not infrequent in which the disease begins several days after contact with possibly infected materials last took place; in these cases the spores were probably present on the person (*e.g.*, under the finger nails) or on the clothing of the patient, but had not at first been able to find a site favourable to their development. Thus, a card grinder, having dislocated his shoulder, left his work; on the twelfth day after the accident he took part in a street fight, 24 hours later he was taken ill and died of pulmonary anthrax.

5. Death is almost invariably the result of diffusion of the bacilli throughout the body by means of the bloodstream, but the mortality is not the same in the three forms of the disease. The death rate from the external form has decreased. It may be that the virulence of the disease varies in different years. Better means of securing prompt diagnosis have undoubtedly brought to notice a number of cases which, being relatively mild, might in times past have escaped recognition and have undergone spontaneous cure. But there can be no doubt that the early application of modern methods of treatment—use of an anti-anthrax serum* combined with the strict enforcement of "surgical rest" by means of splints, plaster of Paris, sandbags, &c.—is largely responsible for the decrease. Thus, anthrax of the eyelids, *i.e.*, on a site which does not permit of excision, had at one time a very high mortality (nearly 40 per cent.), but has now a death rate only slightly above the average. Anthrax of the wrist had a relatively high death rate, even with serum treatment, but as a result of the additional enforcement of surgical rest the disease now runs an average course. Effective treatment is closely bound up with early diagnosis, the beneficent results of which were

* Such as that prepared by Professor Sclavo of Sienna (the discoverer of anti-anthrax serum), or by the J. K. Mulford Co., Philadelphia.

proved by statistical evidence, which shows that of cases treated in the same institution those first seen by a practitioner having special knowledge of anthrax were diagnosed on the average 24 hours earlier than those seen by other practitioners. Of the former, 74 per cent. developed mildly, and 7·4 per cent. were fatal. Of the latter only 50 per cent. developed mildly, and 15 per cent. proved fatal.*

6. In internal anthrax death is almost the rule. It may take place on the third to the fifth day of the disease; occasionally it is startling in its rapidity. A warehouseman had felt out of sorts since early morning, but remained at work till teatime. He was helped home by a fellow worker, collapsed on the road, was unconscious when home was reached, and died within half an hour.

7. The early symptoms of anthrax, whatever its form, are few, and are peculiarly indefinite and inconclusive. Failure to ensure early recognition of the disease may be due (1) to want of knowledge or to carelessness on the part of the patient, or to his being misled by the lightness of the early symptoms. Thus the manifestation of external anthrax may be regarded by the patient as an ordinary pimple or boil; the symptoms of internal anthrax may suggest an attack of influenza, or bronchitis, or even pneumonia; (2) it may be due to want of insight and experience on the part of the medical attendant; and (3) to want of facilities for a rapid bacteriological examination.

8. For the better instruction of the workers a placard showing coloured illustrations of external pustules, with a written warning as to the symptoms of the disease, is required to be exhibited in factories. All witnesses acquainted with the appearance of external anthrax criticised the illustrations so published up to that time as insufficient or misleading, on the ground that the appearances were shown at too late a stage and were too diagrammatic. Since this evidence was given a new placard has been issued by the Factory Department giving more ample illustrations of pustules at earlier stages.† The exhibition of this placard should, we consider, continue to be enforced.

9. The medical attendant must be alive to the possibilities of the disease and a knowledge of clinical bacteriology would be a valuable asset. It is especially desirable that a bacteriological laboratory to which material may be sent in cases of doubt should be close at hand. The diagnosis of even the external form of anthrax should be bacteriological. Though the appearance of a fully-developed "malignant pustule" is in most instances highly suggestive of its true nature, two considerations weaken a diagnosis based upon clinical appearances only—the features of the sore may be closely imitated by a vaccine pock or by some cutaneous effects produced by a diplo-coccus probably identical with the pneumococcus; secondly, it is desirable that the condition should be recognised before it has attained its full development and classical appearances.

10. Bacteriological examination in the early stages of internal anthrax is also a desideratum, but the early symptoms are so misleading that the necessity for such examination does not suggest itself, with the result that this form is not often recognised during the patient's lifetime. In its early stages recognition by bedside methods is impossible. Peculiar and anomalous grouping of symptoms, *e.g.*, tightness across the chest and persistent nausea, nausea and joint pains, joint pains and shortness of breath, or an almost imperceptible pulse with, however, a feeling of being in good health and with unexpected manifestations of physical energy, may perhaps in future arouse suspicion. In these cases the examination by serological tests‡ (*e.g.*, estimation of the opsonic index)§ may be found to offer greater advantages than cultural methods. Many witnesses made suggestions for applying the considerations underlying these requirements. These we deal with later (*see* page 26).

INFECTED VARIETIES OF MATERIAL.

1. Evidence as to the materials liable to convey infection can be acquired in three ways—consideration of incidence among animals in the countries from which materials are obtained, and of the precautions taken in those countries; careful record of the materials handled by every person who contracts anthrax, and analysis of the records so obtained; bacteriological examination of materials, particularly of those handled by persons who contract anthrax.

2. Efforts to obtain first-hand testimony from buyers of wool living in the countries from which infected wool and hair are exported met with scant success, not from any unwillingness on the part of the witnesses, but because they appear to be among the last who hear of anthrax among the flocks. Dr. Norris, who as Director of Quarantine in Australia, had obtained a wide knowledge of the subject, and Sir Stewart Stockman, Chief Veterinary Officer of the Board of Agriculture, gave us much assistance.

* Q. 527 *et seq.*, Summary of evidence, Anthrax—Diagnosis of.—Eurich.
† These are reproductions of paintings made by Dr. F. W. Eurich of actual pustules and are illustrative of different stages and appearances of the disease.
‡ Serological tests = Biological tests applied to the serum of the blood.
§ Opsonic index = A figure indicating the relative power of phagocytosis possessed by the blood, that of normal blood being taken as unity.
Phagocytosis = The engulfing of invading organisms by the white corpuscles of the blood.

3. No precise statistics were forthcoming as to incidence of anthrax among animals, except in countries where the precautions taken reduce the risk attaching to wool and hair to a minimum. Thus New Zealand has apparently been free from anthrax since 1907, when certain precautions were adopted; anthrax occurs in Australia, in districts which have become permanently infected, and in Great Britain, and a small quantity of infected wool may get into commerce occasionally, but the precautions taken prevent the possibility of the wool and hair from animals bred in them becoming considerably infected. Records of outbreaks in France, Germany and Austro-Hungary were also given.

4. The conclusion to be drawn from the evidence is that anthrax among animals is universal, but, while every variety of wool and hair must, therefore, be regarded as potentially infective, the degree of risk varies enormously, with the result that the list of what may be described as dangerous materials is quite short. Of the countries from which these are exported—India, Central Asia, Persia and Mesopotamia, Asia Minor, Peru, Russia, Egypt and South Africa—statistics were only available as to incidence of anthrax among animals in the last three. Incidence appears, however, to be severe among animals in India and all Asiatic countries, and one of the precautions against the disease strictly enforced in Australia and New Zealand is the prohibition of import of animal products from India, except after sterilisation. The summarised replies of consuls to inquiries made by the British Government in 1907,* and the replies of the Government of India to similar inquiries in 1911, also indicate the widespread incidence of anthrax among animals in Asiatic areas and in India, and that supplies of wool and hair imported therefrom must be expected to be highly infected.

5. Freedom of material from danger depends much more on precautions taken for the purpose of preventing infected material passing into commerce and for prevention of anthrax than on the actual recorded incidence among animals. The evidence showed that in Asiatic countries no records are kept and no precautions of this kind are taken. The conclusion we have arrived at after consideration of the general evidence as to incidence of anthrax among animals, and as to the conditions obtaining in various countries is that **all materials must be regarded as being possibly infected, except those derived from countries in which notification of cases, and measures for prevention of anthrax, including destruction of wool and hair of infected animals, are effectively enforced.**

6. Fortunately the systematic investigation by the Factory Department of cases of anthrax occurring in factories and the records compiled by the Medical Inspector of Factories, together with the results of bacteriological examination of materials, made by the Bradford Anthrax Investigation Board, provide a much more definite and reliable basis for preparing a list of materials liable to convey infection. Study of Appendices 2 and 3 to this report, in which tabular summaries are given of the materials handled by persons who have contracted anthrax, and of the records of cases show that persons handling certain materials alone frequently contract the disease, and further, that certain other materials are referred to so often in connection with cases as to afford ground for the presumption that they may be infected. Many materials are never manufactured unmixed with others, but excluding all those which have apparently not caused cases when handled alone, the following list is obtained, the numbers of cases and fatal cases caused in the period 1899–1917 by each material alone being stated in brackets:—*East Indian wool* (92^{9}), *Persian wool* (62^{14}), *Turkey mohair* (27^{4}), *Russian camel hair* (10^{6}), *Van mohair* (8^{2}), *Cape mohair* (5), *East Indian goat hair* (4^{1}), *alpaca* (3), *cowhair* (2), *Russian goat hair* (1), *Colonial wool* (*Australian and New Zealand*) (4) *home wools* (2). Materials frequently mentioned as being handled, in conjunction with others, by persons contracting anthrax are *Egyptian wool* (53 *cases*), *Cape wool* (10 *cases*), *Syrian wool* (10 *cases*), *Oporto wool* (10 *cases*), *Buenos Aires wool*, *China wool*, *Peruvian wool*, *Spanish wool*, *Chevrette and other goat hair*, *cowhair*.

7. During 1916 and 1917 efforts on behalf of the Committee were made to identify the infected materials in many cases of anthrax, and a considerable number of samples of the varieties of materials handled by each patient was collected. The samples were examined bacteriologically by Dr. Eurich, and the following were found to be infected in addition to several samples of blends and partly manufactured products, the number of infected samples being stated in brackets:—East Indian wool (29), Persian wool (21), East Indian goat hair (16), Egyptian wool (4), alpaca (4), grey cowhair (1), scoured Oporto wool (1). It is by no means certain that raw materials, of which samples are found by bacteriological examination to be infected, are those causing infection in particular cases, but where a material is found to be infected in case after case the cumulative result is sound evidence of its danger.

8. A summary of the results of bacteriological examination of materials published in the Annual Reports of the Bradford Anthrax Investigation Board from 1908 to 1917 is given in Appendix 33 to this report. The following table shows the number of samples found to be infected and the proportion infected of the total samples examined of each variety. The

* Annual Report of the Chief Inspector of Factories for 1907.

appendix should be consulted for detailed analysis and for the figures as to sub-varieties. Similar figures are given for manufactured or partly manufactured materials.

Material.	Samples found to be infected.	
	Number.	Proportion of Total Samples examined.
Raw Materials :—		Per cent.
Mohair	47	6·0
Turkey mohair	142	15·8
Cape mohair	82	7·4
Van mohair	40	10·2
Alpaca	34	2·2
Persian wool	130	5·3
East Indian wools	69	11·6
East Indian goat hair	33	33·3
East Indian cashmere	12	19·0
Russian cashmere	1	100·0
Russian goat hair	1	20·0
Egyptian wool	7	15·6
Syrian wool	2	10·0
Cape wool	1	11·1
Manufactured or Partly Manufactured Materials :—		
Blends	9	15·0
Scoured materials	12	5·7
Card sliver	2	28·6
Tops and rovings	10	27·0
Yarn	8	24·2
By-Products, &c. :—		
Noils	7	14·6
Waste materials	4	9·8
Shoddy	4	8·3
Dust produced in manufacture	9	17·9

9. The above figures do not give, in all instances, a true idea of the possible infectivity of particular materials. Where a small number of samples has been examined, *e.g.*, Russian goat hair and cashmere, Syrian wool, Cape wool, the proportion of infected samples stated may be unduly high or unduly low. A more important vitiation of the results is the fact that in some instances large numbers of samples have, for reasons other than statistical, been taken from one lot. Thus 11 of the infected samples of the East Indian cashmere were from one lot, 59 infected samples of Cape mohair were from one bale. The stated proportion of infected to non-infected samples may, therefore, be too high. On the other hand the inclusion of large numbers of non-infected samples from particular lots of alpaca probably cause the stated proportion of infected to non-infected samples of this material to be too low. Making due allowance for these sources of error, however, we are of opinion that all the varieties of materials named must be regarded as capable of causing anthrax among persons handling them. Whether the general evidence, the record of cases of anthrax, or the results of bacteriological examination of samples be taken as a basis on which to prepare a list of dangerously infected materials the result is the same. All the varieties of wool and hair included in this list are used either as raw material, or as noils, or as waste products in each of the three branches of the wool trade.

10. East Indian wools, goat hair and cashmere, Persian and Syrian wools, Van mohair, Turkey mohair, Russian cashmere and goat hair, Egyptian wool, as well as certain varieties of wool which do not reach this country in large quantities, are produced in the area included in the southern, western and central portions of Asia, Egypt, and the south-eastern parts of Russia, and are exported from the ports of Karachi, Bombay and Madras in India, Basra and Bushire in the Persian Gulf, Beyrout, Constantinople, Cairo and the Black Sea and Baltic ports.

11. We cannot say definitely that all wool and hair produced in every district of this enormous area is dangerously infected, but we have no evidence which would justify us in excluding any variety from a list of dangerous materials. It would be a mistake to require difficult precautions to be taken in the case of materials free from danger, but having regard to the conditions in this area, the absence of any records and of measures for prevention of anthrax, and for preventing the mixing of infected with non-infected materials, the known high infectivity of the main varieties of material produced, and the state in which many materials are packed for export, we are of opinion that **all materials from Central, Southern, and Western Asia and from Egypt should be classed as dangerous.**

12. The only other materials included in the table of materials found by bacteriological examination to be infected are Cape wool and Cape mohair, produced in British South Africa, and alpaca, which is produced in Peru. These must at present be regarded as dangerous, but we see no reason why the South African Government should not adopt precautions similar to those enforced in Australia, New Zealand, and Great Britain, in which event Cape wool and Cape mohair would become practically free from danger. We are not able to say that the list of dangerous materials given is exhaustive, but no other particular materials appear to us to require inclusion at present, although there is some evidence that certain other materials may be dangerous. Thus of 64 cases of anthrax occurring at Mazamet (France), where an enormous industry in the removal of wool from sheep skins is carried on, 35 were traced to South American, 22 to Spanish, 9 to North African, 4 to Hungarian, 3 to Cape, 1 to French, and 1 to Australian skins and skin wool.*

13. The list of infected manufactured or partly manufactured materials and by-products included in the above table proves that wool and hair remain infected at every stage in the course of manufacture, and that the by-products of combing—noils and waste—are also infected. This was to be expected from consideration of the incidence of anthrax in later processes, *e.g.*, in spinning and weaving. The proportion of samples found to be infected is very high, but this may possibly be explained by the fact that most of the samples were collected in connection with cases of anthrax. Among the infected waste materials were three samples of new clippings produced as waste in the manufacture of Cardigan jackets; and an infected sample of shoddy consisted of a pulled mixture of Cardigan jacket and army blanket clippings. One case is reported by the Factory Department in which a tailoress contracted anthrax, the cause of infection being stated to be infected cloth. Finished cloth, blankets, or articles of wearing apparel, therefore, may still possibly retain anthrax spores and thus be capable of causing anthrax.

INFECTED MATERIALS.

1. We heard much evidence as to whether infection is distributed regularly throughout all the material or confined to certain portions only. Medical and veterinary witnesses pointed out that in civilised countries sheep and cattle are sometimes found in public abattoirs suffering from anthrax (instances were given, and one came to our notice in Bradford). Animals showing symptoms of illness may be killed for food in order to prevent a heavy loss should death occur. This practice appears to be the rule in less civilised parts of the world, from some of which wool is exported to this country. In all parts of the world, also, the skin is usually removed from the bodies of sheep which have died, and subsequently the wool from the skin. In either event the wool becomes bloodstained, and if the animal has died from, or has been killed when suffering from, anthrax, the bacilli in the blood will produce spores. Blood on wool, therefore, may be expected in some instances to be highly infected.

2. This conclusion was stated some years ago by the Bradford Anthrax Investigation Board and is supported, especially in their earlier work, by the results of examination of bloodstained material. In some cases a high proportion of bloodstained samples was found to be infected, and some of the bloodstains contained spores in enormous numbers. Thus in two instances 10 per cent. of the bloodstains removed from particular lots of material were found to be infected. Many lots of wool though heavily blood-stained are naturally quite free from infection.

3. One frequent effect of intestinal anthrax (the usual form in animals) is gastritis and diarrhœa. The semi-fluid contents of the alimentary tract become mixed to a greater or less extent with the products of inflammation—blood and serous discharges—from the infected walls, and, as was pointed out in evidence, the wool of an animal will become infected by their discharge during illness, either by direct contamination or by the movements of the animal when lying down on soil saturated with the fluid. The wool may also become infected by fluid, which may be more or less bloodstained, which frequently escapes from the mouth, nose and anus, before and after death. It appears probable that, in these circumstances, wool, after drying, may show no visible indications of blood, though it may be highly infected, and even that both bloodstained and non-bloodstained parts of the same fleece may contain anthrax spores.

4. These facts were pointed out in evidence, and are supported by the record of observations made by Captain Kelly of the Indian Medical Service in an actual outbreak of anthrax in Seistan and Kain (Eastern Persia). He states that the disease took three forms, in one of which there was a copious discharge of watery fluid from the nose, which became tinged with blood in the later stages of illness, and in the second in which there was profuse diarrhœa, the discharged fluid becoming very bloody towards the end of the illness. Anthrax bacilli were found in each form.†

* Le Charbon Professionelle, by J. Cavaillé, Berger-Levrault, Paris, 1911, and Annual Report of the Chief Inspector of Factories, 1913, p. 138. Report of the Medical Inspector of Factories.

† Annual Report of the Chief Inspector of Factories, 1907, p. 260. Report of the Medical Inspector of Factories.

5. The soil becomes infected by the discharges above referred to, by blood escaping through killing or skinning, or when the body is eaten by carrion birds or animals, and by the ejecta and vomit of these creatures; further, every place where an affected animal has died or lain down may become a fresh centre of infection, and there may be periods in warm moist countries in which the anthrax bacilli are able to multiply in the soil, if offering suitable pabulum, *e.g.*, in marshy districts where there is much vegetable matter. Evidence was also given that animals undoubtedly recover from anthrax in some instances. Nevertheless expert witnesses agreed that the wool of animals shorn in the ordinary way would not frequently be infected, either by infected soil attached to it, or by excrement containing spores, to such a degree as to cause danger to persons handling it; but a healthy sheep might lie down on ground on which an animal had recently died from anthrax, and so cause gross and dangerous infection of its wool. This can, however, only be a remote possibility, and **wool and hair shorn from living healthy animals can probably be regarded as practically free from danger.**

6. Most of the dangerous materials are dry and dusty, and contain much earth and mineral matter, and dust has been thought to be one of the principal causes of anthrax. But the evidence we heard strongly discredited this assumption. Mineral dust in wool may occasionally contain spores from the infected soil, but it was pointed out that in the very dusty processes, such as blending, the proportion of cases of internal anthrax is not so high as in the process of combing, which is free from dust. Pulmonary anthrax is caused by inhalation of infected matter, but it was suggested that this takes the form either of fine small fibres of infected wool or hair or particles of blood abraded from infected bloodstains. Distinction, however, between mineral dust and other substances which may be caused to enter or float in the air is impossible. **Hence, all dust from infected wool must be regarded as dangerous.** We are supported in this conclusion by the fact that a number of samples of dust have been found to be infected.

7. Discharge from the bowels, mouth and nose, and the escape of blood from the body, are the only modes by which wool can become dangerously infected of which we have evidence. Assuming, as was strongly and almost unanimously urged, that wool and hair only generally become infected, in one or other of these ways, when an animal has died or been killed when suffering from anthrax, then the only material which can be infected is that removed from the skin or the body after death. Many witnesses also urged that when wool has not been wetted the only parts which are infected are the bloodstained portions. We think the weight of evidence, however, points to the conclusion that wool infected in the way first mentioned may either be not bloodstained or may be so slightly stained as to show no visible indications of the presence of blood when dry. We are in agreement that the infection is derived from the blood of the animal and that bloodstains may sometimes be heavily infected, but it appears probable that spores may frequently become deposited on wool without visible indication of blood, though in some of these cases chemical or other tests might reveal it.

8. Wool or hair removed from the body of animals after death, or from skins, is known as skin material, whether the animals have been killed for food or have died from disease. There is no means, save by bacteriological examination, of distinguishing infected from non-infected fleeces so that **all skin material of the dangerous varieties must be regarded and treated as if infected.**

EXISTING REGULATIONS.

1. There are in force in Great Britain at the present time three codes of regulations and one of special rules having for their object the prevention of anthrax in industrial occupations, namely, regulations for (1) the processes of sorting, willowing, washing, combing and carding wool, goat hair and camel hair, and processes incidental thereto; (2) the use of East Indian wool; (3) the use of horsehair from China, Siberia or Russia; and special rules for (4) handling of dry and drysalted hides and skins imported from China or from the west coast of India. In addition the Board of Agriculture enforces regulations (given in appendices to this report) for prevention of the disease among animals, and incidentally for prevention of the sale and distribution of infected products of animals dying from anthrax in this country.

2. The code first-mentioned deals with processes of worsted manufacture, the second with the use of one variety of wool, and these two are the subject of our enquiry. In some factories both are in force. The former extended to woolcombing factories the precautions required in woolsorting by special rules given legal force in 1897, on the recommendation of the Departmental Committee of 1895, though they had been in operation as voluntary rules from 1885.

3. In principle there has been no alteration in the precautions observed in woolsorting since 1885, nor in those observed in woolcombing since 1901 (except in the voluntary sorting out of blood which commenced in 1908 and which we refer to later), when it was first officially recognised that danger persists in processes of manufacture of wool later than sorting.

Though the existing regulations apply to all processes of woolcombing, practically no precautions are required by them in any process after opening and sorting. Their application is limited to certain varieties of material—Van mohair, Persian locks, Persian wool, alpaca, pelitan, East Indian cashmere, Russian camel hair, Pekin camel hair, all mohair other than Van mohair—and there is some differentiation as to treatment of these materials. The number of persons employed in 1901 in processes subject to the special rules for woolsorting and woolcombing was 4,065, and, though it has naturally somewhat increased, the number now employed in processes under the existing code of regulations will not differ materially from this figure. This does not represent, even approximately, the number of persons exposed in the worsted industry to risk of anthrax (*see* page 11).

4. The existing regulations are based on two principles, (1) that infection is caused by dust, and (2) that material derived from animals dying from disease (fallen fleeces, &c.) is possibly infected. Effective measures are prescribed for preventing a dusty atmosphere in opening and sorting, but none is required in later processes, save willowing, some of which are very dusty. No search is required to be made for the materials considered to be specially dangerous (damaged wool, fallen fleeces, &c.), but if damaged wool be observed by a workman in opening, he is required to report the fact, though no effective method of then dealing with the material is prescribed. The regulations were most severely criticised from both the administrative and practical points of view. (*See* Summary of Evidence: Regulations—Administration, Existing.)

5. We have pointed out on pages 13 and 14 that anthrax occurs in every process of manufacture of wool, from the factory warehouse to weaving inclusive, and the incidence in the worsted trade is especially severe in washing, carding, combing, and spinning, as well as in the warehouse processes, a fact of which no account is taken in the existing regulations; further, that the number of cases notified annually, both of external and internal anthrax, is slowly increasing. From consideration of the data as to the materials used in the worsted trade we are in agreement, also, that the list in the existing regulations of materials in the handling of which precautions are required, is incomplete, although the varieties we consider should be added are obtained from the same Asiatic area (including Egypt in that area) as those already scheduled. We had, therefore, no hesitation in coming to the conclusion that **the existing regulations are unequal to the task of coping with the nature of the disease.**

6. The second code mentioned applies to the use of East Indian wool, a material extensively manufactured in each of the three branches of the wool trade—worsted, woollen, and felt. The Factory Department recognised as early as 1906 that East Indian wool is a dangerous material, but, in the absence of definite proof, this was strenuously denied by the trade, and, as a result, the code was brought into force as a measure for prevention of dust and not of anthrax. **There is, therefore, the anomaly that no measures are enforced in the woollen trade, the felt trade, or in warehouses, for the prevention of the disease, and consideration of the data as to the severe and increasing incidence of anthrax in these branches of the trade in wool show precautions to be very necessary.**

POSSIBLE MEASURES FOR PREVENTION OF ANTHRAX.

1. Quite early in our investigation we felt compelled to conclude that measures differing very widely in principle from those required to be taken by existing regulations would have to be devised if the incidence of anthrax is to be reduced. Witnesses were, therefore, encouraged to the utmost to put forward suggestions, and a large number was collected (*see* summary of evidence). They can be divided into two classes, (*a*) those which can be enforced in factories by means of statutory regulations, and (*b*) those which aim at minimising danger by other action. The latter are considered on page 28.

MEASURES IT IS POSSIBLE TO ENFORCE BY REGULATIONS.

1. Suggested measures which may be embodied in regulations aim respectively at (1) removing or lessening risk of infection, (2) reducing the fatality of the disease, (3) providing means for improved personal hygiene and welfare of workers.

MEASURES FOR REMOVING OR LESSENING RISK OF INFECTION IN FACTORIES.

1. The most important of the suggested precautions of this class are (*a*) suppression of dust in all processes, and (*b*) removal, from materials of the dangerous varieties, of all portions likely to contain infection.

2. (*a*) *Suppression of dust.*—In referring to dust most witnesses had in mind the impregnation of the atmosphere with dust to such a degree as to involve personal discomfort, either immediately or after prolonged exposure. Thus combing was excluded by all from a list of

dusty processes. An observed bodily effect appears to depend on the nature of the dust to some extent—the finer the particles the greater the discomfort. Some witnesses suggested that in their experience, where there is much dust there is much anthrax, and in this generalisation they included both internal and external, fatal and non-fatal cases.

3. In Appendix 1 we give the results of an investigation as to the quantities of dust in the air in various processes of manufacture of wool. These show that all processes before combing may be dusty, though the cardroom is frequently almost free from dust. The dust in the air during combing is no greater than in the outside air. Though not dealt with in that report it may be pointed out that spinning and preparing are similarly free from dust. Comparision of the results with the data of incidence of anthrax shows, however, no clear connection between anthrax and the quantity of dust in the air. For comparative purposes the purely warehouse processes and those of sorting, willowing, and blending, &c. must be taken together since warehousemen carry on all these operations save in exceptional instances.

4. The number of cases occurring in the worsted trade in warehouse processes (warehouse, sorting, willowing, blending and pulling) and scouring is 129, of which 42 were fatal (*see* table on page 13). These are the processes before washing, and some are exceedingly dusty, though suppression of dust in opening, sorting and willowing is required by existing regulations, and to some extent achieved. In the occupations after washing, of back-end drier attendants, "fearnought" willowing, preparing, combing, top and noil packing and spinning, which are quite free from dust in the ordinary sense, there have been 86 cases and 19 deaths, while if carding, which is frequently free from dust, be included, the total cases are 158 and deaths 39. There is thus some indication that the fatality is greater, and the ratio of cases to persons employed is certainly greater, in the dusty warehouse processes than in those, after washing, which are free from dust.

5. If, however, dust be greatly infected it is to be expected that inhalation cases (pulmonary anthrax) would be much more frequent in dusty processes than in those free from dust. The number of cases of internal anthrax (nearly all of which were pulmonary) occurring in each process since 1899 is given in the table on page 13, from which it will be seen that 25 internal cases, all fatal, have occurred in this period in the warehouse processes before the material is washed, while 23 cases have occurred in processes after washing If carding and waste willowing (which are sometimes though not usually dusty processes) be excluded, the number of internal cases in processes quite free from dust in the ordinary sense is 10, of which 9 were fatal. No internal case has been recorded in spinning, but we desire to guard carefully against any suggestion that none has in fact occurred, or that none is likely to occur.

6. Though imponderable factors (*e.g.*, the effect of washing and other processes on the state and concentration of infection, the removal of bloodstains from materials, &c.) make it impossible to draw a perfectly just conclusion, cases of internal anthrax (and, therefore, fatalities) do appear to be more frequent in the dusty processes than in those free from dust, and, having regard to the number of persons employed, the incidence of internal cases is clearly higher in the former. Nevertheless, the proportion of internal cases to total cases is nearly the same in the dusty warehouse processes (including scouring) taken together (19 per cent.); in carding (18 per cent.); and in combing (21 per cent.); but is highest in the least dusty process of combing. Some factor, other than dust in the usual sense, must, therefore, be exerting influence, and causing both internal and external cases in processes like combing entirely free from dust. Examination of the data as to incidence of anthrax in the woollen and felt trades results in a similar conclusion. Among the suggestions made for prevention of dust were (1) more elaborate provision of exhaust or other effective means for removal of dust in opening, sorting, blending, pulling blends, willowing, feeding the washbowl, carding, stripping, card cylinder and roller grinding, waste willowing, and in any other dusty processes; (2) compulsory willowing of all wool and hair before blending; (3) compulsory oiling, by prescribed methods, of all wool after washing.

7. **That dust is dangerous, and that its suppression, as far as practicable, is necessary we all agree, but careful consideration of the above facts, and of the evidence relating to measures already taken for prevention of dust, compel us to conclude that such further measures as can be taken or enforced by regulations for preventing a dusty atmosphere will not remove danger of anthrax, and, even if carried out, may possibly not materially reduce the number of cases occurring under existing conditions.**

8. (*b*) *Removal of Dangerous Portions from Materials.*—Nearly all witnesses urged on us the desirability of requiring removal of bloodstains from material at the earliest stage possible, and, with one or two exceptions, all stated the opinion that if all bloodstains can be separated from wool, anthrax will be but little heard of. The results of bacteriological examination of samples prove that some of the bloodstains found in wool are heavily infected, and if these be allowed to remain the danger after washing will be proportionately great. Nevertheless, it is doubtful whether, in certain circumstances, blood would always be visible (*see* page 20). It was also pointed out in evidence that (1) material which has undergone any wet process, *e.g.*, washing or wet fellmongering, will have the infection spread from any blood which might

have originally been present, and that parts so infected could not be picked out; (2) blood is friable, and may easily break up into dust in manipulation, whether in packing, transport or manufacture of wool; (3) blood, present in wool, may range from a mere stain on a few fibres, to a heavy mass held together by much wool; and (4) even the smallest bloodstains may contain thousands of spores.

9. Persons must be trained to recognise bloodstains before they are competent to sort them out of wool, but the requisite skill and knowledge are not difficult to acquire. Several practical difficulties in certain classes of works were indicated, and elaborate measures proposed for overcoming them, so as to ensure the proper removal of bloodstains and secure the employment only of persons trained and efficient in their recognition. Practically all the witnesses, however, engaged in the occupation of sorting out bloodstains stated that, even with the greatest care, the removal of all from wool is impossible, especially from coloured (brown and black) and false packed materials like Persian wool, which is one of the most dangerous varieties.

10. The removal of bloodstains was recommended in 1908 by the Anthrax Investigation Board. Great efforts were made to bring this proposal to the knowledge of the occupiers using dangerous materials, and to ensure that it was properly carried out. The Board's bacteriologist demonstrated to sorters and others the characteristics of dried blood as found in wool, and the sorting out of blood was generally adopted in 1908 and 1909. We made inquiries as to the extent and thoroughness with which it has been done, and we are satisfied that, with a few exceptions, the removal of blood has been, and is, carefully carried out in Bradford. In some factories, combing the most dangerous materials, by means of a system by which a bonus is paid according to the weight of blood removed, and by careful supervision and instruction of the sorters, it has been brought to a high state of perfection—probably higher than could be attained by regulations alone. It is, therefore, of value to examine the statistics of incidence of anthrax since 1909 as compared with the period before that date.

11. In the worsted trade in the nine years 1900–1908 there were 112 cases (40 deaths, 20 internal), while in the nine years 1909–1917 there were 164 cases (38 deaths, 32 internal). Thus in the period during which blood has been removed from wool, an increase has taken place of 46 per cent. in the total number of cases and of 60 per cent. in internal cases as compared with a similar period in which no blood was removed, while in each period the fatality has remained about the same. Consideration of the general incidence, however, ignores the facts that in some factories sorting out of blood has been, and is, defective and that, what is of greater importance, removal of blood affords no protection to warehouse operatives.

12. A number of factories can be selected, however, in which the conditions are known and the incidence in these studied. Accordingly, four factories were chosen in which the sorting out of blood has been properly carried out since the beginning of 1909. We are satisfied that in these four factories no considerable improvement in the efficiency with which blood is removed can be attained whatever regulations may be enforced. In one, blood was removed by skilled sorters till the factory was closed at the end of 1913, in two it is removed partly by skilled sorters and partly by warehousemen, and in one it is removed by warehousemen only. All the persons engaged in removing blood, whether skilled sorters or warehousemen, have been trained in its recognition, and the conditions of their work and the supervision exercised are excellent.

13. Since the beginning of 1900 a total of 126 cases, of which 39 were fatal, and 28 internal cases, have occurred in manufacturing processses in these four factories, 53 (19 fatal, 11 internal) in the period 1900–1908, and 73 (20 fatal, 17 internal) in the period 1909–1917. The processes before blood is removed are the purely warehouse operations, and opening and sorting. Blending is done after blood is removed, by warehousemen who may also do sorting, but pulling the blends is done by men employed in scouring. It is not possible, therefore, quite accurately to separate the processes carried on before, from those carried on after blood is removed. The possible error introduced in connection with blending is, however, quite small. In warehouse processes in the period 1900–1908 in the four factories there were 5 cases (2 fatal but none internal), while in the same processes in the period 1909–1917 there were 13 cases (5 fatal, 5 internal), *i.e.*, an increase in the latter period of 160 per cent. in the total cases, of 150 per cent. in the fatal and from 0 to 5 in internal cases.

14. In occupations later than warehouse processes in the period 1900–1908, the number of cases was 48 (17 fatal, 11 internal), while in similar processes in the period 1909–1917, during which blood was removed from the material, there were 60 cases (15 fatal, 12 internal); in comparison with the period when no blood was removed from the wool, an increase of 25 per cent. in the total cases, a decrease of 12 per cent. in fatal cases, and an increase of 9 per cent. in internal cases.

15. The figures are small, but the large comparative increases in the period 1909–1917 in total cases, fatal cases, and internal cases in the warehouse processes, *i.e.*, in processes before the separation of blood, appear to indicate three possibilities—use of material of

greater infectivity, increased use of infected material, or better recognition and reporting in this period as compared with the earlier period of 1900–1908. Whichever may be correct, it should operate in similar or even greater degree in the later processes, and, therefore, a similar or greater comparative increase in incidence ought to have appeared in them in the period 1909–1917 unless the removal of blood has exerted a modifying influence. An increase in total cases has certainly occurred in these processes in this period, during which blood has been removed, but it is comparatively small, while only one more internal case has been recorded and there has been a decrease in the total fatal cases (probably due to improved methods of treatment of external anthrax). We know of no new factor in operation in the later period except the sorting out of bloodstains, and we think that this process has probably been effective in modifying the expected increased incidence in the later processes of combing from scouring to combing inclusive. However this may be, it is clear that sorting out of bloodstains cannot *prevent* anthrax in the later processes and can afford no protection to warehouse operatives. On the whole, though there is strong presumptive evidence that removal of bloodstains has modified the increase in incidence of anthrax in later processes, there has been a general increase both of the fatal internal form and of the external form of anthrax in the period during which bloodstains have been removed.

16. With the intention of trying to find an explanation of the incidence of anthrax in processes after blood has been removed, we had a large number of samples of material collected, chiefly in connection with cases of anthrax, which were examined by the Bacteriologist of the Bradford Anthrax Investigation Board (Dr. Eurich). They were not in any way *selected*, except in the sense that they were taken from particular varieties of material, but were taken haphazard. Many were found to be infected and more than half the infected samples were free from visible blood. Some of the infected materials had been washed or treated by some wet process abroad, but others entirely free from blood, including samples of Persian wool and alpaca, had certainly not been so treated.

17. However brought about, much wool is certainly infected apart altogether from visible bloodstains,* a fact which explains sufficiently the incidence of anthrax in handling wool from which blood has been removed and one which must be taken into account in devising measures for preventing the disease. Removal of blood cannot in any event be used as a precaution against anthrax in the woollen and felt trades, because the infected materials used in these trades have mostly been washed abroad or are by-products from the worsted trade, and, therefore, show no signs of blood as a general rule. Nor can it be used for protection of persons employed in port warehouses, for obvious reasons. We were, therefore, compelled to come to the conclusion that **regulations making sorting out of blood compulsory would have but small effect in further reducing the incidence of anthrax, though in itself we are convinced it has been a valuable precaution.**

18. A further suggestion made was that if both bloodstains and skin material be removed from wool and hair, anthrax will be prevented among those who handle these materials. We have already pointed out that, *primâ facie*, wool or hair of animals dying from, or killed when suffering from, anthrax—*i.e.*, skin material—is the only material which may be expected to be dangerously infected, and we made careful inquiries as to the possibility, and as to the probable effectiveness, of requiring the sorting out of skin material, which would, of course, include bloodstains as well as material not bloodstained.

19. There is no practical means of separating infected skin material from that not infected. Bacteriological examination is useless, because samples only can be examined, and one or many infected fleeces might, therefore, be missed. It would thus be necessary to regard and treat as infected all skin material of the dangerous varieties, whether derived from butchered animals or from those dying a natural death from disease, &c. This is a large quantity of material, and no suggestion was made as to how it was to be dealt with, save that Mr. Ackroyd suggested disinfection for Turkey skin mohair†. Bloodstains when picked out of wool or hair are now burned if in small quantity, or disinfected by steam if in large quantity. The latter method is impracticable for disinfecting skin wool because of the severe damage caused, and no effective method of disinfection which does not cause damage was then known.

20. Persons of great knowledge of wool and hair, *e.g.*, buyers and skilled sorters, can detect skin material in certain varieties of wool and hair, *e.g.*, mohair, even when mixed with shorn material, but very considerable training of the ordinary person is necessary. Skin material may be of any quality; thus, it may include fine mohair which has reached shearing length, or it may consist of short wool from an animal which has not long been shorn; further, skin wool or hair is removed by shearing from the body of an animal immediately after death, or from the pelt after the latter has been removed from the body; by fellmongering by action of lime or other chemical on the pelt; and by pulling or sweating (allowing the skin partially to putrefy and then pulling the wool out by the roots). Most skin material removed by fellmongering or by pulling is not difficult to detect by experienced sorters (we questioned several, however, who stated they could not detect skin material at all), but it was stated that the fine qualities removed from the body or even from the pelt by shearing are sometimes

* *See also* pages 16 and 20. † Q. 8148.

extremely difficult to detect even by persons of great experience, and that if so removed immediately after death would probably be indistinguishable from ordinary fleece material.

21. All the dangerous varieties of wool and hair are sent to this country with skin and fleece material mixed, and in purchasing some, *e.g.*, mohair and alpaca, an estimate of the quantity of skin material present is always made by the prospective purchaser. Some buyers stated that they refuse to buy Turkey mohair containing skin material, and that if all took this attitude it would be possible to obtain it always unmixed, since skin material is frequently kept separate, or is separated, from fleece material in the country of origin, and parcels of Turkey mohair are sent here entirely free from it. This appears to indicate that for such materials a regulation requiring sorting out of skin material might be effectively applied, though, as was pointed out, it would be expensive and the skin material would have to be dealt with effectively when removed.

22. However this may be in connection with Turkey mohair, it is quite inapplicable to certain other materials. Persian wool is frequently, if not usually, false packed, *i.e.*, short skin material or locks are put inside fleeces, while, though skin material is sometimes exported as such, no effort is made to keep skin and fleece material separate. Indeed, they are so mixed as to make separation a practical impossibility. Similar remarks apply to East Indian cashmere and to other Asiatic materials. Many samples of Persian wool and other Asiatic materials, and some samples of alpaca also, were found to be infected though showing no indications which would allow of their detection and removal. Furthermore, nearly all East Indian wool and goat hair, and Egyptian wool, is washed abroad, and skin and fleece material thus inextricably mixed. There is not the remotest possibility that skin material could be removed from any of these materials in such a way as to leave the remainder free or even approximately free from infection. Having regard to the skill required for picking out skin material, the impossibility of separating it from materials like Persian, East Indian, and Egyptian wools, and the difficulty of knowing what to do with it if it could be separated, the conclusion was forced on us that **search for, and removal of, skin material mixed with fleece material is not a measure which in general is likely to result in the prevention of anthrax even if it were practicable.**

MEASURES FOR REDUCING THE FATALITY OF THE DISEASE.

1. Many witnesses urged the embodiment in regulations of measures for preventing a fatal issue when anthrax is contracted. It was stated that successful treatment is usually a question of the stage at which the disease has been recognised. If external anthrax be recognised in the early stages, the recovery under treatment is usual, but if not so recognised it may be doubtful or impossible. Accordingly, for the purpose of securing early recognition it was suggested that (1) in every district where anthrax is likely to arise (*i.e.*, in nearly all districts where wool is manufactured) a medical practitioner having the necessary experience of the bacteriological diagnosis of anthrax should be appointed for the purpose of examining any person employed in the manufacture of wool who may be ill; (2) employers should keep a register of names and addresses of operatives who should be compelled to give to the employer notice of their addresses and of every change of address; (3) the employer should be required to make inquiries when any person is absent from work without known cause; (4) the employer should at once report to the appointed surgeon any case of absence due to illness and development of suspicious signs, *e.g.*, pimples; (5) the affected operative should similarly report both to the employer and to the surgeon; (6) the appointed surgeon should examine the affected person and advise his removal to hospital or other institution if he believes the affection to be anthrax.

2. This system, in some form or other, is now voluntarily carried out in certain wool-combing factories in Bradford and elsewhere, and probably it has been an important factor in causing the decrease in the fatality from external anthrax already referred to (*see* Incidence of Anthrax, page 11). It was, however, demonstrated to us quite clearly that it does not give good results where the internal form of the disease is contracted. Even medical men of the greatest experience of anthrax have, in definite instances, found it impossible to make a diagnosis of the internal form before death. Internal anthrax is still, therefore, practically always fatal. Better means of diagnosis may, of course, be discovered,* but, in

* Such a method is the estimation of the opsonic index. By this is understood the comparative estimation of the power of phagocytosis (*see* footnote on p. 17), one of the defensive forces of the body against microbic invasion. The entry of germs may stimulate or depress phagocytosis. The amount of phagocytosis of the germs in question of which a patient's blood is capable, is compared with the degree of phagocytosis shown by the blood of a healthy person. The result of the calculation is termed the "opsonic index," normal phagocytosis being taken as unity.

Repeated trials have proved the applicability of this test to cutaneous anthrax; but simpler laboratory methods—microscopic and cultural—suffice in this form of the disease. In internal anthrax, on the other hand, they are generally of no avail, though occasionally anthrax bacilli have been cultivated from bloodstained sputum and from the vomit. The appearance of anthrax bacilli in the blood is, however, a comparatively late occurrence.

The estimation of the opsonic index may be expected to offer early evidence of internal infection. It has been found possible to employ it hitherto in one case only. Early on the third day of the illness, and 24 hours before the death of the patient, the index was 0·5, showing a degree of lowering of the opsonising power of the patient's blood serum clearly indicative of anthrax infection, which was verified post mortem (Dr. F. W. Eurich). Its applicability in the earlier stages of pulmonary or gastro-intestinal anthrax can only be shown by its further use.

existing circumstances, we have but little hope that the suggested precautions, if given statutory force, would result in any decrease in the fatality of the internal form of the disease. Whether early diagnosis would diminish the fatality of internal anthrax is another question. The further suggestion was made that a bacteriological and medical expert should also be appointed who could be called in at once in cases of doubt, as is now possible in Bradford and district.

MEASURES FOR THE PERSONAL HYGIENE OF OPERATIVES.

1. Many witnesses pointed out the need for improved welfare conditions for the operatives, such as provision of: (1) cloakrooms in which outdoor clothing not needed in working hours could be deposited, with separate accommodation for storage of overalls; (2) overalls for the use of all persons manipulating dangerous varieties of wool, whether washed or unwashed; (3) lavatories, including basins, soap, towel, and hot and cold water (one basin for every five persons employed and a separate towel for each worker were suggested as reasonable); (4) reasonable time for washing before each break for meals, and when ceasing work; (5) messrooms for all operatives, and the prohibition of taking food or drink into, or consuming it in, any workroom; (6) the cleansing of floors, walls, and ceilings by means of a vacuum plant, and cleansing of dust chambers, exhaust systems, &c.; (7) corresponding duties, placed on the operatives, of using the facilities provided. We are in sympathy with these suggestions, but feel that, while most desirable in themselves, no appreciable decrease in anthrax would result from such possible improvements.

2. The administrative weakness of existing regulations was much criticised in evidence, and suggestions were made for the inclusion, in a new code, of certain purely administrative requirements for the purpose of ensuring their effective application. Those suggested included (1) the keeping of a register in every factory in which wool is used, in which must be entered a statement of the kind, amount, country of origin, and quality of every lot of material used, whether raw wool, hair, noils, or by-products, the names of sorters employed, the amount of possibly infected material removed by each, and the quantity, quality, marks, and kind of material sorted by each; (2) giving notice to the District Inspector of Factories before commencing to use dangerous material; (3) power to take samples of materials for examination; (4) the prohibition of the manufacturing of dangerous varieties of material in any factory not possessing a licence from the Home Office permitting it, the granting of the licence being dependent on the arrangements made for the safety of the operatives.

3. The above brief outline of the most important suggestions for new regulations sufficiently indicates the lines on which we would have had to consider recommendations for a new code had no more effective method of combating the danger been available. It is not, however, exhaustive, and many suggestions on points of detail were put forward which are stated in the summary of evidence.

RESULTS OF THE ENQUIRY IN RELATION TO REGULATIONS.

1. The conclusion we draw from the evidence heard in connection with regulations and existing conditions in the wool trade is that if the policy of attempting to control the incidence of anthrax by regulations is to be persisted in, then a long and intricate code would have to be constructed, in which the important suggestions briefly outlined above and many others, elaborated in detail, would be included, together with certain purely administrative regulations for the purpose of securing effective application.

2. Most of the precautions suggested are already in operation in some form; many, *e.g.* the sorting out of bloodstains, and suppression of dust, are very expensive, and if they be logically extended and improved would become much more costly, *e.g.*, if the sorting out of skin material of certain varieties, as well as of bloodstains, be made compulsory as it should be in new regulations, or if compulsory willowing or provision of exhaust in dusty carding and other processes be required. The code would have to be so comprehensive and so strictly enforced as to be a severe handicap to industry, not only in processes and factories already under regulations (practically the application of existing regulations is limited to the processes of opening and sorting), but also in spinning, weaving, and other processes; in factories not up to the present time under regulations; in the use of by-products (noils) and waste products; in the woollen and felt trades; and in port warehouses. Not only would the precautions required be costly, but their administration would be harassing alike to administrators, employers, and operatives. No new departure likely to exert any far-reaching effect was suggested in evidence, nor did any make its appearance in our deliberations.

3. Practically all we could do, therefore, was to recommend that precautions already in operation should be given legal force. Careful consideration of the manner in which they are now applied convinced us that, though in some factories their strict enforcement is defective, on the whole they are as effectively carried out as can reasonably be expected. Having regard to the difficulties of enforcement by inspection, compulsion is not likely to increase in any great degree the effectiveness of precautions already voluntarily taken. Thus, measures

which can be applied in factories appear to have reached the limit of their usefulness, and whatever can be effected by new regulations is not likely to result in any considerable decrease in anthrax. We were also unable to find any precautions which could be enforced in warehouses with any prospect of success, while the position in the woollen and felt trades appears to be even more difficult than in the worsted trade, owing to the fact that the materials used are nearly all washed abroad, and, therefore, show no indications whatever of possible danger. The question whether any and, if so, what alternative measures are possible naturally arose.

4. The dangers of anthrax are different from those usually controlled by regulations under the Factory Act, in that they are caused, not by an inanimate substance or article used in manufacture but by living organisms accidentally attached to the material handled, without external indication by which their presence or absence can be judged. They may be present in material which to the eye appears to be perfectly clean, or be absent from the foulest material, and no manufacturing process up to and including weaving can cause their destruction. The concentration of infection is no doubt modified by various processes, *e.g.*, the warehouse processes, willowing, washing, and carding, but the spores so removed from wool are not destroyed. On the contrary, they may remain alive in dust in the factory or they may be further distributed in dust, washing liquids, by-products, and waste products, and may cause anthrax among animals or human beings far distant from the factory in which regulations apply.

5. Regulations aim at so controlling the operations in a factory, the work and the actions of the operatives, as to reduce the absorption of a poisonous substance (which is usually the actual material used in manufacture) below the toxic limit or as to prevent contact with dangerous substances, articles or machinery. The material used in the wool trade is not itself dangerous, but the invisible living organism accidentally attached to it is. No regulations can attenuate the virus or eliminate it to such an extent as to prevent danger. A single inhalation or the breathing of an atmosphere, as in combing, quite free from dust in the ordinary sense, may, if the germ be there, have fatal results.

6. Again, scratching and even mere rubbing of the skin may suffice to cause infection. Avoidance of contact with wool and, therefore, with the organism is, of course, an absolute impossibility. Infection may get on to the clothing and be transferred to other persons, *e.g.*, members of the family of an operative. All processes of manufacture of wool and all movements of material in transport favour the wide distribution and dissemination of spores, and, whatever regulations may accomplish, the danger is always present and the spores are always alive.

7. These considerations led us to the conclusion that **the danger of infection from anthrax in wool is not one which can be dealt with advantageously by means of regulations, and, given a satisfactory alternative, is one which ought not to be dealt with in factories.** The gravest objection to the policy of attempting to prevent anthrax by regulations applied in factories is that the effect only is dealt with and the cause is ignored. If a break in a river bank occurred so as to allow the water to flood the surrounding country, efforts would be made to close the leak, and it would be considered the height of folly to attempt to prevent evil results from the flood by controlling the actions of people living in the neighbourhood or by attempting to drain off the water without stopping the flow from the river. Yet that is equivalent to action taken by means of regulations, or in factories, to control anthrax.

OTHER MEASURES FOR CONTROLLING ANTHRAX.

1. Certain proposals were made suggesting action apart from or in addition to regulations. These included (1) action in the country of origin of the material; (2) disinfection of wool and hair.

2. *Action in Country of Origin.*—As we have already indicated, anthrax is a disease of animals which results in infection of their wool or hair. If the possibility of infection by soil or other materials which become attached to wool be excluded (a possibility which is still doubtful), the disease is only communicated to man by direct handling of the bodies or products (skin, wool, hair, hides, &c.) of animals which have died from anthrax, or, indirectly, by means of materials infected by dust from, or contact with, infected animal products. In other words, industrial anthrax is entirely dependent on animal anthrax, and if the disease were prevented among animals, anthrax among operatives would cease. The problem is, therefore, primarily agricultural, and not one which it ought to be necessary to deal with in factories at all.

3. The precautions taken in Australia were described by Dr. Norris, and those taken in France and Great Britain by Sir Stewart Stockman. The most important are (1) compulsory notification to a Public Authority of all cases of anthrax among animals; (2) compulsory destruction, under supervision, by burning or the deep burying, of all carcases (including the wool or hair and the hides) of animals which have died from anthrax, and prohibition of

the cutting of the bodies (anthrax bacilli cannot form spores unless exposed freely to air); (3) disinfection of the surroundings and surface on which an animal has died; (4) preventive inoculation of animals (*see* Appendix 22). In addition, Australia, for the purpose of preventing the re-introduction of infection, prohibits the importation of animal products and even animal food from certain countries except under severe restrictions.

4. Efforts should be made, it was suggested, to secure the adoption of similar precautions in countries from which dangerous materials are imported. We agree that this is the only proper way of attacking the problem, *i.e.*, by stamping out the disease among animals. For its enforcement, however, a highly organised system of control is necessary. This does not exist, and is impossible at present, in the Asiatic regions in which a large proportion of the infected material is produced. We see no reason why it cannot be adopted effectively in South Africa and perhaps in Peru, but we have no hope that it could be applied successfully in Asia for many years to come.

5. Efforts have also been made repeatedly by means of circulars and through consular officers to secure the separate packing of infected material in the country of origin—in most instances without effect. But in the packing of alpaca in Peru it was suggested that some success had followed, and that infected material is not now packed with sound material. For the purpose of testing the effect of this we had many samples of alpaca collected. They were examined bacteriologically and a proportion found to be infected. This proportion was comparatively low, but was certainly not less than in a recent period before efforts were made to secure separation of infected material previous to packing. The degree of infection found was, however, always scanty, and possibly alpaca is not very dangerously infected.

6. Attempts might be made to ensure the separate packing of infected and non-infected material in all countries which export infected material, and we were urged to send a Sub-Committee to the packing centres to ascertain what steps could be taken. In the difficult situation created by the war this did not appear to us to be practicable. Sir Stewart Stockman and other witnesses, however, who have experience of the conditions in Asiatic countries, pointed out that even if inspection by British representatives could be secured in each district, little good effect could be expected. Dr. Norris stated that, judging from his experience of the working of the quarantine organisation in Australia, no effect whatever could be expected unless each area and even each premises in which dangerous material is produced and packed be inspected by British representatives and the inspection supported by putting all materials in quarantine on reaching this country.

7. No suggestion was made as to what was to be then done with the infected material after the separation and separate packing had been secured. After examining the proposal in all its bearings, we felt compelled to conclude that this method of dealing with the danger is impracticable and offers no prospect of success, at all events in Asiatic countries.

8. The only two possibilities left were disinfection or prohibition of importation of all dangerous materials. The latter could not be considered, having regard to the very large quantity of indispensable material involved, while all methods of disinfection known at that time either caused severe and costly damage to material or were ineffective in destroying anthrax spores.

DISINFECTION.

1. We were finally forced into the position of having either to recommend a code of regulations, which would be irksome and ineffective, or to take steps to find a suitable method of disinfection of wool and hair.

2. We had heard much evidence as to various experiments which had been made in the period between 1880 and 1914 for the purpose of devising a method of disinfection. Based on the failure of all these experiments, the opinion was generally expressed that disinfection of wool and hair is impracticable, but it was pointed out that, in any event, no successful process was known. The twin difficulty of disinfection lies in two diametrically opposed facts: that anthrax spores are among the most resistant of all known micro-organisms, and that wool is easily damaged. The Anthrax Investigation Board had definitely proved the use of steam to be impossible, but certain experiments made by Mr. George Ackroyd, though they resulted in severe damage to the material, afforded some indication that disinfection by other methods might be possible.

3. It was suggested to us that the whole world is ripe for the adoption of disinfection of wool and hair, provided a satisfactory method can be devised. In these circumstances, we decided to appoint a Sub-Committee to go into the whole question and, if possible, to devise a process applicable to wool and hair. Their successful efforts are embodied in a report the importance and value of which cannot be over-estimated, and we, therefore, adopted it.*

* Report of the Departmental Committee appointed to enquire as to precautions for preventing danger of infection by anthrax in the manipulation of wool, goat hair, and camel hair. Vol. I., Report of the Disinfection Sub-Committee. [Cd. 9057.] Published by H.M. Stationery Office.

4. The method of disinfection devised by the Sub-Committee consists essentially of two processes, the first removing protection given to the spores by blood and other substances in wool, the second causing disinfection. The Sub-Committee's experiments, as well as those carried out independently by Professor Delépine, demonstrate beyond doubt that anthrax spores, if sufficiently exposed by the first process, are completely destroyed by the second in less than twenty minutes. They also show that the resistance of blood to disintegration may vary considerably, and the Sub-Committee point out that machinery such as can be used on a small experimental scale is, compared with that which would be used in practice, necessarily very inefficient in causing disintegration. In consequence they were not able to secure with absolute certainty the complete disintegration of all blood *except by prolonged treatment.* If, however, the preliminary treatment be sufficiently drastic, complete exposure of all spores can be ensured. This is the key to successful disinfection.

5. Based on a careful consideration of all the conditions of the experiments and of actual commercial practice, the following method is recommended:—

Stage 1.—*Preliminary treatment*, consisting of agitation (by means of rakes which thrust the wool through liquid as in scouring machinery) for 20 minutes in a solution of soap in water (preferably also containing a little alkali like sodium or potassium carbonate) at a temperature of 102–110° F., assisted by squeezing through rollers.

Stage 2.—*Disinfecting treatment*, in which the material is agitated by similar means for 20 minutes in a 2–2½ per cent. solution of formaldehyde in water at a temperature of 102–105° F., assisted by squeezing through rollers.

Stage 3.—*Drying* in a current of air heated to 160° F.

Stage 4.—Standing for a short time to ensure by the progressive action of the formaldehyde, with which the blood and other substances have been saturated, the complete destruction of any weakened spores which may in rare cases survive stages 2 and 3.

6. The details recommended for stage 2 are based on actual experimental and bacteriological results which place beyond question the fact that, if exposed by the preliminary treatment, the spores will be destroyed, under the conditions suggested, in less time than that recommended. Those recommended for stage 1, however, are in the nature of an arbitrary decision, based certainly on experimental results but assuming that machinery and methods which will be used in practice will be more efficient than those used in the experiments. For this there is evidence, and, in any event, it is certainly possible to make the preliminary process effective in completely exposing the spores. The method of disinfection is, therefore, quite sound, but we think the verification of the details recommended for stage 1 (preliminary treatment), by experiments with the machinery by means of which it is proposed to apply the process, should be regarded as necessary. (*See* p. 40, Immediate Action.)

7. Stages 3 and 4 are necessary for commercial reasons, apart from disinfection. The experimental results show them to have powerful effects in completing disinfection, but the Sub-Committee regard them in the light of a safety factor. They insist, and we agree, that in practice the preliminary treatment can, and should, be made so efficient that complete disinfection is ensured at the end of the second or disinfecting stage.

8. The possession of an efficient and practicable method of disinfection permits a much wider view to be taken of the whole problem of the prevention of anthrax, not only among persons handling animal fibres, but in the manufacture of all animal products and in agriculture. The whole question is so complex and the different branches of the trade in animal products so intimately related as to make it necessary, in our opinion, to consider the question as a whole as far as possible and, so far as the trade in animal fibres is concerned, to apply measures, not to particular branches considered separately, but comprehensively to all branches involved. Disinfection affords the only means by which this can be done, having regard to the impossibility of securing the adoption in Asia of agricultural precautions, which, as we have pointed out, is the proper method of preventing anthrax.

9. We have, therefore, no hesitation in recommending that:—

(1) The policy of attempting to control the danger of infection from anthrax in wool by regulations under the Factory Act should be abandoned, and instead the principle of compulsory disinfection substituted.

There will necessarily be a period before disinfection can be brought fully into operation. This we deal with later in the report.

THE PROCESS OF DISINFECTION.

1. Before considering measures for bringing disinfection into operation, the nature of the process devised must be carefully considered. The greatest difficulty in disinfection of wool and hair, apart from that of damage, is the fact that the spores, themselves highly resistant, are in wool frequently protected by blood or other substances, the chemical composition of which is such as to enable them to impose an almost insuperable bar to the attack

of disinfectants on the spores. The Sub-Committee also found this to be their greatest difficulty, and finally overcame it by submitting the wool to a preliminary process by which the protecting substances are disintegrated and removed. This is an essential part of, and the key to, successful disinfection. Two results follow: (1) that disinfection of wool in bales, and even in fleeces, is impossible; (2) that a large volume of highly infected liquid remains from the preliminary treatment. Bales and fleeces must therefore be opened before being fed into the disinfecting machines, and persons doing this will be exposed to risk against which special measures for their protection must be taken.

2. The liquid from the preliminary treatment of wool will be highly infected, although not more so than that produced in the worsted trade by ordinary scouring, which is now discharged into the drains. Several outbreaks of anthrax among animals have been traced to infection from the latter, and we are in agreement that highly infected liquids, whether produced in scouring or in disinfection, should be sterilised before discharge. Means, therefore, will have to be provided for securing this.

3. The disinfectant used is formaldehyde, a substance the vapour of which, when inhaled, violently attacks the mucous membrane of the nose, throat and lungs. Measures for preventing the escape and the inhalation of this vapour are therefore necessary.

4. The method is highly technical, and chemical and other tests of the solutions and of other materials are constantly necessary. The whole process must, therefore, be under rigid scientific control. Special plant and machinery, occupying considerably more space than scouring machinery ordinarily used in woolcombing, is required for the process, and for economical working it must be kept fully employed. The disinfecting solution cannot be used indefinitely without purification, for which special arrangements will be necessary. Finally, the Sub-Committee point out that standing of material after treatment is desirable as a safety factor for ensuring the death of all spores.

IMPOSSIBILITY OF DISINFECTION IN FACTORIES.

1. We are in agreement that disinfection of dangerous wool and hair must be compulsory, and the nature of the administrative measures for enforcing it have been carefully considered. If it is to be carried out in each factory in which infected materials are used, the method to be followed must be prescribed in detail, and arrangements made for enforcing its exact observance by inspection. In other words, a code of regulations for disinfection will have to be substituted for that by which manufacturing processes are now controlled. From every point of view, of administration, of employers, and of operatives, we think the strongest objection can be taken to this course. Inspection is extremely difficult, disinfection is foreign to the business of employers, and non-observance of regulations in many particulars is inevitable.

2. The value of disinfection is greatly reduced if it be not properly carried out with minute attention to detail, and if done in factories cases of ineffective disinfection would certainly arise, as they have done, both in this country and in Germany, in the disinfection of horsehair, which is now required by regulations to be done in factories. A further strong argument against disinfection in factories is that it would have to be carried out at the last stage in the course of transit to the consuming districts. Though the factory workers might receive an uncertain and doubtful protection, transport workers, and dock and sale warehousemen would receive none whatever.

3. In all factories the requisite special plant would have to be installed, and, though in some worsted factories it might be possible to substitute disinfection for scouring (though new plant would be required), since disinfected material is as clean as scoured material, in woollen and felt factories a new department would have to be organised. The provision of the requisite space would be a difficulty in almost all factories, and in many insuperable. Few factory occupiers would be in a position to provide the necessary expert and scientific control of the process of disinfection, put down the necessary plant and make provision of the space requisite for it and for storage of the material after treatment, take the steps necessary for prevention of danger to operatives manipulating material before disinfection, and carry them out in such a way as to ensure the attainment of their object. The establishment of a large number of small disinfection plants, and of the necessary subsidiary arrangements for sterilising waste effluents, purification of formaldehyde, &c., would also make the cost of disinfection unbearably high. We are therefore agreed that **disinfection in factories in which wool is manufactured is both impracticable and undesirable.**

CENTRAL DISINFECTING STATIONS.

1. The difficulties and objections to disinfection in individual factories can be avoided in establishments in which the sole business is disinfection, and in which the whole of the work of disinfection could be concentrated under expert scientific control. This proposal of central disinfection is not new. It was put forward by Dr. Legge in 1907 for the disinfection of horsehair by steam, and has been advocated since that time by writers in various countries, with the further suggestion that admission of wool to consuming countries should only be

allowed through fixed ports. It has never, however, been examined in detail, nor has any attempt been made to work out a scheme on practical lines. We think the time has now arrived when this should be done. The advantages of adopting this course appear to us to be as overwhelming as do the disadvantages of factory disinfection, and accordingly we recommend that—

(2) Disinfection of wool and hair should be permitted only in central disinfecting stations, the sole business of which is disinfection.

MATERIALS REQUIRING DISINFECTION.

1. We have pointed out that the varieties of material used in the wool trade which are now recognised to be dangerously infected are imported from three widely separated areas:—(1) That comprised in the central, southern, and western portions of Asia (including India and Egypt); (2) South Africa (including Natal); and (3) Peru. All infected materials can be divided into two classes, *i.e.*, those of high grade and those of low grade. The dangerously infected materials of the former class are Cape mohair, imported through Durban, Port Elizabeth, Cape Town, and other ports from South Africa and Natal; Turkey mohair, imported through Constantinople from Asia Minor, Anatolia and Western Armenia; alpaca, imported through Mollendo, Callao, and other ports from Peru. These three articles form the staple supply for the manufacture of mohair and alpaca goods, and the best qualities are sorted very carefully into many grades or matchings. Though alpaca and Cape mohair are certainly infected in some degree, the degree of infection in both usually appears to be comparatively low, at all events in high-quality fleece material. Turkey mohair, or some qualities of it, is highly infected.

2. In certain factories using each of these materials no case of anthrax has ever been recorded. We were informed that high quality Turkey mohair can be obtained free from skin material, and that if pressure were brought to bear by buyers the absence of skin material could be ensured. The whole of the evidence placed before us by both professional and trade witnesses indicated that in materials which can be included amongst those of high grade, skin material only is likely to be dangerously infected, that infected material because it is skin material is usually not of the highest quality, and that, therefore, it is generally found among the inferior qualities of any variety of high grade wool or hair. Possibly the firms which have escaped cases of anthrax have done so by reason of the high quality of material used and the consequent infrequent presence, or perhaps absence, of infected material. It was also stated that the usual examination for purpose of purchase always reveals the presence or absence of skin material.

3. The effect of the disinfection process is to break up the fleeces of material and mix the different parts or qualities in such a way as to make sorting much more difficult. It may possibly still be done, but more time is required and the separation of the different qualities is not so perfect. Any interference with trade practices should, naturally, be avoided if it can be done without endangering the object in view, *i.e.*, the suppression of anthrax. We cannot say definitely that no cases of anthrax will occur if use of high qualities of alpaca and mohair without disinfection be permitted, but it appears to be a possibility. We are, therefore, of opinion that while all skin material, and all inferior qualities (not in fleeces) of these varieties should be disinfected, the use of a defined quality or defined qualities should be allowed, for a time at least as an experiment, without disinfection if by any means effective separation from them of all skin and inferior material before reaching this country can be assured.

4. Materials of the low grade class comprise all those imported from the western, southern and central parts of Asia (including India), and from Egypt, except average or first quality Turkey mohair, named in the list of dangerous materials given on page 19, with the addition of inferior qualities of alpaca, not in fleeces, and of low qualities of Cape wool and Cape mohair from South Africa. The only one of these low grade materials which we know to be sorted into qualities is Persian wool, and that by one firm only which has expressed willingness to accept disinfection even though it affects sorting. It must be understood that the sorting of Persian wool by this firm is not sorting of the same type as that of alpaca and mohair of high quality. The last two are sorted into many qualities, while Persian wool is not, to begin with, of so fine a quality and is sorted into three matchings at the most. This does not detract from the credit attaching to the attitude of the firm in question, but it ought not to be supposed that manufacturers sorting alpaca and mohair for trade purposes could possibly follow this example. We are in agreement that there is no prospect whatever that skin wool or infected material can be separated from non-infected material of the varieties which we include in the low grade class, either because of the manner in which they are mixed or because infected and non-infected materials are washed together in the country of origin.

5. The erection of central stations and the making of suitable arrangements will necessarily require time, and it will probably be convenient to commence disinfection on a

small scale. Some varieties of materials are undoubtedly much more dangerous to handle than others, *e.g.*, East Indian goat hair, Persian wool, East Indian wool, and Egyptian wool. Probably at least 70 per cent. of the cases of anthrax are caused by these materials together, of which about eighty million pounds are imported annually. Efforts should be made to secure their disinfection as soon as possible, and in making arrangements for disinfection preference should be given to them. After being brought successfully into operation in connection with these materials disinfection should be extended as quickly as possible to other infected materials, but necessarily some time will elapse before complete arrangements can be made to disinfect all.

6. At present no Turkey mohair is being imported into this country, and the normal annual imports of Cape mohair and alpaca are about 18,000,000 lbs. and 6,000,000 lbs. respectively. The situation, therefore, appears favourable for an attempt to meet the anticipated difficulties in connection with sorting by taking steps, in the period which must elapse before disinfection can be brought fully into operation, to ascertain if it be possible to obtain supplies of these materials free from infection. The application of disinfection to high quality Cape and Turkey mohair, and alpaca should, therefore, be left to the last, and the intervening period should be utilised for the necessary enquiries and negotiations.

7. The suggestion we make is an attempt to afford the trade an opportunity of meeting anticipated difficulties, and should be regarded as an experiment which, if not successful in preventing anthrax in the use of these materials, must be abandoned in favour of disinfection of all qualities of every infected variety whatever the difficulties of sorting may be. It is a trade matter, and the trade should, therefore, combine to ascertain what arrangements can be made to secure proper grading and packing, and what guarantees it can obtain or give that defined qualities can be obtained free from danger. All three of the materials named are graded to a greater or less extent and packed abroad, and we are assured that it is then possible to separate them into at least a first quality, an inferior quality and skin material, that it only needs a firm attitude on the part of English buyers to ensure this separation, and that, assuming in these high grade materials only skin material is likely to be infected, the first need contain no infected material.

8. We are not able to say what constitutes a suitable guarantee. This in our opinion is a question as to which the trade should make suggestions, but it should be clearly understood that failure to secure freedom from anthrax among operatives involves the ultimate application of disinfection. With this proviso probably the guarantee of English buyers, given after personal examination, that the material contains neither skin material nor inferior qualities, could be accepted. In any event systematic bacteriological examination of samples should be enforced.

9. Accordingly we make the following recommendations :—

(3) Disinfection of all materials (except defined qualities of Turkey mohair) derived from Southern, Central, and Western Asia, and from Egypt should be compulsory.

(3a) If it be found necessary to exercise preference as to the order in which disinfection be applied to materials, East Indian goat hair, Persian wool, East Indian wool, and Egyptian wool most urgently require it, and should be dealt with first, while Cape mohair and alpaca should be left to the last.

(3b) If in the period before the scheme of disinfection can be fully developed the trades concerned are able to make arrangements under which suitable guarantees can be given that defined qualities of Turkey mohair, Cape mohair, and alpaca fleeces consist only of material shorn in the ordinary way from living healthy animals, and that they contain no skin or inferior qualities, those defined qualities should be exempt from the requirement of disinfection for the time being.

(3c) The disinfection of all skin material, and of inferior qualities (not in fleeces) of Turkey mohair, Cape mohair, and alpaca should be compulsory.

(3d) Future action in connection with the exempted varieties should be determined in accordance with the result of the experiment of exemption.

We avoid making more specific recommendations at this point in view of the nature of the recommendations made later in the report as to the organisation to be constituted for carrying out disinfection.

POSITION OF THE CENTRAL DISINFECTING STATIONS.

1. In order to come to a decision as to the places most suitable for the establishment of central disinfecting stations, many factors in connection with anthrax and the trade in wool have to be considered. The factories in which dangerous material is consumed are scattered

over the whole country, from the North of Scotland to the South of England, while dock warehouses, through which most of it passes, are situated at the ports. The statistics of anthrax in wool-consuming countries show the disease to occur among (*a*) dock labourers and transport workers generally; (*b*) persons employed in wharves and warehouses at the docks; (*c*) sample room employees, and buyers examining material before purchase; (*d*) persons manipulating animal fibres in every manufacturing operation; (*e*) and occasionally the general public from use of articles made from infected raw materials.* Unless the materials be disinfected immediately on landing, some of the classes of workers named will remain in danger of infection. If then disinfection is to be carried out in this country, the central disinfecting stations should be situated at the ports through which wool enters the country, and disinfection should be required before any distribution, or even exhibition for sale, takes place. It would probably also be necessary to prohibit the landing of dangerous materials except at certain ports, and even there it would be essential that they should be transferred direct from the ship to the disinfecting station.

2. This would certainly afford a solution of the problem of providing means for preventing anthrax in dock warehouses and factories in the worsted, woollen and felt trade. The advantages of adopting this course are that only two ports, London and Liverpool, are concerned; larger quantities of material collect at these than at any ports in the world, and are there mostly sold by public auction; control would be comparatively simple. On the other hand, the cost would be high; the stations would have to be on a very large scale; the necessary space in a convenient position might be difficult to obtain; disposal of the large quantities of effluent and other waste products might be difficult; the danger of anthrax among dock and transport workers and of spread of infection in transport would still remain; material would have to be repacked for transport to other countries, to sale warehouses and to consumers; and wool going to other countries would escape disinfection and thus enable those countries to compete on unduly favourable terms. In our opinion, too, a much wider view ought to be taken of the question of anthrax, and a successful method of disinfection renders this possible.

3. The disinfection of materials produced in this country is not in question. All those known to be appreciably infected are imported. Every part of the body of an animal—blood, flesh, bones, skin, wool, and hair—may become infected, may convey infection, has commercial value, and is transported to various parts of the world according to the demand. Having regard to the increasing demands for animal products; the uses to which they are put—the making of clothing, leather, brushes, bedding, manures, animal food, &c.; the use of waste materials produced in manufacture as manure and as animal bedding; the fact that few processes of manufacture cause destruction of anthrax spores; and finally, the rapidly extending means of communication and transportation; it is plain that anthrax among animals is likely, in the absence of precautions for its prevention, to spread more and more and to become prevalent in districts hitherto comparatively free from it.

4. The spread of infection during ship transport is a factor of which we heard evidence. Sir Stewart Stockman pointed out that in this country infection of animals usually takes place by the eating of infected imported food. Definite instances of this were given, in some of which anthrax bacilli were cultivated from the food, *e.g.*, grain from Russia and cattle cake from Bombay transported in association with animal products. The same fact has been observed in Australia and other countries.

5. Anthrax among human beings is not confined to the manipulation of animal products, but occurs in handling materials not usually regarded as capable of conveying infection. No less than 28 cases, of which 12 were fatal (one internal), came to the knowledge of the Factory Department between 1901 and 1917 in the handling of such material as grain, rice, beans, cases of oranges, rape seed, cotton seed, tins of fruit, cotton, coffee, &c., and in sack mending. The source of infection in these cases is sometimes difficult to trace, but the evidence available suggests that the materials have become infected from dust from, or from contact with, animal products (wool, hair, hides and skins), packed and transported in ships with them. Furthermore, some materials are washed at ports, *e.g.*, Karachi and Cairo, others are beaten with canes, *e.g.*, at Bombay, before being shipped, and the cumulative effect of evidence of this nature compels the conclusion that infection is probably being spread during the whole course of transport of wool and hair from the producing to the consuming districts.

6. London and Liverpool are the greatest distributing centres in the world for wool and hair, but some of the materials from India, Persia, and other Asiatic areas are exported direct to other countries, *e.g.*, to France viâ Marseilles, and to the United States. Some which are brought to London and Liverpool are re-exported to France, the United States and other countries, and some of these may even again return to this country. If disinfection be applied at English ports infected materials will in any event be carried on long journeys before disinfection, while some will escape altogether. Not only, therefore, will infection be spread as a result, but a certain handicap will be imposed on English manufacturers in having to bear the cost of disinfection which materials going to other countries will avoid. This is a factor which ought to be considered.

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* *See* par. 13, page 20.

7. Some of the material as it reaches this country contains large quantities of grease and dirt—sometimes as much as 50 per cent. of its total weight. If disinfection be carried out before the wool is shipped considerable transport charges will be saved by the cleansing of the materials which, as we have pointed out, is an incidental effect of disinfection. Even material which is washed in India and Egypt often contains a considerable quantity of foreign matter, while since all East Indian and Egyptian wool must be disinfected this washing will be an unnecessary and, therefore, a wasted process, of which disinfection could take the place. The trade would be saved some of the cost imposed if disinfection were carried out before the materials are exported.

8. From whatever point of view the subject is considered, whether of economy; or spread of infection*; or prevention of anthrax among workers in the country of origin, in transport, and in consuming countries; it seems desirable that disinfection of wool and hair should be carried out at the earliest stage possible in the course of the material from the producing to the consuming districts. The advantages of disinfecting wool before it is exported may be summed up as follows:—(1) Anthrax spores would be destroyed at an early stage; (2) danger to transport workers and the possibility of the spread of infection in transit would be avoided; (3) the disinfecting stations would be of more convenient size, and there would, therefore be less difficulty in obtaining the necessary space and in disposing of the waste products; (4) double packing and, in regard to some ports, double cleansing would be avoided; (5) transport charges would be reduced by the removal of a considerable proportion of the foreign matters always present in wool; (6) the necessity of providing that all materials should pass through certain fixed import ports would in part be avoided; (7) the danger of material going to countries where disinfection is not carried out or is doubtful would be avoided.

9. Wool and hair are usually transported along well-defined routes, and their collection, transport and distribution may be likened to the removal of sheep from one field to another. When grazing, sheep are scattered. For removal they are collected in a flock at a gateway through which they pass along a road to the gateway of the second field. Through this they pass, also in a flock, again to become distributed over the grazing area. So does wool travel from the producing areas through the gateways of the producing countries—ports like Karachi and Bombay in India, Basra at the head of the Persian Gulf, Cairo in Egypt, &c.—across the seas to the gateways of the consuming countries—London and Liverpool in England, Marseilles in France, Boston in the United States.

10. The producing areas in India are very largely Native States, *e.g.*, Rajputana, &c., over which authority is limited. In other countries the flocks are largely nomadic, *e.g.*, Afghanistan, Persia, Mesopotamia and Kurdistan, &c. No scheme of disinfection can be made effective in such areas. Clearly the points at which disinfection can be most conveniently and effectively carried out are the gateways through which the material leaves the exporting country or enters the consuming country, at which points it is in the ordinary course gathered together in large quantities.

11. As we have previously pointed out, wool may travel by alternative routes, that selected depending on demand, safety of travelling, and convenience of marketing, &c. Thus, Central Asian wool may travel south to Karachi and thence to Liverpool; or, alternatively, north to Bokhara, &c., and from thence overland viâ the Caspian to the Black Sea ports, or to Nijni-Novgorod and across Russia to the Baltic ports for shipment. It may therefore be necessary to establish disinfecting stations at the ports in this country for dealing with the comparatively small quantities of material which come by such alternative routes, and perhaps with the skin material and inferior qualities of Cape and Turkey mohair and alpaca. **Generally, however, the ports through which wool is exported to this country appear to us to offer incontestable advantages as the points at which central disinfecting stations should be established.**

12. Accordingly we recommend that:—

(4) Every dangerous variety of material should be disinfected at the earliest stage possible in its course from the producing to the consuming areas, and, in particular, that East Indian wool and goat hair should be disinfected in two stations situated respectively at the Indian Ports of Karachi and Bombay (other stations may also be found necessary); Persian wool at a station situated at the Persian Gulf Port of Basra; Egyptian wool at a station situated at Cairo.

Further consideration will be necessary before coming to a decision as to the points at which Syrian wool, Turkey skin and inferior mohair, and other materials should be disinfected.

13. In making the above recommendation we have carefully considered the conditions under, and the methods by, which wool is collected in Asiatic countries; and particularly the fact that establishments for the washing and presspacking of wool have come into existence comparatively recently in India, Mesopotamia and Persia. The scheme of disinfection should be fitted into the existing trade organisation with as little disturbance as possible and with sympathetic regard for existing institutions and customs. The establishment of disinfecting stations at ports like Bombay, Karachi and Basra will merely provide a channel through which

* Q. 9983.

the stream of wool will pass without any diversion or dislocation of traffic. There should be no interference with the trade before the materials reach the disinfecting stations. We regard it as certain that disinfection enhances the value of the material. It is a cleansing process and, therefore, a wider circle of users will be attracted because wool issuing from the disinfecting station will not only be free from infection and of a uniformly high standard of cleanliness, but, as a consequence, the packages themselves will carry a guarantee as to weight and condition and the system of marking be very materially improved. While no consideration should be permitted to interfere with the *efficiency* of disinfection, the authority to whom disinfection is entrusted should assume a benevolent attitude towards *all* the interests concerned. Disinfection although compulsory should be introduced with the co-operation of all branches of the trade.

INCIDENCE OF COST OF DISINFECTION.

1. The Sub-Committee on Disinfection made careful enquiries as to cost, the results of which enabled them to give an estimate of the capital and working costs of disinfection in central stations. The estimated capital cost of a central station capable of disinfecting annually ten million pounds of raw wool is given as 18,000*l*., to which 75 per cent. must be added owing to the great rise in prices since the beginning of the war. The cost of erection of stations at the exporting ports for disinfection of the Asiatic materials (of which, including Egyptian, about 80,000,000 lbs. are exported annually) will, therefore, probably approximate to 250,000*l*. at present prices which will, we think, operate for some years. Additional capital will be required for erection of further stations in this country and elsewhere. The estimated working cost of disinfection is approximately one penny to three-halfpence per pound of raw material disinfected at present prices. This estimate has been prepared on a very liberal basis, and it should be possible in practice to reduce the cost of disinfection below the figure given. We have considered carefully how it should be borne.

2. The benefit of the measures proposed, which aim at securing destruction of anthrax spores at the earliest stage possible and the prevention of the spread of infection, will not be confined to English traders but will be shared by every trading country in the world. Moreover, the ultimate aim should be to secure prevention of anthrax among the flocks, and the penalty of disinfection imposed on those materials from districts or countries where no precautions are taken may have the effect of hastening the adoption of agricultural precautions. We therefore recommend that :—

(5) The infected varieties of wool should themselves bear the cost of disinfection by means of a charge levied on the quantity disinfected.

In making this recommendation, however, we feel compelled to point out how vital it is to keep the cost within reasonable limits in order to prevent injury to the trade.

3. The capital cost of central disinfecting stations involves the provision of a considerable sum. Having regard to the objects in view, the fact that several stations will be needed at widely separated points, and to the existing world conditions we recommend that :—

(6) The capital cost of disinfection should be provided in the first instance by the British Government, but should be repaid by means of a sinking fund, provision for which should be made by a charge imposed on wool disinfected.

This is allowed for and included in the estimate of working costs prepared by the Sub-Committee.

CONTROL OF DISINFECTION BY DISINFECTION AUTHORITY.

1. If disinfection be established on the scale and in the form we recommend, it will have far-reaching effects and will necessitate a large organisation to carry it on. We have carefully considered what form this organisation should take. We have already shown that disinfection either by private enterprise in factories or by private enterprise in the producing countries is impracticable. Some of the difficulties would be avoided if disinfection were carried on by private enterprise in central disinfecting stations operating on a commission basis, but we think it undesirable to allow commission disinfecting factories to become established. There are also very strong reasons against allowing compulsory measures, the chief aim of which is the protection of the health of industrial workers, to become the subject of business enterprise, especially when, as in this case, it would be in the nature of a monopoly.

2. Anthrax resulting from the manipulation of animal fibres is no doubt partly a trade question, and disinfection on the scale we propose involves some amount of interference with trade, but it is also one concerning the health of a large section of the community and, in some respects, even of the whole community. It is, further, a question of the transport and admission into the country of materials which may convey and spread disease germs. No private person or body ought to deal with questions of public health, and none can deal with the admission into the country of any material. All dangerously infected material is imported, it passes through many hands in the course of trading, and the interests involved are not entirely British. Moreover, the enforcement of disinfection, especially if carried out at exporting ports, involves the exercise of powers which cannot possibly be placed in the hands

of private persons or bodies. The problem is, in fact, so vast, the interests involved so complex, the effects of a considered scheme so far-reaching, as to make it necessary, in our opinion, for the Government themselves to undertake the task of organising and placing disinfection of wool and hair on a proper basis. Accordingly, we recommend that:—

(7) An organisation, which we will designate "the Disinfection Authority," should be constituted by the Government and should be given the necessary powers and facilities for bringing into operation and enforcing disinfection of wool and hair.

DUTIES OF THE DISINFECTION AUTHORITY.

1. Direction of disinfection is naturally the primary purpose of the Disinfection Authority. We think, however, that ultimately much wider duties will be assumed. The desirability of international notification of all forms of anthrax was pointed out to us and the collection of information is clearly a necessary preliminary to the successful elimination of the disease, whether agricultural or industrial. In the course of our inquiry we have been much impressed by the wide extent of the incidence of anthrax; the absence of any but the vaguest knowledge of it in many parts of the world; the extraordinary value of the results of the very limited inquiries the Bradford Anthrax Investigation Board has been able to make; the fact that most efforts to prevent the disease deal with the effect, and ignore the cause, of infection; and by the want of co-ordination in dealing with the whole question.

2. In this country the Board of Agriculture, which deals with anthrax among animals, is of the opinion that a large proportion of the outbreaks in Great Britain are caused by imported infected materials; that in transport of wool, hair, hides, &c., animal food and other merchandise travelling with these materials become infected from them, and that outbreaks of anthrax among animals, and, in some cases, among human beings, are repeatedly caused as the result; that dust discharged by fans from factories using dangerous wool, effluents from wool washing and the treatment of hides, refuse derived from factories manufacturing dangerous materials and used as animal bedding and as manure, cause outbreaks among animals. The Factory Department also recognise the above facts, and further, that anthrax spores are not destroyed by manufacturing processes and must, therefore, be distributed in greater or less degree in waste, by-products, and manufactured goods.

3. The former department imposes regulations on farmers and others for prevention of anthrax among animals, the latter by means of several distinct codes imposes restrictions on employers and operatives for prevention of industrial anthrax. In both cases the effect of infection is dealt with and no attempt is made to prevent the cause, *i.e.*, the importation of infected material. In existing circumstances neither department can do otherwise but each is dealing with part of the same problem, both recognise that transport and import of infected material are the keys to the situation, and co-ordination of their efforts is certainly desirable. The possession of a method of disinfection of wool and hair permits of effective action against the cause of the evil, from these materials at least, and the beginning of an attempt to bring into harmony the efforts of different departments or authorities—a course which we think is essential. Accordingly we recommend that:—

(8) The duties of the Disinfection Authority should be the organisation of disinfection; the erection, management, and control of central disinfecting stations; the preparation, publication, and revision of lists of materials it is considered should be subject to the requirement of disinfection, and of materials not subject to restrictions; and the exercise of such powers as may be necessary for preventing the admission of dangerous materials into the country without disinfection.

4. To the extent indicated by this recommendation the functions of the proposed Disinfection Authority would be administrative, but we contemplate another phase of the work it should undertake. The collection of information will be necessary for the effective carrying out of its administrative duties, and we think advantage should be taken of this to establish means for co-ordination of efforts to prevent the disease. Ultimately, therefore, its duties should be expected to include (1) collection of information as to incidence of anthrax and the precautions taken for its prevention among animals and human beings in all countries, (2) the furtherance of efforts to prevent the disease by the supply of the collected information to all authorities concerned, (3) dealing generally with the question of anthrax in all its ramifications. These further duties can only be undertaken after disinfection has become established, but they will not be administrative. Nor will they interfere with the duties of other departments, though they may result in the supply of information or suggestions on which action can be taken by these or by organisations in the countries of origin of infected materials.

5. Anthrax is not caused among industrial workers by wool only, but also by hides, horsehair, bones, and other animal products. We include this branch of the question in clause 3 of the preceding paragraph. The method of disinfection devised for wool and hair is

not necessarily suitable for disinfection of other animal products, but one of the duties of the authority should be to consider what measures can be taken for prevention of anthrax in other industries.

6. We have made certain recommendations on page 33 as to the materials which require disinfection, and as to certain exemptions of high quality material which it is necessary to sort. This we have done, because we are anxious not to impose a hardship on a branch of the trade when it appears possible to us there may be no necessity for it, but the recommendation should not be taken as binding the proposed Disinfection Authority or hampering in advance its freedom of action or initiative.

INTERNATIONAL CO-OPERATION IN DISINFECTION.

1. Trading in, and manufacture of, animal products is international. Materials produced in the dangerous Asiatic area travel southwards to India and Persian Gulf ports, or westwards to Beyrout, Alexandretta, and Constantinople, or northwards through Russia. Most of it ultimately reaches London or Liverpool, but considerable quantities are retained in Russia, and portions go direct to France, the United States and other countries. Materials sold at the sales in London or Liverpool, or sent to the United States or France, may be re-exported, and may even again be sent back to the country from which they were re-exported.

2. Most civilised countries have adopted regulations aiming at the prevention of the disease in industry or agriculture, or both. Those in force in Australia have been described. They include stringent quarantine restrictions on all materials entering the country which are likely to convey infection, and the stringency and effective application of these measures is principally due to the fact that anthrax is recognised to be a standing menace to the principal Australian industry, *i.e.*, the production of wool. In France, Germany, Austria-Hungary, Italy and Belgium measures are enforced which are similar to but apparently less effective than those enforced in agriculture and industry in Great Britain.

3. Much attention has recently been given to the problem of prevention of anthrax in the United States where the incidence of the disease in agriculture, in industry, and in transport appears to be assuming serious dimensions. Most severe import restrictions, including disinfection in certain circumstances, were recently imposed on all wool and hair entering the country, but their enforcement has been postponed. This we understand is largely due to the fact that the attention of the United States Government has been drawn to our investigations as a Government Committee.

4. We have suggested that in this country co-ordination of efforts to prevent anthrax is desirable. The co-operation of all countries is still more desirable. Though import and transport of infected material are in many instances the chief causes of the constant renewal and perpetual nullification of efforts to prevent anthrax, Australia and New Zealand alone control them effectively. Both are producing and not consuming countries, and probably no single consuming country could hitherto have afforded to take steps in this direction. There is, however, evidence that many countries would be willing to co-operate if a reasonably satisfactory method could be found.

5. Disinfection affords the only means of coping effectively with the danger from wool and hair derived from certain regions, and apparently the only reason why it has not been adopted is that, except for *certain* kinds of horsehair, no efficient and satisfactory method has been available which does not damage material severely.

6. Anthrax, whether among human beings or among animals, is beyond doubt universal in its prevalence, and, therefore, its prevention is of importance to every country. In our opinion it should be so treated, and not, as hitherto, as if only the territory of the particular state or community were affected. If every country co-operated there should be comparatively little difficulty in securing the disinfection of wool and hair under the most satisfactory conditions at the earliest stage possible in the producing countries, since none would then have any interest in attempting to avoid it. Moreover, international agreement to require disinfection of wool before importation would remove apprehensions of diversion of trade and possibilities of interference with trade rivalries. A practicable process of disinfection of wool and hair lends itself admirably to a concerted scheme of action, undertaken by all countries, of which advantage should be taken. We, therefore, recommend that:—

(9) The British Government should establish the Disinfection Authority and should then take steps to obtain the co-operation of the Governments of all organised countries (1) in securing the disinfection of wool and hair and (2) in such other measures as the Disinfection Authority may advise for the general prevention of anthrax.

7. The co-operation of producing countries should also be secured. India could afford great assistance to the object in view by prohibiting the export of wool and hair before disinfection; South Africa could similarly help by enforcing agricultural precautions and the destruction or separation and separate packing of possibly infected material. The underlying

object in setting up the Disinfection Authority is the stamping out of the disease,—primarily, from our point of view, to prevent infection of wool, but generally wherever it may exist. And though disinfection is a weapon fashioned to deal with one part of the problem and is ready to hand, yet other methods should be used when found desirable. The aim should be to secure the general co-operation of all countries in whatever measures may be proposed. Having regard to the large quantity of infected material produced in the Native States of India and in Afghanistan and other Central Asian States their co-operation in attempts to eliminate anthrax should be encouraged to the utmost.

CONSTITUTION OF THE DISINFECTION AUTHORITY.

1. To the question of the constitution we ought to recommend for the Dininfection Authority we have given anxious thought. On the one hand Government departments, on the other many technical, trade and industrial interests will be affected. Wool is not a material which can survive inexpert treatment undamaged, and though no doubt the management of the disinfecting stations will be in the hands of experts yet much will depend on their superior direction. A much more important matter is, however, the cost of disinfection. The success of the scheme depends on this being kept within reasonable limits and the disinfection stations themselves must, therefore, be conducted as business undertakings.

2. While we recognise that Government control of disinfection is necessary, and that the real work of the Disinfection Authority will devolve on a few who should be able to devote their whole time to it, we think it essential that the Authority should consist of representatives of the Government, of business men thoroughly conversant with the trade in and manufacture of wool, and of the operatives, who should be jointly responsible for the management. This body would consider the problems which arise, deal with the general direction of the disinfecting stations, and decide on all other matters in connection with anthrax.

3. Though we feel compelled to outline what we have in mind as a result of careful consideration of the whole question, we recognise that we cannot make definite recommendations at the present moment as to the constitution of the Disinfection Authority. The question of international representation, if found to be desirable, is one for future consideration with which we are not in a position to deal.

MEASURES FOR ENFORCING DISINFECTION.

1. It remains to suggest measures by means of which effective disinfection of the materials named in the lists of dangerous varieties may be assured. It is essential, in our opinion, that the expert and managing staff of each disinfecting station wherever situated should be British (apart from arrangements which may ultimately be made as to international co-operation of consuming countries).

2. "*Disinfection*" should be defined as the treatment, for the purpose of destroying all anthrax spores, in a disinfecting station authorised by and under the control of the Disinfection Authority; "*Disinfecting Station*," as a station for the disinfection of wool and hair authorised by and under the control of the Disinfection Authority; and "*Disinfection Certificate*" as a certificate signed by an authorised officer of the Disinfection Authority, stating that the material named in the certificate has been disinfected in, packed in, and despatched from an authorised disinfecting station. The disinfecting station should necessarily undertake, under authority from the owners of the material, the disinfection, baling, marking, and despatching of all material in order to prevent the mixing or contact of disinfected with non-disinfected materials, which might occur if the former were returned to the owners after disinfection. The authorised officer should also issue with each lot of material disinfected a "disinfection certificate" containing a statement of the bale and packing marks, &c. This certificate would then accompany each lot of material, and would serve as the guarantee or authorisation under which it would be admitted to a consuming country or accepted for shipment from an export port.

3. Practically what is proposed is the enforcement at ports abroad, in some cases possibly on foreign territory, of precautions which would usually be expected to be put in force in home ports. The question resolves itself into two parts, of which the first relates to material exported from British territory, and the second to that from foreign ports. For the former the simplest way of ensuring the object aimed at would appear to be for the Government of the exporting country, *e.g.*, India or Egypt, acting on the advice of the Disinfection Authority, to prohibit the export of named materials except after disinfection in an authorised disinfecting station. In this way no infected material would leave the exporting country and all materials whether exported to Great Britain or to other countries would be treated alike. No material of the dangerous classes unaccompanied by a disinfection certificate or packed elsewhere than in an authorised disinfecting station should be permitted to be shipped from ports in British territory or to be landed in the countries co-operating in the scheme.

4. It may be possible to secure the adoption of similar measures at ports not on British territory. The task of securing effective disinfection would be rendered so much easier and the advantages of disinfection as soon as possible are so great that, where possible, this should be done. We therefore recommend that :—

> **(10) Arrangements should be made with the Governments of British territory abroad whereby the export of materials, decided by the Disinfection Authority to be dangerous, is prohibited except after disinfection in a disinfecting station under the control of the Disinfection Authority and unless accompanied by a disinfection certificate. And, further, that where possible, similar arrangements should be made with the Governments of such other countries as may appear desirable.**

5. Although by arrangements on the above lines we think a great step towards successful prevention of anthrax will have been taken, safeguards are called for in the case of materials from certain districts and countries of central Asia which may be transported by routes on which there is no disinfecting station and would thus escape disinfection. Disinfection in this country of certain other materials and of the skin and inferior qualities of exempted varieties may also be required. This will necessitate the establishment of a disinfecting station at a home port, but apart from this certain measures will require to be enforced in this and other consuming countries co-operating in the scheme in order to support the measures taken at the ports in the country of origin.

6. We have considered two courses in relation to Great Britain (1) prohibition of the use for manufacturing or other purposes of any materials included in the dangerous list or not included in the list of materials free from restrictions issued by the Disinfection Authority, (2) prohibition of the entry into the country except through a disinfecting station of any material included in the dangerous list or not included in the list of materials free from the requirement of disinfection, unless accompanied by a disinfection certificate issued by an authorised officer of the Disinfection Authority. It was thought perhaps possible to enforce the first proposal by means of the Factory Act in factories in the ordinary course of inspection by Inspectors of Factories. But it has insuperable objections. The inadequacy of inspection for such a purpose was clearly demonstrated in evidence. Factories would not be visited often enough ; few inspectors have sufficient knowledge of wool and hair to enable them to check the use of materials by personal examination, and for administrative purposes each occupier of a factory would have to keep a register of materials and disinfection certificates. Apart from this, too many loopholes for the escape of materials would be left, and the escape might only be indicated by an outbreak of anthrax. Transport and port warehouse workers would also receive very uncertain and doubtful protection.

7. We finally came to the conclusion that the control of all dangerous materials must be exercised at the ports.

We, therefore, recommend that—

> **(11) All materials included in the dangerous lists should be allowed to land only at fixed ports, unless accompanied by a certificate of disinfection; and the port or customs officers should be empowered either to refuse admission of any such material, or to permit it to be landed only if transferred direct from the ship to a disinfecting station.**

8. We are not in a position to say what, or if any, legislation will be necessary for bringing the full scheme of disinfection into operation, but it has been pointed out to us that under Section 42 of the Customs Laws Consolidation (39 & 40 Vict. c. 36), 1876, the Privy Council is empowered to prohibit by Order the import of any infected cattle, sheep or other animals and hides, skins, horns, hoofs, or any other parts of cattle or other animals, in order to prevent the dissemination of any contagious distemper. Possibly this may provide powers under which immediate action might be taken, but we feel this to be a subject for consideration by Government Departments with which we cannot deal in this report.

IMMEDIATE ACTION.

1. The increase of anthrax among woollen, felt and warehouse workers, and the steady growth of the number of cases even in the worsted industry, has impressed on us the necessity for immediate action. A considerable time will necessarily elapse before the full scheme of disinfection can be organised and brought into operation, especially in the present world conditions. It may be inadvisable, and indeed impossible, to proceed at once with all the measures we have outlined. **We are strongly of opinion, however, that disinfection itself should be brought into operation immediately, even though on a small scale, and that routine disinfection of East Indian goat hair, Persian wool, East Indian wool, and Egyptian wool, should be established as soon as possible.**

2. It would be inadvisable to commence immediately the building of large central stations at Karachi, Bombay, Basra, and Cairo. Enquiries and the necessary negotiations, however, should be set on foot with a view to their erection as soon as possible, but while this is being done we think it a matter of urgency that a small temporary station should be put

into operation in this country at the earliest possible moment. Although we are satisfied that the Sub-Committee's inquiries have been conducted with the greatest care and foresight the process has not yet been worked on a large continuous scale as it will have to be when applied in practice. Many practical problems will arise, *e.g.*, as to protection of workers in feeding the machines, preventing the escape of formaldehyde vapour, packing the material, cleansing the formaldehyde solution,* &c. The wool trade should also be given an opportunity to estimate the changes in established practice which the adoption of disinfection will bring about, and to make adjustments necessary. Such a course will probably save time and meanwhile allow other parts of the scheme to be developed. Accordingly we recommend that:—

> **(12) A small experimental disinfecting station should be established without delay to settle the type of station to be used and the arrangements necessary for bringing the whole scheme into complete operation.**

3. The objects we have in mind in making this recommendation are (1) to provide a necessary connecting link between the experimental work of the Sub-Committee and practical disinfection on a large scale, (2) to avoid expense and waste of time in overcoming those practical difficulties inseparable from the launching of a scheme, whether commercial or not, for exploiting a new process, (3) to provide training for the managing staff of a disinfecting station and experience in the application of disinfection, (4) to establish now the principle of disinfection, (5) to reduce as soon, and as much, as possible the risk from handling the most dangerous materials.

4. A further consideration we have in view is that in seeking the co-operation of other countries success is much more likely to be attained if disinfection has already been applied in this country. On these, as well as on purely humanitarian, grounds we urge the immediate establishment of the experimental station. Probably this step could be taken without waiting for legislation if that should be necessary for bringing the full scheme into operation. The goodwill of a large body of users is already assured, and if no other way be possible probably disinfection could be established for a short period as a voluntary measure. We have considered the desirability of making a recommendation as to the place at which the experimental station should be situated. We have finally decided, however, that this is a question which should properly be left to the Disinfection Authority who will be responsible for it.

DISINFECTION NOT NECESSARILY THE FINAL SOLUTION.

1. Repeatedly in the course of our inquiry we have been forced to the conclusion that, as we have already said, the problem of anthrax prevention is naturally an agricultural one which should be dealt with by means of precautions among the flocks, but that, except by means of disinfection, every attempt to deal with the evil after the infected materials have become articles of commerce is an attempt to deal with an effect and not with a cause.

2. Accordingly we made great efforts to forge an effective weapon by the use of which the danger could definitely be removed so far as wool is concerned, and we consider ourselves fortunate in being able to devise the method of disinfection for wool and hair—the branch of the question assigned to us. Nevertheless this is an unsatisfactory solution, although it is the best which can be adopted at the present time, and we regret that we should have had to consider, for example, the desirability of applying disinfection to the products of a country like South Africa, where the state of civilisation is such as to afford hopes that the disease among animals can be stamped out, and the mixing of infected with non-infected materials prevented.

3. Disinfection of wool and hair ought not to be regarded as permanently necessary. The true solution of the problem is the prevention of anthrax among animals, and the destruction of all parts of those (comparatively few) which may die from the disease even when the most careful precautions are taken. We are not in a position to make any definite recommendations as to measures for securing this, but the Disinfection Authority should by every means in its power encourage the adoption of precautions for preventing outbreaks of the disease among the flocks, not only in South Africa but also in Asiatic countries. They should be prepared to remove any material from the list of those requiring disinfection immediately the adoption of agricultural or other precautions makes such a course possible.

PRECAUTIONS IN FACTORIES.

1. We have carefully considered whether we should recommend a temporary code of regulations enforcing precautions in factories during the period before disinfection can become fully operative, but the objections to this course appear to us to be overwhelming. We are compelled to conclude, as we have already stated, that anything which can be accomplished by regulations can have but little further effect in checking anthrax among operatives. But a more weighty objection is that we fear if this course be adopted that diffusion and waste of energy will result, and that disinfection will thus be delayed. We think disinfection should

* *See also page 30.*

be pressed forward with the greatest energy possible, and probably it can more quickly and easily be brought into effective operation than a code of regulations. The only precaution likely to be of value in preventing anthrax is the sorting out of possibly infected materials (bloodstains, skin material, &c.). This is already carried out to some extent in most factories —in some, excellently, but not at all in a few. It is, however, inapplicable in connection with many materials, and, although we view with disapprobation the inaction where no steps are taken to remove bloodstains from such material as Persian wool, we are not prepared to recommend that it should be made compulsory as a temporary measure. Nevertheless, until disinfection becomes operative, we strongly urge all users of Persian wool and mohair, which are the most heavily bloodstained of all materials, to sort out bloodstains as a temporary, if only partial, measure of removing some of the danger. In taking this attitude we assume that disinfection will be brought into operation in accordance with our recommendations, even in the present difficult conditions, without any undue delay.

2. We are of the opinion that the precautions required by the existing regulations should be enforced till such time as disinfection can replace them, except that where Persian wool is sorted separate opening should no longer be required. We are convinced that this precaution is of no practical value and there appears to be no reason against opening and sorting this material in one operation.

It will probably be desirable to undertake the disinfection of one variety of material at a time, and it will certainly be desirable to ensure the disinfection of all the material of a particular variety once the routine disinfection of that variety is commenced.

DUST AND HYGIENE.

1. Many witnesses suggested that dusty conditions should be prevented apart from the question of anthrax. The results given in Appendix 1 show that certain processes of manufacture of wool, especially of certain varieties, are intensely dusty and much discomfort is thus caused among operatives though we could not obtain any definite statements as to direct injury to health.

2. The varieties of wool and hair which are generally dusty are those which are also generally liable to be infected and the process of disinfection is a cleansing process so that it is possible that when disinfection becomes operative dusty conditions will to a large extent disappear. It cannot yet be said, however, exactly what the conditions in the manufacture of disinfected wool will be. We cannot, therefore, take up any definite attitude at the present time. We are agreed that, apart altogether from the question of anthrax, dust should be eliminated in every process as far as possible. We accordingly recommend that:—

(13) The question of dust prevention should be allowed to stand over till disinfection becomes operative, and when the time arrives for the abrogation of the existing regulations, some inquiry as to the conditions in regard to dust should be made with a view to the adoption of such precautions as may then be found necessary.

3. By direct measures the prevention of dust in such processes as blending and carding is very difficult. The provision of steam sprays in blending bins in which men are required to work was very strongly criticised by all witnesses who had had personal experience of the work in bins where they are provided, and we think their use as a precaution against dust is undesirable. In processes like card roller grinding, dust should be prevented by the provision of exhaust arrangements in connection with the grinding machine, whether or not the wool manufactured is dusty, but generally speaking it appears to us to be economically unsound to attempt to prevent the production of dust, or to attempt its suppression in each process. Where possible the dust should be removed from the wool at the earliest stage possible, *i.e.*, before blending. The evidence as to the process of willowing, by means of which this can be achieved, was somewhat conflicting, but we saw it successfully in operation and many witnesses stated they considered it to be a necessary process if clean wool be desired, and if it be desired to keep the carding machinery in proper order.

4. The opening and sorting of alpaca is a dusty operation because of the shaking necessary, and in the sorting of mohair many small fine hairs are caused to enter the atmosphere. So long, therefore, as these materials are allowed exemption from disinfection, the precautions in regard to prevention of dust required by existing regulations should be enforced.

5. The standard of personal hygiene of Bradford wool workers was strongly and adversely criticised in evidence, but it is useless to speak of raising it until means for personal cleanliness are provided in all factories. The nature of the impurities in raw wool is such that in all processes careful welfare provision should be made for the operatives. This can be secured by a Welfare Order under the Police and Factories (Miscellaneous Provisions) Act of 1916, without necessity for resort to regulations. When disinfection is fully established and the existing regulations are no longer needed for prevention of anthrax the whole of the questions of dust and welfare in the wool trades should be surveyed in the light of the evidence placed before us.

BRADFORD ANTHRAX INVESTIGATION BOARD.

1. The Anthrax Investigation Board was formed in 1905 as a local body for the study of anthrax in Bradford and district, with a view to devising measures for the prevention of the disease among operatives and determining precisely the classes of wool and hair which may be expected to convey infection. It is thus a signal instance of the recognition by enlightened members of a great industry of the duty to combat in every way in their power the menace to life inherent in certain materials used. In the 12 years of its existence many thousands of samples of materials have been examined and the results of these and of the enquiries of the Board, published in annual reports, have been of the greatest value in enabling us to come to a decision as to the varieties of materials which should be classed as dangerous and in other matters.

2. Throughout our enquiry we have availed ourselves to the utmost not only of the information gathered but also of the services of the Board's bacteriologist (Dr. Eurich) and of their laboratory facilities. Many hundreds of samples of materials collected on our behalf have been examined for us and the Disinfection Sub-Committee was given facilities for the laboratory work necessary in connection with the disinfection experiments. We desire to express our great appreciation of the assistance afforded to us in our investigations both directly and also in the form of the accumulated experience of the Board. We freely acknowledge that our work and recommendations are built up from the solid basis provided by the data collected by the Board, lacking which our difficulties would have been enormously increased, and, we might still be groping in the dark or attempting to deal with the danger by half measures. Although bacteriological examination in cases of anthrax, and of materials used, will still be necessary in Bradford our findings constitute, we think, a fitting conclusion to some aspects of their work.

COST OF ENQUIRIES BY THE DISINFECTION AUTHORITY.

We have recommended that the cost of disinfection should be borne by the material disinfected. The cost of enquiries instituted by the Disinfection Authority and of the general work of co-ordination clearly cannot be so placed. These duties are mainly concerned with the general question of anthrax and are in the nature of a service to the whole community. Should the Authority undertake duties in connection with other materials, *e.g.*, the prevention of anthrax in the manipulation of hides, the cost would properly be borne by them but the cost of general duties cannot with propriety be charged to any particular materials. We think this work of enquiry and co-ordination will never be properly carried out unless undertaken by the State. Accordingly we recommend that:—

(14) The cost of all general duties of the Disinfection Authority should be provided for by the State out of State funds.

CONCLUSION.

1. We commenced our inquiry with an outlook limited to the worsted trade and with the sole intention, in accordance with our instructions, of amending the existing regulations in that branch of the trade. We have been driven by stages which followed in logical sequence to work out a process of disinfection of wool and hair (other than horse-hair) and to recommend the abandonment of the attempt to control anthrax by means of regulations as totally inadequate to cope with the danger. By further logical steps we arrived at the conclusion that the simplest and in the end the cheapest and most effective method of preventing anthrax in the various branches of the wool trade is by disinfection of wool and hair abroad, a course which possesses the further advantage of destroying anthrax spores at the earliest stage possible and thus prevents the spread of infection.

2. Compelled by the chain of reasoning which led up to this decision to survey the whole subject of anthrax, the conclusion was forced on us that the prevention of the disease must be treated as a world problem if any finality is to be reached in dealing with it. We recognised, as have other enquirers, that what is needed is combination of effort throughout the world to deal with the cause of infection instead of isolated attempts to deal with the effect. We have ended our inquiry, therefore, by recommending the constitution of a body the primary duty of which should be the organisation of disinfection of wool and hair as near as possible to the source of origin, but the ultimate and chief aim of which may well be the study of anthrax throughout the world.

3. The previous Home Office Departmental Committee on Anthrax of 1895 pointed out the great difficulties of a Departmental Committee in attempting to deal with one aspect of a subject presenting so many ramifications. They also apparently felt that anthrax is a problem of great importance which cannot usefully be considered from one point of view alone, and suggested on public grounds the investigation of the question by a Royal Commission or at

least by a Committee of various Government Departments. But we think such a temporary body would become involved in the same difficulties as a Departmental Committee. We have come to the conclusion that the suppression of anthrax can only be attained by sustained inquiry and effort by a permanent body such as the Disinfection Authority we propose. We feel that the results obtained by the Bradford Anthrax Investigation Board—a body of extremely limited opportunities—point to the way by which alone a solution of the problem may be arrived at, and afford a hope that work undertaken on similar lines by a Government organisation armed with powers and facilities for world-wide inquiry and action will enable a real advance to be made. The one thing hitherto lacking has been a basis on which such work could be commenced. This, we trust, has been found in the disinfection of wool and hair.

4. The Committee desires to record its appreciation of the valuable services rendered by the Secretary, Mr. G. Elmhirst Duckering. His thorough knowledge of factory organisation in the North of England, his careful preparation of the evidence to be placed before the Committee, and the ability displayed in organising the experiments in the investigation, together with his invariable readiness to render assistance in every way possible, have largely contributed to the success of the work, and the Committee cannot speak in too high terms of appreciation of his services during the five years in which they have been examining the subject. No greater compliment can be paid to him than to say the Committee owes to him the process of disinfection recommended in their report.

WM. MIDDLEBROOK (Chairman).
T. M. LEGGE.
GEO. H. FEATHER.
SAMUEL WALKER.
EDWARD H. FOSTER.
HERBERT MORAN.
W. M. JACKSON.
WM. MACKINDER.
WALTER BARBER.
F. W. EURICH.
T. GRUNDY.

G. ELMHIRST DUCKERING,
Secretary.
22nd August 1918.

Woolcombers, Limited, Bradford,
14th June 1918.

Dear Sir William,

You will remember that some time ago I asked to be allowed to resign my membership of the Departmental Committee on Anthrax for the reason that I could not afford the time necessary for the study of the subject. Out of deference to your wishes I withdrew that request, but the reasons which then actuated me have increased in force, and I feel compelled to press you now to accept my resignation. In resigning at so late a stage in the labours of the Committee I recognise that I am placing you in a position of some difficulty, and, therefore, I think it necessary to state at some length the considerations which influence me.

My work in the business with which I am connected has greatly increased in extent and complexity in the four and a half years since the Committee was appointed, but in addition, on account of circumstances arising out of this most deplorable war, I have been compelled to undertake a large number of abnormal duties outside of, but arising out of my business, mostly in connection with Government administration, which would have been unnecessary in normal times. In consequence the strain has become unendurable, and I must be relieved of some of it. You will, I am sure, agree that I must give first consideration to the business interests for which I am responsible.

The Committee was appointed for the purpose of revising the regulations now applied under the Factory Act in wool-combing and other processes. I attended numerous meetings at which evidence was heard and the effects discussed and weighed. The result was to force on us the conclusion that regulations had reached the limit of their usefulness, and that but little reduction in the incidence of anthrax could be expected from the enforcement of such additional regulations as we could recommend.

In order to investigate the possibility of disinfection we appointed a Sub-Committee which, judging from the reports of tests carried out, have apparently successfully devised a method of disinfection of wool. Their investigations included experiments in which the process was applied on a practical scale, and it appears to be practicable for use commercially. We have unanimously adopted their report and have formulated certain general principles and recommendations based on it. These (*e.g.*, the recommendations that attempts to prevent anthrax by means of additional regulations applied in factories should be abandoned; that disinfection cannot be carried out in, and should not be permitted in factories devoted to the manufacture of wool; that disinfection should be carried out only in central disinfection stations, controlled by the Government, situated at ports in the countries of origin of wool) are the logical outcome of the investigations and their results. With them I am in entire agreement. Their effect is to make no longer necessary the study of anthrax in direct relation to manufacturing processes, which was essential for preparation of regulations applying to those processes.

Nevertheless, in order to elaborate details of the Committee's proposals, careful study, requiring much time and thought, is needed of other factors with which I have only limited acquaintance. The constitution of the body to whom the control and management of disinfection is to be entrusted, the means for enforcing disinfection, international co-operation in disinfection, supplementary action for preventing anthrax in the countries of origin of wool are among the questions to which I refer. They are of considerable complexity, they must be considered and dealt with, and they demand careful thought. I feel I ought not to take part in the deliberations of the Committee or sign the report unless I have studied these factors and the new situation created with the care they deserve and which the alterations suggested in the draft report at the last meeting show to be necessary. For this I am entirely unable to afford the requisite time.

I wish to state in the clearest possible terms that in no point am I in disagreement with the Committee. On the contrary, the course it is proposed to recommend has, in its broad principles, my complete approval and appears to me to be the only one likely to result in the elimination of anthrax. The details can, however, only be elaborated by those who can give the time necessary for their close consideration. This I cannot do, and, therefore, I think I should make way for someone who can give more efficient service to the Committee. I am taking this course with great reluctance but equally in the interests of the work of the Committee, the trade and of myself I feel it to be the only proper one to take.

In conclusion I wish to thank you for the courtesy which you have extended to me at all times.

Yours faithfully,
(Signed) Ernest W. Marsh.

Sir William Middlebrook, M.P.,
Chairman of the Departmental Committee on Anthrax.

Printed under the authority of His Majesty's Stationery Office
By Eyre and Spottiswoode, Ltd., East Harding Street, E.C.4,
Printers to the King's most Excellent Majesty.

DEPARTMENTAL COMMITTEE ON ANTHRAX.

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO

PRECAUTIONS FOR PREVENTING DANGER OF INFECTION FROM ANTHRAX IN THE MANIPULATION OF WOOL, GOAT HAIR, AND CAMEL HAIR.

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DEPARTMENTAL COMMITTEE ON ANTHRAX.

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO

PRECAUTIONS FOR PREVENTING DANGER OF INFECTION FROM ANTHRAX IN THE MANIPULATION OF WOOL, GOAT HAIR, AND CAMEL HAIR.

VOL. III.—SUMMARY OF EVIDENCE AND APPENDICES.

Presented to Parliament by Command of His Majesty.

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SUMMARY OF EVIDENCE.

CONTENTS.

SUMMARY OF EVIDENCE.

In the following summary of evidence an endeavour has been made to bring together under appropriate heads the statements of fact, views, opinions, and suggestions of each witness. Its original purpose was to enable the Committee to formulate regulations based on a full comprehension of the general body of evidence. Though the work of the Disinfection Sub-Committee has profoundly altered the situation, the summary is still valuable in enabling a grasp to be obtained of the fundamental facts and difficulties of the wool trade. The figures in brackets in the body of and at the end of each summary refer to the questions in the verbatim transcript of evidence. The letters in brackets after the name of each witness have the following meanings :—

O = Official witness. E = Employer.
P = Professional witness. M = Manager or the equivalent.
W = Operative employed in the wool trade.

G. ELMHIRST DUCKERING,
Secretary of the Committee.

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(1) Address, Absence, Illness of Operatives—Notification of and enquiry as to. (2) Medical examination. *See* **Registers.**

T. M. Legge (O) : Periodical medical examination of persons employed is required in several industries by codes of Home Office regulations. Anthrax is, however, so sudden in its onset and so difficult to recognise in its early stages that it is doubtful if even daily medical examination would result in detection of all cases. (384–5.)

Medical practitioners attending any person suffering from anthrax contracted in a factory must report the case to the Chief Inspector of Factories, who notifies the district inspector. The latter then requires the certifying surgeon to make a report to him. The occupier usually first hears of the case when the certifying surgeon goes to the factory for the purposes of his report. Witness is strongly in favour of the practice adopted in one Bradford factory, where an appointed doctor is informed by the occupier whenever any person is absent from work and required to see the absent person and report whether or not he or she is suffering from anthrax. (188–93.)

G. A. Taylor (O) : Witness points out that most medical men have very little experience of anthrax, and that many cases have proved fatal because a proper diagnosis was not made till the disease had progressed too far for treatment. In order to avoid this he suggests that a medical officer should be appointed by, and be under the control of, the Home Office for the purpose of examining any person manipulating dangerous material who is ill, whatever the cause of illness, and whatever medical attendance there may be. The medical officer should have received training in and be an expert in diagnosis of anthrax before his appointment. His name and address should be posted in the works, and every person should be required to notify (1) the appointed medical officer and the employer at once if he developes illness after leaving work, and (2) the occupier if he becomes ill or developes pustules when at work.

The occupier should also be required (1) to make enquiry within 24 hours should any person absent himself (or herself) without known cause; (2) to refer every case of illness to the appointed medical officer; (3) to keep a health register. (*See* Registers.)

Each employed person should also be required to notify his or her address and every change of address to the employer. Witness knows of no other occupation under the control of the Factory Department in which there may suddenly arise an acute danger to life as in the case of anthrax. There may be occasions, *e.g.*, when a man stays away to attend a football match, where enquiries will be futile, but from his own experience as a factory manager he sees no great difficulty in carrying out these suggestions. The various managers and foremen can report when any person is absent.

He was not in favour of a suggestion that a certificate from a medical practitioner or panel doctor as to the nature of illness could be accepted as a sufficient explanation of the absence of an operative. His reason was the inexperience of most doctors as to

G. A. Taylor (O)—*continued.*

anthrax, and the danger of delay. The appointed doctor ought to see every person who is absent through illness, even when it is due to physical injury. (1541–55, 1655–61, 1712–3, 1886–901, 1968–70, 2064–7.)

F. W. Eurich (P) : Witness analyses details of 20 fatal cases of internal anthrax and shows that the correct diagnosis at a reasonably early stage of the disease was made in one case only. In 4 cases no medical advice was sought, in 8 the patients were dying when medical aid was sought, in 3 suspicion was aroused by sudden and unexpected deaths of the patients, and in 4 suspicion was not aroused till collapse occurred. The inferences drawn are (1) that, apart from difficulty of diagnosis, the disease in its early stages is regarded by patients as not being serious; and (2) that medical men are apt to misinterpret the symptoms. Similar conclusions are drawn from an analysis of 13 cases of fatal external anthrax.

Witness analyses all non-fatal cases treated in one institution and separates them into two classes, in one of which he places all cases seen by Dr. Mitchell (who is appointed to examine, with a view to early diagnosis of anthrax, persons employed in certain works who may be ill), and in the other he places all cases not seen by Dr. Mitchell. He shows by figures and two charts that Dr. Mitchell's cases are diagnosed on the average 24 hours earlier than cases seen by other doctors and are correspondingly less severe. The mortality among Dr. Mitchell's cases is 7·4 per cent. and the mild cases 74 per cent., while of the others 15 per cent. were fatal and only 50 per cent. were mild cases. The reason for earlier diagnosis by Dr. Mitchell is that he sees many more cases and is, therefore, more experienced than other doctors, and also that he examines workers specially to see if they are suffering from anthrax. The conclusion drawn is that early diagnosis is desirable for successful treatment, and that this can only be obtained if the cases are seen by a doctor specially skilled in diagnosis of anthrax.

The reasons for the failure to secure early diagnosis by the present system are that (1) most medical practitioners rarely see a case of anthrax, and, therefore, are inexperienced in the symptoms of the disease; (2) that the symptoms are so mild in the early stages or so nearly resemble those of other common non-fatal illnesses—influenza, &c.—as to cause the patients to disregard the disease; and (3) that pustules are frequently covered with plasters which prevent the discharges being washed away, act as poultices, and so foment the disease. Witness suggests that a medical attendant should be appointed whose duty would be to see, with a view to detection of anthrax, every person absent from work among dangerous materials without known cause; and to see in consultation with medical practitioners every person absent on account of illness which might possibly be anthrax. The medical attendant should be appointed by firms who use such material, but he should not be a public official. (518–21, 525–38, 830–42, 917, 1060–3.)

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W. Mitchell (P): Witness has had special experience of anthrax in Bradford, and is of opinion that its successful treatment is dependant on early diagnosis of the disease. The external variety is usually curable if treated in its early stages. In 1905 he was appointed by the Commercial Union Assurance Company, who were carrying the risks for Woolcombers, Ltd., to examine as soon as possible all workers employed by this firm who were absent from work, to ascertain if they were suffering from anthrax, and to take any necessary steps to ensure their recovery. The cases of absence were reported from the two factories concerned by telephone and the fee paid was 5*s.* per visit. The total cost was about 140*l.* per year and an average of 10 cases a week were enquired into. The area covered was the whole of Bradford, Shipley, and Baildon, and the cases of absence occurred principally after holidays and week ends. The wide area then caused difficulties, but the use of a motor car would now obviate these.

In July 1906 Messrs. Woolcombers, Ltd., undertook their own risks, and from that date to April 1914 witness made 340 examinations, 35 of the cases proved to be anthrax, and 5 (roughly 14 per cent.) terminated fatally. There was also one case which proved to be anthrax (fatal) which occurred during a holiday and was not referred to witness. The firm, however, did not report all cases of absence, but first made their own enquiries and reported only those which were due to suspicious causes, and the fee was, therefore, raised to 10*s.* 6*d.* per visit. The effect of the change was that the work was easier, but a much more careful examination and diagnosis was necessary in each case in order to eliminate the possibility of anthrax. A report is made to the company on a printed form, a copy of which was put in (Appendix 11). In opinion of witness it is safe to leave the preliminary enquiry as to cause of absence to representatives of the firm if intelligently carried out. The cost of the examination was about 180*l.*, spread over eight years, and the work was practically confined to operatives from three factories. Another firm similarly employed witness at a fixed fee of 10*l.* 10*s.* per year, and witness thinks this is a fair indication of the average yearly cost per factory. The object of the examination is to secure early diagnosis, and it should be enforced in every factory where there is risk of infection from anthrax. It is desirable that the examination should be in the hands of one, or at most two, medical men in any particular district, because of the experience required.

In Bradford an average of 0·04 case per medical man per year occurs, so that most doctors never see a case. The number of medical men to be appointed would depend on the number of cases to be referred. Private employment of a medical man by firms is not desirable on account of the possibility of appointment of inexperienced doctors, and of want of independence of the appointed doctor. There is also the difficulty of professional etiquette. These difficulties would be avoided if the appointment were made by the Factory Department. Witness thinks the cost should be borne by the employer, and sees no other practicable method of remuneration.

The appointed medical man should not treat the cases. This can only be done efficiently in an institution. All persons should be required to report illness or development of pimples to their employer or to the appointed medical man or to both. They should certainly be able to report to the medical man on account of the danger of anthrax developing during holidays or when the mill is closed. All cases of development of pimples not causing absence, and of absence due to illness or to pimples, should be reported by the employer to the appointed medical officer, even when the person ill has been removed to an infirmary or the illness has been diagnosed as anthrax. There is often want of experience among young institution doctors. Witness defines an expert in diagnosis of anthrax as a medical man who has had experience of sufficient cases of external anthrax to recognise the pustule, can use a microscope, recognise the bacilli, and is alive to the possibility of anthrax. There is no such thing as an expert in internal anthrax, because no means of diagnosing this form of the

W. MITCHELL (P)—*continued.*

disease in its early stages is yet known. He sees most cases referred at his surgery, but has had very little trouble in finding persons whose addresses have been given to him by the employers. Presumably the latter have a register of addresses. (7166–81, 7177–222, 7262–5, 7295–8, 7313–4, 7329, 7342–62, 7382–7, 7390–404.)

G. H. Feather (E): Witness is decidedly of opinion that early diagnosis of anthrax is essential for successful treatment. In his experience, many doctors are not able to diagnose anthrax in its early stages, and he gave illustrations. He suggests, therefore, that in every district a doctor having experience of anthrax should be appointed to whom cases of illness among persons working among dangerous materials should be referred. He should not, however, be notified when any person is absent from work without known cause. The occupier should be required to make enquiries as to the cause of absence from work of any of them, and to call in the appointed doctor in any case of suspicious illness. (*See* Register.) The operatives should also be required to report to the employer the cause of absence from work and to the appointed doctor and the employer when suffering from any illness. There should also be an authority who should be called in to verify bacteriologically every case of suspected anthrax, but witness agrees that the difficulty of this is great in districts where there are few factories using dangerous materials and in country districts. He, however, strongly emphasised the necessity for early diagnosis and for bacteriological confirmation of cases. (4433–46, 4523–4, 4529–30, 4614–5, 4650–61.)

G. Ackroyd (E): Early diagnosis of anthrax is essential for successful treatment. For this reason and to ensure more reliable information a medical officer should be appointed by the Home Office for every district liable to outbreaks of anthrax. Every employer of a person ill, the patient, and the medical practitioner attending him, should be required to report the illness to the appointed medical officer. In some cases the employer should keep a register of names and addresses of his workpeople and should ascertain the cause of their absence from work, while in some cases the workers should notify the employers of their addresses and the development of pimples or illness. These requirements should, however, be conditions of the grant of a license allowing the dangerous materials to be treated. (6881–90, 6983–8.)

J. H. Halliday (M): Early diagnosis is essential for successful treatment of anthrax. In his own factory witness required each foreman to report daily the absence of, illness of, or development of suspicious pimples by any worker, and enquiries (at his home, when necessary) were then made as to the cause. This action was taken on account of the danger of anthrax. When the cause was found to be suspicious illness, *e.g.*, influenza or pustules, medical attention was obtained.

Each employer should be required to keep a register of the names and addresses of all his workers, and the latter should be required to notify him of their addresses and of any change of address. Each worker should be required to report to the employer the reason for absence from work, and any illness, pimple, or affection, whether or not it caused absence. An instance was given of a pimple developing on a worker continuing to work, which he did not report, but which was seen by and reported by a foreman and proved to be anthrax. Employers should not be required to ascertain by enquiry the cause of absence because, in many cases, it would cause unnecessary trouble.

A medical officer with experience of anthrax should be appointed for each district, to whom any case of illness could be referred, either by employer, patient, or operative. He should not have power to examine any person in a factory, but his powers should be limited to giving an opinion on application.

In witness's factory every case of illness came before him, and he exercised some discretion in sending the affected person to the doctor. If the

J. H. HALLIDAY (M)—*continued.*

affection were a sore or anything likely to be anthrax, the operative was sent to the panel doctor with instructions to get a report as to whether it was or was not anthrax. In cases of suspicious illness the manager ought not to be allowed to exercise any discretion.

Witness has known cases of wrong diagnosis, and agrees that there should be appointed by the Home Office a specially qualified man to whom suspicious cases could be referred without delay for an opinion as to the nature of the illness or affection. (5906–31, 6006–12, 6129–35.)

"B. A." (W): Witness always sends to the home of any person in his charge, who is absent, to ascertain the cause of absence unless he has been informed. If there be anything suspicious the doctor is then sent. If a workman notices a pimple developing he reports the fact to his foreman and he is sent to the doctor. Witness developed a boil on his neck of which he did not like the appearance. He reported to the manager and was sent to the doctor. It proved to be anthrax. The foreman does not assume any responsibility for saying an affection is or is not anthrax. (2702–3, 2315–22, 2785–9.)

T. Larkin (W): Witness developed a pimple on the forehead, but thought it was a heatspot. He did not report to the foreman till he began to feel unwell two days later. The foreman told him he did not think it was anthrax, but to go to the doctor appointed to examine such cases next day if he felt no better. He went to the doctor next day and the pimple proved to be an anthrax pustule. There were notices posted in the works directing operatives to report at once if pimples develop and to go to the appointed doctor. Witness, however, was inexperienced and trusted the foreman, who was also inexperienced, and this explains the delay. (2950–67, 3068, 3096–101, 3117–23, 3217–28.)

"S. J." (W): Witness developed a white blister on his temple on Sunday and reported to the manager next day in accordance with the works' regulations, though he did not think it was anthrax. Later in the day he was sent to the appointed doctor who said it was anthrax, and sent him to the infirmary. Witness has not known any case where a workman reporting a pimple has not been sent to the doctor. (3853–66, 4168–78.)

"F. J." (W): There is no objection, in the opinion of witness, to requiring every person employed amongst dangerous materials to notify his or her address, every change of address and the reason for absence from work to the employer. Nor to making it compulsory for every person who is ill to be examined by a doctor experienced in anthrax so long as the operative does not have to bear the cost. That is already done in some combing works. (*See* Register.) (4909–14.)

"C. W." (W): There is no objection whatever to requiring the workers to notify the employer of their addresses (*see* Register), any change of address, and the reason for absence from work; nor in giving power to a doctor to examine any person suffering from illness which may be anthrax. (5198–203.)

"G. J." (W): Witness developed a pimple and reported to the manager, who sent him to the appointed doctor, but it was not anthrax, though he was stopped working, and the examination was repeated by the doctor. If any person in the works has a pimple he reports to the foreman, and it is examined by the manager before he is sent to the doctor, which only occurs if the manager thinks the pimple dangerous. (5472–80, 5536–42, 5545–51.)

Action in Country of Origin.

T. M. Legge (O): A circular drawing attention to the unsatisfactory condition of Persian wool was prepared in 1903 by the Chambers of Commerce of Bradford, Halifax, Keighley, and Kidderminster. In 1905 copies of lectures on anthrax and the circular of 1903 were sent through the Foreign Office to Consular Officers, in many parts of the world where

T. M. LEGGE (O)—*continued.*

anthrax occurs, who were asked to furnish information as to incidence of anthrax in their districts. In 1909 and 1910 similar action was again taken through the Foreign Office and the Secretaries of State for the Colonies and India after consultation with the Anthrax Investigation Board as to the information desired. The information received was, however, of small value. The first circular was followed by improvement which only continued for a short time, and no permanent good effect resulted. The impression gained from the Consular reports was that it is impossible to get action taken by Governments like that of Persia. (39–40, 59–66, 224.)

No effective steps have been taken to prevent packing of fallen fleeces with sound wool in the countries of origin, though this would greatly reduce the danger of anthrax. Australia and New Zealand introduced measures to prevent importation of infected material, and the latter country appointed inspectors in India to enforce precautions as to bone meal exported to New Zealand, which is known to have caused anthrax. If a deputation from the Committee, backed by the Foreign Office, were sent out to the countries of origin something might be effected in this direction. Communications are useless; personal authority is needed. It would be within the competence of the Committee to recommend that there should be supervision at places like Karachi and Bagdad with a view to preventing the packing of fallen fleeces with sound wool. This would probably be effective and is almost the most important work the Committee could do. (219–25, 486–93.)

The information as to the collection and packing of wool in India and other countries, obtained from Consular reports and elsewhere, is very vague and contradictory. (79, 142, 194–6, 228–38.)

G. A. Taylor (O): Nothing is known as to how and why locks and peices are packed inside fleeces of sound wool. It is very necessary that the Committee should go to the countries of origin to obtain information as to methods of collection and packing and to take steps to prevent packing of infected with sound material. If this practice could be stopped anthrax among workers in this country would be prevented, even if the infected materials were still imported, because then there would be certainty as to what material is dangerous and what is free from danger. The material packed inside fleeces and bales is frequently of origin foreign to that of the fleeces. No effective steps can be taken till reliable information is secured and this can only be obtained in the country of origin. (1570–4, 1808–13, 1940–44.)

W. P. Norris (O): It is possible to control the importation of infected material but only by adopting the American system of quarantine, by which control is extended to ports of foreign countries. It is necessary, however, that the control should be exercised by officers responsible to the importing country only. New Zealand took this course for enforcing observance of conditions under which bones (which were known to have caused anthrax) were allowed to be exported from India to New Zealand. This proved successful, as no case of anthrax has occurred since the officer was appointed. The only safe precautions which can be taken are (1) total exclusion, or (2) admission under quarantine, subject to supervision in the country of origin by some competent person accredited by the importing country. The supervision must be exercised in the wool-growing districts, and wool admitted only from those districts indicated by the accredited representative whose decision would be based on the conditions as to disease among animals in any district. Supervision or regulations at the port of shipment in the exporting country or in the importing country is "locking the door after the horse has got out." The packing of the wool should also be supervised, and questionable lots rejected. Information obtained on the spot as to occurrence and distribution of communicable disease is also essential. Investigations should be made as to the possibility of introducing measures on these lines, which have been found necessary (unless there is total exclusion)

W. P. Norris (O)—*continued*.

by experience of quarantine organisation in Australia. An attempt should be made to deal with the cause and not, as at present, with the effect of the presence of infected material in wool. (8498–521, 8575, 8581–5.)

Sir S. Stockman (O): There are, at present, no restrictions on the importation of infected material into this country. Restrictions would be excellent if they cause no serious disturbance of trade or injury to material, but not otherwise. Wool-importing countries are civilised, but countries supplying dangerous wool are frequently uncivilised or only partly civilised. There would, therefore, be great difficulty in taking measures in the country of origin for preventing infection of material. Supervision by a British representative would probably be ineffective. In countries where large outbreaks of anthrax occur regularly, the conditions of soil and climate are favourable to the existence of anthrax spores. In these countries preventive inoculation of the flocks is the only measure likely to prevent infection of material. Apart from this, treatment of material (disinfection) at the port of entry into this country is the best safeguard if a suitable method can be found. To be effective in preventing anthrax among animals in this country, however, it would have to be done abroad because transference of infection to animal food occurs in transit. (9978–85, 10,135–9, 10,276–82.)

In England cases of anthrax among animals would probably not be reduced by any further measures which could be taken. Inspection of a whole countryside is very difficult. It is an excellent thing to publish notices and to bring literature before owners of animals. The mortality among human beings might be reduced by this means, but not the incidence of anthrax. (10,233–46.)

F. W. Eurich (P): Very little is known of the collection of and methods of dealing with wool in the country of origin. It is highly desirable to obtain information with a view to making recommendations for action through our Government. There is a Factory Act in India which applies to the adapting of any article for transport or sale. Locks and pieces (which have been removed from skins) are packed inside good fleeces in the country of origin, *e.g.*, in Persia; infected wool is washed with sound wool, *e.g.*, in India; and skin wools are removed from pelts by a wet process, *e.g.*, in Turkey. It is impossible in this country to remove infected material from locks, wool washed in the country of origin, or skin wools, as bloodstains are destroyed and anthrax spores distributed. Proper steps to prevent infection from such materials can only be taken in the exporting country. If bloodstained wool could be excluded in the country of origin from all contact and packing with sound wool, very little would be heard of anthrax from wool in this country. Investigations as to possibility of action for the purpose of attaining this should be made on the spot. It is not possible to instruct consuls or others as to what is required. Investigations should be made by persons conversant with the whole question. (697–718, 730, 743–6, 811–29, 871–2, 986.)

Importation of skin wool should be prevented, or it should be packed separately in the country of origin. It might be possible to disinfect skin wool in the country of origin, but there are difficulties, and skilled supervision would be necessary. (8747–60, 8765.)

G. H. Feather (E). The only possible way of ensuring that wool is obtained free from foreign locks, &c., is by action in the country where the wool is grown. Any action decided on should be jointly undertaken by Great Britain, France, Germany and America, who are the principal buyers of Persian wool. Action by this country alone might divert the supply of wool to other countries. Some of the locks are stated to be imported into Persia for the purpose of being packed inside fleeces. There might be difficulty in getting Eastern countries to stop false packing, but if concerted action were taken by

G. H. Feather (E)—*continued*.

importing countries with prohibition as an alternative the growers would probably prevent it. (4355–73, 4467–9, 4541–52, 4572–3, 4616–21, 4637–8, 4704–7.)

In 1905 the buyers of Persian wool issued a circular letter to wool-brokers dealing with the false packing of locks in fleece wool, a practice which became very noticeable about that date. The brokers forwarded the letter to Persia and it had a good effect, which, however, was only temporary. In January 1911 it was found that of the infected samples found in one lot of material, 90 per cent. originated from locks and the Anthrax Investigation Board issued circulars to the trade giving all the facts. These were sent to Persia, and in certain marks of wool improvement followed. In others, however, the practice of false packing still continues. An association consisting of French, German and English buyers agreed not to purchase lots of wool containing false packed locks, a list of which is posted in the saleroom. This, however, failed in its object, because German and French buyers, particularly the latter, continued to buy these lots. It is, therefore, necessary that any action taken should be taken by the Governments concerned, with power to enforce it. (4304–22, 4447–57, 4616–21, 4692–701.)

G. Ackroyd (E): Manipulation of washed materials like East Indian wool or skin wool can only be made safe by action taken in the country of origin, the best course being to prevent anthrax among the flocks. Acting on representations from England, packers of alpaca in Peru are taking measure to prevent packing of infected material (bloodstains) in sound material. It is too early to say whether these are effective. The Committee should go to the country of origin, take steps to ascertain what action can be taken there, especially in regard to preventive measures among the flocks, and bring the question home to the woolgrowers. It is desirable to secure co-operation of other countries using wool, in whatever action is taken. If bloodstains were kept and packed separately from sound material, danger of anthrax would almost be removed, because contamination could not take place, and the bloodstained materials could then be disinfected. Any action taken would have no effect unless pressure was brought to bear.

It is necessary to bear in mind that pressure to prevent packing of bloodstained with sound material in the country of origin might cause attempts to be made to wash bloodstained material. In that case the danger would be greater than it is now. The material would be of greater value if free from danger. China camel hair is given as an instance of material so treated in the country of origin as to be free from danger. The method of treatment is not known, but is apparently quite different from that used in India. (6561–5, 6745–8, 6880, 6891–6, 6960–75, 6991–3, 7041–3, 7103–4, 8145, 8151, 8156–7.)

There will always be danger of anthrax in every process of manipulation of Turkey mohair till some alteration is made in the country of origin. Before making regulations requiring the disinfection of certain materials information ought to be obtained as to why they are so strongly infected. (8220, 8234.)

J. H. Halliday (M): False packing of locks inside fleeces of Persian wool has greatly increased since 1905. If this practice could be prevented there would practically be freedom from anthrax so far as this material is concerned. Protective regulations must be maintained in this country till wool is sent free from anthrax infected material. Efforts to ensure the latter have been made by means of communications to persons in the trade in Persia and elsewhere, but with slight success. A better result might be obtained by sending practical men out to the packing centres.

China camel hair is given as an instance of material properly packed and made free from danger in the country of origin. The same result might follow if some authority exercised supervision in the Persian packing centres. East Indian wool is washed in India, the infection thus distributed and indications of it hidden. The only possible way of preventing anthrax from this material is by action in the country

J. H. HALLIDAY (M)—*continued.*
of origin. The marks on bales sold in England indicate the packing centres. Any stringent regulations in this country for the purpose of controlling false packing might divert the trade to other countries. It is, therefore, necessary to secure co-operation of other wool-consuming countries. (5807–20, 5849–54, 5947–51, 5993–8, 6066–9, 6079–89, 6137–41.)

A. Drake (M): It is to the advantage of the purchaser to prevent mixing of fleece and skin Turkey mohair (apart from anthrax), and it would be prevented if buyers agreed not to accept any material with skin hair in it. This has been attempted several times, but has failed. In times of competition some buyers break the agreement and say they will take the skin hair out themselves.

No effort is made to prevent anthrax among animals in Asia Minor. The Turkish Government did introduce inoculation of buffaloes for preventing some disease, but it was not anthrax. The bulk of the Turkey mohair passes through English hands in Constantinople, and some of it is classed there. It is quite easy to pick the skin hair out, and, in fact, this is frequently done when the material is being classed. Most of the material, however, comes to Bradford unclassed and, therefore, with skin material in it. Some firms buy skin material and mix it in with fleece mohair.

Regulations in this country requiring the removal of skin from fleece mohair before manufacture would help buyers to get mohair free from skin material, but the only effective way of ensuring separate packing in the country of origin is to refuse to purchase the mixed materials. Bradford buyers examine the material before purchase in order to judge the amount of skin hair it contains. They are at fault, since were there no market in Bradford for the mixed materials they would not be sent here mixed. It is doubtful if pressure on the Turkish Government would be followed by improvement in packing of mohair. (9478–86, 9511–32, 9536–72.)

W. H. Midgley (M): Some firms in Constantinople remove skin material from fleece mohair, but great quantities come to Bradford mixed. The only course which can then be taken to prevent danger is to sort it out. This can be done, but the prevention in the country of origin of the practice of packing skin material with sound material, or the refusal of buyers to purchase parcels of hair found on examination (which is always made before purchase) to contain skin material, would be much more effective courses. Witness's firm adopts the latter course, and if this were generally adopted methods of packing would be quickly altered. In inspecting a parcel it is, however, impossible to detect small pieces of skin material which are packed in the bumps. Dealers in the country of origin have many methods. Some take every care to keep skin material out, others do not. Packing of skin material with sound material is not necessarily fraudulent, but may be because of ignorance. It would require supervision on the spot to prevent this, and even then it might be difficult. (8813–43.)

Anthrax—Conveyance of Infection. (*See* **Infected Materials—Bloodstains, Dust, Skin Material, &c.**)

T. M. Legge (O): The view that blood is the carrier of anthrax spores, though not new, was made prominent by the work of the Anthrax Investigation Board. The presence of an infected fleece in a bale may conceivably cause infection of other fleeces, but the danger of this is small. Danger of infection from soil of countries subject to anthrax is almost negligible. (88, 172–7, 200–8, 217–8.) Anthrax among persons manipulating washed wool has been prominent of late years. (77–9, 200–8.)

Flies would be attracted by bloodstains, and, if the latter were infected, spores might be carried and deposited in a scratch or sore or on food, but if food were really infected in this way cases of intestinal anthrax would be more common than they are. (392–4.)

G. A. Taylor (O): Blood is the original carrier of anthrax spores, but in passage of wool through manufacturing processes indications of blood are lost, though anthrax spores remain attached to the wool. Bloodclots missed by sorters would be dissolved in scouring and the spores spread throughout the muddy water. The dust and wool thus become generally infected. During carding and combing much of the dust and remaining bloodstains are removed from the wool and remain in the card clothing. Spores are also spread throughout the tops, noils, waste and dust. Part of the dust is thrown off into the air during carding and the remainder during grinding of card cylinders and rollers. Soil and earth are not infected unless they contain particles of blood. There may be attrition of bloodstains in opening and sorting. Willowing would certainly cause attrition, but probably not entire breaking up, of bloodclots. (1261–4, 1362–70, 1400–4, 1430–43, 1460, 1776–9, 1826–9.)

Cases of anthrax are known to have arisen in workmen's families, *e.g.*, when washing clothing. The infection must have been carried home on the clothing. Spores may be conveyed by means of the hand to any part of the body or clothing. (1491–7, 1520, 1759–64.)

W. P. Norris (O): In Australia infection has usually been conveyed to human beings by inoculation, *e.g.*, by cuts among men skinning dead animals. An instance is given (a pustule on the neck) of a man contracting the disease when inoculating animals (preventive inoculation). Two cases of intestinal anthrax are mentioned, one being that of a boy in a fellmongering district. No inhalation cases are recorded, and few cases, if any, from manipulation of wool. The principal incidence is among persons associated with infected living or recently dead animals.

Among animals infection occurs by the ingestion of infected food; rarely, if ever, by inoculation. Infected pasture or cake foods are most probable sources of infection. (8278–87, 8294–313, 8586–92.) It is difficult, if not impossible, for infection to be conveyed directly from animal to animal. Anthrax infection is a matter of place, not of case. The soil and wool become infected by the bloody discharges escaping from the intestines of an animal when dying from anthrax, or by blood from the body of an animal killed when suffering from, or skinned, or cut, after death from anthrax, or by means of a body buried near the surface. Spores then form which survive in soil or other surroundings for long periods, and may be brought to the surface by worms. Tilled soil favours, but untilled soil does not disfavour, survival and perpetuation of anthrax organisms once these are introduced. Animals become infected by eating the pasture thus infected.

Infection may be spread by wild animals. This is not recorded in Australia, but in the United States it has been shown that ejecta of animals or vomit of carrion birds which have eaten flesh of dead animals infected with anthrax can convey infection to country previously clean.

Anthrax is not natural to Australia, but has been imported. This is known to have occurred in the case of infected bone-meal used for poultry food and for manure. It may have been introduced by live animals whose wool or hair has become contaminated by infected earth or the discharges of an infected animal, but infected food accompanying the animals is a more likely means. Greasy infected wool would be less likely to convey infection by means of dust and, therefore, by inhalation than dry material. (8314–32, 8566–72.)

Australian seasons are comparatively dry and there is no wetness of the soil, but incidence of anthrax is greatest in the late spring and early summer, which would be relatively wet seasons. (8343–56.)

Anthrax germs may exist both as spores and bacilli, and may multiply in soil or on plants in certain conditions. There is no evidence that the anthrax germ is a natural habitant of soil, but in certain districts the soil does become so infected that there is always liability to outbreaks of anthrax.

W. P. NORRIS (O)—*continued*.

It is very doubtful if infection could be conveyed to human beings by such soil attached to wool, but it might by wool of animals which have lain down in wet soil on which an animal has recently died of anthrax. (8358–67, 8564–5.)

Infection can only be conveyed from an animal by blood or tissues containing blood. Urine and excreta would not be infected unless they contained blood. It is very improbable that wool could be infected unless stained by blood, and also unlikely that wool sheared from the living healthy animal could be infected. It is possible, though not probable, that infection could be conveyed by living animals. There are no records of animals developing anthrax while in quarantine in Australia. (8441–62.)

Hides, wool, hair, bones, and animal manures are regarded in Australia as being possible means of conveying anthrax, and there are regulations governing their importation. Cases of anthrax among animals and human beings in the neighbourhood of tanneries and from imported bones are recorded in Australia. (8463–77, 8495–7.)

Sir S. Stockman (O): Anthrax is caused by the growth in the blood of a specific bacterium which would not grow in wool or hair. Gross infection of wool or hair takes place by means of blood when an animal is skinned. When an animal suffering from anthrax is dying bloody fluid escapes from the mouth, nose, and anus, and soil and wool will thus become infected. In the early stages of the disease there may be multiplication in the stomach of the bacilli in infected food which has been eaten, and these may be excreted in the fæces. An animal might also lie down on soil infected as above by an animal recently dead and so cause infection of its wool or hair. This would, however, be a rare case in this country, even when animals are herded together. There are cases of recovery among animals, but the wool would not be infected in such a case. (10,041–57, 10,194–5.)

The danger of animals becoming infected by any means other than the food they eat is very slight. They usually suffer from intestinal anthrax, and only very rarely from external pustules. Food, *e.g.*, grain, becomes infected by contact with dry infected hides, frequently placed on it in holds of ships. Cattle cake, chiefly made in England from imported seed, is known to be infected. The seed may have become infected in transit or the woollen bags used in expressing the oil may be infected, as the material used for their manufacture is sometimes infected. Anthrax has been cultivated from imported grain. Shoddy grain, *i.e.*, the sweepings of the holds of ships, is known to be the most dangerous. It probably contains dust from infected hides. Cases of anthrax occur among workmen employed in grain warehouses. There is much anthrax in Aberdeen, which is also a district in which is used much cattle food imported from China, Manchuria, India, Russia, the Mississippi Valley, and the Argentine. (9950–62, 9975–6, 9983, 10,208–314, 10,338–42.)

Anthrax is not conveyed directly from animal to animal, but an infected animal may cause infection of food, *e.g.*, by bleeding at the nostrils, and other animals might eat this and so become infected. Several animals may be attacked in an outbreak because they eat food from a common (infected) source, or because there is carelessness in dealing with the body of the first infected animal. In this country infection is usually imported in food from abroad, though in certain limited areas the soil also has become infected. Cases also arise near tanneries and wool-washing factories. Though the soil of certain areas has apparently become permanently infected from careless disposal of bodies (so that outbreaks of anthrax may be expected), yet there are many other areas where bodies are also carelessly dealt with which have not become infected. The reason for this difference is puzzling. Parts of the country into which artificial foods and animal products, *e.g.*, bones, are most largely imported show the highest incidence of anthrax among animals.

Sir S. STOCKMAN (O)—*continued*.

Clayey soils retain the infection better than others. (9926–49, 9969–74, 10,188–90.)

When not growing in the body of an animal the anthrax organism exists almost entirely in the form of spores which can survive for long periods in, and may have become a habitant of, the soil in some countries and areas. In all probability it originally came from the soil and may be able to gain a bare existence in that medium and have periods of growth and propagation in some countries (but not in Great Britain, owing to weather conditions). A bad outbreak of anthrax is not necessarily entirely due to infected soil. An animal getting infection from soil may die, and itself become a centre of infection, if the body be left, from which other animals may become infected. A number of centres may thus be formed and what is practically an enzootic results. The Argentine and France are given as instances where this may occur. Wool containing soil from badly infected districts would not be a dangerous source of infection to men manipulating it. Witness has kept spores for six years and found them still alive, though slightly weaker. (9963–77, 10,058–64, 10,188–90.)

Animals may get infection from soil either by the spores being splashed on to the herbage in wet weather, or by eating the dried up grass close to the ground in dry weather. Anthrax bacilli may live and grow on vegetation, but this is doubtful. Anthrax is most prevalent in England at those seasons when the animals do not go out to grass, probably because they chiefly become infected by eating imported food. Witness disputed the accuracy of the usual view that anthrax is most prevalent in moist warm seasons. (10,065–75.)

It is stated that hay grown on infected soil is infected, but this has not been proved by cultivation of the bacilli, as in the case of cake and grain. Outbreaks of anthrax among animals herded together in covered yards in winter are very likely in certain countries, and the floor and any floor covering (straw, &c.) will become badly infected. In such cases the wool or hair of live animals might become infected, but it is doubtful. Subject to these qualifications shorn wool is free from infection and only skin wool is likely to be infected. The regulations in this country preventing movement of animals which have been in contact with another suffering from anthrax are for the purpose of preventing movement of an infected animal in the incubation stage, and not because of the danger of conveyance of infection from animal to animal. (10,086–93, 10,098–112.)

Anthrax has been traced to shoddy bought for manure, but used as litter, and cases are known to occur on sewage farms and near rivers which receive liquid used in tanneries and for wool washing. Cases have also occurred in the neighbourhood of factories which discharge dust into the open air by means of fans. (10,141–71.)

Use of infected waste materials as manure on arable land will probably not convey infection to animals directly, but may infect the soil. (10,355–59.)

F. W. Eurich (P): Persons manipulating wool may become infected by anthrax (1) internally by inhaling the spores as dust, by swallowing the spores in or on food, or by getting the spores into the mouth and swallowing them; (2) externally by the spores being rubbed through the unbroken skin, *e.g.*, down a hair shaft, or by getting them into a wound or into a small lesion caused by skin disease, *e.g.*, a pimple. Anthrax has been experimentally introduced into the blood of animals by rubbing on the skin. Most anthrax pustules occur at points where there is friction, *e.g.*, the neck, brow and wrist. In any case it does not need a *visible* break in the skin to permit entrance of anthrax spores. (513, 956–65, 992–93, 1071–77.)

Spreading of infection from one dry fleece to another is a possibility which is unlikely, but which cannot be quite disregarded. From a sample of Van mohair, one colony only was cultivated, which may have resulted from contamination by contact with

F. W. Eurich (P)—*continued.*

Persian wool. It cannot, however, be concluded that scanty cultivations indicate spreading of anthrax spores from dry infected to dry sound wool. There may be quite other reasons for scanty cultivations. Infected locks wrapped in a sound fleece might infect that fleece, but could not infect other fleeces in the same bale. There may be some spreading of spores in a loose wool like camel hair. Multiplication of anthrax bacilli (and possibly, therefore, of spores) may take place in damp wool, *e.g.*, where infected wool has been water-damaged, but the germs do not spread more than half an inch from the original centre. (605–10, 672, 697–712, 722–4, 731–3, 742, 799, 811–9.)

The anthrax spore is adherent to wool fibres and does not exist in them. The discharges of an animal suffering from anthrax frequently contain infected blood which may infect the wool. The discharges may also be infected apart from the blood, but not extensively. (682–91.)

Certain wools in some cases are willowed. This causes the bloodclots to break up into dust which may be breathed. In certain conditions bloodclots are not completely dissolved in washing, and some wools are carded without previous washing. In these cases the blood is broken up into fine dust and the infection spread by carding. Cutting of bloodstains by shears, *e.g.*, in sorting, and any careless handling of wool containing them may break them up and spread infection by means of dust. (725, 803–5, 822–5.)

Treatment of infected bloodstained wool by any wet process causes dissolution of the blood and spreading of the spores from the bloodclot over all the wool treated. The danger, therefore, becomes hidden and broadened but less intense, and absence of visible blood is no indication of freedom from infection.

Anthrax bacilli can exist in living blood. At certain temperatures in certain conditions (such as poverty of food) in the presence of free oxygen the bacilli become spores which are much more resistant than the bacilli, and may remain quiescent, but alive, for very long periods, till the conditions again favour their development. The conditions necessary for spore formation are present as soon as blood containing the bacilli is shed and begins to dry on wool. (751–61.)

W. Mitchell (P): Persons manipulating wool become infected with anthrax externally by the spores obtaining entrance through the skin either through a break in the continuity of the integument, or by being rubbed through the unbroken skin, as in the case of other spores. Internally infection may be introduced by inhalation or by swallowing the spores, but probably also by way of the skin without development of an external pustule. Friction may possibly cause an invisible break in the skin through which the spores obtain entrance. A pustule may also develope internally precedent to an attack of internal anthrax, and may require a break in the integument before infection can be introduced. (7270–81, 7335–41.)

G. H. Feather (E): Infection is not conveyed by card waste, noils, and combing by-products. (4377–8.) Infected matter is likely to be deposited on clothing unless protected by overalls. (4423–7.) Washing conveniences are necessary for persons manipulating wool, but care is necessary in using these. An instance is given where a man carelessly wiped his dirty hands on a towel which was subsequently used by another before eating, and he contracted intestinal anthrax in consequence. (4430–2, 4489, 4628–30.)

Anthrax is now more prevalent among combers than formerly—possibly because locks are now more infected and are more frequently packed in fleeces—and, as it is impossible to remove all bloodstains from locks, some blood gets through to the cards and is there broken up. (4583–7.)

Material which is not bloodstained has been found to be infected, and it is suggested that this usually results from washing infected bloodstained material. Witness knows of no unwashed infected

G. H. Feather (E)—*continued.*

material except bloodclots. Dust found to be infected is always found to contain blood, though this may not be visible. (4608–13.)

G. Ackroyd (E): Blood is the carrier of anthrax. Manipulation of the material may cause attrition of the clots and therefore distribution of the infection. It is not possible, at present, to say definitely that dust does not convey infection, but witness inclines to the view that dust is, in general, free from anthrax unless it has become contaminated by blood, by wetting or attrition of the bloodclots. If bloodstains be left in wool the processes after washing would be the most dangerous. (6299–321, 6338–41, 6465–6.)

It is possible that mohair fibres, being strong and sharp, may cause minute lacerations of the skin, either internally or externally, and so provide a way for the introduction of infection. Van mohair has a peculiar acrid odour—probably caused by the herding of the goats in caves or covered yards in winter—which may denote something favourable to the spread of anthrax. Danger of fleece mohair arises entirely from the skin mohair mixed with it. The latter is usually good quality material, so thoroughly cleansed as to be nearly free from infection. (6407, 6428–30, 6625, 8150.)

Persian wool is typical of carding sorts, and mohair of preparing sorts. In combing Persian wool danger is greatest in processes after washing, probably because the skin wool is obtained by a dry process and the infection is not distributed till the material is washed. If the unbroken bloodclots be removed by sorters the material should be harmless. In combing mohair danger is greatest in sorting, probably because the skin material has been obtained by a wet process and the spores thus spread over the material, so that the sorter can neither see any sign of, nor remove the danger. In such cases the material conveys infection in a less virulent form through every process, and the final products (tops and noils) are also infected. (8220–5.)

The analysis of all the cases occurring since 1905 shows a preponderance of internal cases in the processes presumably more dusty. More fatal cases occur, however, after the material is washed than before. The number of persons employed in processes subsequent to washing is greater than before in the proportion 75 : 25, but the process of carding is more searching than any process before washing, except willowing, and persons are more liable to small injuries. (6606–21).

Witness cannot explain cases apparently due to manipulation of Home and Colonial wools, but points out that much is still unknown concerning anthrax. Dry and dusty wools appear to convey infection most readily, but anthrax is not confined to the countries in which these are produced. (6528–30.)

J. H. Halliday (M): Blood undoubtedly carries infection. No case of anthrax occurred in the works managed by witness before 1906, but 18 have occurred since. The reason is that Persian wool since 1905 has contained a large proportion of bloodstains and false-packed locks. Sorting out of bloodstains was commenced early in 1909, but, in spite of this, 14 cases occurred subsequently and continued to occur up to the time the works were closed. Re-sorting was regularly done from 1911 to 1913 and, on the average, one-tenth of a pound of bloodstains per bale was found to have been left in the sorted wool. In spite of this, 4 cases occurred in this period, though they were slighter than before the bloodstains were sorted out.

There may be infection in wool, particularly in locks, apart from visible bloodstains, and bloodclots may also get so broken up as to escape detection. Witness suggests that if false packing were prevented there would practically be freedom from anthrax. Of the 18 cases occurring between 1906 and 1913, 10 resulted from the manipulation of wool after, and 8 before washing. The material is willowed before and after washing, and there is no dust in any subsequent process. 78 per cent. of the workers

J. H. HALLIDAY (M)—*continued.*

manipulate wool after, and 22 per cent. before washing. Witness suggests that the reason for more cases occurring after washing is that this process sets the spores free from the bloodclots, or that the warmth of the wash-bowl and drier may bring the spores into a condition favourable for development. (5633–4, 5667–71, 5791–841, 6032–46, 6068–9, 6148.)

In some cases material known to be infected has gone through the works without causing any case of anthrax. Witness suggests that, in such instances, the coincident conditions necessary for the growth of the spores have not occurred. Sorting out of bloodstains may prevent anthrax over extended periods, but no matter what care is exercised in this respect there is always danger of cases occurring. (5835–49.)

Witness has knowledge of cases of anthrax occurring in the manipulation of tops, noils, and waste, but thinks the infection in these materials must be small. (5833–62, 6191–2.)

Dust is a carrier of infection. Infection may be conveyed on clothing unless protected by overalls. Outdoor clothing hung in workrooms (except comb-rooms) may get infected matter deposited on it. (5887–901, 6000–3.)

Witness thinks it is not dangerous for meals to be taken in comb-rooms (on account of the absence of dust) in which in his experience external cases only occur. He gave an instance of a case of intestinal anthrax occurring in his card-room, though meals were never taken there. (6212–6.)

"B. A." (W): There is always danger of anthrax where there is blood. Cutting doubtful clots or pieces of dung or crumbling blood in the hands for purpose of verification may cause danger. Infection is conveyed by bloodstains, but witness has known cases occur in manipulation of wool from which the bloodstains have been sorted out. (2369–85.) Anthrax spores may get under the nails or on the hands, and so be conveyed to a pimple or to any part of the body where there is irritation. Witness thinks he contracted anthrax in this way by rubbing his neck. (2246–7, 2315–20.)

Witness has known anthrax to occur in a workman's family from washing his clothes. (2417–8.) Hair on the face collects dust and might thus cause infection. (2720–9.) (*See* Infected Material—Dust.)

T. Larkin (W): Witness got very hot and perspired a great deal when blending dangerous wool. An anthrax pustule developed on his forehead immediately afterwards. He thinks the heat caused the pores of his skin to open and so allowed entry of the anthrax spores. Bloodstains had been sorted out of the material before it was blended. (2950–74.)

Witness thinks hair on the face a danger because dust and germs may collect in it. On many occasions men lick the moustache and the germs might be swallowed. (3069–83.)

"W. R." (W): Some men engaged in sorting out bloodstains never learn to recognise them properly. This is why infection gets through to the combs. Hurried sorting has the same result. Witness has known cases of anthrax arise in the manipulation of wool from which the bloodstains have been removed and assumes that some have been left in, but has never definitely ascertained that this is a fact. He has known cases where sorters have been so hurried as to be entirely careless in their search for bloodstains. (3351–2, 3488–502, 3556–60.)

Witness suggests that the warmth of the wash-bowl "brings the anthrax germs lively," and so explains the incidence of anthrax in processes after washing. (3584–6.)

"S. J." (W): In the opinion of witness there is always more anthrax where the dust is greatest, and he gives instances which support this. He has seen bloodstains passing through the cards in material from which they are supposed to have been sorted out. He thinks sorters are often hurried too much to be able to remove all bloodstains. Witness contracted anthrax which he thought was due to dust

"S. J." (W)—*continued.*

falling from the top of a bin on the side of his face as a pustule developed at this point two days later. (3700–863, 3958–74.)

Clothing becomes infected unless protected by overalls, and it is necessary to wash when working among infected wool. (3974–98.)

One cause of the increase of anthrax cases among combers is the greater speed of working now as compared with some time ago. More wool goes through the machines in a given time, and the risk is, therefore, concentrated, while the greater speed of the machines also causes a more dusty atmosphere. (4157–60, 3700–14, 3759–804, 3921–39, 4019–27, 4033–39, 4195–200, 4215.)

"F. J." (W): Clothing and overalls become infected when men are working among infected wool, and infection is thus carried away. To prevent the deposit of infected dust on outdoor clothing proper storage places are necessary, and they should be separate from those provided for overalls because the dust from the latter may convey infection. (4933, 4940–2, 4979–82.)

Witness has known cases of anthrax caused by inhalation, and also external cases. (4945–50.)

"C. W." (W): In the experience of witness woolsorters disease in past times was usually caused by inhalation, but anthrax is now more usually of the external form. It was formerly more prominent among, but was never confined to, sorters. Cases still occur among persons manipulating material from which bloodstains have been removed. (5173–95, 5228.)

Overalls should be disinfected before being taken home. Persons should be prohibited from going with overalls on into a room provided for storing outdoor clothing because of danger of transference of dust and short fibres from the overalls to the clothing. (5204–8, 5221–3.)

"G. J." (W): Cases of anthrax occur more frequently where there is much dust, and witness gives instances in support of this view. Men sweat when working, and this causes the dust to stick to the skin and so favours infection. Pustules occur in his experience most frequently round the face and neck where perspiration takes place most freely. (5381–403.)

There are many flies in the washhouse in which he works, and many cases of anthrax have occurred there. (5425.)

Foreman and six skilled sorters (W): Are employed in sorting out bloodstains, in which they have great experience, but cases of anthrax occur in the manipulation of material from which they have removed bloodstains. They do not think they miss bloodstains, but the fleeces have skin locks packed inside them. (9145–65.)

Anthrax—Diagnosis of. (*See* **Anthrax—Disease of.**)

T. M. Legge (O): In 1899 there was much doubt as to the verification of the diagnosis of suspected anthrax. The Home Office prepared a memorandum on the subject, which was circulated to medical practitioners in Bradford, and provided facilities for bacteriological examination of material in doubtful cases. Very little use was made of these owing chiefly to delay caused by the complicated procedure necessary, and they were withdrawn on the appointment of Dr. Eurich as Bacteriologist to the Anthrax Investigation Board. The importance of the detection of the bacillus is illustrated by a workmen's compensation case in which a workman died from a disease that clinically had all the appearances of anthrax, but the widow was refused compensation because in an examination of the blood, anthrax bacilli were not detected.

Internal anthrax may be diagnosed as other diseases, *e.g.*, pneumonia, and for this reason some cases of anthrax are not reported. Bradford cases are instanced which were diagnosed as pneumonia and only acknowledged as anthrax after bacilli had been found in the post mortem examination. Clinical

T. M. Legge (O)—*continued.*

signs of anthrax are, however, as a rule, so definite and clearly marked as to leave no doubt as to the diagnosis. Bacteriological examination of material may fail unless made without delay, as anthrax bacilli disappear within 24 hours in the absence of nutriment, or by reason of attacks of other organisms. In some cases, also, for reasons not at present known, it appears very difficult to demonstrate the presence of bacilli in the blood, even in typical cases of anthrax, though they must have been present originally. Other diseases may be mistaken for anthrax, *e.g.*, contagion from children recently vaccinated. (35–7, 125–30, 147–9, 188, 197–8.)

G. A. Taylor (O): There is much ignorance among medical practitioners as to symptoms of anthrax, and delays in correctly diagnosing the illness have frequently resulted fatally. (*See* Medical Examination, page 3.) (1540–9, 1655–61, 1712–3, 1886–901.)

W. P. Norris (O): Animals usually suffer from intestinal anthrax, though pigs present external signs in the throat (swellings). In sheep there are practically no premonitory symptoms, and death occurs from what is frequently described as an apoplectic stroke. When suspicion has been aroused by deaths, it is possible to detect symptoms of anthrax in sheep under close observation, but the disease progresses more rapidly than in human beings. In Australia, the first intimation of anthrax results from the sudden death of animals. This may be reported, or come to the ears of stock inspectors, who make enquiries, and, in case of doubt as to diagnosis, remove the tip of the ear and send it, with proper precautions (made necessary by the fact that if putrefaction has set in before examination there is danger that all bacilli will have disappeared), for bacteriological examination. Animals dying or dead from anthrax have the bacilli throughout the bloodstream, and sufficient blood for examination is contained in the small veins of the tip of the ear. Cases have occurred where infected animals have been killed in slaughterhouses, and suspicions (afterwards proved correct) aroused by the dark spleen. In sheep the state of the spleen is a less important symptom, but the blood becomes broken up. (8288–93, 8380–6, 8416, 8441–5, 8529–34, 8596–7.)

Sir S. Stockman (O): In 1911 the Board of Agriculture adopted bacteriological verification of diagnosis of anthrax in animals, and the diagnosis was found to be incorrect in from 33 to 50 per cent. of the cases reported. Anthrax carbuncle has been seen very occasionally in animals, but external pustules are very rare. On the larynx or pharynx of the pig it is quite common to find a necrotic area with a black centre. In cattle, horses, and sheep, anthrax is usually intestinal before it becomes generalised. It is probably never pulmonary except as part of the generalised infection. In pigs and horses it is not possible to find many bacilli in the blood. Farmers would not know that their animals were suffering from anthrax, but a death without definite premonitory symptoms, or swellings on the throat of a pig, should lead them to suspect the disease. They are instructed by means of leaflets, (Appendices 23 and 24.)

Severe symptoms in animals only appear just before death, which is sudden. There are certain ill-defined symptoms present, however, during the early stages which may cover a period of seven or eight days. In sheep practically no symptoms are observed. The animals are found dead. In reported cases of anthrax, unless the veterinary inspector is convinced the disease is not anthrax, he is obliged to send to the Board of Agriculture a smear of blood and a bloodstained swab for examination. Bloody fluid escapes from the mouth, nose, and anus of an animal when dying of anthrax, and occasionally there is severe hemorrhage from the kidneys or bladder, but in the case of pigs the blood is obtained from a gland in the throat, owing to the difficulty of finding bacilli in blood from other parts of the body. (*See* Bacteriological Examination.) This method is preferable to that of sending part of an ear. Blackwater fever also causes escape of blood

Sir S. Stockman (O)—*continued.*

from mouth, nose, and bowel, but there is local emphysema as well, which distinguishes it from anthrax.

Human beings in England frequently contract anthrax when cutting up or skinning carcases on farms, &c. A considerable proportion of the cases are fatal, owing to failure to diagnose the disease in its early stage. This is not altogether due to medical incompetence, but partly to the delay of the patient in seeking medical advice and to the rarity of the disease, in consequence of which medical men do not think of anthrax. Warning is given by the veterinary inspectors to the persons concerned of the possibility of contracting anthrax by infection from bodies of animals. (9923, 9953–6, 9998–10,016, 10,030–1, 10,045, 10,196–205, 10,219–26, 10,283–7, 10,348–54.)

F. W. Eurich (P): Witness, acting as bacteriologist to the Anthrax Investigation Board, has undertaken investigation in Bradford of over 100 cases of human anthrax, clinically, bacteriologically, and in connection with occupation. Out of 20 cases of internal anthrax, one only was diagnosed by the medical practitioner at a reasonably early stage of the disease, *i.e.*, on the day after the commencement of the illness at the doctor's second visit. In four cases no medical advice was sought; in eight, medical advice was obtained when the patients were dying; in three, the unexpected death of the patients roused suspicion of anthrax; in four, anthrax was only suspected when collapse occurred. In 35 per cent. of the cases the Medical practitioner failed to make a correct diagnosis, while in 20 per cent. the patient did not think the illness sufficiently serious to require medical attention. Out of 13 cases of fatal external anthrax no medical advice was sought in one case; in one, a correct diagnosis was not made till the eighth day; in three, advice was only sought on the fourth day; and in five, on the third day. In three cases advice was obtained within 36 hours of the commencement, but two were erysipelatous anthrax, and one was complicated by cirrhosis of the liver. The inferences drawn, apart from the difficulty of diagnosis, are, that the symptoms of both internal and external anthrax are such that (1) the patients regard them lightly, and (2) medical practitioners are apt to misinterpret them. In one case a correct diagnosis was only made when anthrax was suggested by the friends of the patient. Of 67 cases treated in an institution, 27 were first seen by a practitioner (Dr. Mitchell) having special knowledge of anthrax, and 74 per cent. developed mildly, while 7·4 per cent. proved fatal. Of the remaining 40 cases, first treated by practitioners having no special knowledge of the disease, only 50 per cent. developed mildly, and 15 per cent. were fatal. By means of charts a strict comparison is drawn showing that the cases first seen by the less experienced practitioners are more severe at each stage than those seen by the experienced practitioners.

Early diagnosis is essential in order to lessen the severity of and mortality from the disease, and this is only obtainable if cases are seen by practitioners experienced in anthrax. In internal anthrax the symptoms are not distinctive, and in any of its forms anthrax is a rare disease so that the ordinary practitioner has but very little experience of it. Its early symptoms are not alarming to the patient, who therefore neglects to obtain medical advice. Symptoms of pulmonary anthrax closely resemble those of pneumonia or of influenza; and the pustule resulting from accidental infection from vaccination pox closely resembles that of external anthrax. Bacteriological verification is therefore necessary in all cases of suspected anthrax, and a method by which this may be obtained is described. There are aberrant forms of the external pustule which do not resemble the published illustrations. (500–4, 511, 518–21, 525–38, 541–7, 830–42, 936–8, 953–6, 971–3, 974–77, 977, 1006–10, 1066–70.)

W. Mitchell (P): For the purpose of securing early diagnosis of anthrax witness is retained by several firms to examine those of their workpeople suffering

W. MITCHELL (P)—*continued.*

from any disease likely to be anthrax. Diagnosis in the early stages of the disease is not difficult, but it is necessary to have a thorough knowledge of the symptoms and bacteriological confirmation is essential. In internal cases probably, the latter can never be obtained (in the early stages) but in external cases it is always a simple matter by means of the microscope and by culture. Anyone can quickly become expert in recognition of the early symptoms and in bacteriological confirmation. Early diagnosis is essential as the disease progresses very rapidly. Many practitioners and institution doctors do not recognise the disease sufficiently early or do not realise the seriousness of it. They also sometimes diagnose other diseases as anthrax. The fatal cases have diminished as a result of better and quicker recognition of the disease.

There is great variation in the appearance of developed external anthrax pustules, but in the early stages the great majority are alike. Witness severely criticised all the illustrations of pustules published in various warning placards. Witness never diagnoses an external case as anthrax on clinical signs only. There are cases which no man can say are anthrax from a superficial view. The pustule should be pricked and if pus be present it can safely be decided that the case is not anthrax. If pus be absent careful microscopic examination of a blood smear will reveal anthrax bacilli if the disease be anthrax. In some cases suspected to be anthrax from clinical symptoms, witness has failed to discover bacilli at first, but has always found this to be due to a fault in staining, or to not taking the blood from the right place. In order to diagnose external anthrax it is necessary to have knowledge of the requisite simple microscopical and cultural methods and to have in mind the possibility of anthrax. Many failures occur because the medical practitioner is off his guard and does not think of anthrax. Internal anthrax (pulmonary and intestinal) cannot be diagnosed with certainty in the early stages, and there is no known method of confirmation. (7172–83, 7212–22, 7236–7, 7241–6, 7256, 7295–8, 7313–4, 7325, 7364–87, 7390–404.)

G. H. Feather (E): The workmen manipulating witness's wool live in a country district, and of the last four cases reported as anthrax, three were diagnosed as anthrax, which bacteriological examination proved not to be that disease, and one proved to be anthrax which was not diagnosed as anthrax.

Witness, therefore, considers bacteriological confirmation of the diagnosis to be essential. Early diagnosis is essential to successful treatment. (4433–46, 4650–61.)

Anthrax.—Disease of. (*See* **Anthrax—Diagnosis of.**)

T. M. Legge (O): A short account of the life history and mode of spread of the bacillus anthracis is given in the report of the Departmental Committee on Woolsorting of 1897. The identity of woolsorters' disease with anthrax was proved by Dr. John Henry Bell, of Bradford, by inoculating animals with the blood of a woolsorter suffering from the disease. All died, and their body fluids were found to be crowded with the bacillus anthracis. Internal cases of anthrax are much more frequent in Bradford than in other parts of Great Britain, and the fatality rate is also much higher. 82 per cent. of the deaths occur in Bradford and amongst women 10 deaths occurred in 31 cases, while outside Bradford no death took place among the 79 cases of anthrax in females. The total number of cases occurring outside is greater, however, than the total number in Bradford. Pulmonary anthrax resembles pneumonia, and it is natural to suppose that in outside districts the disease might be less frequently identified than in Bradford. As a general proposition the facts do not support this though it may be true in some cases. Instances are recorded (some in Bradford), where deaths certified to be the result of pneumonia have been proved by bacteriological examination to be pulmonary anthrax. (107–32, 159–61.)

After death of a person from anthrax, the anthrax bacilli also die and rapidly disappear, and it has not

T. M. LEGGE (O)—*continued.*

always been possible to find the bacilli in cases of anthrax, which, clinically, are typical, even when the search has been made by competent authorities. Such cases ought, however, to be diagnosed, treated and certified as anthrax if clinically they appear to be anthrax. On the other hand, the clinical appearances of anthrax sometimes resemble those of certain other diseases, and, where bacilli are not found, each case must be treated on its merits for the purpose of a decision, as to whether it really is anthrax. In exceptional instances anthrax can only be considered to be proved if the bacilli are found.

Internal anthrax is nearly always fatal; of 36 Bradford cases one only recovered. This was treated by means of Sclavo's serum, the use of which affords the only possibility of recovery in many instances in both external and internal cases. At the time of the report of the Departmental Committee of 1897, the occurrence of cases of anthrax was not recognised in the later processes of woolcombing, and internal cases were much more frequently observed than external. External cases are now much more frequent than internal in Bradford, and more cases occur in later than in earlier processes. No satisfactory explanation of the apparent change in type has been advanced. (35–7, 147–8, 159–68, 197–9, 200–4, 189, 226–7.)

W. P. Norris (O): Anthrax is usually fatal to animals, and is very rarely, if ever, of the external variety. Infection is caused by eating infected food, the disease is of the intestinal form, and very rapidly becomes generalised, much more rapidly than in man. From one to three days elapses between infection and death and from the first appearance of symptoms to death is only a matter of a few hours. The disease is caused by bacilli which grow and multiply in the blood. (8286–93, 8441–50.)

It is incorrect to speak of persons being immune who have not suffered from the disease. All that can be said is that they have escaped. Sheep are not more immune than any other animals. (8302–8, 8357.)

Animals which die of anthrax have the germs of the disease throughout their bloodstream. The disease should be verified bacteriologically with necessary precautions due to the fact that putrefaction causes death and disappearance of the bacilli. (8380, 8533–4.)

Sir S. Stockman (O): In England it is not usual to find a large number of animals attacked in an outbreak of anthrax, but frequently more than one is attacked. The average is 1·3 per outbreak. The reason for this is that they are subject to a common source of infection. The disease is not contagious. Very occasionally anthrax carbuncle has been observed in animals, but they usually become infected by eating infected food and the disease is, therefore, most commonly intestinal at first and then becomes generalised. The period elapsing between the appearance of severe symptoms and death in animals is short, but the incubation period may be any length up to eight or ten days, and the animal may even recover. In sheep probably no pathognomic symptoms would be observed. The animal would be found dead. The rapidity of the disease depends on the dose of infection. It is unsafe to rely on a diagnosis of anthrax in animals unless confirmed bacteriologically, precautions being taken to avoid the effect of putrefaction. (9923–8, 9950–62, 10,005–16, 10,030–2, 10,195–205, 10,227–30, 10,348–54.)

Anthrax is caused by the growth and multiplication in the blood of a specific bacterium, and infection causing disease in human beings generally originates from the blood of an animal dying from the disease. The other body fluids are not infected unless they contain blood. The disease is usually fatal to animals but there are certainly cases of recovery. Witness is not in agreement with the usually accepted view that anthrax among animals occurs more frequently at one season of the year, his view being that the controlling factor is the supply of infected food. He points out that in England most cases occur in winter, because then imported artificial foods liable to be infected are used. In France and South Africa the statistics

Sir S. Stockman (O)—*continued.*

show very little variation throughout the year (but in Russia cases rise enormously in the summer). (*N.B.*—It is possible that in certain countries animals are allowed to feed on infected areas at certain seasons only). Plains cattle in India are immune to anthrax even when given large doses artificially by inoculation. This is probably due to immunisation resulting from the great infection of the soil. Sheep are not generally immune. Dogs are resistant but not immune. The natives round Bathurst and in the Gambia eat much partially cooked flesh of animals dying from anthrax, but do not appear to suffer from anthrax. (10,041–56, 10,070–87, 10,175–87, 10,219.)

F. W. Eurich (P): In human beings the disease of anthrax is manifested (1) externally as a malignant pustule, and (2) internally as an affection of the lungs (pulmonary), or stomach and bowels (intestinal). In either variety the bacilli may get into the general circulation and produce generalised anthrax. On account of the anatomical structure of the external parts of the body—fewer blood vessels, lymphatics, and lymph channels than internally—external anthrax developes less readily into generalised anthrax, and is therefore easier to treat successfully than the internal form. The symptoms of internal anthrax are also by no means distinctive, and the commencement is thus overlooked. The whole of the 20 cases of internal anthrax seen proved fatal. (501–12.)

An analysis of all cases of anthrax shows that the internal form is rarely recognised in its early stages, and practically it is always fatal (98 per cent. of the cases). External anthrax is frequently not recognised in the early stage and in a high proportion of such cases proves fatal; but when quickly recognised the proportion of fatal cases is much lower. The causes of the non-recognition of anthrax are: (1) that the internal variety resembles other diseases (influenza, pneumonia, &c.) in its early stages; (2) want of knowledge on the part of medical men, due to the fact that anthrax is comparatively a rare disease; (3) thoughtlessness and want of knowledge on the part of patients, who therefore do not obtain medical advice quickly (because they think the disease is merely influenza or a pimple, and do not suspect anthrax); and (4) misapplied first aid, *e.g.*, putting plasters on pustules, &c. The only certain method of definitely proving the disease to be anthrax is by bacteriological examination of blood, bearing in mind that various conditions result in death and disappearance of the bacilli (*e.g.*, putrefaction, the germicidal power of blood, absence of oxygen, &c.). Cases of recovery from internal anthrax have been reported, and witness has also known one case of recovery from generalised anthrax. (513–47, 830–6, 840–2, 1006–10, 8764–5.)

In animals anthrax almost always takes the internal (intestinal) form and is usually fatal. One of the symptoms is the discharge from the intestines of blood containing bacilli which in suitable conditions produce spores. The bacillus is a rod-shaped organism with square ends. In the presence of free oxygen (or air) at suitable temperatures, where nutrition is absent or scanty, the bacillus develops into an oval body or spore, which is a dormant but living form of the organism, highly resistant to all destructive agencies and to the passage of time. Drying in the open air of blood containing bacilli is a condition favourable to spore development. On regaining suitable surroundings, *e.g.*, below the skin, or in the lungs or stomach, of human beings or animals—the spore developes into the bacillus, which multiplies rapidly and is very readily destroyed. It is extremely difficult to state the limit of time from the commencement of the disease within which it is necessary to secure medical attention in order to permit of successful treatment. Some cases cure themselves spontaneously, and it is partly a question of the health and condition of the patient. The virility of anthrax germs varies enormously, and the rate of progression of the disease depends in some degree on this. (683–91, 751–61, 837–9, 987–8, 984, 1033–9).

It is not necessary for the production of pulmonary anthrax that sharp lacerating dust particles should be inhaled, but where this occurred infection would be more likely. Witness has known two cases in which

F. W. Eurich (P)—*continued.*

a pustule was situated in the larynx and one where it was in the bronchial tract. This is some indication that pulmonary anthrax developes by means of a pustule, as in external anthrax. Anthrax rarely developes on the fingers, probably because of the comparative absence of hairs. An actual lesion of the skin, or at any rate a visible lesion, is not necessary for the introduction of infection. Spores may get down the hair shafts or possibly the sweat glands. (950–70, 992–3, 1071–77).

W. Mitchell (P): Anthrax is a curable disease if recognised at an early stage. The disease, once the infection is introduced, progresses very rapidly. Clinical appearances are sometimes deceptive in the early stage, even in external anthrax. No man can distinguish between influenza and internal anthrax in the first stages. (7170–6, 7241–2, 7255–6, 7270–81, 7335–41, 7364, 7382–7, 7390–404.)

"B. A." (W): Witness contracted anthrax. It appeared to be a boil on the neck, but the colour was alarming and he was sent to a doctor. Witness was not unwell. (2315–27.)

Thomas Larkin (W): Witness contracted anthrax after perspiring a great deal in the course of his work. A small pimple appeared on the forehead, but there was no wound of any sort before it appeared. Two days later he felt unwell and had a headache, on the fourth day he went to a doctor and was ill for seven months. He did not obtain medical advice earlier because he and the foreman thought the pustule was an ordinary "heat-spot." (2950–67, 3097, 3117–23, 3217–28.)

"S. J." (W): Witness suffered from anthrax. A white blister appeared on his temple and looked like a burn. The blister burst and water ran down his cheek. He did not feel unwell, and thought it was nothing, but showed it to the foreman, who sent him to the doctor. (3852–66.)

Anthrax from Wool.—History of attempts to prevent.

T. M. Legge (O): The history of attempts up to 1897 to control the danger of infection from anthrax is given in the report of the Departmental Committee appointed in 1895 to inquire into the conditions in certain industries in which anthrax occurred. In that report it is stated that in the wool industry anthrax is confined to the worsted branch (principally in the early processes, particularly in sorting), and the materials regarded as dangerous are said to be used in this branch only. The disease was known as "woolsorters' disease," and this was shown, by Dr. Bell in 1879, to be anthrax. In 1880 a coroner's jury, inquiring into the death of a man from anthrax, stated that, in their opinion, sorting of Van mohair, Cape hair, Persian, and all dry Eastern wools, is dangerous to life, and made recommendations, including one, that statutory powers for enforcing precautions should be obtained if not in existence. In the same year Mr. Spear reported to the Local Government Board on the incidence of the disease in Bradford. Shortly afterwards a code of voluntary rules was drawn up by representatives of employers, woolsorters, and the factory department.

Following another inquest in 1884 this code was revised and issued by employers, woolsorters, and the Sanitary Committee of the Bradford Town Council. The rules required opening of all wool by persons skilled in judging the condition of the material. If any dead or fallen fleeces or damaged material were found, the whole bale was to be deemed noxious, as well as all Van mohair and Persian and foreign skin wool and hair. If no objectionable material were present, the wool (except Van, Persian, and foreign skin material) was to be treated as usual. All noxious material was to be opened over a fan, saturated with water, washed, and only partially dried before sorting. If steeping was injurious, the material was to be disinfected. All mohair, Persian, camel hair, cashmere, and alpaca was to be sorted over exhaust, the dust from the exhaust, with all sweepings from floors, walls, and under sorting screens, collected twice per week and burned. All

T. M. Legge (O)—*continued.*

pieces of dead skin, scab, and clippings or shearlings were to be disinfected before being dealt with or sold. Other provisions dealt with bags in which material is imported; open cuts or sores, and treatment of them; cloakrooms; storing and eating food; ventilation, warming, sprinkling floors with disinfectant and sweeping daily, limewashing of walls of, and storing wool in sorting rooms; washing conveniences; early medical treatment; reporting cases of suspicious disease to the Borough Medical Officer of Health; affixing the regulations, and penalty for non-observance. Similar regulations were adopted in Keighley.

The Departmental Committee of 1895 recommended the adoption of this code of voluntary regulations, and in 1897 they were given statutory force as a code of special rules, except that no rules for securing early medical attendance and reporting suspicious illness were included, and certain duties of workpeople and a standard of exhaust draught were added. After this date cases of anthrax, some fatal, began to be frequent in woolcombing processes subsequent to sorting (or where no sorting was done), not controlled by the special rules. In 1899 the Bradford Chamber of Commerce and the Bradford and District Trades and Labour Council jointly applied to have woolcombing certified a dangerous trade and to have special rules established. The Home Office pointed out that it was undesirable to have a code for woolsorting and another for woolcombing, both of which would, in many cases, apply to the same factory, but eventually a code for woolcombing, based on recommendations of the abovenamed bodies, was established in 1901, which embodied, in addition to the requirements of the woolsorting code, (1) separate opening of specified materials, (2) steeping of Van mohair, (3) willowing of specified materials: and provided for a much higher standard of exhaust draught for the opening screen.

Cases of anthrax, particularly from Persian wool, continued, and in 1903 a circular drawn up by the Chambers of Commerce of Bradford, Halifax, Keighley, and Kidderminster drew attention to the unsatisfactory condition in which this material is received. In the same year the Home Office received copies of resolutions adopted jointly by the Bradford Chamber of Commerce, National Union of Woolsorters, Bradford Wool Warehousemen's Union, and the Bradford Woolcombers' Association, proposing amendments and additions to both codes. After conferences between the Home Office and these bodies a new code of regulations was established in 1905 in place of the two previous codes of special rules. The formation of a local expert committee was also suggested, and the Anthrax Investigation Board of Bradford and district was formed. Efforts were also made by the Home Office through the Foreign Office, India Office, and Colonial Office, and the Consuls to obtain information as to anthrax in the countries of origin, but the results were of little value.

After the above code was established in 1905, incidence of anthrax in factories outside Bradford, in the heavy woollen districts, &c., became acute, the infection being traced to East Indian wool, a material not previously recognised as dangerous, though Persian wool was also used in some cases. The Anthrax Investigation Board was consulted, and the Secretary of State suggested that East Indian wool should be added to the schedule of dangerous materials to which the woolcombing regulations applied. This was put before users of the wool in a circular to the trade. The danger of anthrax from East Indian wool was, however, strenuously denied, and the Home Office was not in possession of definite proofs (since obtained) that this material is infected. The use of East Indian wool was, therefore, certified as dangerous on account of the dust produced, and a separate code of regulations, which provided for suppression of dust in certain processes, was established in 1908. Incidence of fatal anthrax in blending in 1910 caused inquiry to be made, and the Anthrax Investigation Board recommended certain precautions. (*See* Anthrax Investigation Board.)

Inquiry into incidence of anthrax in the Lancashire felt industry led to discovery of anthrax spores in Cape wool. A further outbreak of anthrax in Kilmarnock in 1911 led to an inquiry and report by Mr. Taylor and Mr. Verney, two of H.M. Inspectors, as to the use of East Indian wool, which indicated seriously dusty conditions. Mr. Duckering then carried out an experimental inquiry as to dust in the air in processes in manufacture of wool, and his report is presented to the Committee. Finally, the Anthrax Investigation Board was requested by the Secretary of State to carry out experiments as to the practicability of disinfection by steam. Suggestions and experiments had been made by Dr. Bell and Dr. Evans (Medical Officer of Health for Bradford), who found that it was not possible to destroy the anthrax spores unless the process of disinfection was so severe as to destroy the wool; but certain more recent experiments appeared to indicate the contrary. The Board's experiments showed, however, that disinfection by steam was quite impracticable, except for bloodclots, owing to irreparable damage caused to the material.

In 1912 an International Sub-Committee (of which witness is a member) of the International Society for Labour Legislation was appointed to consider anthrax and draw up general regulations. Suggestions were made, but have not yet been published. Finally, the Secretary of State appointed the present Committee to consider revision of the regulations. (29–93.)

Anthrax—In Country of Origin.

T. M. Legge (O): The fact that East Indian wool contained anthrax spores was denied in 1907 at a Conference at the Home Office. Mr. Webb said he had many years experience of manipulation of this material in Karachi and had never known a case of anthrax to occur. The fatal nature of anthrax among animals in India was, however, known from Indian Government records. The Consular reports mention cases of human anthrax treated by native doctors, and others treated by medical men attached to various missions, but they indicate that anthrax, though it occurs among persons manipulating wool in Persia, China, Siberia, and India, is not so prevalent as among those manipulating the same material in this country. Possibly the knowledge of native medical men is inferior, and cases may, therefore, escape correct diagnosis. (78–9, 140–2, 194–6.)

Sir S. Stockman (O): It is the duty of the Veterinary Department of the Board of Agriculture to make enquiry into cases of anthrax among animals in Great Britain. By arrangement the Local Government Board informs witness of all cases reported to the Board of human anthrax arising from contact with animals. The number thus referred averages about six per year—principally among knackers and farm labourers. The infection is always conveyed by external inoculation, and most of the cases are fatal.

Since 1911 diagnosis of cases among animals in this country has been verified bacteriologically. The average annual number of cases in the years 1911–1914 is 756 among cattle, 5 among sheep, 60 among pigs, 31 among horses, and 1 among dogs. Outbreaks result in an average of 1·3 cases per outbreak. Details of distribution of the cases in different counties are given. Anthrax shows no decided tendency to increase or decrease. The incidence is greatest in parts of the country where animals are largely fed on artificial foods, *e.g.*, Aberdeenshire, Banffshire, the West Riding and Wiltshire. The infection is partly enzootic, *i.e.*, in some parts of the country the soil is infected, but it is principally imported in artificial foods for animals and animal manures, *e.g.*, raw bones, shoddy, and blood. The climate of the country is generally unfavourable to soil infection.

In some parts of the country high incidence appears to be due to the trades carried on, *e.g.*, in Wiltshire from tanneries, and round Kidderminster from wool-washing, &c. About 13 per cent. of the cases appear

Sir S. STOCKMAN (O)—*continued.*

to be due to soil infection, 69 per cent. to imported food, and 18 per cent. to other causes. The chief causes of variation in incidence are the numbers of animals in given areas, use of bone or shoddy manures, and feeding with artificial food.

Every owner of an animal is required to report any case of anthrax or suspected anthrax, but very few would definitely know what disease caused the death of an animal, especially in sheep. Sudden death ought, however, to make them suspect anthrax. Instances were given where cases of anthrax were not reported, and the skin and wool got into commerce, but these cases are rare. Generally, the tendency is to report everything as anthrax. There is no obligation to ascertain the cause of deaths among animals except in the counties of Lanark and Midlothian, where owners are required to report every death among cattle to the Local Authority (unless it is certified by a veterinary surgeon to be not from a scheduled disease) who then send a veterinary officer to make enquiries. Incidence of anthrax among animals in Great Britain is greatest in winter, when most artificial foods are used, and this also accounts for the greater incidence among cattle than sheep. Cases are known and were given where animals "killed to save their lives," and the carcases sent for food were found to have been suffering from anthrax.

In South Africa about 420 cases of anthrax are reported annually, but there is much more anthrax among goats and sheep than is reported. Ostriches, among which there is much anthrax, are not included in the returns. The incidence is evenly distributed throughout the year. More cases are reported among goats than among sheep. South African hides and skins are recognised as dangerous.

In France anthrax is reported to occur on 300–700 premises annually. Many thousand cattle and 3,000,000 sheep are annually inoculated in France against anthrax. There is no seasonal incidence. The Algerian goat is insusceptible to anthrax, but when imported into parts of Southern France, it was not resistant to infection there.

In Germany anthrax is reported to occur in about 5,000 premises annually. There are no statistics as to anthrax in Asia Minor, Persia, India, and the East generally, but the incidence is high, and is not seasonal. In places where animals are herded in yards, *e.g.*, Asia Minor, anthrax is likely to be frequent. The plains cattle in India are quite immune from anthrax, and inoculation with virulent anthrax cultures produces no effect. This is probably due to automatic preventive inoculation from soil, because they do die from anthrax. No precautions are taken against anthrax in Asia Minor. Sheep in those countries are not more susceptible to anthrax than in this country.

In Russia, where the statistics are good, there were over 26,000 deaths among animals in 1913. The incidence rises greatly in the summer months and reaches a maximum in July. No precautions are taken against anthrax. The same remark applies to Hungary and China.

There is a great deal of anthrax in South America and the Argentine, but this is principally among cattle, and may not affect the sheep districts, which are possibly different from the cattle districts. The statistics do not give separate figures for sheep and cattle and witness cannot say if sheep are affected or not.

Much mortality from anthrax occurs in the Gambia, and the natives eat the flesh without appearing to suffer ill effects. West African hides, skins, and wool are recognised to be dangerous.

Anthrax is expected to occur from time to time in every country in Europe. (9915–10,016, 10,070–97, 10,125–6, 10,129–35, 10,172–87, 10,220–32, 10,247–9, 10,256–66, 10,283–327, 10,367–75.)

W. P. Norris (O): Witness has not found it possible to get exact figures as to incidence of anthrax in Australia. The report of the Microbiological Department mentions cases among human beings in 1911 and 1912, but doubtful cases only are referred to this Department. Dr. Cleland obtained from the

W. P. NORRIS (O)—*continued.*

Government Statistician data as to 29 *deaths* from anthrax among human beings in the period 1894–1904. Of these 26 were males and three females. Details of the females are not given, but 17 of the males might reasonably be held to come in contact with animals or animal products—seven were farm labourers, four graziers, two butchers, and one each shepherd, drover, carrier, and produce dealer. The cases are all external or intestinal. No inhalation (pulmonary) cases are recorded. Apparently no cases are definitely known to have occurred among persons manipulating wool in New South Wales, though witness would not say that no cases have in fact occurred. Dr. Cleland appears to be surprised that no such cases are recorded.

Amongst animals anthrax is enzootic in the Riverina district of New South Wales (the most important sheep district), along the old cattle tracks between New South Wales and Victoria and in a small district of Tasmania. Ninety-five per cent. of the area of Australia is free from anthrax. Anthrax was originally a cattle disease in Australia, the first case occurring about 1850 near Sydney, and from there it spread inland, but later it affected both sheep and cattle. Up to 20 years ago there were large outbreaks among sheep. Protective inoculation is now practised, and outbreaks are relatively small and infrequent. There were nine in New South Wales in 1913. Usually more than one animal dies, and witness remarks that large flocks of sheep may die without being noticed, though for some considerable period the flocks have been carefully shepherded. There is no evidence of anthrax among wild animals in Australia.

Anthrax was probably originally imported in cattle food, but in recent years cases have been definitely traced to bones imported from India. In the period 1909–1912 there were eight cases of anthrax among sheep and five among cattle in New South Wales, six outbreaks in Victoria between 1911–1913, one outbreak (four cattle) in Tasmania in 1912, and one outbreak (two horses) in South Australia in 1913–1914. No cases have ever been recorded in Queensland or West Australia. Cases of anthrax are compulsorily notifiable, and the diagnosis is bacteriologically confirmed in cases of doubt. When an outbreak occurs the premises are put in quarantine and disinfected, all the stock possibly in contact are inoculated (Pasteur system), carcases, including the wool, are burned or buried deeply, the pasture or place where the animal died is fired, and it is recommended that the stock be kept off the pasture for 12 months.

There may be and probably are cases of anthrax in which the body of a sheep is not discovered; some which are concealed and some which are not reported through ignorance, especially on small farms, but they must be rare. The symptoms and dangers of the disease are brought to the notice of flock owners by leaflets and official publications and by the agricultural press. Cases were quoted of animals being found suffering from anthrax when brought in to be killed by butchers.

Certain trades, *e.g.*, fellmongering, skin pulling, and tanning, are carried on in Australia, which cause occasional cases of human anthrax. The materials dealt with are principally produced in Australia. Witness estimates these cases to average less than one per year. There are stringent import regulations designed to prevent fresh introduciton of anthrax. There is no doubt that the incidence of anthrax among animals in Asiatic countries is very high. (8276–84, 8294–356, 8362–3, 8368, 8380–99, 8414–6, 8477, 8497, 8505–6, 8509–15, 8523, 8529–34, 8564–74, 8593.)

A. Drake (M): Witness has never heard of a definite case of anthrax among the men who class mohair in Constantinople. He has known men die, however, from what he thinks was anthrax, and quotes one case of a man employed by his firm who had a pimple on his cheek. He went to a chemist who put a red-hot skewer through it. He did not come to work the following day, and on enquiries being made it was found that he had died. Employment of classers is quite casual, and if a man does not turn up to work someone else is employed without enquiries. Cases might not, therefore, be heard of.

A. DRAKE (M)—*continued.*

Witness has never heard of anthrax among goats in the mohair districts of Asia Minor. There is, however, no veterinary service, and no precautions whatever are taken against disease among sheep and goats, though some efforts have been made to prevent disease of cattle and buffaloes. For this purpose veterinary surgeons were obtained from Vienna.

Mortality among goats is frequently very high in winter, but witness understands that is from cold. In the early months of 1907 there was great mortality from disease among both sheep and goats, especially in Syria. In some districts 80 per cent. of the flocks died. Goats are herded in covered yards in severe weather, and no precautions are taken when animals die. (9405–18, 9418, 9432–3, 9449–55, 9511–23, 9574–82, 9590–602.)

Anthrax—Incidence of.

T. M. Legge (O): After establishment of special rules for wool sorting, in 1897, cases of anthrax began to be frequent in processes not controlled by the rules. In 1901 a new code of rules covering processes of wool-combing was brought into force, but cases, particularly from Persian wool, continued to occur. It is remarkable that the enquiries made up to 1897 revealed no noteworthy incidence of anthrax in any process after sorting. The fact that the report of the 1897 Committee made no mention of anthrax in later processes is incomprehensible if cases were then known to occur. In 1881 Mr. Spear stated that cases of internal anthrax were much more common, *or at any rate more commonly reported*, than external. At the present time external cases are much more common than internal. About 1905 the incidence of anthrax from use of East Indian wool became acute. In 1910 fatal cases of anthrax were attributed to dusty methods of blending and there was continued incidence of anthrax in the Lancashire felt industry.

A chart is given showing the total cases in Great Britain, the Bradford cases and the fatal cases for each year 1899 to 1913 inclusive. It shows that the incidence of anthrax in Bradford and of fatal cases has not materially altered for some years, but exhibits a tendency to become lower. The incidence of cases in the whole country is, however, steadily increasing. The incidence of fatal cases in Bradford is much higher than elsewhere. There was no fatal case among women outside Bradford, but about one-third of the female cases in Bradford (31) were fatal. 82 per cent. of all fatal cases occur in Bradford. Internal anthrax rarely occurs outside Bradford. The high fatality rate of 1905 was due to the high proportion of internal cases in Bradford.

All the cases of anthrax which occur are not reported (instances are given), but probably fewer cases escape in Bradford than outside, and reporting is better now than a few years ago. Probably the increase in the total number of cases is due in part to the better reporting, and to the fact that practicable remedies, and the regulations, are insufficient to cope with the disease. The incidence of cases in this country depends on the incidence of anthrax among animals in the country of origin of wool. The general increase is not due to any change in methods of manipulation of material. (35, 38–9, 67, 78–9, 81–4, 94–139, 159–61, 165, 169–71, 181–2, 194–204, 240–5.) (*See also* Dr. Legge's Tables, Appendix 2.)

G. A. Taylor (O): The persons manipulating washed wool—among whom three-fifths of the total internal cases noted by Dr. Eurich have occurred—work chiefly in the card-rooms as card feeders, wool runners, back-end minders, grinders, strippers and jobbers, and in comb-rooms as back wash, gill box and comb attendants. It would be difficult to get a return of the workers employed in each occupation unless this was required by law, but witness is willing to assist in attempting it. Incidence of anthrax is highest in those card-rooms where measures for the prevention of dust, *e.g.*, willowing and oiling, are not taken. (1392–5, 1439–42, 1585–91, 1697–1701, 1780–8.)

F. W. Eurich (P): Witness has seen over 100 cases of anthrax among human beings in the Bradford district. Twenty of these were fatal internal cases, the occupations of the patients being as follows:—(a) *Pulmonary cases* (17).—Woolsorters, 3; woolpuller and runner, 2; washbowl feeder, 2; woolwasher, 1; wooldrier, 1; willeyer, 2; card feeder, 2; back-end minder, 1; card grinder, 1; box minder, 1; combing jobber, 1. (b) *Laryngeal cases* (1).—Combminder, 1. (c) *Gastro-intestinal cases* (2).—Card-minder, 1; card-grinder, 1. Twelve of the patients manipulated washed and eight unwashed wool. The conclusions as to danger of varieties of wool drawn from results of bacteriological examination of wool agree generally with those of Dr. Legge, drawn from a consideration of the incidence of anthrax. Witness has known cases of anthrax to occur in manipulation of wool after the bloodstains were sorted out by skilled sorters. Incidence of anthrax among men sorting the bloodstains out of wool is very low, one case only being observed.

Witness has no evidence that anthrax is more common among town dwellers than among country workers under the same conditions. It is to be expected that incidence of anthrax would be higher among uncleanly persons and among those of feeble constitution than among the cleanly and robust. Incidence of anthrax is higher in some factories than in others, partly because a greater amount of dangerous material is used and partly because precautions are less efficiently carried out. In 1914 the number of cases recorded in the Bradford district in manipulation of wool was 10, of which one was internal. Though there was restricted use of mohair, there was a full supply of Persian wool. (504–6, 512–17, 588, 806–10, 838–9, 918–19, 966–91, 1033–59, 8761–4.)

Examination of Dr. Bell's clinical notes (although these are incomplete) and reports of inquests from 1878 to 1896 show that cases of anthrax were not confined to wool-sorters in that period. Dr. Bell's notes only refer to fatal cases, 13 of which are recorded as occurring to persons manipulating material after washing, while two non-fatal cases are referred to in Mr. Spear's report to the Local Government Board. These figures cannot show the full incidence of anthrax in the later processes of wool-combing prior to 1897, because the records are imperfect, and fatal cases only are mentioned. The proportion of cases in these processes as compared with those before washing appears, however, to be higher now than before 1896. Probably workers are now protected in the earlier processes by the regulations. (8714–28.)

W. Mitchell (P): Witness has had special opportunities of studying anthrax among persons manipulating wool in Bradford, as he is employed by three firms to examine those workers who are ill, or who develope pimples which may be anthrax. (*See* Medical Examination, page 4.) Incidence of anthrax has not diminished in Bradford for many years in spite of the removal of bloodstains from wool, but the incidence of fatal cases is lower—probably owing to their earlier diagnosis. (7170–4, 7213–22, 7309–14, 7327–8.)

G. H. Feather (E): Since 1906, 17 cases have probably been caused by infection from Persian wool owned by witness. Cases may possibly have occurred before 1906 and escaped notice, but witness knows of none in the history of his firm (50 years). Before the disease was known as anthrax it was known as wool-sorters' disease, and it was then largely confined to wool-sorters, though none of the sorters employed by witness's firm suffered. At the present time anthrax is more prevalent amongst workers in processes between washing and combing than among sorters.

After 1908 witness had bloodstains picked out of his wool, but cases have continued to occur. This may be because some bloodstains were missed. (*See* Infected Material—Bloodstains.) It is very difficult, if not impossible, to get all bloodstains out of locks, and these are being sent in increasing quantities mixed with Persian wool. Anthrax is more prevalent in some mills than in others where the same classes of wool are manipulated. Sorting may be less thorough, or more of the particularly dangerous

G. H. FEATHER (E)—*continued.*

varieties may be manipulated in some works. Witness has heard Marseilles buyers deny the existence of anthrax in Marseilles, but would not be surprised to hear that incidence there is high because of the locks and pieces bought by those buyers (4224–95, 4511–22, 4557–68, 4579–87, 4692–703, 4731–41.)

G. Ackroyd (E): The first recorded case in witness's commission combing works (in which he employs 100 males and 50 females) was that of a noil packer in 1892. This was followed by one in 1894, one in 1898, two in 1899, and one in 1905. There were other suspicious cases in this period also, which were successfully treated and not reported as anthrax. The chief material combed was Persian wool. The cases occurred before and after the material was washed. Probably anthrax always occurred in every process of combing, but cases in the later processes were not recognised (in the period previous to 1900), as it was thought they could only arise from the raw material. More Persian is, however, now used, and other infected wools, like Egyptian and Syrian, have come into use in recent years. This may account for the fact that cases are now more frequent after the material is washed, while formerly they were more frequent in the earlier processes. The Bradford Voluntary Regulations of 1884 caused a material reduction in the incidence of anthrax. The Special Rules of 1900 and the Regulations of 1905 were not based on accurate knowledge, and, broadly speaking, they have not effected a decrease in the incidence of anthrax.

For the last 14 years the material treated by witness has been chiefly mohair and alpaca, and bloodstains have been picked out since 1908. One case occurred in his works in 1909. Some of the material handled (Turkey mohair) was found to contain infected bloodstains, and it was proved that some had been missed in sorting. No cases have occurred since, though material known to be infected has been handled frequently. It is witness's opinion that 90 per cent. of the cases of anthrax would be prevented by efficient picking out of bloodstains. Witness is aware of the high incidence of anthrax in Messrs. Crossley's works since the picking out of bloodstains was commenced, and states the firm took greater precautions than he did.

Witness put in a table showing the incidence of anthrax since November 1st, 1909, in two works, both combing the same classes of wool; in both of which bloodstains were picked out. Works "A" had 16 cases, of which 14 were attributed to manipulation of Persian wool. Works "B" also had 14 cases, in which the infection was caused by Persian wool, but in Works "A" three cases occurred before, and 11 after, washing of the material, nine of the latter being in the card-room, while in Works "B," five cases were contracted in manipulation of unwashed (four of which were in willowing), and nine of washed material, of which three were in the card-room and three in willowing after washing (fearnought willowing). In Works "A" the wool is sorted (and bloodstains removed), scoured, and carded, while in Works "B" it is sorted (and bloodstains removed), willowed (shaken), scoured, willowed (fearnought), and carded. The source of infection had evidently not been removed in either case, and was spread by the first severe process in the course of manufacture—in Works "A" by carding, and in Works "B" by willowing. (6280–382, 6571–89, 6822–3, 6996–7000.)

Since 1905 the Anthrax Investigation Board have received reports on 129 cases of anthrax, 110 of which were verified, and witness has classified these (Appendix 4). The incidence has steadily increased from 1905 to 1913, the increase being among non-fatal cases. Witness ascribes this to better reporting and diagnosis. The incidence of internal cases was much above the normal in 1905–6 and 1910–11. In these two periods all the internal cases occurred in seven works, but no specific reason for the outbreaks can be given. (6590–604.)

In the period 1905–13 there were 18 fatal internal, and 14 fatal external, cases. Of these, 10 internal

G. ACKROYD (E)—*continued.*

and three external occurred in manipulation of unwashed, and seven internal and 11 external in manipulation of washed, material (one internal case was doubtful). About 15 to 25 per cent. of the persons employed work in processes before, and 85 to 75 per cent. after, washing. The total fatal cases are greater in number in processes after, than in processes before, washing, but if the number of workers be taken into account the incidence of fatal cases is much greater in manipulation of unwashed wool. Of the nine fatal cases due to mohair alone, four (all sorters) occurred before, and five (spinner, comber, top packer, box-minder, drawing and spinning overlooker) after, washing. It is suggested that the high incidence of fatal cases in manipulation of mohair may be due to minute lacerations or to inoculation caused by the sharp-pointed hairs peculiarly characteristic of mohair, but more fatal cases are caused by Persian, though about 30 million pounds of mohair is used as against about 5 million pounds of Persian. (6605–31.)

Long-fibred materials are "prepared," and those of shorter fibre are "carded." Of a total of 107 cases in Bradford district, 21 occurred in manipulation of preparing, and 86 in manipulation of carding materials, though the quantities of the two sorts combed are about equal. Of the cases in preparing, the infection originated from raw materials in 16 (15 sorters and one wash-bowl minder), and from washed materials in five (one comber, two top and noil packers, and two spinners and drawers). There were no cases between washing and combing. In the 86 carding cases, 33 were caused by raw, and 53 by washed, materials. This difference in incidence in preparing and carding is explained by the fact that preparing is a much quieter and less severe process than carding. Mohair is the chief preparing material, but if short-fibred and of low quality (about 10 per cent. of total), it is carded. Carding materials are frequently coloured, and are often of lower quality than preparing materials. Infected material is more frequently found in low qualities, and is also more difficult to pick out of coloured wools, but the process is probably equally to blame with the material Preparing materials are generally sorted, and this is the most dangerous occupation in the preparing process, while in the carding process, washing and carding are the most dangerous occupations. Carding is a cleansing process, while preparing is not. In the former, infected materials (bloodclots, &c.) are broken up and partly removed from the wool. In the latter this does not occur till the process of combing is reached. This may explain the incidence of anthrax in carding and its absence in processes of preparing between washing and combing. (6632–68, 7158–64.) (For analysis of cases caused by each material, *see* Infected Materials—Varieties.)

In the manipulation of mohair, the incidence of anthrax is highest in sorting, probably because the material is very carefully sorted. A high incidence of anthrax in dusty processes is only possible where bloodstains have not been removed. A high temperature in the workroom would contribute to a high incidence of anthrax by lowering the general health. The incidence of anthrax depends in some degree on the standard of health among the workers.

The analysis of cases for 1914 confirms the conclusions drawn from the incidence in previous years among persons manipulating mohair and Persian wool, but witness suggests that one reason why the incidence varies in the different processes of combing these two materials is because of the different methods of removing the materials from skins. Persian wool is removed by a dry, and mohair by a wet, process. In the former the bloodstains remain whole, and in the latter infection is distributed. In both cases skin material is mixed with fleece material, and these facts may explain the high incidence of anthrax among mohair sorters. Bacteriological examination of samples of tops and noils from witness's works showed presence of anthrax spores, thus proving that infection persists through all processes. This goes far to explain the incidence among spinners. (6818

G. Ackroyd (E)—*continued*.

–42, 6877–9, 7059–66, 7086–93, 8028–9, 8138–44, 8220.)

J. H. Halliday (M): Witness has managed for 25 years a commission combing works where 56 males and 50 females are employed, and in which 60,000 lbs. of wool is combed weekly, consisting principally of camel hair and Persian wools; and irregularly of alpaca and cashmere; East Indian, Syrian, and Egyptian wools. Skilled sorters have always been employed, and bloodstains have been picked out since the beginning of 1909 after training the sorters to recognise them. The number of workers employed in each process is—warehousemen, 8; skilled sorters, 7–12; in the washhouse, 11 (including raw and washed wool willowers); in the card-room, 11 males and 9 females; in the comb-room, 7 males and 41 females.

So far as witness's knowledge goes the first case of anthrax in the works occurred in 1906. The reason for cases commencing to occur in that year was the bad condition of the Persian wool, which has continued. Since 1906, 18 cases have occurred in nine years. Four of the cases occurred before the removal of bloodstains was commenced, and 14 after. Two (one card jobber and one drying machine attendant) were internal cases and were fatal. The cases were distributed as follows: one each of sorters, warehousemen, blend pullers, raw wool willowers, and drying machine attendants, four wool washers; three washed wool willowers; two male and one female card-room hands; and one male and two female comb-room hands. All the dusty processes precede washing, but 22 per cent. of the workers are employed before and 78 per cent. after washing. Eight cases occurred in processes before and ten in processes after the material was washed. In the four years before 1909 (in which year the picking out of bloodstains was commenced) two cases occurred before and two after washing.

The temperature of the washhouse, or that at which the wool is washed and dried, appears to favour the development of the disease, as eight of the above cases occurred in the wash-house (four wool washers, three washed wool willowers, and one drying machine attendant). Washing may break up the bloodclots and expose the spores. Batches of material known to be infected have passed through the works without cases arising. Witness could only explain this by suggesting that the spores did not find a position suitable for development.

Sorting is done quite as much at the present time as formerly, but the reason that the incidence of anthrax is now lower among sorters is because they are protected by existing regulations, while the reason the incidence is now so high in later processes is that wools being sent to this country contain much more and more badly infected material than formerly. There has been no reduction in the incidence of cases since the picking out of bloodstains was commenced in witness's works, but the cases are slighter. Witness has known cases of anthrax to occur in manipulation of tops and of noils and of waste. (5593–600, 5607, 5627–37, 5791–849, 5855–62, 5935–6, 5978–99, 6032–46, 6148.)

"B. A." (W): Witness cannot say that dust causes anthrax, but in his experience incidence of anthrax among men manipulating the same wool in the same process is highest where there is dust, and he gives an instance of men working at a washbowl close to dusty blending bins where the incidence is much higher than among men working at a washbowl situated at a distance from the bins in the same works and washing the same wool. In the works in which he is employed, cases of anthrax have occurred in manipulation of wool from which the bloodstains have been picked out, and he thinks this is because it is impossible to remove all bloodstains. Cases have also occurred among members of a workman's family when washing his clothes. He thinks anthrax is not more prevalent at one works than another if the same materials are combed. (2369–85, 2417–8, 2576–9, 2584–89, 2602–4, 2697–701.

T. Larkin (W): In the commission combing works in which he is employed there have been three cases of anthrax (including himself) in 10 years (one each in the warehouse, washhouse, and comb-room). Bloodstains are carefully picked out from all wools, and he thinks the comparative immunity from anthrax in the works is due to the care with which this is done. He thinks incidence of anthrax higher among woolcombers than wool-sorters. (2950–74, 3102–7.)

"W. R." (W): In the works where witness is employed, bloodstains are picked out of the materials by warehousemen, but cases of anthrax have occurred in the card and comb-rooms, and he thinks this is because bloodstains are missed. More cases of anthrax occur among combers than sorters, but few sorters are employed in commission combing works. He thinks the warmth during washing favours the development of the spores, and that there is not much danger till the material is washed, though sorters run a certain amount of risk. Wool may be properly sorted, but infectious material missed. Witness compared two works using the same materials in one of which sorting for bloodstains was hurried and in the other it was not. The former had many more cases of anthrax, and he associates hurry with increased danger of anthrax. (3326–41, 3407–11, 3424–6, 3503–11, 3568–92, 3617–21, 3657–63.)

"S. J." (W): In the cardroom of a Commission Combing works where witness is employed, 17 cases of anthrax have occurred and others have arisen in different parts of the works. Speaking from memory, cases have been much more frequent in the last seven years in the works of which he has experience than formerly. Witness compared the cardrooms in two Commission Combing works in which the same materials are dealt with, in one of which the cards are run at a higher speed and the atmosphere is much more dusty than the other. Incidence of anthrax is high in the former and low in the latter. The higher speed of the cards causes more dust, but also causes speeding up in other processes such as picking out bloodstains and washing in which no more men are employed than formerly. This results in less thorough picking out of infectious material and in imperfect cleansing of the wool. Witness thinks dust is the cause of the rise in the incidence of anthrax and gives his own case as an instance, but the increased quantity of material put through the works in a given time would also have an effect. Witness has no figures to prove this increase, but says as much is now put through in a day as was formerly put through in a day and a night. (3681–720, 3763–804, 3838–63, 3921–39, 3975–84, 4045–50, 4157–60.)

"F. J." (W): Witness remembers the time when "Woolsorters disease" was prevalent in Bradford. There were cases among woolcombers at that time, but the incidence was chiefly, and was more marked, among sorters. He thinks the greater incidence among combers now is due to hurried and careless removal of bloodstains. (4847–55).

"C. W." (W): Witness remembers the time when anthrax was known as "Woolsorters disease." Internal cases caused by inhalation were most common, and it was frequently called congestion of the lungs. The disease was not confined to sorters but so many sorters died that attention was concentrated on it as being one peculiar to woolsorters. Witness knew of no external cases at that period but has known them more recently. All classes of persons who manipulate wool are subject to anthrax at the present time. This is due either to hurried or to careless sorting out of infected materials; but with the greatest care it is not possible to remove all bloodstains from wool by sorting. Witness gives instances from his own experience. (5173–83, 5192–95, 5225–31.)

"G. J." (W): In the washouse in which witness is employed five cases of anthrax have occurred. One washbowl is close to the blending bins and the air is dusty. The other is in a clear atmosphere. The incidence of anthrax is higher (4 : 1) at the dusty bowl than at the other, and he associates dust with anthrax. (5365–89, 5472–80.)

Anthrax Investigation Board.

T. M. Legge (O): Arising out of the discussions which took place in drafting the 1905 regulations for woolcombing and woolsorting, suggestions were made for the formation of a local expert committee for the study of dangerous varieties of material, anthrax cases arising from their use, and additional preventive measures. The result was the constitution in July 1905 of the Anthrax Investigation Board for Bradford and district. In 1910 the Board recommended that where blending is done without preliminary sorting special measures should be taken to remove dust from wool, or to allow time for it to settle before persons entered the blending room, that blending should not be done in underground rooms, and that bloodstained material should be removed before blending.

When it became obvious, largely through the work of the Board, that bloodstained material was much more dangerously infected than dust, the Home Office requested the Board to investigate the possibility of steam disinfection of wool. The investigation was carried out by a committee on to which experts were co-opted, and they reported unanimously in June 1913 that the use of this method except for bloodstained material is impracticable for wool and hair used in Bradford on account of its damaging effect on the fibre. (56, 59–65, 85, 88–9.)

F. W. Eurich (P): The objects of the Anthrax Investigation Board are the study of anthrax cases, the investigation of anthrax generally, determining more precisely the dangerous classes of wool and hair, and the discovery of further means of preventing anthrax. (501.)

G. Ackroyd (E): The want of precise knowledge revealed in the discussions preceding the 1905 regulations and the desire to make effective rules for the prevention of anthrax were the reasons for the formation of the Anthrax Investigation Board. The objects of the Board are (1) the investigation of anthrax generally, (2) the determining of materials conveying infection, and (3) the study of better means of prevention of the disease. Witness's evidence is largely based on information gathered by the Board, of which there is sufficient to warrant changed regulations. He agrees with the summary of the work of the Board given in its Seventh Annual Report. (6302–9, 6566–7.)

Anthrax—Notification of.

T. M. Legge (O): Section 73 of the Factory Act requires every medical practitioner to report to the Chief Inspector of Factories every case he attends of visits which he believes to be anthrax. The occupier of every factory is also required to notify the district inspector of factories and the certifying surgeon of every case of anthrax occurring in his factory. While the practitioner must report every case he believes to be anthrax, whether or not it really is a case of this disease, the occupier need only report actual cases, and is entitled to await a definite decision before reporting. The latter can have no knowledge of his own and must be guided by medical men. In both cases failure to report is punishable. All the reports received are referred to witness, who has kept statistics of all cases reported since 1899.

Reporting is affected by the fact that great experience is needed to recognise anthrax, and many medical practitioners in parts of the country outside Bradford lack the experience and knowledge. Reporting is better now than it was some years ago, and the increase in the number of cases recorded in the annual statistics is partly accounted for by improved reporting. Witness thinks very few cases are missed at the present time and that the reason why no decrease is observed is that the remedies it is practicable to apply are insufficient.

It is difficult to state on what grounds cases should be reported as anthrax. It is not always possible to demonstrate bacteriologically the presence of bacilli, and witness thinks clinical evidence should in many cases be accepted as sufficient. The effect of the method of reporting is that the certifying surgeon and the occupier may not hear of a case for several

T. M. Legge (O)—*continued.*

days. In witness's opinion this is of no practical importance since the occupier is only concerned in the methods of preventing the disease in his factory. It may, however, make it more difficult to ascertain which of the materials has caused the infection. Witness did not regard favourably a suggestion that the medical practitioner should be required to notify the occupier as well as the Home Office, but he was greatly in favour of the occupier being required to employ a medical man to visit any person manipulating dangerous materials who stayed away from work without stating the reason.

The reporting of cases occurring in Persia, China, Siberia, India, &c., is very defective, but anthrax appears to attack the natives less readily than Europeans. (4–10, 17, 98–101, 125–30, 140–9, 169–71, 183–93, 211.)

Sir S. Stockman (O): The Board of Agriculture has an arrangement with the Local Government Board by which the latter notifies the former of any case of human anthrax apparently arising from contact with animals. This sometimes leads to discovery of unreported cases of animal anthrax. There is a statutory obligation on the owner of any animal or carcass, or the person in charge of it, to notify an inspector of the local authority if he suspects it to be suffering from or to have died from anthrax. The notification of animal diseases order of the Board of Agriculture also requires veterinary surgeons to report any case they may observe. The duration of illness is short, and the symptoms of anthrax are vague, so that there may be some cases of failure to report, but there is rather a tendency to over report on the whole.

In Midlothian and Lanarkshire every case of death of an animal must be reported unless a veterinary surgeon certifies that death was not due to a scheduled disease. The local authority or their inspectors must report to the Board of Agriculture every case of disease which a veterinary surgeon cannot say definitely is not anthrax, which comes to their knowledge, and the inspector must also report the case to the medical officer of the local authority. The Board of Agriculture itself undertakes verification of the diagnosis, and no case is recorded in the statistics as being anthrax unless the diagnosis is verified. This is the explanation of the fall in the number of cases reported after 1910 when bacteriological confirmation was commenced. Before this about 30 per cent. of the cases reported as anthrax were, in fact, not this disease. (9915–9, 9990–10,016, 10,220–30, 10,286–8.)

W. P. Norris (O): The disease of anthrax in both human beings and animals is compulsorily notifiable in Australia. The proprietor or person in charge of any animal or of premises in which cases of anthrax occur, and the medical attendant of any person suffering from anthrax, are required to give notice—in respect to animals, to the nearest police station and to the Stock Branch of the Agricultural Department, and in respect to persons to the Health Department. The regulations are brought to the notice of all concerned by publication in the agricultural and other press. Agriculturists are aware of the importance of suppressing anthrax, and report cases promptly Some few are, however, without doubt, not reported. (8345–6, 8369–79.)

Anthrax—Precautions against.

T. M. Legge (O): In 1910 H.M. Factory Inspectors were instructed to press occupiers to adopt the following precautions against anthrax: (1) to discontinue blending in underground rooms; (2) to remove bloodstained materials; (3) to use dust extracting machines, or to blend in enclosed chambers provided with steam jets for allaying or fans for removing dust, and to prevent entry of workers till the dust had settled. (83, 87.)

W. P. Norris (O): (*See* Regulations—Existing.) Distinctly large outbreaks of anthrax among animals formerly occurred in Australia. They are now relatively small and infrequent. This is due partly to the compulsory notification of outbreaks and destruction by burning or deep burying of all carcases of

W. P. Norris (O)—*continued.*

animals which have died from anthrax, and partly to encouragement of the practice of preventive inoculation. Reported outbreaks are investigated by stock inspectors, who supervise the destruction of carcases and the quarantine and disinfection of premises. Preventive inoculation is voluntary, but is carried out by the authorities where an outbreak has occurred. The flockowner is also recommended to avoid placing stock on the possibly infected pasture for at least 12 months. Measures are also taken by means of leaflets and by publication in the agricultural press to bring the dangers of anthrax and the precautions which can be taken against the disease to the knowledge of flockowners and others.

Stock inspectors have power also to adopt any necessary measures, but the practical measures usually taken are quarantine of premises till active infection has disappeared, burning of carcases intact (including the wool of sheep), and preventive inoculation. The term "quarantine" is interpreted in such a way as to give ample powers. (*See* Definitions.) The local police act locally for the stock branch of the Department of Agriculture, but in any serious matters an inspector of stock would act.

The Pasteur system of inoculation is used and the establishments in which the vaccine is prepared are under Government inspection and control. There is some danger to life of the animals in its use and a few deaths occur; the mortality may reach 1–2 per cent., but it is under control. The actual inoculation is not supervised by the Government. In some known infected areas it is carried out annually, though not now so extensively as 20 years ago. Anyone can obtain the vaccine, but a register of persons to whom it is supplied is kept.

A further precaution against the introduction of anthrax in Australia is the prohibition of import of any animal products (wool, hair, hides, bones, &c.) except in quarantine through certain ports and subject to the requirement that, if necessary, they must be disinfected. Notice of intention to import these materials must also be given before shipment. The imported materials must be dealt with as the Quarantine Officer may direct, power is taken to refuse permission to import, and any treatment required after importation must be carried out under the supervision of an Inspector.

In the opinion of witness the only certain way for prevention of anthrax in a country which must draw its supplies of wool and hair from other countries, is for the country to have organisations in the supplying countries which could make enquiries as to the precautions taken for preventing infection of the material. If there were supervision of the districts or even the premises from which the wool is drawn, choice could be exercised as to the materials which could be accepted. At the collecting centres also there should be supervision so that questionable lots could be rejected. There should be international notificaton of outbreaks of anthrax in any district or country. Unless this be enforced no country is safe, and products of all districts or countries from which notification cannot be obtained should be regarded as suspicious. That is the experience of the working of the quarantine organisation in Australia. In witness's opinion materials known to be infected should be disinfected before they are manipulated.

It is not likely that anthrax could be introduced into a country by importation of live animals, though all live animals entering Australia are put in quarantine for 14 days at least. Anthrax might be introduced in imported fodder. (8320, 8341–2, 8345–8, 8369–436, 8458–508, 8516–22, 8535–46, 8567–80, 8585, 8598–603.)

Sir S. Stockman (O): The Board of Agriculture require, by regulations, precautions to be taken when an outbreak of anthrax occurs among animals. (*See* Regulations—Existing.) Disinfection of premises is required, but as applied to farms is probably not usually an effective precaution unless it be done before sporulation has taken place. Fodder would be destroyed only if it had been given to the diseased animal as food and not consumed, but no store

Sir S. Stockman (O)—*continued.*

of grain or fodder would be destroyed. Animals which have been in contact are put in quarantine in order to gain time to see if other cases develop, and to prevent, if this be the case, the establishment of another infected area.

The only effective means of preventing outbreaks of anthrax among animals living on infected soil or exposed to infection is the adoption of preventive inoculation. It is practised to a small extent in Great Britain, but not generally. It is, however, practised in France, Germany, Hungary, the Argentine, and to a limited degree, in South Africa. Statistics show that preventive inoculation reduces the mortality from about 10 per cent. to about one per cent. of the flocks or herds. A number—probably a half per cent.—of the inoculated animals die as a result of inoculation, and immunity lasts for about a year.

Witness can suggest no precautions for preventing anthrax in the manipulation of wool. Disinfection is the only precaution likely to be effective, but no means of disinfection which does not destroy the wool is known. It is common knowledge that dock labourers handling wool and hides, particularly the latter, contract anthrax, and witness has thought of suggesting preventive inoculation. This cannot be done, however, because fatalities occur, and one cannot annually inoculate human beings with anthrax. If a method of disinfection of wool and hair could be found which, while destroying anthrax spores, does not affect the material and is not unduly costly, witness thinks the whole world is ripe for its adoption; but if there be a chance of destroying the industry, disinfection cannot be recommended.

So far as anthrax among animals is concerned, it is impossible to do more than is done in Great Britain. It is impossible to inspect a country side and to prevent ignorant people in the country doing wrong things. All that can be done is to bombard them with literature on the subject. As regards human beings, the exhibition of placards giving warning as to the characters and symptoms of the disease, and provision of means for quick medical treatment, will reduce the mortality, but witness regards it as hopeless to think of eliminating the disease. (10,032–40, 10,098–124, 10,135–40, 10,233–96, 10,360–6 10,376–82.)

Anthrax—Treatment of.

T. M. Legge (O): The use of Sclavo's serum affords the only possibility of successful treatment of internal anthrax, but no treatment of this form of the disease offers more than a remote chance of success. Recovery (in external cases) has followed use of Sclavo's serum even after anthrax bacilli have been shown to be present in the blood. It is not possible to form any accurate judgment of the value of Sclavo's serum from the statistical records of recovery or death following its administration. It is used in hopeless cases because it is the only means which can be used with any prospect of success after the disease has reached a certain stage. Its administration is also the only possible treatment when the pustule developes in situations, *e.g.*, the eyelid, where operation (excision) is impossible. It is beyond question that the anthrax bacilli disappear from the blood after injections of Sclavo's serum and one internal case recovered under this treatment. (162–8.)

F. W. Eurich (P): External anthrax is more susceptible to treatment than internal anthrax, because the anatomical structure of the outer parts of the body are more likely to cause the infection to remain localised. In internal cases there is such an absence of definite or distinctive symptoms or the symptoms so closely resemble an ordinary cold, or influenza, or pneumonia, that the patient himself, or the doctor called in is misled until the disease is so advanced as to defy treatment. Witness has never known recovery to take place in a definite case of internal anthrax.

The Committee may consider treatment of anthrax, but this would be futile, because any recommendation which might be made could not bind a medical man. (508–11, 873–5, 1006–10.)

W. Mitchell (P): The use of Sclavo's serum sometimes causes joint troubles, arthritis and skin eruptions. Witness has seen one man incapacitated for 12 months from this cause. Witness also read a letter from Dr. J. H. Bell describing this effect on one of his patients. The use of Sclavo's serum is not dangerous to life.

Anthrax ought never to be treated in private houses. Witness attempted to do this in his early experience, but the patient should be under observation for several days by someone who can act at any moment For this reason every patient should go to a hospital or other institution. Usually patients are ready enough to do this, but it is in their discretion to refuse. Such refusal, in the opinion of witness, ought to exempt the employer from the obligation to pay compensation under the Workmen's Compensation Act in the event of death. It would be impossible to empower medical men to order the removal of patients to an infirmary since the latter have the right of refusal to go. (7199–204, 7255–60, 7325, 7360–2.)

Anthrax—Statistics of.

T. M. Legge (O): One of the duties of witness is to keep statistics of anthrax occurring in industrial occupations. Witness prepared a chart based on his statistics showing the fatal cases, the Bradford cases, and those occuring in other parts of the country in the period 1899–1913 inclusive. In the statistics the cases are classified largely according to the special rules and in accordance with the material—wool, horsehair, hides, &c.—causing infection. A list of the cases of anthrax occurring each year is published in the Annual Report of the Chief Inspector of Factories. In the first two or three years the statistics are not quite accurate, because a few cases were excluded which would now be included.

The statistics show that the number of cases occurring annually in manipulation of wool has increased in recent years, but has not increased in Bradford (*i.e.*, the worsted trade). The increase has taken place in districts outside Bradford (*i.e.*, in the woollen trade). The fatal cases have not increased in number, but most of them occur in Bradford (82 per cent. of all deaths). This is partly explained by the fact that internal anthrax is practically confined to Bradford, and partly because the danger of some of the materials used in Bradford is more intense than that of material used elsewhere. Careful enquiry has been made as to the correctness of the diagnosis in reported cases, and witness has held the balance fairly where there has been doubt. (17, 94–135, 226–7.)

Bacteriological Examination.

T. M. Legge (O): In 1899 the Home Office made arrangements for the bacteriological examination of material for the purpose of verification of human anthrax, but owing to the delays and complicated procedure it was not of much value. The bacilli, though originally present in material, cannot always be found bacteriologically, *e.g.*, if examination is delayed more than 24 hours in *post mortem* cases they may die for want of nutriment or be destroyed by other organisms.

It is desirable and possible that fallen fleeces be sorted out and isolated till proved to be free from infection. The bacteriological examination necessary would, however, involve great labour, and it would be sufficient if all such material were treated as infected. (35–7, 149, 197–8, 311–3, 413–5, 478–9.)

G. A. Taylor (O): Witness suggests that all blood-stained material should be disinfected or destroyed without permitting any to be reserved for bacteriological examination. (1686.)

W. S. Smith (O): In the horsehair factory at Pavia (Pacchetti Bros.) no bale of hair is manipulated till a bacteriological examination of the material has been made. In the opinion of witness there is no objection to allowing wool to remain in sorting rooms till the material has been bacteriologically examined. In many works chemical examination of materials is a matter of routine, and there is no reason against

W. S. Smith (O)—*continued.*

employment of this principle for bacteriological examination of each bale of wool. It would be better than having a standard of dust in the air or in wool. It would be a considerable undertaking, but it is done at Pavia, where five or six bacteriologists are employed, and 12 to 30 samples can be examined per day by one bacteriologist. (7830–3, 7875–8, 7956–69.)

Sir S. Stockman (O): For the purpose of verification of diagnosis of anthrax in animals bacteriological examination of material is made in the laboratory of the Board of Agriculture. Blood is sent on a sterilised swab or as a smear, and instructions as to preparation are issued to persons taking the material for examination. The snear is stained with methylene blue (Sir John McFadyen's method) and examined microscopically. The anthrax bacilli can be detected, even in the presence of putrefactive organisms, by means of the special forms they assume when degenerating, *i.e.*, by the peculiar swelling of the membrane, in which the bacilli develope, which becomes stained pink. No other organism known to witness produces these degeneration forms though it is not possible to distinguish undegenerated anthrax bacilli from putrefactive bacilli. A swab is much to be preferred to a portion of the ear of an animal. Its packing is safer and more certain. In a few cases of uncertainty inoculation of guinea pigs is resorted to, but this is only infrequently necessary, and mistakes in the bacteriological diagnosis are rare. Witness has not tried the method for human anthrax, but sees no reason why it should not be successful. (10,199–205, 10,348–54.)

W. P. Norris (O): In cases of doubt, diagnosis of anthrax among animals in Australia is verified by bacteriological examination of the tip of the ear sent to the authorities for that purpose. If putrefaction of tissue sets in, anthrax bacilli are destroyed. (8380–1, 8529–34.)

F. W. Eurich (P): Witness's duties, as bacteriologist to the Anthrax Investigation Board, include bacteriological examination of manufacturing materials and of material from cases of human anthrax arising in the area of the Board's operations. Bacteriological examination in cases of human anthrax cannot be made compulsory, because it requires the consent of the patient to take his blood for examination. It should be used, however, where possible for verification of diagnosis. Certain precautions are necessary in taking and sending blood or material from a pustule, because blood, many body fluids, and putrefactive organisms possess the power of destroying anthrax bacilli. As usually taken in a capillary tube it may originally contain many bacilli, but these may disappear entirely if there be delay in the examination, *e.g.*, when it has to be despatched to a distance. A definite instance is quoted. The best method is to soak silk threads in blood or serum from the pustule, place these in a small strong glass tube, stopper it with cotton wool, and place it in another strong slightly larger glass tube which contains a little calcium chloride and can be corked. The calcium chloride causes the blood to dry rapidly, and the bacilli then form spores which will not be destroyed. Smears on glass slides should also be taken, dried, and sent for microscopic examination. The outfits described should be used by doctors—their distribution to factories would be valueless.

The object of the bacteriological examination of manufacturing materials was to ascertain the naked eye appearances of danger and the degree of risk attaching to various kinds. Witness found it necessary to work out a method suitable for examination of wool and hair, and for this reason the earlier work was excluded from statistics put in as evidence Classification of materials sent for examination was also very faulty. In this early period 312 samples were examined, of which four were infected. In the six years following 4,745 samples were examined, and 311 found to be infected. Details are given in other sections of the summary. It is feasible to require bacteriological control of material as it comes into the factory. (502, 542–67, 939–49, 971–3, 981–4, Appendix 5.)

W. Mitchell (P): (*See* Anthrax—Diagnosis.) Witness considers bacteriological confirmation to be essential in all cases of human anthrax. This probably cannot be obtained (before death) in internal cases, but can be in external cases. It can be done either by microscopical examination of a blood smear or by culture, and is a very simple thing which anyone can easily learn. A microscopical examination requires a short time, but a culture does not give results till next day. (7241–6, 7382–404.)

G. Ackroyd (E): Before 1905 there were no bacteriological examinations of wool or hair so far as witness knows, and decisions as to danger of material were often guess-work. The drawing up of a list of dangerous materials should be based on experience and the result of bacteriological examinations. Witness suggests that disinfection of Turkey skin mohair should be compulsory, unless the material has been shown to be free from danger by bacteriological examination. The method of sampling should be to take 2 lbs. of bloodstains or, if these are not available, 8 lbs. of skin mohair from different bags. The whole of the material should be treated as infected till proved to be free from infection. Witness pointed out the difficulties which would arise if this were not compulsory. Dealers can hardly be expected willingly to send their material for bacteriological examination and risk a heavy decrease in value which would follow a report that it is infected. Nevertheless, witness is of opinion that the examination should be made before it is sold to combers or spinners. It is desirable in everyone's interest that it should not be manipulated till the prospective degree of danger is ascertained. He suggests that if one sample only out of 20 is found infected, removal of bloodstains should be deemed sufficient treatment, and instances his own freedom from anthrax in support. (6322–37, 7147–50, 8010–7, 8147–56, 8231–34, 8267–9.)

J. H. Halliday (M): Witness suggests that it should be compulsory to have the bloodstains first found in any bale of wool bacteriologically examined. If found to be infected, greater care and precautions could then be observed. It should not be compulsory to await the result before allowing the material to go through the processes of manufacture, and the examination would, therefore, not be very useful for small lots. If, however, the material were allowed to be sorted and stay in the sorting room pending bacteriological examination, there would be no reason why the result of examination should not be awaited before it is further treated. (5842–9, 5960–4, 6051–61, 6108–22, 6149–50.)

Blending.

T. M. Legge (O): (*See* Dusty Processes.) An experimental inquiry by Mr. Duckering showed the value of willowing for preventing dust in blending, the figures for dust in the air being very high where it was not done. Blending is not specifically mentioned in any of the existing regulations, but it must be included under the head of incidental processes. Cases of anthrax have occurred in blending and in pulling blends, but wool must be treated in accordance with the regulations before blending, though there are no specific precautions required for the process. A recommendation dealing with blending would be a good thing, but it is a difficult process to regulate. (81–7, 249–51, 423–4.)

G. A. Taylor (O): (*See* Dusty Processes.) Blending follows sorting, the wool being usually thrown down into a bin and spread evenly on a pile. Much dust arises in throwing the wool down and in spreading. Pulling blends is also a dusty process unless the wool is damp. If wool were effectively willowed before blending no precautions for prevention of dust in blending or pulling blends would be necessary. In some parts of the country blending and pulling are done by women. (1312–51, 1706, 1845.)

W. S. Smith (O): Blending and pulling blends are dusty processes and should, for that reason, be regarded as dangerous. The conditions in blending vary enormously. Sometimes the process is carried out in bins and sometimes on the open floor. Exhaust can be applied, *e.g.*, by hoods over open floors (this, as at present applied, is useless), or by hollow walls with the inner one of wire mesh for bins, but the difficulties are so great in either blending or pulling as to be almost insuperable. For pulling, portable exhaust hoods with flexible ducts would be necessary. Steam sprays in bins are very trying to the workers, and of little value in preventing dust, except that the dampness induced in the wool does reduce the dust in processes subsequent to blending. If the dust be effectively removed from the wool before blending, the difficult precautions for prevention of dust in that process and in pulling would be unnecessary. (7422, 7441, 7468–70, 7734–42, 7970.)

G. H. Feather (E): In some cases blending is a dusty process. The only difficulty in requiring removal of dust from wool before blending is that of providing space for the necessary willows. Some wool dealers and merchants buy wool, blend it, and, perhaps, willow it. The regulations should apply to such premises and to places where by-products are similarly dealt with. (4414–8, 4482–7.)

G. Ackroyd (E): Those materials combed in witness's factory which require blending are looked over for bloodstains as they are being thrown through a trap door on to the blend. Greater care is taken in blending low qualities. In dealing with material which has been previously sorted, this method affords a valuable means of ascertaining whether bloodstains have been effectually removed and, if not, of removing them. There would be some dust in the air when blending or pulling a blend of dusty wool like Persian if proper precautions were not taken. Blending would be dangerous if, and ought not, therefore, to be, carried out under unfavourable conditions. Blending in closed bins is not advisable. Provision of exhaust and sufficient space and allowance of reasonable time will go far to prevent excessive dust in blending. Two cases of anthrax occurred from East Indian wool in a certain factory, and a steam spray was provided in the blending bin, since which no cases have occurred. Witness does not handle the really dusty wools, and for those sorts fairly free from dust and free from bloodstains, there is no objection to blending straight from the bale. (6348–52, 6408–17, 6435–43, 6824–31, 6977–8, 7002–37.)

J. H. Halliday (M): (*See* Dusty Processes.) Blending is a dusty process, follows sorting in the works managed by witness, and is done in bins and on open floors; the men spreading the wool over the blend in both cases. The dust in the air of bins is at least 10 times that in the air during floor blending (figures were given). A steam spray in bins is unsuitable as it damps the wool and prevents proper willowing which follows blending. Pulling blends is also a dusty process (figures were given). The dust should be prevented in the opinion of witness apart from the question of anthrax. (5700–19, 6123–8.)

"B. A." (W): (*See* Dusty Processes.) After being sorted, wool is thrown down a shoot from the sorting room into bins and blended. The bin is a square box or small room two storeys below the sorting room, and there are closing doors in the shoot which only open by the weight of the wool on them. Their purpose is to prevent dust returning to the sorting room. A steam spray is provided in the bins. It is the duty of one man to spread the wool, which collects in a heap at the foot of the shoot, over the surface of the blend. This man turns on the steam spray, signals to the sorting room, and wool is thrown down. While this is being done no one is in the bin. After about 20 minutes this is stopped, the spreader turns the steam off, enters the bin and spreads the heap of wool, which takes about fifteen minutes. He then comes out and the process is repeated. Blending is going on all day like this, and men take it in turns to spread for the day. There is no ventilation in the bins. The steam prevents dust while the wool is being thrown down and wets it on the surface, but as soon as spreading is commenced the air becomes very dusty. The steam makes the bin very hot and causes the man to perspire. The wet on the surface of the wool also causes the dust to stick in

"B. A." (W)—*continued.*

cakes to the spreader's hands, face, and clothing. In opinion of witness men ought not to be allowed to work under these conditions which affect their health in the long run.

It is necessary, however, to enter the bin to spread the material, but if the dust were removed from the wool by willowing before blending, it would be free from objection. Witness thinks this is the only effective method of preventing dust in blending. The dust also escapes from the bin and affects men feeding a washbowl close to. Cases of anthrax have occurred at this point more frequently than at a washbowl away from the bins. Cases have also occurred in pulling the blends in the bins. (2340–96, 2532–53, 2658–61, 2678–86, 2783–4.)

T. Larkin (W): (*See* Dusty Processes.) Warehousemen, including witness, blend all wools. This is done in bins, which are small rooms boarded off from the washhouse close to the washbowls. The wool falls five storeys down a shoot from the sorting room. The bins are provided with steam sprays. A blend takes three to four hours making. When it reaches a certain height, the spreaders stay in the bin during the time the wool is coming down the shoots. They do this for their own convenience because it is difficult to get out. The steam spray prevents dust when the wool is coming down, but not during spreading, which is very dusty. Witness wears a handkerchief over his mouth when spreading, but the dust is drawn over the top of it. He always gets a cold when doing this, but has not known permanent ill effects. The dust caused in blending should be prevented, but if it were removed from the wool previously, blending would be free from objection. (2818–35, 2975–3002, 3087–90, 3124–33, 3171–5, 3229–42.)

"W. R." (W): Blending in Commission Combing works is usually done by warehousemen in bins. These are small rooms usually with no ventilation. The wool must be spread evenly over the surface of the blend by hand. In some cases men do this at the same time as wool is being thrown down shoots from the sorting room, and in some the wool is thrown down and spread alternately. Witness has worked continuously for four hours spreading wool in a bin. The air is exceedingly dusty, and it affected his breathing. In some cases a steam spray is provided in the bin, and he has worked in a bin with the steam spray on and the wool coming down. He was instructed to do this, but he believes that is altered now and men leave the bin while wool is coming down. The steam spray is of no benefit. If it prevents the dust it wets a man through. The conditions as to dust were so bad that witness refused to spread wool and left his employment in consequence. He remarked he would sooner die in the street than in the bin. The more dust that is removed from wool before blending the less objectionable this process becomes.

Witness has blended wool straight from the bale without sorting, and quoted a case where half a goat was found when pulling a blend of goat hair. (3383–406, 3416–26, 3437, 3515–25, 3540–1, 3556–60, 3609–16.)

"F. J." (W): Mohair and alpaca are not generally blended. (4951–5.)

"C. W." (W): Mohair and alpaca are sometimes blended at the washbowl side, and this is a dusty process. (5190–1.)

"G. J." (W): Blending is done at the feed end of the washbowl in bins connected by shoots with the warehouse three storeys above and wool is thrown down the shoots. The bins are closed by sliding doors, but blending is exceedingly dusty, and as soon as a man opens the doors to go into the bin to spread the wool, which must be done by hand, dust escapes in great quantity and affects the men working the washbowl. Steam sprays are provided in the bin to lay the dust, but they have very little effect. Blending is being done in one bin while the blend in the other bin is being pulled by hand. Pulling is a very dusty operation also. The only way, in the opinion

"G. J." (W)—*continued.*

of witness, to prevent dust in blending and pulling is to willow the wool previously. (5362–80, 5390–4; 5516–22, 5565–74.)

Bonus to Persons picking out Bloodstains.

G. A. Taylor (O): A bonus is paid by many firms to men engaged in picking out bloodstains. This is based on the weight of bloodstains removed, and is in addition to the wages earned. In the opinion of witness it has a good effect. (1281–2.)

G. H. Feather (E): Witness lays stress on careful sorting out of bloodstains. Some materials (*e.g.*, those false packed) require longer for sorting than others. Hurried sorting involves danger in later processes. Witness's sorters are allowed plenty of time for sorting and are not hurried. (*See also* Q. 9133–44.) They are paid on the weight of wool sorted, but they also receive sixpence per pound for all bloodstains found, so that more time spent on sorting does not necessarily mean the earning of a less wage. The men are watched, and if a high wage is earned inquiries are made as to the care exercised. They are aware of this and do not scamp their work. (4407–68, 4588–602, 4639–45.)

G. Ackroyd (E): Witness likes the system of paying a bonus for picking out bloodstains, but it acts in different ways, and each case should be judged on its merits. He gives his men a shilling a week extra at the end of every six months provided there is no case of anthrax in that period.

Some firms give a fixed sum in addition to wages for every pound of bloodstains removed. Witness thinks where there are few bloodstains this is a good system, but where there are many the temptation to earn large sums of money results in hurried and therefore careless work. Thus, for Persian locks he thinks the system good, but for Persian skin wool he thinks it bad. (7001.)

J. H. Halliday (M): Witness gives the men he employs as sorters a fixed sum per pound of bloodstains removed in addition to their wages, on condition that no bloodstains are left in the wool. He thinks this a more efficient system than giving a higher piece rate wage in the expectation that more time will be devoted to sorting. (5673–5, 6151–2.)

Foreman and six skilled Sorters (W): Witnesses are paid sixpence per pound for all bloodstains picked out of wool as well as a sum per bale for sorting. The rate paid for removing bloodstains is sufficiently remunerative to enable them to sort slowly and carefully and they are quite satisfied. Some bloodstains may be missed but not many. Persian wool and camel hair are the principal materials sorted. (9133–44.)

Carding and Card Grinding.

G. A. Taylor (O): (*See* Dusty Processes.) The process of carding follows that of scouring and drying. Before being put into the carding machines wool is oiled either in a special oiling machine (willow) or by sprinkling oil on it from a watering can. Washing of dusty wools as usually done does not remove all the dust and dirt. The wool is conveyed to the carding room either in trucks or by blowing it from the driers through a tube into chambers or bins in the card room. The latter is a dusty method, and the card room is affected unless the dusty air is prevented from escaping from the bins into the room. Carding itself is in many cases a dusty process, unless the wool has been willowed, dust and short fibres being thrown into the air by the revolving cylinders. The persons working in card rooms are wool runners, card feeders, back end minders, grinders, strippers, and jobbers. The card attendants (feeders and back end minders) are usually females. The object of carding is to lay the fibres roughly parallel, but much dust, dirt and short fibre is removed from the wool and remains in the wire of the card clothing. Any blood clots which have survived previous treatment are also broken up and distributed. At short intervals the collections in the card wire are removed—"stripping or fettling"—by men called strippers or fettlers, by means of a hand

G. A. Taylor (O)—*continued.*

comb. The material removed is technically known as card waste, which also includes the daily sweepings from under and round the cards. The stripping leaves much dust loosely held in and on the card wire.

At intervals ranging from three weeks to six months the points of the wires on the card clothing must be ground. To do this the rollers of small diameter are removed to a frame two at a time and ground by means of an emery roller placed between them. This is a very dusty operation. The large card cylinders are ground in the card itself by revolving them in contact with a revolving emery roller. Dense clouds of dust are thrown off, especially in the early stages. The dust produced in grinding consists of wool dust, broken up blood clots, particles of steel and emery, and some short fibre.

If infected blood clots be allowed to remain in the wool, or if wool washed or wet fellmongered before removal of infected blood clots be carded, the dust produced in blowing wool into the card room, in carding, and in card cylinder and roller grinding must be infected, and there is grave danger of internal and external anthrax. It is essential therefore, that it should be prevented from affecting the air. Effective willowing before washing (which witness thinks should be compulsory) removes the greater part of the dust from the wool, and if the latter be also properly oiled there is then very little dust in carding or card cylinder grinding. Effective oiling by itself reduces dust, but it is necessary to ensure that the oil is evenly distributed over the wool. This occurs where an oiling and opening machine (fearnought willow) is used, but not always when oiling is done by hand in the usual way.

If willowing be not done the card cylinders should be cleaned by vacuum apparatus between stripping and grinding. This is already in use in one works, the nozzle of the vacuum apparatus being slowly traversed across the face of the slowly revolving cylinders, and the dust thus effectively drawn away. Witness quoted figures showing that determinations of dust in the air during grinding gave the same result in two works, in one of which the wool was willowed before washing and effectively oiled by machine, and in the other was not willowed, but the cards were cleaned by vacuum before grinding. The card waste is sometimes sold and sometimes willowed and put back into the blend. Stripping and grinding of cards is done one machine at a time while the ordinary work is in progress. A whole day is required for the grinding of a card, and grinding is being done every day except Saturday. (1318–28, 1377–472, 1845–63.)

W. S. Smith (O): Witness found the conditions in card rooms varied greatly. In some, carding was dusty in itself, and in some it was not. Card cylinder grinding was also sometimes dusty and sometimes not. Card roller grinding was always dusty. Dust in these processes is particularly dangerous from the point of view of anthrax, because carding breaks up blood clots. The dust is also dangerous in itself, because it contains steel and emery particles in addition to sandy matter. He quoted a case where definite injury to health was found to occur among men grinding card clothing in the course of its manufacture, and he thought the fine dust given off not materially different in character and quantity from that produced in card grinding if the wool dust be excluded.

The card roller grinding frames should always be enclosed and provided with exhaust. This is done successfully in a number of factories. It is possible to provide covers and exhaust to carding engines, and witness has seen this effectively done in the felt but not in the worsted trade. Dust can also be prevented in card cylinder grinding by cleaning the card clothing after stripping and before grinding by means of a vacuum process. This is successfully applied in one factory. The plant consists of an aspirator connected to permanent steel pipes in the card room, to the latter of which can be attached a flexible tube terminating in a nozzle which is traversed across the card clothing.

Witness is of opinion that regulations should require the removal of dust from wool in the early stages of its treatment (before blending). Special measures for dust prevention in card rooms would then be un-

W. S. Smith (O)—*continued.*

necessary, except in card roller grinding. In any case, however, regulations should require the prevention of dust in carding and card cylinder and roller grinding, enclosing of roller grinding machines and provision of exhaust, efficient dust collection, and provision of fresh air inlets in the card room. The exact means to be adopted should be left to occupiers. (7422, 7427–30, 7441, 7746–81, 7908–21, 7981.)

G. H. Feather (E): Unless wool be willowed before washing, carding must be dusty. A dusty atmosphere should be prevented, apart from the question of anthrax. (4419–22.)

G. Ackroyd (E): Efficient washing of wool will prevent dust in carding, if this be done under proper conditions. Blowing wool from the drier to the card room may cause dust, but this depends on the method. Where card rooms are dusty more care should be taken in cleansing the material. Measures to prevent dust in card cylinder and roller grinding should be taken if there be excessive dust. The Horsfall system of grinding causes less dust than the usual method. (6830, 6837–47.)

J. H. Halliday (M): In the works managed by witness the wool is willowed before washing and is oiled by hand and passed through a willow after washing and before carding. There is no dust in the card room. Witness quoted figures showing that the dust in the air of a card room, where similar wool is used, but not willowed either before or after washing, is 13 times greater than in his card room. The card clothing is ground once in three months on the average. The infrequency of grinding, as compared with some works, is due to the fact that wool is willowed and sand and debris thus removed. There is practically no dust in grinding the cylinders. Figures quoted showed 100 times as much dust in the air of a card room, using unwillowed but similar wool, during grinding of cylinders. In grinding card rollers there is some dust, and witness thinks the grinding frame should be enclosed and provided with exhaust. He, however, pointed out that the dust in roller grinding, where similar but unwillowed wool is used, is 20 times greater than in his factory. Eleven males and nine females are employed in the card room, and the cards have hopper feeds (automatic). (5741–66, 5770–80, 6162–7.)

T. Town (M): If wool be not oiled it flies all about the place in carding. The best way of getting oil evenly distributed on wool is by means of a willow. The grinding of card rollers causes much dust, but the grinding frame can be altogether enclosed. (8993–9000.)

J. Campbell (M): Witness showed the working of the vacuum apparatus for cleaning card clothing before grinding, and pointed out that its use prevented most of the dust in grinding cylinders. (9089–93.)

E. Marsh (M): Oiling of wool tends to reduce dust, but there is no standard as to the quantity of oil which is put on wool before carding. It depends on the material. With some wool the dust in carding cannot be prevented by oiling. If too much oil is used the fibre becomes so sticky as to block up the card wires and prevent the action of the machine. (9221–6.)

S. Wade (M): Wool cannot be carded if there is too much oil on it. The method of oiling adopted—spraying the wool in thin layers on the drying grids—ensures uniform oiling. Witness could only explain the freedom of his card room from dust by suggesting the dust was washed out in scouring. He does not use a willow, and a dusty lot of wool was in combing. (9227–47.)

C. E. Biggin (M): Witness uses a fearnought willow after washing for ensuring uniform oiling of wool before carding. At other works he had oiling done by hand, but this results in uneven distribution of the oil, and when the wool is passing through the "lickers-in" of the card, dust is thrown off. It is impossible to remove all dust from wool by washing, and if oiling is not uniform there is always dust in

C. E. Biggin (M)—*continued.*

carding. Willowing before washing also prevents dust in the card room, but witness prefers willowing to follow washing. (9328–61.)

"S. J." (W): The duty of witness, as card jobber, is to clean the carding machines, keep them in repair, and keep them running. Dangerous wools are sorted, blended, washed, and dried before carding. He is paid daily wages, and he has known 17 cases of anthrax among persons working in the card room in which he is employed. In his opinion cases are more frequent now in card rooms than formerly. They have occurred particularly in the last seven years, and some works are affected more than others. The air of some card rooms is very dusty, and incidence of anthrax is greatest in these. In some works wool is willowed before and after washing, and there is little dust in carding; in others, it is not willowed at all, and there is much dust. In the experience of witness where there is most dust there is most anthrax, and he quoted works of which he has experience, but he had no figures in support of these points. He, however, pointed out the impossibility of expecting a working man to get figures, and that he is comparing works of which he has definite knowledge.

Dust is produced in blowing wool from the drier to the card room, as the wool is going through the cards and in grinding the card clothing. Washing is not sufficient to remove all dust from wool, but most of any dirt remaining is removed in carding. Willowing before washing reduces, but does not prevent, all dust in carding. Wool is oiled after washing, but this is not necessary for proper carding. Use of oil prevents dust if the oil be evenly distributed, as happens when it is done by means of a willow or by hand when the wool is placed in layers, but not when unevenly distributed as results from oiling in tubs by hand. In the latter case some wool is carded practically dry and dust rises. The amount of oil used also has some effect. It is easy to tell from the condition of the air whether or not wool has been properly oiled.

The speed at which cards are driven affects the dust in the air. In some works cards are driven faster than in others, and faster now than formerly, with the result that the air is more dusty and more cases of anthrax have occurred. Witness mentioned and compared works. The result of faster carding is that everyone from the warehouse upwards has to work faster, there is more pressure, and, witness suggests, proportionately less care in sorting out bloodstains, washing, &c. In the works where witness is employed as much wool is now carded in one day as was formerly done in a day and a night, and the speed of the swifts (90–92 revolutions per minute) is greater. Wool is fed into cards by (1) an automatic hopper, or (2) by placing a weighed quantity on a fixed portion of a lattice feed by hand, or (3) by putting as much as possible on a lattice feed by hand. In the last case the amount carded can be varied enormously and can be increased at will (up to a limit). More wool is carded at night than in the day. Men then take the place of women. Formerly 30 bales were carded per 24 hours; now 45 to 50 bales (18,000 to 20,000 lbs.) are carded, and the cards produce about 15,000 lbs. per 24 hours (48 to 50 lbs. per card per hour), but the number of persons employed and the machinery have not been materially increased.

It is to be expected that if more infected material be carded in a given time, the incidence of anthrax will rise proportionately, and more dust and dirt collect in the card clothing. Witness has no figures (other than those given), *e.g.*, as to speeds of the working parts of cards, to give in support of the above statements, which are based partly on his own experience and partly on what he has been told by men working in other card rooms. Cards may be speeded up by increasing the speed of all the machines from the engine room, by changing the wheels, and by putting more stuff through, and witness has seen some of these methods adopted.

Cards are stripped by hand and the clothing ground by reversing the motion of the cylinders and revolving an emery roller (strickle) in contact with

"S. J." (W)—*continued.*

it. Grinding is going on in a card room every day, and in some cases it is necessary to grind an individual card at very short intervals. Grinding of cylinders and rollers are very dusty operations. Dust in the former can be prevented by cleaning the clothing by means of a vacuum apparatus which witness has seen and describes as exceedingly good. There is no dust where it is used. Dust in grinding card rollers can be prevented effectively by enclosing the grinding frame and providing exhaust.

Witness has seen bloodstains going through the cards, but these may have been missed accidentally. He has himself opened bales of Persian wool and sent them down into the bins without sorting when there has been insufficient wool sorted for the night turn. He contracted anthrax which he thinks was due to dust falling from the top of the bin, into which wool is blown, on to his face. This collects in a boarded-off part and does not get into the card room. The clothing of card jobbers comes in contact with wool and strippings, and overalls should be worn. Washing conveniences, mess rooms and cloak rooms should also be provided for card-room hands. The vacuum apparatus is exceedingly good for cleaning walls, and is much to be preferred to sweeping. Witness thinks women's clothing unsuitable for the card room, but knows no other reason against their employment in carding. (3664–4119, 4127–34, 4155–60, 4184–215.)

"G. J." (W): More wool is now washed in a given time than formerly, and a greater weight is in the washbowl at one time. It is, therefore, not washed so thoroughly, and so may cause more dust in the card room. (5416, 5431–5.)

Changes in Method of Manipulating Wool.

T. M. Legge (O): Witness does not know of any change having been made in the manipulation of wool in recent years, and thinks the increase in the number of cases of anthrax is due to better reporting and to the fact that the precautions it is possible to take are insufficient to cope with the disease. (169–71.)

G. H. Feather (E): Broadly speaking, the treatment of wool combed for witness is the same now as it was 20 years ago. If any change in methods of manipulation of the class of wool (Persian) in which he trades has taken place, it has been in the direction of more universal sorting. He thinks the increase of anthrax is due to greater infection in wool and particularly in Persian locks. (4235–6, 4579–87.)

G. Ackroyd (E): Up to 1900 witness combed Persian wool and kindred materials, but since that date he has combed principally mohair and alpaca. His experience goes back to the time when anthrax was known as woolsorters' disease, and it is his opinion that sorting was more carefully and more extensively done then than now. More carding is done now in proportion to preparing than formerly and more Persian wool is used. Similar materials, *e.g.*, Egyptian and Syrian wools, have also come into use in recent years, and these are carding materials. These changes probably account for some of the increase in the reported cases of anthrax. (6264–98, 6380–2, 7153–64.)

J. H. Halliday (M): Witness gives evidence principally in relation to Persian wool and camel hair. There have been changes in the method of manipulation of wool due to the regulations of 1906. Prior to that date opening and willowing were done in the warehouse without exhaust. Now each of the processes has to be done in separate rooms with exhaust. Generally speaking, there have been no other changes in methods of manipulation, though camel hair (but not Persian) was generally sorted more carefully 20–25 years ago than now. Sorting is done quite as generally as formerly. More alpaca is combed by Commission Combers now than formerly, but witness has not much experience of this material. He thinks the increase in anthrax is due, not to any change in methods, but to the great increase in the practice of false packing of locks in fleece wool which

J. H. HALLIDAY (M)—*continued.*

occurred about 1905 and has continued. The increase in the proportion of cases after the material has been washed is due to the protection, afforded by the operation of regulations, to persons working in processes before washing. (5808–20, 5932–46, 5978–92, 6153–8, 6217–20.)

"W. R." (W): The only recent change in methods of manipulation of wool is that now warehousemen look over for bloodstains all dangerous wools which reach Commission Combing works unsorted and in bales. The reason for cases occurring in processes after washing is that infected material is missed. (3572–92.)

"S. J." (W): In the experience of witness the only change made in recent years in methods of manipulation of wool is that every process has been speeded up and the machines treat a greater weight of material now than formerly. This causes carelessness and more dust owing to the speed of working. (3691–712, 3759–803, 3829–38, 3921–69, 4033–44, 4053–71, 4095–98, 4127–31, 4157–60, 4195–215.)

"F. J." (W): In the opinion of witness less skilled sorters are employed now than formerly in Commission Combing works. Instead of being sorted by skilled sorters the materials combed are now looked over for bloodstains by warehousemen. (4763–81.)

"C. W." (W): There has been no change in recent years in methods of manipulation of wool, but the conditions have altered. (5184–6, 5196–7.)

"G. J." (W): In the opinion of witness the only change in methods of manipulation of wool in recent times is that all the processes have been speeded up and the machines are made to give a bigger output. (5417–24, 5523–35, 5552–8.)

Cleansing of Exhaust Systems, Dust Collectors, &c.

T. M. Legge (O): The existing regulations require the extracting shaft and the space beneath the sorting boards to be cleaned out once a week. The former is cleaned out with a brush while the exhaust is running and the latter by sweeping, which witness regards as dangerous. The regulations require provision of and wearing of overalls when dust is being collected and removed, but witness regards this as an inefficient precaution. (353–7, 358–63.)

G. A. Taylor (O): The present regulations permit sorting screens to have a sort of tray below the screen on which the bulk of the dust from the wool collects. They also require provision of an exhaust funnel so arranged that the dust in the tray can be swept into it, but they do not require the dust to be swept in. As a rule, the trays are at present cleaned by sweeping the dust and fibre into a bucket, and the impact causes dust to rise to the face of the worker. Witness suggests that the exhaust hopper should extend under the whole screen so that dust falling through will be removed automatically by the exhaust and cleaning thus rendered unnecessary. Such screens and hoppers are in use in some works in Bradford. Receptacles for collecting dust removed by exhaust have usually to be entered for cleaning purposes. This should be prohibited; all dust collectors should be required to be so constructed that no person need enter to remove the dust. (1533–9, 1638–45.)

W. S. Smith (O): (*See* Dust—Collection.) Though the existing regulations require provision of an exhaust funnel under sorting screens such that dust, not removed by the exhaust, may be swept into it, this dust is not usually swept into it, because it is said to cause the choking of the ducts. Generally, it is swept into a bucket. This practice is dangerous, and should not be permitted. Though ducts ought not to block up if properly designed, it is necessary to prescribe by regulations that the exhaust ducts shall be provided with suitable means for cleaning. This is done in several codes of regulations.

It is necessary also to place a direct obligation on the occupier to have exhaust ducts and dust collectors cleaned periodically. It is not possible to lay down any definite requirements as to the period within

W. S. SMITH (O)—*continued.*

which dust collectors should be cleaned. It depends on many things—their size in relation to the work they have to do, type of fan, &c. It is necessary to enter most existing dust collectors, but this should be prohibited, as many self-cleaning collectors are now obtainable. Any dust chamber may be made self-cleaning by providing a V-shaped bottom with a worm at the inverted apex. Alternatively, if it be necessary for persons to enter any chamber for any purpose, it should be compulsory to provide water sprays to wet the dust as it enters the chamber, and precautions for their protection should be prescribed. (7673–85, 7802–13, 7825–7, 7842–6.)

W. Root (E): Witness uses a Spencer and Halstead bag filter for collecting dust discharged by his sorting exhaust. The dust collects automatically in bags attached to the lower end of the filters. A fortnight's collection does not more than quarter fill the collecting bags with dust, even during sorting of the most dusty materials. Removal once a fortnight is, therefore, ample. (8959c–8959o.)

E. B. Whitley (E): Witness collects the dust from his sorting exhaust in a chamber which has an outlet in a specially constructed water tank. The chamber is swept out by hand twice per week. Some dust is collected in the water tank and the water at intervals is run down the drains. (9604–10.)

J. H. Stott (M): Two methods of dust collection are used in the factory managed by witness. In one the dust is collected automatically in bags by means of a dust filter. It is unnecessary to enter this for cleaning purposes and is, in the opinion of witness, the best method possible. A dust chamber is used in connection with another exhaust system, and it has to be entered twice per week in order to sweep up and collect the dust by hand. About two buckets full are collected on each occasion. The men wear respirators and overalls when cleaning the chamber. (8884–908.)

C. E. Biggin (M): In the factory managed by witness dust is collected by means of a cyclone collector discharging into a dust chamber below, from which the dust is shovelled weekly into bags. Part also collects in a relief shaft and is removed fortnightly and part escapes on to the roof. (9300–17.)

H. Barker (W): Witness showed how the exhaust ducts are cleaned. This is done twice weekly with the fan stopped by dragging a weighted ball of sacking through the ducts by means of a rope which passes through a hole in each end of the duct. The dust, if it collects in the duct, is pushed out by the ball. Inspection holes are provided at intervals along the duct. The dust from the exhaust is collected in a dust chamber which is cleaned out by hand periodically but not at fixed intervals. The men wear overalls and respirators when cleaning it. (9722–7, 9785–801.)

"F. J." (W): Witness suggested if works were more frequently inspected exhaust pipes would more frequently be cleaned. (4969.)

"A Sorter" (W): Dust from the sorting exhaust is collected in a chamber which is cleaned out by hand once per week. The amount of dust collected depends on the number of sorters working, but averages 8–10 lbs. per week. (9362–3.)

Cleansing of Rooms, &c.

T. M. Legge (O): The requirements of the present regulations as to sprinkling floors with disinfectant, daily sweeping, half-yearly cleansing and yearly lime-washing are confined to rooms in which raw material is treated—opening, sorting, and willowing rooms. The floors of other rooms get dirty, *e.g.*, where blending is done, and ought to be included. It is necessary that scrupulous cleanliness be observed in all rooms into which dangerous wools are permitted to enter. The word cleansing was used in the existing regulations to permit of the use of methods other than sweeping, *e.g.*, the vacuum cleaning apparatus. Hand sweeping is a dusty and dangerous process, and use of a vacuum cleaner is much to be preferred. (334–6, 364–72, 460–2.)

G. A. Taylor (O): Witness thinks hand sweeping of floors, benches, &c., should not be permitted. He suggests that all floors and walls of opening, sorting, blending, carding, and combing rooms should be cleaned daily by means of a vacuum cleaning apparatus, and that the floors of the opening and sorting rooms should then be treated with a disinfectant. The method prescribed by the existing regulations is unsatisfactory. Sweeping always causes dust, but with the vacuum cleaner this is impossible. Witness pointed out that the vacuum plant is successfully in operation in one works. (1296–9, 1484–90, 1648, 1679–80, 1759, 1830–4.)

W. S. Smith (O): Witness has seen vacuum apparatus used for cleaning walls, &c., in works under the existing code of regulations. It is successful and its general use is practicable at the present time. He described the plant and pointed out the difficulties in providing power to cause the vacuum. (7673–85.)

W. Mitchell (P): The sprinkling of floors with disinfectant before sweeping prevents a certain amount of dust and conduces to health in the workroom. It does not, however, result in disinfection. (7323–4.)

G. Ackroyd (E): Damping of floors with disinfectant is useless from the point of view of disinfection, *i.e.*, killing anthrax spores. It is, however, of real value in producing a feeling of well-being and contentment among workers who are thus less liable to contract anthrax. (6801–6.)

J. H. Halliday (M): Witness is aware that sprinkling of floors with disinfectant will not kill anthrax spores, but he nevertheless advocates it before and after sweeping of the floors of sorting rooms. It prevents dust and is of use. A sticky disinfectant should not be used—it causes accumulation of dirt on the floor. (5688–9, 6047–50.)

"B. A." (W): Dust and sand from the bales of wool collect on the floors of opening rooms and are swept up several times a day after sprinkling with disinfectant. (2173, 2444–6.)

"S. J." (W): In the card room in which witness is employed the wool is blown from the drier to a bin. Dust, carried with the air, escapes through a screen in the top, and is deposited in a chamber over the bin. A man cleaning away the deposit of dust pushed some down which fell on to witness's face. Shortly afterwards an anthrax pustule developed. Witness thinks walls and beams in cardrooms should be cleaned by vacuum apparatus, which he has seen used with highly satisfactory results. The dust on the floor of the cardroom under the cards is swept up by means of a hand brush five to nine times per day. The cardroom floor is sprinkled (with disinfectant) once per week. (3852–72, 3908–12, 4179–83, 4192–4.)

Cloakrooms.

T. M. Legge (O): In the present regulations provision of cloak-rooms is only required for persons who handle unwashed wool. Anthrax is, however, contracted by other persons, *e.g.*, card room hands, who only handle washed wool, and provision should be required for storing the outdoor clothing of all persons who manipulate dangerous wools, whether washed or unwashed. In the opinion of witness there should be in all large factories a well thought out system of washing accommodation, cloakrooms and messrooms, (375–81.)

G. A. Taylor (O): Whether or not bloodstains are removed from wool, regulations should require the provision of a cloakroom for storing outdoor clothing and of a separate room for storing overalls for all persons employed in manipulation of dangerous materials, including those employed in combrooms. There should be separate provision for males and females. It should also be made compulsory for the workers to use these rooms only for the purpose for which they are provided. (1483, 1498–99, 1508–12, 1517, 1864–70.)

G. Ackroyd (E): If overalls are kept in the factory a place for their storage should be provided, but witness was of opinion that a cloakroom for storing outdoor clothing is not always necessary. (6899–900.)

J. H. Halliday (M): It is objectionable and dangerous to leave overalls lying about in workrooms. When not in use they should be kept in specially constructed cupboards. Provision should be made for storing the outdoor clothing of all persons employed in processes previous to combing, but witness thought this unnecessary for combroom hands. (5894–6, 5899–901.)

T. Town (M): Persons employed in the factory hang their outdoor clothing in the messroom. Witness thought a separate room necessary for them to dress and undress, *i.e.*, remove outdoor clothing and put on overalls. (9021–2, 9035–8.)

"B. A." (W): Witness hangs his outdoor clothing in the place provided for this purpose in the factory. He has known anthrax to arise among members of a workman's family when washing his clothes. (2407–18.)

T. Larkin (W.): Witness hangs his outdoor clothing in the cloakroom provided in the factory. It is satisfactory. His overall he wraps up and keeps in a can when not in use. (3003–18.)

"S. J." (W): Witness hangs his outdoor clothing up in the dining-room provided at the works. This he thinks is satisfactory. (3899–907.)

"F. J." (W): In the works where witness is employed overalls are hung up in the room provided for storing outdoor clothing, one being hung up as the other is taken down. To avoid infection he thinks that cloakrooms should be provided and that separate provision should be made for storing overalls. There is always danger from dust on the overalls if stored in the same room as outdoor clothing. (4922–6 4939–42, 4979–81.)

"C. W." (W): In the factory where witness is employed overalls are left in the working room, and outdoor clothing is stored in a room provided for the purpose. Provision should be made for separately storing both overalls and outdoor clothing so that there should be no contact. If together there is danger of short hairs and dust being transferred to the clothing from the overall. (5204–8, 5221–3.)

"G. J." (W): Witness keeps his overalls in the workroom, as no special place is provided, but hangs his outdoor clothing in the cloakroom. (5444–52.)

Dangerous Trades. (*See* Regulations—Reference.)

T. M. Legge (O): There is no definition of what is meant by a "dangerous trade." Section 79 of the Factory and Workshop Act gives power to the Secretary of State to certify any trade as dangerous (*i.e.*, any manufacture, machinery, plant, process, or description of manual labour, used in factories or workshops) if he be satisfied that it is in fact dangerous or injurious to health or life or limb either generally or in case of any class of persons.

In July 1899 application was made to the Secretary of State to certify woolcombing as a dangerous process; woolsorting had already been so certified, and eventually combined regulations were made for the two processes. The use of East Indian wool was certified in 1908 to be dangerous, not because it was an anthrax-infected material, but because it was a dusty wool. (16, 38, 79–80.)

Definitions. (*See* Regulations—Administration, Elasticity of, Existing.)

T. M. Legge (O): The object of the definition of "opening" in the regulations was to define the first step preparatory to sorting, and to distinguish it from the mere breaking of the steel bands on the bales. Regulation 1 of the existing code reads "No bale of wool . . . . shall be *opened for the purpose of being sorted.*" The first part, undoubtedly, refers to the breaking of the bands, but with the second part probably covers both the breaking of the bands and the opening of the fleeces for sorting.

The expression "Men skilled in judging the condition of the material" is one accepted in Bradford as meaning persons employed in sorting, and is analogous to "A competent person" used in Acts of

T. M. Legge (O)—*continued.*

Parliament. Under recent Acts a "Competent person" is defined as one possessing certain certificates, but there is no definition of "Men skilled in judging the condition of the material."

The expressions (1) "damaged wool," (2) "fallen fleeces," (3) "skin wool," (4) "disinfectant," and (5) "willowing" are not defined in the regulations. Witness believes (1) to mean wool damaged in transit by sea water, (2) to mean fleeces of animals which have died from disease, and (3) to mean wool removed from skins.

The expression "properly constructed receptacle" is not defined, and is analogous to "men skilled in judging the condition." It is a very unsatisfactory term and one more definite should be used. The regulations do not prescribe any method or material for "damping with disinfectant," and there is, therefore, no control.

The sorting referred to in regulation 4 of the existing code is not defined, but is a manufacturing process of separating the material into qualities and is not in any sense a search for infected material. In the case of some materials, *e.g.*, Persian wool, sorting is usually confined to removal of string and other extraneous matters. The term "cleansed" in regulation 13 was intentionally used (without definition) to permit of other methods than hand sweeping being adopted, *e.g.*, a vacuum cleaner apparatus. (268–71, 291–2, 308–14, 328, 349–51, 436–43.)

G. A. Taylor (O): Witness understands the term "sorter" to mean a skilled sorter, *i.e.*, a person who has served an apprenticeship in sorting wools. Sorting is usually, and was originally, understood to mean the manufacturing process of separating material into qualities. Witness suggests that, for purposes of regulations, sorting should be defined as "including sorting for bloodclots, classing, looking over for matter foreign to wool and looking over for the removal of bloodclots and bloodstained material."

The term "properly constructed receptacle" for dust removed by exhaust has been interpreted as meaning one which prevented dust escaping into the air. The meaning should be enlarged and made clear by definition. The regulations do not define "damaged wool." but the Anthrax Investigation Board expressed the opinion to the Home Office that it means wool damaged by sea water. The expression "men skilled in judging the condition of wool" does not include men skilled in recognition of bloodclots. (1211–2, 1276–80, 1533–9, 1651–4, 2005–6.)

W. S. Smith (O): Witness considers it necessary to define processes for which regulations require definite precautions to be taken, *e.g.*, in regard to dust. Apart from regulations, inspectors can enforce under the Factory Act precautions in regard to dust when *danger to health* can be proved, but the meaning of this is not clearly defined in the Act, and the wording is in very general terms, so that the enforcement is difficult. In the absence of definitions, Inspectors judge dusty conditions by observation. This allows very great scope for the personal factor, which results in strict enforcement in some districts and lenient enforcement in others. Witness urges, therefore, that the regulations should carefully prescribe what is required.

Witness defines exhaust as "A sufficiently good current of air applied by means of hoods and ducts to remove dust at the point of production, and to convey that dust to a distance for collection." The use of indefinite and undefined terms, such as "Suitable air inlets," causes grave difficulty in administration, and witness suggests this term should be defined as meaning "inlets which have a total effective area three times that of the total area of the exhaust inlets." Instead of the term "Properly constructed receptacle" for dust, witness suggests the use of the term "A proper dust collector," which should be defined as "A bag filter, a cyclone collector, a chamber with water spray, a chamber with baffles, a water tank, or other similar appliance of sufficient capacity to prevent the escape into the open air of dust discharged into such collector."

"Willowing" is a term used to describe two different processes, and "willow" is a name given

W. S. Smith (O)—*continued.*

to two machines of different class, *i.e.*, (1) a shaking machine used for removing dust, dirt, &c., from wool, and (2) a fearnought or teaser, which is a primitive type of carding machine used to open out the wool before carding. Confusion has arisen, and the term should be defined if used. The term "efficient exhaust draught" should be defined as "An exhaust draught which effectually removes as near as possible to the point of origin the dust generated in the process," but even then the definition depends on the interpretation of the word "effectually." The term "Storing" applied to wool in the sorting room can be variously interpreted, and its meaning should be made clear. (7433–43, 7454, 7599, 7605, 7709, 7792–5, 7814–5, 7825–33, 7836–7, 7869–74).

W. P. Norris (O): Witness thinks that, where possible, regulations should be explicit. Nevertheless, in Australia it has been found an advantage, in some instances, to avoid being too precise and, rather than have cast-iron regulations where the conditions may call for emergency action, to give the responsible officers power to take proper preventive measures. He instanced the definition of the term "Quarantine." Originally this term meant simply the isolation of suspected animals, plants, &c., but it is now defined as "having relation to measures for the inspection, exclusion, detention, observation, segregation, isolation, protection (which includes vaccination), sanitary regulation and disinfection of vessels, persons, goods, things, animals, or plants, having as their object the prevention of the introduction and spread of diseases affecting men, animals, and plants." (8400–5.)

G. Ackroyd (E): (*See* Regulations—Elasticity.) Witness is strongly opposed to precisely defined requirements. He strongly urges there should be scope for encouragement of diversity of method, and suggested that regulations should contain general terms as in the electricity regulations, *e.g.*, "Adequate precautions;" "Suitable means to prevent," "As may be necessary adequately to prevent," "If satisfied that safety is otherwise practically secured." He thought, however, that the same result would be secured if power were given to some authority to grant exemption, on stated condition, from any or all regulations in a stringent general code. A bloodstained fleece is not necessarily a fallen fleece. Damaged wool has always been understood to mean wool damaged by water. (6551–4, 7099–100, 7109–15, 7125–33.)

Disinfection of Wool and Hair.

T. M. Legge (O): It is pointed out in the Report of the Departmental Committee on Anthrax of 1895 that anthrax spores (but not anthrax bacilli) possess extraordinary powers of resistance to most processes of disinfection. Dr. Bell, after some experiments, suggested steaming of wool as a practicable measure of disinfection, but Dr. Arnold Evans, in more recent experiments, found that steaming either did not destroy the anthrax spores or, if sufficiently drastic to destroy the spores, caused irreparable damage to the material. In 1913 the Anthrax Investigation Board, assisted by experts, carried out experiments in steam disinfection and came to the same conclusion as Dr. Evans. The results are published in their Eighth Annual Report.

Under the existing regulations, fallen fleeces and damaged wool must be removed, if noticed, and damped with disinfectant. Certain chemical disinfectants are known which, in the laboratory, will kill anthrax spores, but the regulations do not prescribe use of any particular disinfectant, and in any case the damping required is done with a watering-can, cannot cause destruction of anthrax spores, and is useless. (277–80, 291–301, 466, 478–9.)

G. A. Taylor (O): Bloodstains sorted out of material should be either disinfected or destroyed. If disinfection be allowed the strength of solution and time of immersion should be prescribed for chemical, and the temperature of, and the time of exposure to steam in the case of steam disinfection. Materials washed abroad (and the bloodstains thus destroyed)

G. A. Taylor (O)—*continued.*

ought, where possible, to be disinfected. Witness would not agree to a suggestion that exemption from regulations should be allowed to an occupier who disinfects the material he uses. His view was that no effective method of disinfection possible for wool is known at present, and it would be time enough to provide for exemption when a practicable method is discovered. He quoted a case where about two and a half million pounds of the most dangerous materials are combed annually in one factory, and appeared to think the quantity made an effective method of disinfection impracticable. Witness thought the method of sprinkling floors with disinfectant required by existing regulations of little value, and suggested the floors should be vacuum-cleaned first and disinfected afterwards. (1292–9, 1564–5, 1619–23, 1665–71.)

W. S. Smith (O): Witness suggested that sludge from dust discharged by exhaust and collected by a wet method should be disinfected by steam, and pointed out that this is done in the horse-hair factory of Pachetti Bros., of Pavia. It might be difficult to steam the whole of the water in a large tank used as a collector. He would rather have a method of disinfection than a prescribed standard as to dust in air or wool. (7801, 7842–6.)

Sir S. Stockman (O): The regulations dealing with outbreaks of anthrax among animals in this country require the ground and surroundings, where an animal has died from anthrax, to be disinfected. If the weather be cold and if the disinfection take place before spores have time to form it may be of use, but not otherwise. Putrefaction might be used as a means of destroying anthrax organisms. It is necessary, however, that putrefaction should be carried on in a nutrient medium in order to cause anthrax spores to become bacilli. A true septic tank, *i.e.*, one containing nutrient substances at a suitable temperature, would be suitable, but not one containing water. Unless the temperature and food supply are suitable, spores will not become bacilli and would therefore not be destroyed. This method might be used for treatment of shoddy, waste materials, and the liquid from the washbowls. If putrefaction be active, probably anthrax organisms would disappear in a week. Putrefying blood containing anthrax bacilli quickly loses its power of infection, but there is some hæmalytic action of the blood concerned in this.

Witness was not in favour of requiring disinfection of waste materials of value, *e.g.*, as manure, if the method rendered these valueless. Waste materials of no value should be burned. Bones, and possibly blood manure, are stated to be treated in the course of manufacture at a temperature sufficiently high to destroy spores, but witness was doubtful as to blood, though in South America it is said to be submitted to a temperature of 130° C. The temperature must reach boiling point and be maintained for 15 minutes to ensure destruction of spores.

If a method of disinfection could be obtained for destroying anthrax spores in wool, which does not unduly interfere with trade, witness thinks all the countries of the world are ripe for combining to carry it into effect. He, however, quoted the case of the United States, who required disinfection of hides coming into the country, but have had practically to abandon its enforcement because the hides went elsewhere. (10,098–106, 10,141–59, 10,191–3, 10,272–82, 10,315–9.)

W. P. Norris (O): The regulations in Australia require disinfection of surroundings where an animal has died of anthrax. Fire is usually used. Wool and hair are admitted into the country under regulations which require them to be disinfected in certain circumstances. The method used for hair is boiling, but for wool a solution of perchloride of mercury or of formaldehyde or an alkaline cresol solution would be used. The second in 2 per cent. solution is recognised as one of the most effective when the material is exposed to it from four to six hours. Under practicable conditions, cresol solution will not destroy anthrax spores. If there were any doubt as to effective disinfection the wool or hair would be

W. P. Norris (O)—*continued.*

destroyed—it would not be admitted. Steam is used for disinfecting bones, but it is necessary to have means for exhausting the steam from the plant, and wet steam must be used. Super-heated steam is merely a desiccating and not a disinfecting agent.

Witness suggested that disinfection of suspected material should be applied in this country. He put forward certain methods, but in his opinion the method should not be left to those commercially concerned—there should be public control. It is necessary to remove fat from materials in order to allow the disinfectant to act properly, and the conditions of disinfection—strength of solution, time of exposure, &c.—must be prescribed. (8383, 8491–3, 8522–8, 8603–13, 8767–70.)

F. W. Eurich (P): Bloodclots should be sorted out of wool and disinfected before use in manufacture. The albuminous constituent of blood dries, however, and forms a protective covering for the spores imbedded in it. Moreover, certain disinfectants cause coagulation and hardening of the albumen in bloodclots, which thus becomes even more protective to the spores. Present methods of chemical disinfection are, therefore, ineffective for bloodclots, but steam is effective and is the most satisfactory method. If this be not applicable, the bloodclots might be softened in water and allowed to putrefy and then be treated by chemical disinfectant.

Witness has carried out enquiries as to disinfection of wool. Anthrax organisms are present in wool as spores and not as bacilli. The latter are easily destroyed by many methods of disinfection, but the former have enormous powers of resistance to all methods. The method and result of disinfection depends on the environment of the spores. If they are exposed and loose on wool they are more easily destroyed than if imbedded in bloodclots. No method known can secure disinfection of wool in press-packed bales on account of the difficulty of penetration. The material must be loose and open for successful disinfection.

Methods of disinfection may be divided broadly into two classes, *i.e.*, chemical and physical. The only chemical capable of killing anthrax spores which could be used commercially is formaldehyde. A disinfectant may falsely appear to cause destruction of spores, and there is much misapprehension as to disinfectants and their use. Many so called disinfectants are merely deodorants, others are antiseptics, while with all true disinfectants fixed conditions of dilution and time of exposure are necessary to secure disinfection. A deodorant is a substance which masks a disagreeable smell. An antiseptic, strictly speaking, is a substance which prevents putrefaction; but frequently it is one which, so long as it is in contact with a micro-organism, prevents its growth and development. On removal from contact with the antiseptic the organism will grow and develope though, perhaps, the growth may be delayed. Some disinfectants will kill certain bacteria and not others, while there are also differences in the vitality of organisms of the same kind. Anthrax spores are the most resistant of all known disease producing organisms.

Witness carried out experiments in disinfection with formaldehyde, cyllin, and Leach's fluid, (germaphoid fluid), the two latter being of the phenol or carbolic acid and cresol class. He found that naked anthrax spores were apparently destroyed, but if measures were taken to neutralise the active chemical (by means of ammonia for formaldehyde and sodium carbonate for cyllin and Leach's fluid) and so bring its possibility of action to a close, then the spores when treated with cyllin and Leach's fluid always grew in proper culture media, though their growth was delayed. These results were similar to those obtained by the Imperial Health Office of Berlin. In the case of formaldehyde the spores only grew when the dilution was too great or the time of exposure too short. In cases where growth is only retarded by so-called disinfectants their use for wool would be valueless, because after the material is washed the spores would still be capable of causing anthrax in human beings. Formaldehyde in proper strength can be used for disinfecting wool, but it slightly harshens the fibre and

F. W. Eurich (P)—*continued.*

makes it more difficult to spin. It is not poisonous, but it affects the skin of some people, and its vapour is irritating. There is, however, no practical danger in its use. Witness describes the methods he uses for testing processes of disinfection.

Witness has also experimented with steam and the Seymour Jones' and Professor Schattenfroh's methods. The last two are impracticable for wool. The conditions for successful disinfection by steam are (1) the wool must be loose and all parts of it accessible to the action of steam; (2) the temperature must be at least 212° F.; (3) the steam must be wet; (4) the exposure must extend at least 15 minutes after all parts of the wool have reached a temperature of 212° F. In one of the experiments made 30 minutes were required for the material in the centre to reach 212° F., this temperature was maintained for 15 minutes and two colonies of anthrax were cultivated from the bloodclot placed at that point. Disinfection by steam severely damages wool fibre and cannot be used for wool, but it can be used for bloodclots. This result confirms those of previous experiments by other people. Methods suitable for disinfection of horsehair (which include boiling and steaming) are not necessarily practicable for wool. The structure of the fibre of horsehair is different from that of wool.

The conditions necessary for disinfection of wool must be accurately worked out for any method before it is put in use. Formaldehyde, for instance, is decomposed by ammonia, and wool contains ammonia. The strength must, therefore be ascertained after the wool has been put in the solution and all the ammonia used up. Further, Mr. Ackroyd's experiments with formaldehyde showed damage to the wool, but the strength and time of exposure were too great in opinion of witness, so that wrong conclusions as to damage may have been drawn. At present our knowledge of disinfection is not sufficiently good to enable us to require wool generally to be disinfected, but, if a practicable method were devised, witness would suggest that disinfection of Persian and East Indian wools, Turkey mohair, except the best qualities, inferior Cape mohair, and camel hair should be compulsory. Witness thought disinfection of all dangerous material to be impracticable on account of the great quantity, but that if skin material and bloodstains can be picked out, these should be disinfected as the quantity would be comparatively small. If separation of skin from fleece material in the country of origin could be secured, the disinfection might be done abroad, under proper supervision, or in this country. Witness would consider satisfactory the use of a method which destroyed a large proportion of spores, but not all, if no other be available. (719–20, 748–98, 856–911, 989–96, 1028–32, 8615–56, 8738–60.)

G. H. Feather (E): Witness suggests that blood clots removed from wool should be sterilised by steam, but he would leave the way open for other methods of disinfection to be used if found effective.

It is impracticable to disinfect all locks and pieces as the material would be ruined. The only effective method known to witness by which anthrax spores in bloodclots can be destroyed is by steaming. Witness has tried Leach's fluid, formaldehyde, cyllin, kerol, and other things, but none will penetrate bloodclots. (4458–64, 4501–10.)

G. Ackroyd (E): Witness would rely on picking out of bloodclots as a means of preventing anthrax, but would desire use of an efficient germicide, if one can be found, for the materials in which bloodstains are more difficult to recognise, *e.g.*, Persian wool. Bloodstains removed from wool should be either burned or sterilised by steam. General conditions, *e.g.*, temperature and time of exposure, should be prescribed for the method to be followed, but there should be freedom to use other effective methods which may be discovered. Inefficient disinfection could be prevented by prohibiting the disinfecting of material in any factory not licensed by the Home Office for it. Instead of licensing factories for disinfection, stringent regulations prescribing the exact method might be brought into force with a clause providing for exemption, under conditions, to be granted by the Home Office. This would permit of different methods being used with complete official control.

Witness charges one penny per pound for sterilising bloodclots. It is somewhat appalling to have to handle two or three hundredweight of bloodstained material. The blood is friable, and dust is sure to arise. Small quantities only should be sent—one hundredweight at a time. Witness disinfects about 80 lbs. of bloodstains at a time, the material being removed from the sheets and the sheets disinfected at the same time. The method is largely experimental at present as all methods of disinfection of wool are. Steam disinfection causes great damage to material.

Witness had several lots of mohair sent to him for combing which were so badly infected he decided to attempt their disinfection. He tried to disinfect Van mohair by adding formalin to the steeping bath at a cost of a farthing a pound of material. Anthrax was, however, subsequently cultivated from the bloodstains. In another case the heavy clots were removed from Turkey mohair, but it was found impossible to remove all the small bloodstains. Different portions of the material were, therefore, steeped in (1) formaldehyde, (2) cyllin, (3) germaphoid fluid. In each case about 1,800 lbs. of material was steeped at a time in a tank 28 ft. by 3 ft. by 3 ft., fitted with perforated plates just above the bottom and squeezing rollers at one end. The details are as follows:—

——	Strength of Bath per cent. (approximate.)	Temperature (Atmospheric).	Time of Exposure.	Condition of Bloodstains after Treatment.	Result of Bacteriological Examination after Treatment.
Formaldehyde -	1·7	70–80° F.	Varied up to 15 hours.	Partly dispersed	Negative
Cyllin - - -	2·0	Do.	3½ to 5 hours -	Do.	Positive
Germaphoid fluid -	2·0	Do.	1½ to 12 hours -	Do.	Do.

——	Yield of Top to 1 lb. of Noil.		Spinning Properties after Treatment.	Washing after Treatment.	Cost of Treatment per lb.	Decrease in Value of Material caused by Treatment.
	Untreated.	After Treatment.				
Formaldehyde -	(1) 8 lbs. 9 ozs. (2) 9 lbs. 4 ozs.	7 lbs. 4 ozs. 9 lbs. 8 ozs.	Injured -	Less soap required.	¼d.	33–50 per cent.
Cyllin - -	8 lbs. 9 ozs.	7 lbs. 12 ozs.	Do. -	—	¼d.	Considerable.
Germaphoid fluid	8 lbs. 9 ozs.	8 lbs. 6 ozs.	Do. -	33–50 per cent more soap required.	¼d.	Do.

G. Ackroyd (E)—*continued.*

Witness thinks no definite conclusions can be drawn from the results with formaldehyde, as the process is purely experimental. The strength of the bath and the time of exposure were both too great. Witness could give no reason for the difference in the yield of top to noil in the two instances tabulated. The method is successful for disinfection and can be used commercially provided the injury to the material can be prevented. The bacteriologist's report in connection with the cyllin and germaphoid fluid experiments showed that these materials inhibit the growth of but do not destroy anthrax spores. These chemicals are therefore valueless for disinfection of wool. The cost of the method depends very greatly on the extent to which the bath deteriorates. If it can be used over and over again it would be much less than the figure stated. In addition to the deterioration of spinning properties, formaldehyde has an effect on the dyeing properties, causing the colours to appear more brilliant.

Witness is of opinion that the disinfection of all skin Turkey mohair should be compulsory. Exemption should, however, be allowed where samples have been taken by a method and in quantity prescribed, bacteriologically examined, and found to be free from anthrax. (*See* Bacteriological Examination.) He would not without further enquiry extend compulsory disinfection to all skin material and locks of the dangerous classes of wool. The evidence of danger is not sufficiently proved to warrant such drastic action. Very few factories would go to the expense of disinfection plant, but it is not desirable to have all disinfection confined to one factory. It is desirable to secure the separation of infected material in the country of origin, but it would be dangerous to trust to disinfection carried out there. It would be more safely carried out in this country.

Witness strongly urges that further experiments should be carried out. The only practicable method of disinfection at present is by means of formaldehyde, but it is almost as prohibitive as steam and for the same reason, *i.e.*, the injury to the material. The injury possibly depends on the strength of the solution or on time of exposure, or both. Steeping for 12 to 18 hours in water does not injure the material. It is commercially possible, by means of a proper arrangement of machinery to steep the material for 4, 6, 8, or even 12 hours, and witness considers the cost of the process given (¾*d.* per pound) would not be prohibitive. One penny per pound would not be too much. Experiments are required to ascertain to what extent the bath may be used for successive lots. (6565, 6579, 6807–17, 6915, 6963–9, 7133–50, 8030–128, 8148, 8158–60, 8221–56, 8262–9.)

"B. A." (W): Disinfection by means of chemicals used in mills at the present time is useless. Some firms use disinfectants in the washbowl, but they are not efficient. (2521–7, 2590–2.)

T. Larkin (W): The whole of all badly blood-stained fleeces should be disinfected. (2949.)

"W. R." (W): Two firms known to witness use germicidal liquid, and the quantity is not stinted. (3602–4.)

"C. W." (W): Recently a firm has commenced to sterilise bloodstains on commission. (5081–3.)

Dust—Collection and Disposal of. (*See* (1) Infected Material—Dust. (2) Cleansing of Exhaust.)

T. M. Legge (O): (*See* Standards—Dust Collectors.) The woolcombing regulations require the burning of dust from scheduled materials. Dust from East Indian wool, of which there is an enormous quantity, possesses manurial value, and cannot be burned because it chokes the furnaces. Witness sees no sufficient reason for destroying dust which has value rather than using it as manure. The existing regulations require dust collected by exhaust to be discharged into "properly constructed receptacles" and not into the open air. (*See* Definitions; Regulations, &c.) The prohibition as to discharging dust into the open air is for the purpose of preventing the conveyance of infection to persons, animals, or fields outside. Appliances which automatically collect the dust have recently been designed for and are in use with great success in the wool trade. (247–8, 349–57.)

G. A. Taylor (O): (*See* Standards—Dust Collectors.) All dust removed by exhaust or by a vacuum cleaner, *e.g.*, in opening, sorting, blending, willowing, and card cylinder, and roller grinding, should be collected in receptacles and burnt. None should be allowed to escape into the open air. It is difficult to prescribe the use of a standard dust collector in all cases, but the existing requirement of collection in a "properly constructed receptacle" is unsatisfactory. Many occupiers have told witness that dust from East Indian wool is sold as manure and cannot be burnt owing to the large amount of sand in it. He does not suggest that this should be burned, but has seen a method of attempting it by mixing it with hot ashes from the boiler. (1527–39, 1631–6, 1649–50, 1873–5.)

W. S. Smith (O): Regulation 11 of the existing code (requiring discharge of dust from the exhaust into "properly constructed receptacles") is difficult of administration and not sufficiently precise. (*See* "Standards" and *also* "Definitions.")

Witness mentioned cases where dust collected by both wet and dry methods had been found to be infected, and dust should therefore be collected and destroyed or disinfected. The only accurate way of showing whether a dust collector forming part of an exhaust system is efficient is by making determinations of dust in the air discharged; but this is difficult, and a simpler plan is to observe whether dust is deposited on the roof or on the surroundings. Dust collected by a wet method should be steamed before being disposed of. This is done in the works of Pachetti Bros., but it might be difficult to steam the whole of the liquid in a large water tank used as a dust collector.

Certain dust collectors, *e.g.*, cyclone collectors, bag filters and chambers with sloping sides, and a worm in the angle of the V are self-cleaning. It is desirable to prohibit the entering of any dust collector containing dry dust, though it is undesirable to prohibit the use of dust chambers, because they are the only type of collector capable of use with propeller fans. Every dust collector, whether provided with baffles or not, which is not self-cleaning, should be provided with water sprays so that the dust is converted into wet sludge. In a large chamber there is no need to have baffles, and in a small chamber the water spray should be applied so as to deposit the dust before it reaches the baffles. A sewer has been regarded as a "proper dust collector," but witness thinks that this should not be allowed. Dust which has been damped may "heat," and thus be liable to spontaneous combustion. (7792–813, 7825–29, 7842–6, 7946–55.)

Sir S. Stockman (O): Witness mentioned districts where anthrax occurs among animals on farms on the line of drainage from (and is probably due to infection from) tanneries and factories where wool is washed. Shoddy dust and sweepings from factories where wool is treated, are used as manure without any treatment likely to cause destruction of anthrax spores. As to the propriety of allowing this, witness considers that if the farmers like to take the risk of infecting their animals, and if the landlords do not object to their land becoming infected, it is difficult for other people to object. As to the propriety of permitting possible infection of farm servants and others, he considers that is settled by the principal of requiring payment of compensation to them (or to their dependants, if they die), but he points out that the whole question of such use of possibly infected waste materials is very difficult, and is one which should be governed by the opinion of the majority. Personally, he regards it as one where the balance of advantage may lie on the side of risking a few lives per year and permitting the use of such material as manure. He suggests that possibly the anthrax spores would be destroyed by inducing putrefaction in the materials, and considers that all really waste materials like dust should be burned.

Sir S. Stockman (O)—*continued.*

He quoted cases where animals in the neighbourhood of a woolcombing factory contracted anthrax, and the evidence pointed strongly to infection from dust discharged into the air from the exhaust fans. He strongly objects to the air being contaminated with anthrax by dust discharged into the air in this way. It ought to be collected and burned or, if of value, treated in such a way as to destroy infection before sale. Witness considers such dust, even though principally sand, must be infected. Nevertheless, he considers it would be safe to use such material as manure for such crops as hops, where the crop grows above ground and animals do not feed on the land. The danger to human beings is another question. (9935–6, 9945–9, 10,141–71, 10,297–300, 10,355–9.)

W. Mitchell (P): Dust should be removed by exhaust fans, collected and burnt. If blown into the open air it is distributed into the atmosphere and causes anthrax among animals in surrounding districts. (7315–9, 7388–9.)

H. J. Foster (E): Witness showed the Committee the method of dust collection by means of cyclones used in the factory. Those in connection with the exhaust from the willows are fitted with a device for extracting fibre from the dust. (8844–55, 8880–3.)

W. Root (E): Witness showed the Committee the system of dust collection, by means of Spencer and Halstead bag filters, used in his works. The filters are placed in a chamber in the sorting room with an outlet to the open air through the roof. The dust collects automatically in small chambers below the filters. The system is very satisfactory, but the filters could not be placed in the open sorting room (on account of some dust escaping into the air through the filters). (8959c–59o.)

E. B. Whitley (E): Witness showed the Committee the system of dust collection from the sorting exhaust propeller fan. It consists of a large chamber with an outlet terminating in a special device over a tank of water. The collected dust is sent to the Corporation destructor. The dust which collects in the water of the tank is washed into the drains. (9604–10.)

W. Waud (E): The system of dust collection from the sorting exhaust propeller fan, which consists of two large chambers, each provided with a double water spray, was shown to the Committee. The nozzle of the water spray may become stopped up occasionally, but it is not a common occurrence. (9907–11.)

N. Broome (E): The dust from the opening exhaust, which is provided with a Blackman propeller fan, is collected in a chamber of about 210 cubic feet capacity. Part of the walls of the chamber is composed of sacking, which is renewed every week. This permits the air to escape and filters off the dust. Some, however, escapes. It is impossible to keep it all in the chamber. The dust collected in the chamber is dangerous, and is removed and burnt in the boiler furnaces. The dust from the willows and card riddles is sold as manure. (10,425–34.)

J. H. Halliday (M): In the works managed by witness the dust removed by exhaust from opening, sorting, and willowing was collected in dust chambers and receptacles, from which it was removed in wheelbarrows and burnt in the boiler furnaces. The chambers were out of date and unsatisfactory, and were to have been replaced by mechanical dust collectors. These are satisfactory, and should be used for collection of dust, but they should not be required where satisfactory receptacles are already in use. (5781–90.)

J. H. Stott (M): Two methods of dust collection are in use in the works managed by witness. One, a dust chamber, has to be swept out by hand twice a week. In the other system, the dust is automatically collected by means of filters. Men have not to enter this collector for cleaning purposes, and it is the best method yet devised. It is intended to replace the chamber by a similar filter. Witness has used water sprays in dust chambers, but they are

J. H. Stott (M)—*continued.*

useless, as the nozzles very quickly become stopped up, so that the sprays cease to act. (8884–907.)

T. Town (M): The dust from the exhaust is collected by means of a cyclone separator from which it falls into a large chamber, which is cleaned out by hand once a week. The dust is put in sacks and sent to the destructor. It consists principally of sandy matter. (9001–7.)

J. Campbell (M): Witness showed the method of collecting dust from the vacuum cleaner. It is automatically deposited in a sack which is put bodily into the boiler fire every Saturday. (9194.)

S. Wade (M): The dust (collected by a cyclone separator automatically in bags) is sold as manure for the hop fields. (9219–20.)

C. E. Biggin (M): The dust from the exhaust is separated from the air by means of a cyclone separator and discharged into a chamber, which has to be cleaned out by hand. The dust, removed every Saturday, is put into small sacks and sent to the destructor. The firm is required to pay 3*d.* per cwt. for its destruction, and their men are sent with it to see that it is actually destroyed. A considerable quantity of dust escapes and collects on the roof, and has to be removed. Some also collects in a shaft between the fan and the cyclone. (9300–17.)

"B. A." (W): In the works where witness is employed the dust from the exhaust is collected by a cyclone separator and discharged automatically into a sack, which, when full, is emptied and the dust burned. (2169–71.)

H. Barker (W): The dust from the exhaust (centrifugal fan) in the sorting room, over which witness is foreman, is collected in a chamber. Some dust escapes through the outlet on to the roof, and the landlord objects to this. The outlet is therefore covered with sacking. There is no set time for cleaning the chamber, which is done by a man wearing a boiler-suit and respirator. The dust is put into sacks, which are collected by the Corporation men twice per week and taken to the destructor. Nothing is paid for this service, and no steps are taken to see that the dust is actually burnt. (9722–7, 9785–800.)

Dust—Effect on Workers.

T. Larkin (W): When dust is breathed it gets on the chest and gives one a cold. Witness has not known anyone permanently affected by dust from wool. (2991–3.)

"W. R." (W): When dust is breathed it affects one so that one cannot breathe properly. Witness refused to do any blending of wool in bins for this reason. He has known men suffer considerably in health from breathing dust in wool blending. (3399–404, 3609–16.)

Dusty Processes and Dust Prevention. (*See* Willowing).

T. M. Legge (O): Some varieties of wool contain dust which is thrown into the air in opening, sorting, blending, willowing, pulling blends and in feeding the washbowl. Fatal anthrax in blending occurred in 1910 when it was reported that manipulation of East Indian wool was less dangerous than that of materials under the woolcombing code, because dust was better removed from the former by means of dust-extracting machines than from the latter by exhaust screens. Recommendations were made to use dust-extracting machines or to blend in enclosed bins provided with steam sprays to allay, or exhaust fans to extract the dust.

An outbreak of anthrax in Lancashire was attributed to use of antiquated badly constructed willows. An investigation by Mr. Duckering as to the quantities of dust in the air during various processes showed (1) there to be less dust in the air when opening and sorting are done in one operation than when done separately, (2) the value of willowing the wool in preventing dust in subsequent processes, (3) the necessity for provision of exhaust in card grinding,

T. M. Legge (O)—*continued.*

and the value of vacuum cleaning of card cylinders' which witness would like to see adopted.

Steeping, provision of exhaust screens in opening and sorting, prohibition of other work than opening and sorting in opening and sorting rooms, sprinkling and sweeping of floors and cleansing and limewashing of walls of opening, sorting, and willowing rooms are all precautions against dust in the early stages of the treatment of wool. Steeping prevents dust but causes diffusion of spores and therefore greater danger in later processes. The existing exhaust screens also effectively prevent dust, but their construction might be improved. They do not remove all the dust from the wool, but prevent dust getting into the air. Witness would prefer mechanical removal of dust from wool to methods of preventing dusty conditions by removal of dust from air. (*See* Willowing.) Hand sweeping is a dusty process and witness would prefer use of a vacuum cleaner. (81–4, 87, 281–9, 319–27, 334–43, 362–3, 364–72, 399–404, 431–5, 444–7.)

G. A. Taylor (O): If dust be likely to cause injury to health its prevention can be enforced under the Factory Act, but the procedure is difficult, and witness is strongly of opinion that regulations for manipulation of wool should prescribe the methods to be adopted in preventing dust in processes which should be specified. The methods should be so prescribed as to be capable of application in all cases, but occupiers, workers and inspectors should know exactly what is required to comply with the law. (*See* Standards.) Most of the dangerous wools are dusty, and the air is consequently likely to be and is frequently dusty in the processes of opening, sorting, blending, pulling blends, feeding washbowls, blowing wool from driers to cardrooms, carding, and grinding cards and card rollers. Where possible, opening and sorting should be done in one operation, but where it is necessary to shake the material in opening the latter process should be done in a separate room over a floor exhaust screen. Sorting should also be done over exhaust screens. Standards of size, shape, draught, &c., should be prescribed for these. Exhaust systems do not remove dust from wool but only from air.

Blending should be done only in bins provided with exhaust, or with steam spray for damping the wool and allaying dust. Entry into the bins should be prohibited while wool is being put into them and until all dust has settled. Exhaust is needed for pulling blends (but is exceedingly difficult to apply) and also for the washbowl feed lattice. The bins into which wool is blown from the drier should be so enclosed as to prevent escape of dust.

Dust is thrown off by the revolving card cylinders during carding, and is produced in card grinding. Efficient and uniform oiling of wool, use of vacuum apparatus, and provision of exhaust are necessary for preventing dust in cardrooms. (*See* Carding.) An alternative method of preventing dust is by removing it from the wool at the earliest stage possible, which witness thinks is immediately after sorting. (*See* Willowing.) If effective, special precautions in blending, pulling, washbowl feeding, blowing wool, carding and card cylinder grinding would then be unnecessary, provided the wool be effectively washed and oiled before carding. Card roller grinding is a dusty process, and the frames on which the rollers are ground should be enclosed and provided with exhaust whether or not the wool be willowed, as grinding of card rollers produces much steel and emery dust. Witness would also prefer use of a willow for oiling wool before carding as well as a dust extracting willow after sorting.

Waste willowing is a dusty process, and the machine should have a proper exhaust and be entirely enclosed. It should also have a feed lattice and a quiet method of delivery so that material is not violently thrown out. The cleaning of rooms, exhaust screens, walls, &c., by means of a brush should be prohibited on account of the dust raised. A vacuum cleaner can and should be used. Overalls should be shaken periodically over the exhaust draught in order to prevent breathing of the dust from the

G. A. Taylor (O)—*continued.*

overall. (1096–9, 1224, 1243–60, 1286–8, 1325–58, 1379–88, 1396–422, 1444–73, 1484–90, 1644–6, 1706, 1780–8, 1820–3, 1851–61, 1904–11, 2021–9.)

W. S. Smith (O): (*See* Standards.) Witness has made a special study of methods of preventing dusty conditions in manufacturing processes. He is of opinion that it is absolutely necessary to prevent all dust as far as practicable. Some dusts are more injurious than others, but every kind of dust has a more or less pronounced effect on health. Witness examined 19 factories and 7 workshops under the Woolcombing and East Indian Wool Regulations with a view to giving evidence before the Committee. He is of opinion that dusty processes should be scheduled and defined and definite requirements as to exhaust and other preventive measures laid down for each. (*See* Standards.) Dust from wool is dangerous from the point of view of anthrax as well as from that of its effect on the respiratory organs.

All processes up to combing may be more or less dusty, depending on the early treatment of wool. Opening, sorting, willowing, blending, pulling blends, feeding washbowls, carding, and card cylinder and roller grinding should be scheduled as dusty processes in which there is more or less danger. Existing regulations prescribe measures for opening, sorting, and willowing only.

The following methods may be and are employed for preventing dust:—Mechanical exhaust to remove dust from air (used in opening, sorting, willowing, blending, carding, and card roller grinding); mechanical shaking of wool to remove the dust from it; manipulation of wet wool (*e.g.*, Van mohair after steeping); use of a wet steam spray (in blending); enclosing machines which cause dust (*e.g.*, carding machines, willows, and card roller grinding frames); oiling of wool before carding. All these methods witness has seen used successfully and unsuccessfully, depending on the construction of the mechanism and the method of application. He regards steeping as a bad method, because it may break down bloodclots and the wool must be dried for some processes (*e.g.*, carding). The steam spray used in blending is also usually ineffective and it is objectionable from the point of view of the blenders.

Opening and sorting should be done in one operation where possible, as there is then less dust in the air than when done separately. Some materials must, however, be shaken before sorting, *e.g.*, alpaca and East Indian cashmere. Such materials should, therefore, be opened over exhaust in a room used for no other purpose and a standard of exhaust (size of screen and velocity of draught) be prescribed. Sorting should also be done over an exhaust screen, the size of, and the velocity of draught through, which should be prescribed. It is possible to apply exhaust to blending bins and when pulling blends, but witness regards the difficulties as almost insuperable. Exhaust may be effectively applied to the washbowl feed lattice and to cards, and a vacuum process of cleaning the card clothing, after stripping, is effective in preventing dust in card cylinder grinding.

Witness is of opinion, however, that a regulation requiring removal of dust from wool before blending is to be preferred to requirements for prevention of dust in blending, pulling, washbowl feeding, carding, and card cylinder grinding. (*See* Willowing.) If this be not done it is necessary to lay down definite requirements for exhaust for prevention of dust in all these processes. Card roller grinding frames should in any case be enclosed and provided with exhaust, as considerable amounts of steel and of emery dust, both of which are injurious, are thrown off in this process. It is necessary to prescribe methods of dust prevention for willowing (shaking), *i.e.*, by enclosing the machine and providing exhaust to the machine and delivery lattice.

For the purpose of maintaining all the arrangements for prevention of dust in constantly efficient order, a system of self-inspection by an appointed competent person in each works and a keeping of a record of these inspections should be required. (*See* Self-Inspection.) (7411–54, 7548–75, 7734–74, 7814–23, 7854–61, 7882–921, 7970, 7981.)

F. W. Eurich (P): Witness is of opinion that it would materially assist in reduction of incidence of anthrax if more attention were given to prevention of dust in processes after washing, and in carding and willowing where washing is not done. In a paper read in 1912 before the Royal Sanitary Institute, he pointed out that further steps in the suppression of anthrax could be taken by (among other things) protecting the workman from dust by a more extended use of fans and their more direct application to the site of origin of dust, and by the wearing of light and efficient respirators by grinders and all who work near shoots when in use. (928–34, 1011–6, 1053.)

W. Mitchell (P): Witness considers it essential to suppress or prevent dust in all processes of manipulation of wool. Unless dust be removed from wool and the processes thus rendered free from dust, exhaust should be provided wherever dust is produced. (7315–9.)

G. H. Feather (E): If wool is dusty both opening and sorting are dusty operations, and it is best that these two processes be done in one operation since less dust results. It is essential to prevent a dusty atmosphere, when dealing with dangerous materials, from a health point of view apart from the question of anthrax. Scouring alone cannot remove all dust from unwillowed wool, no matter how many times the washing water is changed, and the atmosphere of the carding room, where no other methods of preventing dust are adopted, must be dusty. (4394–7, 4419–22, 4603–13.)

G. Ackroyd (E): It is necessary to prevent excessively dusty conditions in manipulation of wool apart from the question of anthrax. Regulations are necessary for this. Exhaust is necessary for sorting. Blending may be dusty in certain circumstances, and should not be carried on under unfavourable conditions. (6412–8, 6440–4, 7018–27, 7044–6.)

H. J. Foster (E): Witness applies exhaust, at the point where material is discharged from his willows, for the purpose of removing dust which escapes with the material. (8851–5.)

J. H. Halliday (M): Some of the dangerous wools are dusty, and it is undesirable that operatives should be exposed to dust. Opening is a dusty process in spite of the fact that it is done over an exhaust in compliance with the existing regulations. Sorting is also dusty, and should be done over exhaust for which certain details (which witness suggested) should be prescribed. (*See* Standards.) He quoted figures as to dust in the air which showed that opening and sorting done as one operation is no more dusty than sorting done alone and much less dusty than opening done alone. In order to prevent dust in sweeping, the floors should be sprinkled with disinfectant, swept, and again sprinkled with disinfectant.

Blending is a dusty operation, but much more so when done in bins than when done on the open floor. Exhaust can be applied in bins to prevent dust. Witness did this and also used a device for preventing dust passing from the bin to the sorting room, while no one was allowed in the bin when wool was being put into it. Dust was not, however, prevented during spreading. In blending on open floors, the dust is reduced by keeping the blend low and using care in spreading. Witness is not in favour of the use of a steam spray for damping the wool during blending. Pulling is also a dusty process. Dust in blending and pulling should be prevented apart from the question of anthrax.

In order to remove dust from wool, witness willowed all material after blending, but this is a dusty operation, especially if the fans and exhaust ducts are not kept clear. It would be of great advantage to willow wool before blending and so prevent dust in this process, and in pulling, but unless willowing also followed blending the material would be less well mixed. The only dusty process in witness's works after willowing is grinding card rollers. He thinks the frame in which this is done should be enclosed and provided with exhaust. He quoted figures showing that washbowl feeding, carding, and card cylinder grinding in his works are free from dust, and compared these with figures in similar pro-

J. H. Halliday (M)—*continued*

cesses where similar but unwillowed wool is treated. (*See* Willowing.)

Witness thought application of exhaust to blending bins by means of hollow walls and an air supply in the top might be effective, but he was doubtful. He considers steeping absolutely unsuitable for dusty wools. (5609–26, 5685–96, 5700–69, 6123–8, 6136, 6159–61, 6168–87, 6224–39.)

T. Town (M): Witness steeps Persian wool. If it were not steeped the atmosphere in feeding the washbowl would be very dusty. (8962–81.)

J. Campbell (M): Witness demonstrated the cleaning of card cylinders by vacuum before grinding. This prevents nearly all dust in grinding except the steel and emery dust, which is a very small amount. Witness uses a steam spray in his blending bins and showed it in use. The wool is damped, but dust is not prevented. (9089–96.)

S. Wade (M): Witness's cardroom is free from dust though dusty wool was being carded. He puts as little oil as possible on the wool, and relies on efficient washing to remove the dust remaining in wool after shaking it over the opening screen and sorting it. If the temperature of washing be too high, more dust is produced in carding. Feeding the washbowl is a dusty operation, but at the time witness showed it to the Committee it was worse than usual. Willowing is a dusty process and witness was of opinion that the operator runs a greater risk than men engaged in blending, feeding the washbowl with, and carding unwillowed, wool. (9227–76.)

"B. A." (W): The object of opening wool in a separate room is to get as much dust as possible out. Opening of fleeces in the opening room results in more dust in the sorting room, caused by pulling the loosened wool out of the skeps. Witness considers opening to be an unnecessary dusty process, and would prefer to have the wool opened and sorted in one operation. This would cause less dust, but there should be an exhaust screen in front of the sorting bench to remove dust when taking fleeces from the bale at the side of sorter. Sorting is a dusty process, but the dust in the air is well removed by the exhaust, in which witness cannot suggest any improvement.

Blending in bins is very dusty. The methods for preventing this which witness has seen adopted (steam sprays) are not effective in preventing dust in spreading, but cause the wool to be wet on the surface. This results in the dust sticking to the face, hands, and clothing of the workman. It also causes a warm atmosphere, and the men sweat and rub the face with their hands. In witness's opinion, therefore, it is an objectionable method which may become actually dangerous, though it probably lays the dust caused by throwing the wool into the bins. The men are, however, not in them when this is being done. The only effective method of preventing dust in blending known to witness is that of willowing, which removes the dust from the wool. The dust produced in blending escapes from the bins and affects the men working at the wash-bowls. (2164, 2213–8, 2340–96, 2453, 2462–89, 2532–53, 2658–61, 2681–96, 2720–6, 2732–4.)

T. Larkin (W): During opening, the material is shaken as much as possible in order to get the dust out, but much remains in the wool. Some dust is breathed, but the exhaust takes it away fairly well. If bales of wool were opened and sorted in one operation there would be less dust in sorting but more in blending. Witness, therefore, thinks all wool should be opened in a separate room. Sorting is at times dusty in spite of the shaking in opening. He could not suggest any improvement in the opening and sorting exhaust.

Blending is done in bins close to the washbowl, five storeys below the sorting room, and is a dusty process. (*See* Blending.) Steam is blown into the bins to allay the dust. No doubt it does prevent some dust when the wool is being thrown down, but it does not prevent any during spreading, because it only damps the surface of the wool. On the other hand, it is very bad for, and objectionable to, the

T. LARKIN (W)—*continued.*

blenders. It causes the dirt in the wool to stick to the hands and clothing, it makes the bin very hot, and causes colds. It is, however, better than nothing. The dust sometimes escapes from the bin through the shoot into the sorting room. Pulling of wool from the bin makes the air of the washhouse dusty. The dust caused in blending should be prevented. If dust were removed from wool before blending the process would be unobjectionable. (2859–70, 2889–94, 2975–3002, 3008–16, 3124–33, 3171–5, 3182–4, 3229–42.)

"W. R." (W): A certain amount of dust is breathed both in opening and sorting. Witness could not say that dust in the air during these processes is effectively removed by the exhaust screens, but the greater part is.

Blending is done in bins, which are closed chambers having no ventilation except by means of the shoot and a small trap, through which men climb out when the blend is finished. The process is very dusty. (*See* Blending.) A steam spray is fitted in the bin to prevent dust, but it is of no benefit as the men get wet through if the dust is prevented. If dust were removed from wool before blending, the process would be free from objection. Witness expressed the opinion that wool cannot be freed from dust, but was clearly thinking of the use for this purpose of the opening and sorting exhaust screens. (3305–6, 3329–36, 3383–406, 3515–25, 3540–1, 3609–16.)

"S. J." (W): (*See* Carding.) In some works the air of cardrooms and the process of carding itself is dusty, and in some it is not. Stripping of cards does not cause dust, but grinding of cylinders and rollers does, and these processes are more dusty in some works than in others (*see* Carding).

Witness suggests that willowing before washing for the purpose of removing dust from wool and, preferably, also willowing after washing together with efficient and regular oiling (which is best done as the wool goes through the second willow), will prevent dust in carding. Use of a vacuum cleaner for removal of dust from the card clothing after stripping will prevent dust in card cylinder grinding, and use of an enclosed frame provided with exhaust will prevent it in card roller grinding. (3692–832, 3940–57, 3985–8, 4050–64, 4101–19, 4155–6.)

"F. J." (W): Processes after sorting are always a little dusty. Alpaca could not be opened in the sorting room, even if there were no danger of anthrax, on account of the dustiness of the process. (4956–8, 5015–22.)

"C. W." (W): A separate room for opening, especially for alpaca, is essential on account of the dusty nature of the process. Blending is a dusty process. (5133–4, 5190–1.)

"G. J." (W): In the factory where witness is employed the washbowl is close to the blending bins. Much dust escapes from the bins during blending and affects the washbowl men by making the air very dusty. The steam spray provided in the bins has very little effect in preventing dust. Feeding the washbowl is a dusty occupation, and an exhaust is provided on the washbowl lattice, but it is of little use because it very quickly gets blocked up. It is good, however, for the short time it will work efficiently.

Witness has worked with both willowed and unwillowed wool. The latter causes practically no dust in blending, pulling, and washing, and is easier to wash. Witness thinks willowing before blending the only satisfactory method of preventing dust in these processes. Willowing is, however, a bad employment, and much more dusty than feeding the washbowl. He washes more wool in a stated time now than formerly, and it is therefore not so clean after washing, and must cause more dust in the cardroom. (5367–411, 5417–35, 5482–510.)

"Two Sorters" (W): It is necessary to shake alpaca when it is being opened and a separate room and exhaust are therefore necessary. Before these were compulsory the beams of alpaca sorting rooms

"TWO SORTERS" (W)—*continued.*

in which the material was opened were like trees after a snow storm. Very little dust collects on the beams of modern sorting and opening rooms. (9802–31.)

Education of Workers.

F. W. Eurich (P): Many of the cases of anthrax are fatal because the patients do not seek medical advice sufficiently early on account of their want of knowledge of the early symptoms of the disease, and of the danger of delay, or because the appearance of the external pustule does not correspond with that of the illustration posted up in works. It is possible that instruction is now given in some factories, but it should be universal. The diagrams on the official illustration are good so far as they go, but they are not sufficiently comprehensive, and they show the pustules at too late a stage. The printed details are also not presented in a way to attract attention. (519–21, 534–5, 843–5, 974–7.)

W. Mitchell (P): The anthrax placard illustrates the local condition (of pustules) at too late a stage, and is therefore misleading. Persons seeing the big black pustules illustrated ignore little things. They should be educated in the appearance of the pustule at the commencement of the disease. The placards should illustrate the early as well as the later stages. (7266–9, 7293–4, 7330–4, 7364–82.)

"B. A." (W): When foreman of a Commission Combing warehouse witness always gave new men instructions as to the care necessary in handling dangerous materials and as to the manner in which infection shows itself in the early stages of the disease. He also instructed them as to the necessity of personal cleanliness, and impressed on those sorting out blood-stains the fact that the safety of workers in subsequent processes depended on their care and thoroughness. Men recognise the necessity for care, *e.g.*, in getting cuts and scratches covered up, if it be drilled into them. All new men should be given verbal instructions by the foreman, but perhaps this is not always done. Some men read the precautionary notices put up, though perhaps some do not. It would be a valuable precaution to require that each man be served with a copy of all regulations applying to his work and with written warnings. (2428–40, 2704–19, 2726–9.)

T. Larkin (W): Witness contracted anthrax soon after commencing to work among dangerous materials. He was warned when commencing work to be very particular as to cleanliness, always to wear overalls in the works, and to take them off before going home. Before contracting the disease he had not read the regulations nor seen the placard illustrating the disease. He has not yet seen the latter, but read the former after he recovered. Witness thinks most men read the regulations some time or other, but it would be much better if each new man were given a copy of the regulations, and of the placard illustrating anthrax, so that he might study them. (2874–6, 3056–83, 3220–8.)

"W. R." (W): Probably no man reads the regulations posted up in a factory in their entirety. It would be a good thing if each man were given a copy so that he could study them at leisure. (3642–5.)

"S. J." (W): Witness was never given any instructions as to not taking meals in the cardroom, and he has not read the regulations nor heard of new men being instructed in them. Nevertheless, the old workers always instruct new ones and show them what they have to do. It would be a great advantage if every workman were supplied with a copy of all regulations applying to his work. (4132–42, 4161–71.)

"C. W." (W): At all the places where witness has worked the regulations have been posted in a place where they can be easily read. He has read them, but others may not have done so. They can, however, if they like. (5261–8.)

Employment of Females.

G. A. Taylor (O): Opening, sorting, blending, and pulling are sometimes done by women. Witness sees no reason from the point of view of danger why these

G. A. TAYLOR (O)—*continued.*

processes should not be carried on by women. Females also attend the carding engines and combing machines and there is no reason against such employment. (1273–4, 1289–1, 1344–5, 1350–1, 1389–91, 1506–7, 1707.)

G. H. Feather (E): Witness has not known cases of employment of females among dangerous materials except in cardrooms and combrooms. He does not think the danger is greater for women than for men, but in his opinion sorting is not a suitable employment for women. He sees no reason against their employment in cardrooms. (4474–81, 4492, 4622–6.)

G. Ackroyd (E): Females are employed in carding, preparing, box minding, combing, and finishing. Witness sees no reason against this. He has not known instances personally, but understands females are employed in sorting and picking out bloodstains. He thinks the hair and clothing of females might be more liable to afford shelter to anthrax spores. (6260, 6911–14.)

W. Root (E): Witness employs females for opening, rough sorting and picking out bloodstains. They do not understand what skin wool is. They chiefly deal with East Indian cashmere and Persian wool, and get through about 120 lbs. per day each. (8659R–8961E.)

J. H. Halliday (M): Witness employs women in carding, combing, gilling, and finishing, and sees no reason against this. He has known women to be employed in opening, sorting, and blending. He thinks the form of clothing worn by females makes these three processes unsuitable for their employment. (5902–5, 6004–5.)

"B. A." (W): Witness formerly had women working under him in opening fleeces of dangerous materials. He considers opening, sorting and blending unsuitable as employment for women because of the form of clothing worn. Much dust and dirt get on the legs, and men can tie bands round their legs, but it is impossible to tie the bottom of a frock. (2222–8, 2447–9, 2593–601, 2690–1, 2771–9.)

T. Larkin (W): Witness thinks opening, sorting, blending and packing of dangerous materials unsuitable employment for women who, in his opinion, are not strong enough. He does not know whether the danger is greater for women than men, but the former are more liable to be affected by the dust. (3041–5, 3265–72.)

"S. J." (W): Witness as foreman of a cardroom has women working under him on the day turn, but not at night. He considers carding to be an unsuitable employment for women because their skirts collect so much more dust than the clothing of men. (3913–20, 4201–4.)

"Mrs. C." (W): Witness opens and sorts (rough sorting) East Indian cashmere. She says it is a dusty operation, but the overalls she wears cover her to the frock bottom and her clothing does not become dusty. (8927–51.)

First Aid—Injuries.

T. M. Legge (O): The object of prohibiting persons working, with an open cut or sore, among dangerous materials is to prevent anthrax spores alighting on the wound. The person should not work till the cut is covered up. The regulations should require the provision of a first-aid box for treatment of cuts and abrasions. The contents should be specified generally—not exactly, as in the French regulations. (382–3, 388.)

F. W. Eurich (P): One of the reasons why anthrax is sometimes not diagnosed at the earliest stage possible is because of misapplied first aid. Pimples are sometimes covered up by means of plasters. This not only prevents the discharge being washed away, but acts as a poultice, and so encourages the development of the disease. Persons in charge of the application of first aid in factories where dangerous materials are manipulated should be instructed to apply plasters to cuts and fresh wounds, but not to pimples. (534, 540.)

G. Ackroyd (E): Persons working among machinery are liable to injuries of the skin and are thereby more exposed to infection. (6621.)

"B. A." (W): Persons working under witness are told to report to him all cuts, scratches, or pimples. They do so, and are at once sent down to the office for first-aid treatment. (2450–2, 2726–9.)

T. Larkin (W): If witness, or any person working with him, cuts or scratches himself, he goes down to the office for first-aid treatment. Usually witness keeps some sticking plaster in a box on his sorting bench, and uses that. (3077–83.)

"S. J." (W): Witness, and every man working under him, goes to the office for first-aid treatment for all cuts and scratches. He has never heard of any one with a pimple not being sent to the doctor for examination. (4168–78.)

"C. W." (W): Witness has never heard of a workman being disregarded when reporting a cut, scratch, or pimple. (5311.)

Infected Material—Bloodstains. (*See also* Persons Skilled in Detection of Infected Material.)

T. M. Legge (O): Blood is the carrier of anthrax spores, and presence of bloodstained material in wool or hair is an indication of possible infection. The recommendation that bloodstains should be sorted out of wool was of great importance. Blood of healthy animals does not contain the anthrax organism, so that bloodstained wool, sheared from living sheep in the ordinary way or taken from skins of animals killed for food, is not likely to be infected. Bloodstained wool will only usually be infected when the animal from which it has been obtained has died from anthrax. It is, however, impossible to say (without bacteriological examination) whether or not blood is infected. In order to remove infection from wool, therefore, all bloodstains must be picked out. The existing regulations require removal of fallen fleeces and damaged wool, but in the light of present knowledge the removal of bloodstains should now be required. This should be done when the wool is being sorted. It is desirable and possible to remove them from wool (unless it has been washed), though a certain amount of training is necessary to enable men to recognise dried bloodstains in coloured materials.

Removal of bloodstains from unwashed wool will remove nearly, but not quite, all the danger. The dried bloodstains may possibly crumble in manipulation of the material and form dust. There may thus be contamination of wool previously free from infection. This danger is, however, slight. Usually dust will only be infected when it contains particles of dried infected blood, and if bloodclots are allowed to remain in wool, each fresh process of manipulation tends to break them down further and so produce fresh infected dust at each stage. Washing of wool containing infected bloodclots removes the visible indications of blood and causes distribution of the anthrax spores from the blood over all the material. Dust in such wool, *e.g.*, East Indian wool, will contain anthrax spores which, however, were originally present in the blood destroyed by washing. The virulence of the organisms will not be impaired, but the poison will be diluted. (81–4, 88, 146, 150–8, 172–7, 200–7, 217–9, 310–9, 328–9, 408–9, 416–8, 448–59, 463–5, 469–75.)

G. A. Taylor (O): Blood is not necessarily infected, but primarily blood is the carrier of anthrax spores, and if blood did not become attached to wool, anthrax would not arise. Bloodstained material should, therefore, be removed from all wool at the earliest stage possible in order to prevent shedding of the blood in each operation. (*See* Anthrax—Conveyance of Infection.) If bloodclots are removed from wool before it is washed, tops, noils, waste and dust ought not to be dangerous, provided there has been no shedding of blood before the bloodstains are picked out.

Blood may be attached to wool either in the form of stains on a few fibres or as large masses or clots.

G. A. TAYLOR (O)—*continued.*

It is difficult to collect any weight of the former, but the clots can be readily picked out in quantity. Training is necessary to enable men to recognise bloodstains, but this can be given, to an ordinary unskilled warehouseman, by demonstration of their characteristics by an experienced person. In white materials bloodstains are easily recognised, but in coloured wools their recognition is difficult. Careful sorting is necessary to ensure their removal, and means must be devised to prevent hurried or careless sorting and sorting by incompetent persons. All manipulation of material before removal of bloodstains should be prevented where possible. Bloodstains when picked out of wool, should be immediately placed in a receptacle and ultimately destroyed or disinfected. (1180–1, 1220–2, 1261–92, 1362–70, 1400–14, 1436–41, 1575–83, 1671–7, 1681–90, 1721–3, 1750, 1776–9, 1824–9, 1883–5, 1916–20, 1933–4, 1996–2006.)

W. P. Norris (O): Animals which die of anthrax have the bacilli throughout their bloodstream toward the end of the illness, and infection can only be conveyed by means of blood from an animal suffering from the disease. Among sheep and cattle anthrax is usually of the intestinal form. Wool becomes infected by means of fluids containing blood which are excreted shortly before or after the death of an animal. In rare cases the wool of a healthy animal might become infected as a result of the animal lying down in blood from another animal recently dead from anthrax. Gross infection also occurs by means of blood during skinning of a sheep or goat which has died from anthrax. It is difficult to conceive that wool sheared from sheep in the ordinary way can be infected. When not actively growing in the blood, anthrax organisms normally exist in the form of spores. (8358, 8380, 8441–57.)

Sir S. Stockman (O): The disease of anthrax is caused by a bacterium, which lives and grows in the blood of animals. Wool and hair become infected partly by bloody fluid discharged from the mouth, nose and anus when an animal is dying or dead from anthrax, but principally by blood escaping during skinning or by the operator wiping his hands and knife on the material. Animals are also sometimes killed when found to be ill, and if the disease be anthrax the wool becomes stained with infected blood. Wool would only become infected by other means in rare and exceptional circumstances. Usually anthrax is conveyed to human beings by means of infected animal blood. Removal of bloodstained material from wool would diminish the danger, but would not remove it entirely. (10,025–8, 10,320–7, 10,041–57, 10,331–7.)

F. W. Eurich (P): In the early stages of the bacteriological examinations made for the Anthrax Investigation Board, 189 samples of wool and hair and 123 samples of dust were tested. Of these two samples of bloodstained Persian wool and two samples of dust (in which blood was found by chemical test) were found to be infected. In the later stages of the enquiry, 4,745 samples were examined, and 311 were infected. Of 3,972 bloodstained samples examined, 277 (7 per cent.) were infected, while of 772 non-bloodstained samples, 34 (4·4 per cent.) were infected. Of those samples of non-bloodstained materials which had not been treated by a wet process, two only (0·27 per cent.) were found to be infected, and from each of these one colony of anthrax only was obtained. There were reasons for suspecting contamination of these two samples by other infected materials. Witness concludes that infection in wool which has not been wetted is, for all practical purposes, contained entirely in blood attached to the material, or in dust containing blood originally attached to the wool. It is not possible to say that wool is never infected unless it contains blood, but the danger of infection apart from blood is very small.

Witness is of opinion that blood is the original carrier of the anthrax spores, and bloodstains must, therefore, be regarded as an indication of possible infection. Wherever possible all wools should be sorted and bloodstains picked out before the material

F. W. EURICH (P)—*continued.*

is washed. Bloodstains may be recognised by their colour in some cases, but this varies, and in coloured wool they may not be readily distinguishable. They are, however, usually hard and brittle and can be recognised by the sense of touch used in combination with the sight. It is possible by demonstration to train unskilled men to recognise and remove bloodstains. If bloodstains be not removed from wool before the manufacturing processes are commenced they become broken up into fine dust by such processes as willowing and carding, and may thus spread the infection. Any careless handling tends to break up the bloodclots, but the danger of spreading the infection is not great until manufacturing processes commence. Washing and wet fellmongering cause the blood to dissolve, and the spores are thus diffused throughout the material. (*See* Infected Material—Treatment by Wet Process.) Cases of anthrax have occurred in manipulation of wool from which the bloodstains have been sorted out. In at least one case infected bloodstains were found in the material when it was re-sorted for the purpose of tracing the cause of the cases. There is a possibility, but not a grave one, that wool may be infected to some extent even after removal of bloodstains.

In skin materials which are obtained by a dry process, *e.g.*, Persian skin wool, the infection is not diffused, and examinations of non-bloodstained samples are practically always negative even when bloodstains from the same fleece are found to be infected. In skin materials obtained by a wet process, and in materials washed abroad, non-bloodstained wool is frequently infected. (*See* Infected Materials—Skin Material.) Anthrax spores are frequently present in bloodstains in enormous numbers, but the colonies cultivated from non-bloodstained samples are usually few in number.

Animals suffer from intestinal anthrax as a general rule. Infected blood is discharged from the bowels in this form of the disease and becomes attached to the wool. If infected wool be wetted, *e.g.*, in the case of water-damaged wool, there may be multiplication and spread of anthrax organisms, but the maximum extent of the spreading does not exceed half an inch into the surrounding wool. The neck portion of a fleece is usually the most badly bloodstained. This is due to the fact that animals are frequently killed by cutting the throat and also that in animals which die the neck veins become very full of blood which escapes on to the wool when the skin is removed. Witness has not obtained any evidence that blood is more frequently infected on one part of a fleece than on another.

Immediately blood containing anthrax bacilli begins to dry in the air at certain temperatures the conditions are favourable for spore formation. Spores are difficult to kill under any circumstances, but when imbedded in dry blood the albuminous constituent of blood is a highly protective material. Certain disinfectants cause hardening or coagulation of this substance and thus further increase the protection of the spores. Chemical disinfection is, therefore, unreliable. Bloodclots may be disinfected by sufficient exposure to live steam. (*See* Disinfection.) (554–70, 578–81, 584–6, 591–4, 618, 621–4, 665–829, 849–58, 864–71, 918–30, 939–49, 997–1000, 1017–27, 1041–52, 2075.)

W. Mitchell (P): Anthrax spores found in wool originate from the blood of animals suffering from anthrax. Bloodstains break down and become powdered by attrition in manipulation of wool. Material and dust may, therefore, be infected apart from visible blood, though the spores would come originally from blood or tissues containing blood. Danger of anthrax is diminished, but not entirely removed, by the separation of bloodstains from wool. (7299–308.)

G. H. Feather (E): The sorting out of bloodclots by skilled sorters from wool combed for witness was commenced in 1908, but cases of anthrax occurred subsequently. Witness and his brother in 1911 re-sorted part of a lot of sorted wool which apparently had caused infection. Although no bloodstains had been found originally, half a pound per 1,000 lbs of

G. H. FEATHER (E)—*continued.*

wool were taken out in the re-sorting. 10 per cent. of the bloodstains were found to be infected, and their removal apparently prevented further cases. 90 per cent. of the infected samples were found in locks, and 10 per cent. in skin wool. Other cases have occurred since in spite of great care and inducements to the sorters to remove all blood. Probably some escaped removal or contamination of sound wool had occurred. It is possible to remove all bloodstains from Persian fleece wool, but not from Persian locks. Bloodstains may break up and cause contamination of wool not bloodstained, but infection originates from bloodstains. Dust is sometimes infected, because it contains particles of blood.

From the beginning of 1911 to the end of 1913 witness had records kept as to the bloodstains removed from his wool. (Appendix 8.) The following table shows certain particulars relating to Persian wool :—

——	Bagdad.*	Bussorah.*	Bushire.*
Pounds of bloodstains in 1,000 lbs. of :—			
Fleeces - -	0·002	0·0025	0·16
Locks false packed in fleeces.	1·17	1·72	0·45
Skin fleeces - -	6·08	10·09	—
Skin locks and pieces.	0·79	1·34	—

* The quantity of wool examined was :—

Bagdad fleece wool - - -	2,912 bales.
Bagdad skin wool - - -	590 „
Bussorah fleece wool - - -	779 „
Bussorah skin wool - - -	32 „
Bushire fleece wool - - -	343 „

Some lots of fleece wool were entirely free from locks and, therefore, also from blood. Those lots which contained much blood always contained many false-packed locks. There is always much more blood in Persian wool sold as skin wool, but anthrax is rarely found in this. In the period named 1,120 blood-stained samples were examined bacteriologically; 52 were infected, and of these 46 were from Persian wool—37 from locks (80 per cent.) and 9 from fleece and skin fleece. If bloodstains could be removed entirely from wool, infection would be also removed.

It is not possible to find the original bloodstains in washed wool, *e.g.*, East Indian wool. Washing spreads the infection from bloodclots to other wool not bloodstained. It is important to prevent packing of locks inside fleeces because of the difficulty of removing bloodstains from them. All bloodstains should be disinfected after removal. No germicidal liquids will kill anthrax in bloodstains on account of the difficulty of penetration, but steaming will do so. Blood is not found particularly on any part of the fleece except in the case of skin wool where the neck part is usually badly stained. (4256–360; 4391–4; 4454–9; 4501–10; 4608–13; 4730.)

G. Ackroyd (E): Blood is primarily the source of anthrax infection in wool. Secondary infection of wool not stained with blood may occur. Bloodclots are friable and, though they may be picked out in sorting without danger and without causing danger in subsequent processes, any manipulation of material having the bloodstains left in must spread the danger and cause dust. Dust may therefore contain blood, and is to that extent dangerous, but it is not dangerous unless it does contain blood. From a lot of East Indian cashmere every fleece which was bloodstained was removed and examined. Though the bloodstains and dust from the material were infected, every examination of parts of the same fleece which were not bloodstained proved negative. On the other hand, in an examination of a lot of Turkey mohair which had been treated abroad by a wet process, apparently both wet fellmongering and washing, the remnants of bloodstains and material showing no signs of blood were both found to be infected. The conclusion drawn is that infection is primarily confined to bloodstains and is quite local at first, but may be spread to other parts of the wool by any process which dissolves or breaks up the blood.

G. ACKROYD (E)—*continued.*

Witness commenced in 1908 to have bloodstains sorted out of his material and they are now generally removed from wool in Bradford by sorting—efficiently in some factories, badly in others. Witness is aware that anthrax has not diminished as a result of sorting out bloodstains, but this is probably because, in many factories, blood still passes unrecognised. Material combed by him has frequently been sorted elsewhere and bloodstains supposed to have been removed. It is nevertheless looked over for bloodstains in his factory during blending, and from many lots considerable quantities removed—in some cases more than in the original sorting. Several definite instances of this are given. (*See* Persons Skilled in Detection of Infected Material.) Some bloodstains missed in looking over have been examined and found to be infected, *e.g.*, one picked out during willowing of a lot of wool which caused the only case in the works since bloodstains have been picked out (six years).

In the six years before 1908 there were two definite cases of anthrax and several which were suspicious. In no factory has a greater quantity of dangerous wools been combed than in that of witness, and he thinks his comparative immunity from anthrax to be due to the removal of bloodstains in spite of the fact that some infected bloodclots are known to escape removal. He, however, avoids having more than one lot (10–15 per cent. of the total capacity of the works) of badly bloodstained material in combing at one time. If a greater proportion is permitted it is impossible to exercise sufficient care. In some kinds of material bloodstains are too numerous to permit of removal of all and in others the colour of the wool makes their recognition difficult. This, together with inefficient sorting, and the large quantities of dangerous materials dealt with probably accounted for the continuance of cases at Messrs. Crossley and Sons. All persons manipulating wool should be able to recognise bloodstains.

Heavily bloodstained wool is usually put amongst low quality material. Hence the lower qualities, skin material, locks, and pieces and inferiors are most likely to contain bloodstains. The better classes of mohair and Cape winter mohair are almost free from blood. Fallen fleeces are usually bloodstained, but damaged fleeces may be quite innocuous. Bloodstains should be regarded as a sign of danger, but they do not necessarily indicate that wool is a fallen fleece.

Though treatment by a wet process more or less completely dissolves bloodclots, frequently there remain indications (particularly a spiky appearance) that blood stains were originally present. Neither wet fellmongering nor washing wholly destroys blood clots in many cases. The clots are partially dissolved and the wool becomes stained more or less generally. This should be regarded as an indication that infection has been spread and that great care is required. Witness combed one lot of material which had been washed abroad and the bloodstains partly destroyed. The tops and noils produced contained no blood but were infected.

Bloodclots should be removed from the material at the earliest stage possible. Everything which is doubtful should be regarded as, and treated as, a bloodstain. No shearing or cutting of bloodstained material should be permitted on account of the danger of causing dust, though by cutting a doubtful bloodstain its true nature may be proved. Bloodclots should be put into a proper receptacle when removed from wool and should ultimately be destroyed or sterilised. The use of a chemical test for blood in factories is impracticable. Ten per cent. of the bloodstained samples examined bacteriologically for witness have proved infected. There must be danger in sorting out bloodstains, but it is not great if care be taken and the danger of bloodstains recognised. Infection is most likely to be found in material heavily bloodstained (20–40 lbs. bloodstains per 1,000 lbs. of

G. Ackroyd (E)—*continued.*

material), but this is not always true. An instance is given of a fine lot of Turkey mohair yielding only 0·6 lbs. of bloodstains per 1,000 lbs. in which the blood was infected.

Steam will cause disinfection of bloodclots if the steaming is continued for a sufficient time. Anthrax has been cultivated from bloodclots steeped in formaldehyde solution. Apparently the disinfectant will not penetrate bloodclots, but witness cannot say how large the bloodclots must be to prevent effective disinfection. One lot of infected Turkey mohair containing small bloodstains but no clots was apparently efficiently disinfected by means of formaldehyde. No disinfectant has been found to kill anthrax spores in bloodclots. (6310–21, 6338–548, 6560, 6574–80, 6783–95, 6807–9, 7041–3, 7057–8, 7099–102, 7110, 7133–52, 7985–8045, 8053–64, 8087–99, 8110–22, 8131–7, 8141–2, 8161–200.)

W. Waud (E): The class of mohair bought by the firm sometimes contains a small quantity of skin material, but the sorters find very few bloodstains. In the country of origin the religious observances require the cutting of an animal's throat if the flesh is to be used as food. There is much carelessness in this. An animal which is ill or even recently dead might have its throat cut and be left to bleed in the building where wool is stored. This may cause the bloodstains found on mohair. (9888–906.)

J. H. Halliday (M): From witness's experience he is of opinion that bloodstains undoubtedly carry infection. Since 1909 they have been removed from wool in his works. Bloodstains are very difficult to recognise in dark-coloured wool. Witness lays great stress on the necessity for careful sorting out of bloodstains. He has kept records of bloodstains removed in his works. 60 per cent. of all bales contain bloodstains. Some contain very small (a few ounces) and others very large (20 lbs.) amounts. The average is ¾ lb. per bale. Skin wool is heavily bloodstained. Witness has all wool sorted twice. On the average two-thirds of a pound is removed in the first and one-tenth in the second sorting per bale. In three years (1911–1913) 8,618 lbs. of bloodstained material were removed from Persian wool alone in his factory. Blood in wool is disseminated by washing or steeping and anthrax spores thus spread. Since bloodstains have been removed from wool there have been 14 cases of anthrax in the works managed by witness. This is probably due to the fact that bloodstains are missed owing to the difficulties of recognising them in dark-coloured wool and in locks. Bloodstains should be put in a receptacle as soon as found and ultimately destroyed or steamed. (5631–84, 5697–99, 5791–823, 5947–54.)

"B. A." (W): There is always danger where there is blood. Witness thinks certain varieties of wool should have bloodstains sorted out on account of the danger of anthrax. Blood is often contained in dung which, if cut, will show dark red stripes of blood. It is not possible to say dung contains blood unless it is cut. Doubtful cases can usually be decided by either cutting the clot in two with shears or crumbling it on white paper. The dark red colour then shows. Blood in wool is not always dry. Everything which is hard or sticky and everything which is doubtful should be treated as a bloodstain. Inexperienced men or men allowed too little time for sorting will certainly miss bloodstains. In any case, however, it is not possible to sort all bloodstains out of wool. They vary in size from that of a pin's head upwards. The small ones are just as likely to be infected as the large.

Witness has never re-sorted wool to ascertain if any bloodstains have been left in. A fleece which is extensively stained ought to be removed as a whole without trying to pull or shear off the part actually stained. Bloodstains are most frequent on the britch and neck of fleeces. Witness has found bloodstains in Persian wools of all sorts, Syrian, camel hair, Cape and Turkey mohair, and alpaca, but he has never found any in either East Indian wool, Egyptian wool, or goat hair.

"B. A." (W)—*continued.*

Witness has known cases of anthrax arise from manipulation of wool from which bloodstains have been picked out under his direction. All men handling wool should be trained to detect bloodstains. It is more difficult to detect bloodstains in loose wool, like camel hair, than in fleeces. Even though some are missed, it is advisable to pick all bloodstains possible out of wool. (2153–4, 2159–63, 2187–204, 2219–385, 2490–527, 2613–8, 2663–77, 2753–82.)

T. Larkin (W): Blood may be present in wool either as a clot or a mere stain. A week or two weeks' practice is necessary to enable men to recognise them with certainty. Some bales of wool are free from blood and some contain as much as 25 lbs. There is a greater weight of bloodstains in fleece wool than in locks, but bloodstains in the latter are very small and much more difficult to find. Blood is most freely found round the neck and tail parts of a fleece. Fallen fleeces are frequently badly bloodstained. Witness thinks all bloodstains can be sorted out of wool if sufficient time be allowed. Bloodclots vary in appearance and size, but anything which is suspicious, *i.e.*, red or black and hard, should be treated as a bloodclot. (2876–949, 2969–74, 3113–7, 3176–82, 3243–57.)

"W. R." (W): It is impossible to remove all bloodstains from wool, but they should be taken out as far as possible. The britch is frequently badly stained, but blood is found on all parts of a fleece. Persian wool often contains locks, but they are not badly bloodstained. Bloodstained fleeces are quite possibly dangerous, but are not necessarily fallen fleeces. The latter are often bloodstained. (3358–69, 3632–41.)

"S. J." (W): Bloodstains are recognised by their hardness and brittleness. Witness works in the cardroom but has been trained to recognise bloodstains and has seen them in the cardroom. They have been missed by the sorters. All persons who manipulate wool should be trained in their recognition. (4184–91, 4206–10.)

"F. J." (W): Bloodstains are hard and the wool is matted together. They are more difficult to detect in coloured than in white wools. It is necessary to sort bloodstains out of wool as far as possible, but it is not possible to remove all. (4863–903.)

"C. W." (W): Bloodstains are most readily recognised by sight, but are hard to the touch. They are usually found more particularly among the lower qualities, and are easy to detect in white wool. Blood carries infection, and it is necessary to remove bloodstains from wool, but it is doubtful if all can be picked out. Witness gives a case where bloodstains were found in wool which had been sorted twice previously. The bloodstained material in different bales varies greatly in quantity. (5076–94, 5135–72, 5225–48, 5269–81, 5299–304.)

Foreman and Six Sorters (W): The instructions given to witnesses are that everything suspicious is to be treated as a bloodstain. Sometimes dung is thrown out as blood. A bale of Persian wool would have up to 4 lbs. of blood in it, and a bale of Russian camel hair from ½ lb. to 1 lb. It is doubtful if it is possible to remove all bloodstains, but usually substantially all will be picked out. In some cases locks inside Persian fleeces are badly bloodstained, but the locks have sometimes been wetted and they vary a lot. The bloodstains are never large, and are more difficult to find in locks than in fleece wool. (9121–71.)

H. Barker (W): In skin Turkey mohair it will usually be found, on careful examination, that some of the staples are slightly tinged with blood. (9769.)

Infected Material—Dust.

T. M. Legge (O): Existing regulations require certain precautions to be taken to prevent danger from dust. There is much dust in wool, it may contain anthrax spores, and there is certainly danger of infection from it.

In order to prevent infection being carried to persons and animals outside factories, the existing regulations prohibit the discharge of dust into the open air. They also prohibit the eating of food in

T. M. Legge (O)—*continued.*

cardrooms and in rooms where unwashed wool is manipulated, in order to avoid the possibility of dust containing spores settling on the food. A coroner's jury, at an inquest on a cardroom hand who died from anthrax, recommended that this regulation should apply to cardrooms. Dust becomes infected by means of particles of dried blood from the breaking down of bloodclots, and this can occur progressively through all the processes of combing if bloodstains be left in the material. The effect of witness's evidence (249–495) is that existing regulations are largely based on the necessity for suppressing dust. (281–9, 319–27, 336, 352, 375–9, 403–4, 416–8, 480.)

The occurrence of fatal cases of anthrax in 1910 was believed to be due to dust produced in blending. Witness believes the dust in East Indian wool to contain anthrax spores originating from bloodstains, which have been dispersed by washing. The virulence of the organisms will not be diminished, but the poison will be diluted by this means. Only a small proportion of the samples of dust bacteriologically examined have been found to be infected, and other measures, besides prevention of dust, are necessary for prevention of anthrax. The absence of lung diseases among persons manipulating wool is in part explained by the rounded nature of the particles of dust found in the air in the various processes. The soil of certain countries becomes infected with anthrax, and mud attached to wool may in this way convey infection, but this is negligible compared with the danger of dust from attrition of bloodclots. (81–4, 87–8, 150–8, 200–1, 205–10, 217–9.)

G. A. Taylor (O): Bloodstains should be removed from wool as early as possible to prevent attrition of blood, which may be caused by manipulation, *e.g.*, shaking. Dust, although bad in itself, can only convey anthrax when it contains particles of dried blood. Any bloodclots not previously removed from wool are broken up by carding, and particles float into the air. Other particles of blood remain in the card clothing and are thrown off as dust in fettling and grinding or in waste willowing together with particles of steel and emery and may be breathed. If the blood be infected, this dust will be infected. During carding of any infected washed material, or infected skin wools which have been wet fellmongered, infected dust will be thrown into the air also. (1267–72, 1400–72, 1826–9.)

W. S. Smith (O): Dust from some materials, *e.g.*, alpaca, Persian wool, camel hair and East Indian wool is more dangerous than from others. Dust produced in grinding card clothing is dangerous apart from anthrax and should be prevented. In factories where card clothing is made the men engaged in grinding the wires suffer in health. Enquiries also show that cotton card grinders suffer, but no specific investigations have been made among wool card grinders. Dust from wool collected by both wet and dry methods and dust from horsehair have been found by bacteriological examination to contain anthrax spores. (7424–6, 7772–801, 7909–21.)

Sir S. Stockman (O): Soil in districts where there have been outbreaks of anthrax becomes infected, but wool or hair containing a considerable quantity of such soil is not likely to cause anthrax among persons manipulating the wool or hair even when the material comes from Asia where the soil is very badly infected. Spores can, however, survive for long periods in soil. Dust from infected materials is itself infected. Instances are quoted of grain becoming infected by dust probably from dry hides packed on it in the holds of ships. Grain carried in this way has been proved to be infected, but samples of dust have not been examined.

There is danger in dust discharged by exhaust fans from factories where wool is manipulated. Instances of infection of animals in the neighbourhood are given. Dust composed of dried, anthrax infected soil splashed on to growing vegetation, may be a source of infection, but it is a remote possibility only. The dried blood on the surface of hides from infected animals will contain spores, but not that below the surface. (9950–9, 10,041–50, 10,058–69, 10,076, 10,160–9, 10,338–47.)

F. W. Eurich (P): In the earlier investigations of the Anthrax Investigation Board, 123 samples of dust were examined bacteriologically, but only two (from alpaca and Persian wool respectively) were found to be infected. Both samples contained blood and were taken from below sorting boards. Dust may cause infection, but the infection is carried by blood in the dust, much of which is mixed with fine hairs upon which it is occasionally possible to find blood. It is fair to conclude that internal cases are caused by inhalation of dust containing, or of minute hairs stained with, blood. Blood is the original carrier of anthrax spores, but it is conceivable that dust may convey infection even if it contain no blood. The possibility is, however, remote.

In later investigations only few examinations of dust have been made. Samples of alpaca and mohair dust taken from window bottoms and a sample of sludge from a wet dust collector collecting dust from mohair sorting screens were found to be infected. All three samples contained blood. Dust containing blood may be produced by any careless handling of bloodstained wool or by manufacturing processes, *e.g.*, use of shears, in sorting, by willowing and by carding In wools which have been washed or wet fellmongered, bloodstains are destroyed and anthrax spores distributed. Cases of internal anthrax are most frequent in processes after the material has been washed and prevention of dust in these processes would materially assist in reducing the number of cases. Presence of sharp particles in dust is not necessary to cause internal anthrax. (553–64, 633–6, 725, 803–4, 816–25, 950–5, 1011–6, 1064–5, 8696–707.)

W. Mitchell (P): Anthrax spores originate from blood of animals suffering from anthrax, but in manufacturing processes the blood becomes powdered and forms dust. Dust is a considerable factor in causing anthrax by reason of the spores it contains in powdered blood. (7299–308, 7315–9.)

G. H. Feather (E): Wool only becomes infected by means of infected blood, but bloodclots may become broken up and particles distributed. Dangerous wools are always more or less dusty. From a health point of view, it is essential that dust should be prevented apart from the question of anthrax. Witness suggested that a reason why anthrax is more prevalent in the cardroom and less among woolsorters than formerly is that for some reason locks are now more badly infected and, owing to the difficulty of removing bloodstains from locks, they get through to the cards and are broken up. Some material free from blood is infected, but it has become infected through contamination by washing with infected bloodstained wool. Abolition of separate opening would decrease danger as every process before bloodstains are removed increases the danger due to their breaking up into dust. (4298–302, 4421–2, 4583–4, 4604–13.)

G. Ackroyd (E): In 1905 dust was considered to be the chief source of danger, and many expected the dust under sorting boards and in settling chambers to be badly infected. No one can yet say dust is not dangerous, but witness thinks it is only dangerous when it contains particles of dried blood, or if produced in processes after inefficient washing. If bloodstains be removed from wool before becoming broken up the dust in the material will be free from danger; but if not, any manipulation of the wool must spread the danger to the dust. Excessive dust in the air should certainly be prevented apart from the danger of anthrax. Witness gives illustrations which apparently support the view that incidence of internal anthrax is greatest where there is most dust, and he also suggests that the sharp stiff hairs of mohair may help to cause anthrax. There are unexplained cases of anthrax apparently due to English and colonial wools, but dry and dusty wools convey infection most readily.

The incidence of anthrax is much greater in carding than in preparing, and this is probably because, in carding, dust and short hairs, to which blood may be attached, are thrown into the air, while preparing is a quiet process causing little or no dust. Carding

G. Ackroyd (E)—*continued.*

materials are also often coloured and the detection of bloodstains in them is, therefore, more difficult. Washing causes infection (if present) to be distributed over all the material. Dust in processes after washing is usually an indication of inefficient cleansing and may then be dangerous.

Opening of material in a separate room is not necessary, as it is now no longer a question of removing dust, as far as anthrax is concerned, while the shaking and rough handling of the fleece in opening increases the danger on account of possible attrition of blood. Secondary infection does take place usually by means of a wet process, but the dust thus infected should be removed by washing if efficiently done. (*N.B.*—In evidence given at a later date witness proved that washing only will not remove infection in these circumstances.) Dust from bloodstained samples sent for bacteriological examination was found to be infected. (6310–7, 6412–5, 6581–621, 6625, 6628–9, 6649–68, 6777–8, 6824–5, 7007–27, 7044–6, 7054–8, 8161–200.)

J. H. Halliday (M): Persian wools, cashmere, camel hair, and most skin wools are very dusty. In the works in charge of witness the material is willowed before and after washing, and all processes after washing are free from dust. Nevertheless more cases of anthrax occur after washing than before, but the incidence of anthrax is greater before than after washing. Of 18 cases occurring since 1906, 8 (1 sorter, 1 warehouseman, 1 puller, 1 willower, and 4 washbowl feeders) occurred before, and 10 (3 willowers, 1 drying machine attendant, 3 cardroom hands, and 3 combroom hands) after washing. Dust is a carrier of infection. (5821–35, 6000–3.)

"B. A." (W): Some processes in the manipulation of certain wools are very dusty, *e.g.*, blending. Witness cannot say that anthrax is caused by dust, but in the works where he is employed more cases occur among men working in a dusty atmosphere than among men working in the same process at a point where there is not so much dust. More cases occur also in those processes which are dusty than in those which are not. Instances are given. It is the opinion of many workmen that if wool were willowed in order to remove dust, danger of anthrax would be reduced. Witness thinks dust settling on the moustache or beard is dangerous. (2369–85, 2545–53, 2720–5.)

T. Larkin (W): In the works where witness is employed blending in bins is very dusty, but he thinks the low incidence of anthrax is due to the care with which bloodstains are sorted out of the wool before blending. The dust, however, gets on the chest and causes colds. It should, therefore, be prevented. Witness thinks dust settling on the beard or moustache dangerous. (2859–70, 2973–3000, 3070–6.)

"W. R." (W): The air is very dusty during blending in bins. The dust badly affects the breathing, and some men, including witness, have refused to do the blending in bins and left their employment in consequence. Witness has known men become ill from its effects, and he would sooner die in the street than in the bin. (3383–406, 3437, 3515–25, 3613–16.)

"S. J." (W): There are more cases of anthrax in some works than in others where similar wools are used. Witness suggests this is because some works are more dusty than others. The air of some cardrooms is dusty and that of others where the same material is carded is not. Comparing different works and processes in which he has been employed witness is clear that where there is most dust most cases of anthrax arise. He therefore thinks there is a connection between dust and anthrax. He thinks (and gives reasons) that dust caused him to contract the disease. In some works there is more dust now than there was formerly owing to certain changes (speeding up), and the cases of anthrax are more frequent also. This increase in incidence might be caused by the greater amount of material treated. (3692–720, 3763–801, 3853–72, 3921–39, 3985–88, 4005–12, 4050–62, 4157–60.)

"F. J." (W): The removal of dust from air is necessary from the health stand-point even if it

"F. J." (W)—*continued.*

contain no anthrax spores. Some mohair is dusty and some contains a lot of short hairs which are as dangerous as dust. Witness has known several cases of anthrax caused by inhalation. (4782–808, 4825–9, 4945–9, 5015–8.)

"C. W." (W): Mohair is not usually dusty but it contains many short hairs. The dust from alpaca, if shaken in the sorting room, would be injurious to all the sorters. Men working with witness have contracted anthrax (woolsorters' disease) apparently by inhalation, as it affected the lungs and was often called congestion of the lungs. (5071, 5097–108, 5133–4, 5173–81, 5328–9.)

"G. J." (W): In the wash-house where witness is employed four cases of anthrax out of five occurred to men working where the air was very dusty (close to the bins), and in the fifth there was also dust. Witness therefore associates dust with anthrax and would expect cases to arise wherever there is much dust from dangerous wools. Perspiration causes particles to stick to the skin, and in the cases witness has known the disease attacked those parts of the body where perspiration takes place most freely, *e.g.*, the face and neck. This is his reason for thinking they are caused by dust. (5372–407.)

Infected Material—Excrement.

W. P. Norris (O): It is clear from the natural history of attacks that animals become infected by ingestion, either by eating infected food or in some other way, and the germs are so placed that they can readily multiply in the walls of the digestive tract, *e.g.*, of sheep. Intestinal anthrax is the ordinary form of the disease among sheep. It is improbable that urine and other excreta would be infected unless they contained blood. The bloody semi-fluid excreta in the intestines of an animal suffering from anthrax may, however, be discharged shortly before death, and may stain and infect the wool. It has been shown in the United States that the ejecta of animals and the vomit of carrion birds which had eaten the flesh of anthrax-infected animals is infected. It is possible that anthrax was introduced into Australia on wool or hair contaminated by the discharge from another animal, but this is speculative and improbable. Soil may become infected by bloody discharges from the intestines. (8286–93, 8326–30, 8364–7, 8446–53, 8572.)

Sir S. Stockman (O): Animals which contract anthrax practically always become infected by eating infected food or drinking infected water. Sheep and cattle rarely, if ever, suffer from any but the intestinal form of anthrax. In the early stages of the disease when an animal has eaten badly infected food it is beyond dispute that there may be multiplication of anthrax bacteria in the contents of the bowel, where the conditions are very favourable for this. Anthrax bacilli may be excreted in the fæces. In the later stages of anthrax, also, blood is often excreted, and the dung may then convey infection. (9950–6, 10,044–50, 10,194–5.)

F. W. Eurich (P): Animals which contract anthrax usually suffer from the intestinal form. One of the effects of this variety of the disease is the discharge of blood from the intestines. It is possible that the natural discharges of an animal suffering from anthrax might be infected apart from blood, but the possibility is slight. Over 70 samples of a low quality material known as "dockings" were bacteriologically examined (mohair, Cape mohair and Persian), but none was found to be infected. Dockings contain excrement. (657–64, 683–91.)

G. Ackroyd (E): Witness gives details of one case in his own works where "mohair dockings" was one of the materials being combed. Bloodstains had been picked out of all the materials, but some were missed. The dockings (and some others of the materials also) were found to be infected. (6367–77.)

"B. A." (W): Witness first started picking out bloodstains by instructions of his employers. Their characteristics were not known, and everything was, therefore, carefully examined. He found that if dung

"B. A." (W)—*continued.*

be cut open it is often mixed with blood which shows on the cut surface in red stripes, and sometimes when rubbed on the clothes presents visible appearances of blood. There is a large quantity of dung in some kinds of wool, *e.g.*, greasy Persian and Bussorah. Much of it is not bloodstained, but all dung should be picked out unless it is cut open and found to be free from blood. (2219–48, 2494–504, 2758–70.)

T. Larkin (W): When sorting out bloodstains, witness also removes toppings (dockings). He very rarely finds blood in toppings or dung. (2907–8.)

Infected Material—Skin Material and Locks and Pieces.

T. M. Legge (O): At Mazamet (France) wool is removed from skins imported from many parts of the world. 35 per cent. of that so obtained is sent to Bradford, which is the largest market for Mazamet skin wool. (90–1.) Over half the cases of anthrax at Mazamet (60 in 10 years) have been traced to Spanish skins or skin wool, others to South American and South African skins or skin wools. (390–92.)

Damaged wool means wool damaged by sea water in transit, fallen fleeces mean fleeces taken from the bodies of animals which have died of disease, skin wool means wool removed from the skins of animals after death. These terms are not defined in existing regulations. It is important to detect and remove all fallen wool and all skin wool because of the greater risk of anthrax from such material which may originate from animals dying of disease. It would only be dangerous if it had been obtained from an animal which had died from anthrax, but it is impossible to say from the appearance of wool whether an animal has died from anthrax or has been slaughtered. (288–97, 449–53.)

Fallen fleeces may contain dried blood charged with anthrax spores, and their removal and isolation till proved free from infection is both desirable and possible, except in the case of washed wool such as East Indian wool. The labour of carrying out bacteriological examination of such wool would be great, and it would be sufficient if it were treated as if infected. There is a possibility that some of the sound wool in a bale containing an infected fallen fleece may also become infected, but this is not a serious danger, even if dried bloodstains are present, provided the fallen fleece be removed. (298–318, 413–5, 454–8, 465–6.)

Presence of bloodstains is an indication of possible infection, and these could only be seen by examination of the wool after opening. Water damaged wool might be picked out before opening. New regulations should require the removal of bloodstains instead of fallen fleeces, and damaged wool need not be mentioned at all. (408–12, 465–6.) Witness would not expect wool shorn from a living animal to be infected. (175–6.)

G. A. Taylor (O): Locks and pieces are small parts of a fleece. (1185–7.) Persian locks usually reach this country rolled up inside fleeces of good wool. Persian wool should be opened and sorted in one operation, as the dust, blood and locks are all contained within the tied-up fleece. (1194–5, 1220–22.)

Infected skin wools which have been treated by a wet process will have the spores so distributed as to make it impossible to sort out the infected material. The quantity of skin wool used in Bradford is unknown. (1440, 1564–9.) A damaged fleece is understood to mean one damaged by sea water. A bloodstained fleece is not necessarily either a fallen or a damaged fleece. (1651–4.)

W. P. Norris (O): It is very improbable that sheep might recover from anthrax in such circumstances as to leave their wool infected. (8314.) In large flocks in Australia sheep may die without anyone being immediately aware of the fact. Failure to report deaths from anthrax among sheep (reporting of such deaths is required by law) may occur through design or ignorance or by accident or because the disease was not recognised. In such cases the wool and skins would probably get into commerce. (8387–99.) If anthrax be recognised, the body and skin and wool

W. P. Norris (O)—*continued.*

are burned. (8410.) There are cases recorded in Australia where animals suffering from anthrax have been dealt with by butchers in slaughterhouses and elsewhere. There is practically no risk of sheared wool being infected as the illness from anthrax in sheep is so short. Any cases of anthrax occurring from the manipulation of Australian wool must be caused by skin wool accidentally or surreptitiously sent into commerce. It is impossible to deny that this may happen, but it must be a rare and comparatively infrequent occurrence. (8437–40, 8529–34.)

Wool becomes infected by means of the bloody semi-fluid excreta, which is forced out of the body after death or during the convulsive struggles which may precede death, the bacilli in which would form spores in suitable conditions. It would also become infected by blood during the skinning of an animal which had died of anthrax. It is improbable that any other agent than blood could cause infection. (8450–53.) Skin wool is wool removed from the body or skin of a dead animal, and it is very improbable that any wool is infected other than skin wool. (8454–57.) A large quantity of Australian skin wool is used in commerce. Eight to ten million sheepskins are exported yearly. France takes most, then England, and then Belgium, and the wool is removed in those countries. (8547–54.)

Sir S. Stockman (O): The wool from dead animals or their skins is known as skin wool. The skins and wool of animals dying of disease in this country are sold as articles of commerce. In some cases they may have been obtained from an animal which has died from anthrax, but the possibility is slight, because this disease must be reported and the bodies must be burned intact. It is not an uncommon practice to kill an animal which is ill and send the carcase for sale. Cases occur where the animal so killed is suffering from anthrax and the skin and wool then pass into commerce. In some instances such skins have been traced and found in tanneries. (10,017–28.) Anthrax is caused by a bacterium which obtains access to and grows in the blood. Gross infection of wool by blood takes place when a dead animal is skinned. Infection also occurs from the bloody fluid which escapes from the mouth, nose and anus when an animal is dying from anthrax.

There is a possibility that when an animal eats infected food multiplication of the bacilli may take place in the intestines. The excrement would then become infected and might infect the wool. In a few rare cases healthy animals may lie down on the blood or excrement discharged by a sick animal. In such a case the wool would become infected. Otherwise it is very improbable that any wool will be infected except that from an animal which has died of anthrax. There are certainly cases of recovery from anthrax among animals, but in such a case the wool would not be infected. (10,041–57.)

Cases of anthrax occur, and are expected to occur, regularly in every country in Europe, including Great Britain. Infected wool very rarely gets on the market in this country, but in Eastern Europe and in Asia it does. There is very little danger from shorn material unless it may have become infected in transit. (10,129–34.)

F. W. Eurich (P): The conclusion drawn from the bacteriological examination of over 5,000 samples of material in eight years is that infected material preponderates greatly in skin wool and in locks and pieces. In Bagdad (Persian) non-skin wool, out of 72 samples of fleece wool examined, one (1·4 per cent.) only was infected, while in 448 samples of Bagdad locks and pieces, there were 27 (6·0 per cent.) infected samples. In Bagdad skin wools 12 (3·0 per cent.) infected samples were found in 388 samples of fleece wool, and 12 (9·0 per cent.) in 130 samples of locks and pieces examined. In Bussorah non-skin wools, 2 per cent. of the samples of fleece wool and 4 per cent. of the samples of locks and pieces examined were infected. Of 118 samples of non-skin Van mohair examined, one only was infected, and in this case there was a suggestion of contamination from another source, while of 268 samples of skin Van mohair, 35 (13 per cent.) were infected. 409 samples

F. W. Eurich (P)—*continued.*

of non-skin Turkey mohair contained 32 (8 per cent.) infected samples, while in 151 samples of skin Turkey mohair there were 28 (18·5 per cent.) infected samples. (679–96.)

Skin Van mohair is a particularly dangerous material. The proportion of infected samples is the same among both bloodstained and non-bloodstained samples of this skin material. Skin Van mohair, which is not bloodstained, is therefore as dangerous as bloodstained material. This is accounted for by the fact that the hair is removed from the skins by a wet process of fellmongering, which causes the dispersion of the anthrax spores over the wool. (578, 589–604.)

Anthrax was not found in any of the samples of non-bloodstained Persian skin wool examined. This was an expected result, as Persian skin wool is said to be removed from the pelts by a dry fellmongering process. Nevertheless, the proportion of infected samples is always high in Persian skin wool and in Persian locks and pieces, but the infection is found in the bloodstains. (631–64.)

Locks and pieces may fall off during shearing, but they are often the sweepings of the yards, possibly knackers' yards. The wool in locks is shorter than, and is more often infected than fleece wool, because frequently it is derived from the bodies of animals which have been found dead (the wool may not have reached shearing length). (680–1.) Locks are usually wrapped up inside fleeces, and may cause contamination of the fleece in which they are contained, but could not contaminate other fleeces in the bale. (672, 730–2.) Packing of locks and pieces inside fleeces is false packing for the purpose of disposing of them, and is not for convenience of transport. (743–6.)

In skin wools (except Persian skin wool) absence of bloodstains cannot be relied on as an indication that the material is free from infection, nor does removal of bloodstains from skin wools remove the infection. It is impossible to sort out the infected parts of skin wool (except Persian) and locks and pieces. The wet fellmongering process by which skin wool is removed from the pelts causes destruction of the visible indications of blood, and also transfers infection to previously sound wool. The same result occurs when infected wool is washed or steeped with sound wool. There may also be some multiplication of the bacilli. (697–712, 730–2.) The best way of dealing with skin wool and locks and pieces is to prevent them coming to this country, or to prohibit the packing of these materials with sound wool in the country of origin, if this can be made effective. (815, 827–30, 871–2.) If skin material could be excluded or packed separately in the country of origin the danger of anthrax would be minimised in this country. (8713.)

In 1914 special attention was paid to the question of skin wools. The proportion of infected samples in non-skin wools was found to be much the same as in previous years (about 7 per cent.). The proportion of infected samples found in skin material was, however, very high, *e.g.*, 32 per cent. in skin Turkey mohair; 24 per cent. in skin alpaca; 26 per cent. in skin East Indian cashmere. The bacteriological work in 1914 strongly supports the suggestion that anthrax greatly preponderates in skin material. (8657–708.)

The proportion of infected samples in skin Persian wool is much lower than in skin mohair and skin goat hair. This is probably partly because of the dry fellmongering process used in Persia and partly because a greater proportion of the animals is killed for food. (8728–31.)

If the whole of the skin material can be sorted from sound wool and disinfected there will be very little danger from anthrax. (8742–50.) Witness would like to make further tests before making a definite statement, but suggests the logical conclusion which must be reached is that there is practically no danger in any raw wool except skin wool. (8578, 8709.)

G. H. Feather (E): The reason for the severe outbreak of anthrax among persons manipulating Persian wool in 1911 was the locky character of the wool. Of 10 infected samples taken in the factory in which the principal outbreak occurred in January 1911, one was from skin wool and nine from locks and pieces packed inside fleeces, and apparently not belonging to the fleeces. (4289–309.)

After the outbreak in 1911 circulars giving the facts were issued by the Anthrax Investigation Board and sent to Persia. Similar action had been taken in 1905 by buyers of Persian wool. Both circulars caused a decrease in false packing of locks in fleeces, but the improvement was only temporary, and false packing still continues. English, French and German buyers also agreed not to buy lots of wool noted by a Committee of Buyers to be locky, a list of which was posted up in the sale room. This failed because foreign buyers did not observe the agreement. (4310–23.)

From 1911 witness kept records of the material dealt with by his firm. Of 1,120 samples (all bloodstained) examined bacteriologically, 52 were infected. Of the latter, 46 were from Persian wool, 9 being from fleece or skin wool, and 37 (80 per cent.) from locks and pieces. The majority of the samples examined would be from locks, but this was because of the comparative difficulty of finding bloodstained samples in fleeces. One of the other infected samples was from Syrian skin pieces. (For analysis of records *see* Infected Materials—Bloodstains.) The bloodstains from fleece and skin wool were only rarely found to be infected, but those from locks were often infected. Witness concludes that the danger lies principally in the locks, and that if Persian wool could be obtained free from locks it would be almost free from danger, though not quite. (4324–60, 4469, 4574–76.)

Locks are bits of short wool and pieces are large locks. It is most important that locks should not be packed with fleece wool, but in any case bloodstains would have to be removed from the latter. This is easy, but it is extremely difficult, probably impossible, to find and remove bloodstains from locks. (4452–71.) It is stated that locks are imported into Persia and there packed inside fleeces. It would be very desirable to prevent this, and there is no reason why it should not be attempted. If it be true that locks are imported into Persia one would expect to find another dangerous wool of the same type on the market, but witness has no knowledge of such a wool. (4541–52, 4727–29.)

Witness suggests that the reason why more cases now occur among combers than formerly is that more locks are sent here than formerly and they are more badly infected. (4571–87.) There is sixty times as much blood in locks as in fleece wool, and ten times as much blood in skin wool as in locks, but Persian skin wool is not nearly so dangerous as locks. Persian skin wool is removed from the pelt as a whole and would be thought to be fleece wool by anyone not an expert. From enquiries made in Persia on behalf of witness it appears that the process by which the wool is removed from the skin is a dry one. The unbroken character of the bloodclots supports this. (4662–9.)

Marseilles buyers purchase locks for mattress making, probably on account of their relative cheapness. Witness would expect there to be much anthrax in Marseilles, but this is denied by the buyers. International refusal to buy locks would bring an end to false packing in Persia. (4696–707.) Fleece pieces are pieces of wool which fall off in shearing and are not locks in the ordinary sense. They would properly be packed in the fleece. (4719–21.)

G. Ackroyd (E): In 1900 and 1905 fallen fleeces, Van mohair and dust from certain wools were thought to be the chief sources of infection. (6299–301.) Bloodstains are most frequently found in skin material and in locks and pieces. Fallen fleeces and heavily bloodstained fleeces would be thrown among the lower qualities which would, therefore, generally be the most dangerous. (6405, 7049–52.) Little blood is found in mohair, except in skin mohair. (6430.) Witness critically examined a lot of skin Van mohair in which the bloodstains were small and had been apparently dispersed in part by a wet fellmongering

G. Ackroyd (E)—*continued.*

process in which lime was used; 35 of the 268 samples examined bacteriologically were infected, and of these eight were not bloodstained. The anthrax spores must have been originally in the blood, and the wet fellmongering would cause its distribution on to previously sound wool. Distribution of spores enlarges the area of infection, but lessens the intensity at the original centre. (6445–66.)

A lot of skin Turkey mohair was also critically examined. In this an endeavour had been made in Turkey to remove the bloodstains, which were collected in some of the bales. All the bales contained bloodstains however. Much of the material had been sheared from the pelts, but infected samples were found both in that which was bloodstained and in that not bloodstained. (6467–96.)

Wool or hair is usually removed from the pelts by (1) shearing; (2) the usual lime process; (3) treatment with chemicals (*e.g.*, sodium sulphide); and (4) pulling the wool from the pelt after allowing it to decompose partially (sweating). Of these, the first and fourth may be termed dry, and the second and third wet processes. The wet processes cause distribution of the spores from the bloodclots over the wool, so that absence of visible blood does not necessarily indicate freedom from infection. There are usually, however, indications in skin wool if blood were originally present. (6658–64.) Blood is an indication of danger which will usually be found in fallen fleeces, but a bloodstained fleece is not necessarily a fallen fleece. A damaged fleece may be quite innocuous. (7099–7100.)

In 1914 two lots of skin Turkey mohair were critically examined. After removal of bloodstains, it was observed that there were many lumps of material consisting of fibres glued together. The nature of the cementing material was not clear, but traces of blood were present. It was apparent that some of the material had been clipped from the pelts, some removed by the usual lime process and some by sweating. It was impossible to pick out all the bloodstains, which were small and numerous. The material appeared to have been treated by a wet process, apart from the wet fellmongering. Of 16 bloodstained samples examined, 11 were infected. Of six samples of tops produced from the material, four were infected, and both of two samples of noils examined contained anthrax spores. The tops and noils showed no trace of the presence of blood when tested chemically. Out of 50 further samples of the raw material, 31 (some bloodstained and some apparently free from blood) were infected. (7955–8044.)

Bloodstains in skin material sheared or pulled from the pelt should be practically whole, but nearly all skin Turkey mohair recently examined has been washed after being obtained from the pelts in these ways. Possibly an attempt has been made to wash out the blood, and it is said that merchants have done this in order to make the material more acceptable to the Bradford buyers. In any event it is a most dangerous practice. (8125–38.) Some years ago skin Turkey mohair was habitually mixed with fleece material in Turkey, but this practice declined as a result of action by Bradford buyers. It is now growing again and may explain recent cases of anthrax among sorters. (8138–40.) If skin material were always packed and kept to itself the danger from it would be less. Skin material should always be treated as being possibly infected till the contrary is proved. (Witness makes suggestions for regulating the manipulation of skin Turkey mohair). (8148.) Action to secure separate packing of skin material should be taken in the countries of origin. Otherwise there will always be difficulties in connection with dealers in wool in this country. (8141–60, 8226–37.)

Witness critically examined a lot of four bales of East Indian cashmere which was purchased as fleece material. One of the four bales contained a considerable proportion of skin material which had been pulled from the pelts and in which the bloodstains were whole. The whole of every bloodstained fleece, some with slight stains only, was reserved for bacteriological examination. Of the 43 examined, 11 were infected, and these were all skin fleeces, and all came from the bale containing skin material. Further samples from the infected material were then examined in order to ascertain whether parts free from blood were infected, but infection could only be found in the bloodstained portions. These results were checked by two further examinations. The conclusions drawn are: (1) the chief, possibly the only, infected material which concerns the Bradford district is blood from, and adhering to the hair of, an infected animal; (2) infection is present only in wool or hair to which blood adheres; and (3) the infection can be spread to other parts of the fleece by treatment by any wet process which dissolves the bloodclots. (8161–200.)

Lots of Tacna and Callao alpaca were also critically examined, and all bloodstained pieces found were sent for bacteriological examination. Eight were infected and were examined by witness and an expert buyer. Seven contained skin material which had either been sheared or pulled from the pelts. The conclusions drawn are similar to those arrived at by examination of East Indian cashmere. (8201–15.)

It is not always possible to decide definitely whether material is skin material or not—in some cases it is easy and in some difficult. Experts and skilled sorters would usually be able to recognise it, but not always. Fleece material is only dangerous to the extent to which it is mixed with skin material. (8216–9.)

Recent experience indicates that the danger from mohair is the greatest in sorting, and from Persian wool is greatest in combing. This is possibly due to the fact that Persian skin material is obtained by a dry process and the bloodclot is unbroken till it reaches the washing and combing processes, while in skin mohair the bloodclots and infection are dispersed, and, therefore, no signs of danger are visible to the sorter. The danger of Persian wool would be removed by sorting, but that of mohair would not. Anthrax apparently arises only from the blood of a dead animal and the wool or hair removed from the body, so that it is probably only skin wool which is infected. (8220, 8225–37.)

H. J. Foster (E): Has experience of skin material only so far as it is packed in good quality shorn mohair. In the best mohair small quantities of skin mohair are found "salted" into the bale. Skin material is purposely put among shorn material by persons in the country of origin. (*See* Persons Skilled.) (8856–74.)

W. Root (E): Witness uses a good deal of East Indian cashmere, and is able to recognise skin material—as would any expert buyer of wool—but he has never seen any mixed with shorn East Indian cashmere. Shorn fleece material is difficult to pull apart, but skin material is always loose and bitty by whatever process it is removed from the pelts. (8959R–8960W.)

E. B. Whitley (E): Witness does not purchase skin material as such, but a certain quantity comes packed in bales of shorn Turkey mohair. Most has been pulled dry from the pelts. That removed in fellmongering is not usually mixed with fleece material. The sorters find it in sorting and throw it out, but it is not sorted into qualities. It can be recognised readily, and all competent sorters can pick it out. It is loose and can be pulled apart easily, while shorn material hangs together and strongly resists being pulled apart. This is so, even when the hair has reached shearing length before the animal dies—it has no nature, nor life, nor lustre in it when removed from the body after death. It can be recognised even when removed from the body or pelt soon after death. (9682–95.)

Skin material can be recognised among the shorn material in matchings after sorting, but not after the mixed materials have been partly manufactured. A spinner might allow skin material to go along with shorn material if he bought and sorted the raw material himself, but he would not have skin materials in any matchings he might buy from merchants. (9697–704.)

E. B. Whitley (E)—*continued.*

All skin material picked out in witness's warehouse is sold as such on a running contract. Skin material is found in, and can be recognised in, inferior Turkey mohair, but it is not often found in inferior Cape mohair (Cape thirds). (9709–16.) Skin Cape mohair is never packed among shorn Cape mohair as in the case of Turkey mohair. All Cape skin mohair is bought as skin material. (9696, 9705–8.)

W. Waud (E): Bumps of skin material are frequently found in Turkey mohair. Witness's firm buy mohair brought into Constantinople for sale, but do not class it there. The bales of material are examined and an estimate of the value of the lot is made, based on certain considerations, one of which is the average quantity per bale of skin material contained in it. There is never any dispute between the buyer and seller as to what is skin and what not. The whole is purchased, including such skin as may be present, and it is merely a question whether the estimate of value of the buyer coincides with that of the seller. (9834–42, 9881–4.)

Witness could pick skin material out of shorn material, but was not prepared to say sorters could do so. Skin material is material removed from the body or pelt of a dead animal. It is doubtful whether anyone could pick out hair removed from the body while it is still warm, whatever the cause of death. In some cases skin mohair is lustrous (though this is denied by some), and beautifully fine and silky, and there are cases when witness is doubtful whether material is skin or not but, generally speaking, skin material is plainly distinguishable to the expert. The presence, or absence, of blood is not a determining factor, but the ease with which skin material can be pulled apart, the absence of felted bottom growth, and a certain "feel," which is not describable, are distinguishing characteristics. Bad-bred, low quality fleeces resemble, but cannot be mistaken for, skin material. In any case, however, if every bump in a bale be examined witness would say that those thrown out as being skin would represent the minimum quantity of skin material in the bale. (9843–80.) In the districts from which Turkey mohair is imported, it is the practice to cut the throats of animals found to be ill, or even when found to be dead. Certain ceremonies are observed while the animal is bleeding. This practice may account for the bloodclots observed on Turkey mohair. (9888–906.)

J. H. Halliday (M): In a period of two years 60 per cent. of all bales of wool combed in witness's factory (commission combing) contained bloodstains. The average was $\frac{3}{4}$ lb., but in many cases 20 lbs. were found in a bale, particularly in skin wools. (5665–6.) Previous to 1906 he had no cases of anthrax, although the same wools were combed and the same methods followed before and after 1906. The cause of cases which then began to occur was the false packing of locks in fleeces of Persian wool. This was complained of in 1905, and cases occurred in Bradford as a result, and it may have been practised to some extent before that. If false packing were prevented there would be practically freedom from anthrax. Persian wool is now entirely different from that received before 1906, in that it is intermixed with locks, pieces, and low-grade wool. Previously it was free from these. The locks are of lower quality than the fleece wool. Some of them may be foreign (*i.e.*, not Persian), but many are of the same character as the fleeces. (5808–20, 5941–46.)

By keeping records of the bale marks and of the nature of the material habitually sent under particular marks, it is possible to exercise care in the manipulation of material usually found infected or false packed. (6079–89.)

A. Drake (M): In the local centres of Asia Minor where mohair is collected, the inferiors and skin material are put into the tops of the bags. Skin hair is not usually packed separately. (9366–99.) Skin mohair is hair removed from the body or pelt of a dead animal whatever the cause of death may be. Many goats are killed for food, both in Constantinople and up country. The bodies of animals which die are often left where they are found with the skin on, but the hair is sheared off or collected, even if the

A. Drake (M)—*continued.*

animal has been dead some time. Each farmer collects his own skin hair and may buy from neighbours. This he mixes with his shorn material. Hair bought from farmers usually contains more or less skin material. In some instances a few bags at a time of skin hair may be sold as such. (9419–39.)

All Turkey mohair is sent to Constantinople, where it is to some extent classed in qualities and short skin material picked out. Some skin hair is long and fine, and is packed with the shorn material —sometimes after washing. It requires great expert knowledge to recognise this as skin material. The short skin material is sometimes put up into bumps and placed in bags with the shorn material, but usually it is put among inferiors, which are not packed in bumps and contain much more skin material than "average" Turkey mohair.

Anthrax is not known as a specific disease and cause of mortality among goats in the mohair districts. Animals dying in the yards would have the hair taken off, but the bodies would be buried there or left on the dung heap. No precautions are taken to keep the yards clean. (9416–56.) Skin material is "salted" in among shorn material by farmers. It can be recognised by expert buyers and by trained sorters, whether in average Turkey mohair or in inferiors. (9457–66.) Animals dying from disease are frequently skinned, and the hair, if long, taken off the pelt. If short it is frequently left on, and the skin sold for rug making. Hair is removed from the pelt either by shearing or by the lime process or by pulling, both in Constantinople and up country. (9467–77.)

There would be no difficulty in getting shorn and skin material packed separately if all buyers would refuse to buy the mixed material. The great drawback to such an agreement is that in times of keen competition for mohair some buyer would break the agreement and say he would remove the skin material himself. (9478–86.) It is now a custom of Bradford buyers to import hair in the state in which it comes from up-country centres. There is some skin material in most lots of mohair. There *can* be skin material in any quality, but some parcels graded in Constantinople, and lots of certain marks are sold as, and are, absolutely free from it. Generally, however, no parcel reaches Constantinople in this state. (9487–510, 9533–5.)

It is possible that regulations requiring special treatment in this country of mohair containing skin material would have the effect of making up-country packers separate the skin from the shorn material. They could do it quite easily. The only certain way would be for buyers to refuse to purchase all mixed material. There are firms who buy skin material to mix with shorn hair in order to cheapen it. The fault lies with the Bradford buyers who are willing to purchase such lots. Every buyer, whether in Turkey or Bradford, examines the material and forms an estimate of the amount of skin in it. This shows it is possible to detect skin material mixed with sound hair. The Turkish Government would not be likely to introduce any effective measures. (9547–71.)

W. H. Midgeley (M): Skin material is wool or hair taken from the body of a dead animal. It is possible to recognise wool from a dead animal, though it is not easy to explain how it can be recognised. It is dead in appearance. If witness found, on inspection of material his employers proposed to buy, that it contained skin material the firm would not buy it. Only odd bits are, therefore, found in the mohair sorted by the sorters under him. He has rejected many lots because they contained skin material. The best way to deal with the question of skin material is to prevent the packing of it with shorn material. The buyers could do this if they would, as his firm does, refuse to purchase any mixed lots. The packers would then not mix skin with shorn mohair. It is quite possible for sorters to sort out skin mohair from mixed material, and if buyers purchase mixed lots, this is the only way of dealing with them. (8813–30.)

Some Bradford firms buy mohair in Constantinople, class it there, and remove all the skin material. Lots sold by such firms as good mohair are quite free

W. H. Midgeley (M)—*continued.*

from skin mohair. Lots from up country which come direct to Bradford without any classing at Constantinople do contain skin. This is not necessarily because the sellers want to palm off inferior material, but it is a usual custom in the interior to pack skin and shorn material together. It would require someone on the spot to get the custom altered. (8831–43.)

T. Larkin (W): As a rule, alpaca locks and alpaca fleeces are packed separately. Persian locks are packed inside fleeces and are often, apparently, not from the same animal as the fleeces. It is much more difficult to remove bloodstains from locks than from fleece material. A bale of locks might take 10 hours to look over as compared with about 3½ hours for the same weight of fleeces. There is a greater weight of bloodstains in fleeces, but those in locks are more numerous and are very small. Fallen fleeces can be distinguished from shorn wool because they are dry and of a rotten nature. As a rule, they also contain more bloodstains. (2850–8, 2923–40.)

"W. R." (W): Damaged wool is wool which has been sea dipped. Fallen fleeces are the fleeces removed from the bodies of animals which have died of disease. Skin wool is wool removed by means of lime from skins of animals which have been killed. Witness can recognise damaged wool, bloodstains and fallen fleeces. He has frequently found fallen fleeces and has given them to the foreman, who has put them on one side. He has seen half a goat among goat hair. Fallen fleeces are frequently bloodstained. Persian fleeces often contain locks and pieces, but, as a rule, these are not badly bloodstained. (3307–17, 3368–69, 3417–23, 3626–41.)

"F. J." (W): Damaged wool is either a fallen fleece or wool damaged by sea water. A fallen fleece is damaged because it comes from the body of a dead animal. Witness can recognise and distinguish either, and has found them in opening and pointed them out to the foreman. There is not, however, time to recognise and pick out such materials in opening. He has often found locks wrapped up inside alpaca fleeces and they are put there by the seller to get rid of them. They are dangerous. It is much more difficult to pick bloodstains out of locks than from fleeces. (4834–45, 4919–21, 4988–9, 5004–6.)

"C. W." (W): Formerly witness did not understand what fallen fleeces were, but does now as the result of Dr. Eurich's demonstrations. They are any foul smelling wool. He has pointed out damaged wool to the foreman, who sometimes took notice and sometimes did not. He understands that fallen fleeces must be picked out, but does not understand skin wools in foreign material, though he does in English wool. (5135–40, 5511–5.)

Sorter "A" (W): Skin wool is wool removed from the bodies of dead sheep. Witness has had no experience of skin wool, and could not at present recognise it, and could not pick it out of mohair. He understands that skin mohair can be recognised by the ease with which it can be pulled apart. That is not easy with shorn mohair. (8784–804.)

Foreman and Six Skilled Sorters (W): Skin wool and skin locks, which are limy and stick together tightly, are found in Persian wool. Bloodstains are present in these in some cases. These and locks are put inside Persian fleeces. The bloodstains in locks are never very heavy, and they are more difficult to pick out than bloodstains in fleeces. Witnesses could recognise and pick skin wool out from among fleeces of shorn material. (9155–93.)

Foreman and Three Sorters (W): Skin mohair is short, droppy stuff which is the same as fallen fleece, and is mohair taken from the body of a dead animal. Skin material is very rarely found mixed with shorn Cape mohair, but it is found in shorn Turkey mohair. Witnesses can recognise skin material mixed with shorn hair. Usually a bump of skin material will be found in the bottom of a bag, but sometimes there is a little put inside a bump of shorn mohair. This can always be recognised and picked out. The skin material is not often more bloodstained than the shorn material. Turkey inferiors are always found at the top or bottom of the bag, and there are always more inferiors than skin material. All inferiors are thrown out without sorting. There is no difficulty in training any one to recognise skin material and, after a year or two's experience, any sorter would recognise it. Skin material is short in staple as a rule, and is always droppy and easily comes to pieces. Good skin material is sorted and sent with shorn mohair, but short low quality skin is put with the inferiors. (9624–79.)

H. Barker (Foreman Sorter) (W): Skin mohair is mohair taken from the pelt of a dead goat. Most bags of Turkey mohair will contain some skin material, either as bumps or as pieces inside bumps of shorn hair. This can be recognised without difficulty by most sorters, and all sorters could do so after being shown. There is more skin among inferiors than among average mohair. The skin material packed with average mohair is sometimes long and sometimes short, sometimes fine, and at other times coarse. Witness opened a bag of material bought as being absolutely free from skin. It contained one bump which, although not skin, resembled skin in that it was more like "winter hair," but was not "slipey" nor bloodstained. As a rule all skin material contains blood, although it may be only a few staples stained here and there. Witness would not expect to be able to recognise material as skin if it were sheared off the body of an animal immediately it died, unless it had been ill for some time. Nevertheless, witness said he could invariably recognise skin mohair. (*See* Persons Skilled.) (9731–84.)

Infected Material—Treatment by Wet Process.

T. M. Legge (O): The present regulations require "steeping" of certain kinds of wool for the purpose of preventing danger from dust in the early processes of manufacture. This is probably attained, but steeping may cause the bloodclots to break down, lead to the diffusion of spores, and so increase danger in later processes. The existing regulations also require damaged wool and fallen fleeces to be damped with disinfectant and washed without being willowed. The disinfectant would not destroy anthrax spores, and the danger of anthrax, if originally present, would still be present after washing. (*See* Infected Material—Bloodstains.) (277–9, 281–2, 297–301, 316, 405–7.)

G. A. Taylor (O): Bloodstains ought to be picked out of all wool, but this is impossible in the case of washed or wet fellmongered materials, *e.g.*, East Indian and skin wools, which are used extensively. The water used for washing wool in this country is usually changed once per day, and gets very dirty. If infected material be present before washing or wet fellmongering, infection becomes distributed over all the material treated in the same water, and bloodstains are destroyed. Dust in the clothing of cards used for carding such materials will be infected. (1283–5, 1359–65, 1440, 1564–9.)

W. S. Smith (O): Steeping of unopened bales is an ineffective precaution, because the wool must be dried before going through certain processes. Bloodclots may also be dissolved and the spores distributed throughout the wool. The dust disseminated in subsequent processes would thus be infected. (7548–51.)

W. P. Norris (O): Clean scoured wool or hair is not necessarily free from infection. Scouring removes the visible evidence of infection and produces a fallacious sense of security. It is a mechanical process only. (8484–5, 8519–20, 8609–12.)

Sir S. Stockman (O): One of the most badly infected samples of material ever examined by witness was a sample of horsehair which had been specially cleansed and was apparently beautifully clean. Every hair was, however, grossly infected. Witness is convinced that washing will not remove infection. (10,331–7.)

F. W. Eurich (P): Bloodstains can only rarely be found in East Indian wool, because this material

F. W. Eurich (P)—*continued.*

is washed in the country of origin and the colouring matter of blood thus removed. This is the reason why so many samples of East Indian wool free from bloodstains are found to be infected. Persian skin wool is obtained by a dry process, and infected samples free from blood are very rarely found. Washing does not remove infection from wool (figures given in support of this). It is impossible to sort out infected material from wool or hair which has been treated by a wet process. Any wet process, *e.g.*, wet fellmongering, washing or steeping destroys visible indications of blood, disperses infection over the material, and conveys infection from fleece to fleece. Thus skin Van mohair obtained by a wet process is found to be equally badly infected, whether the samples selected are bloodstained or not. In material so treated, danger is concealed but not removed, and absence of bloodstains is not an indication of freedom from infection. The danger becomes less intense, but is broadened by distribution of the spores over a wider area.

Experiments and examination of samples of water-damaged materials show that multiplication of anthrax germs may take place in the wetted material, but the growth does not spread more than about half an inch from the centre of infection. Cases of anthrax are most frequent in processes subsequent to washing, and prevention of dust in these processes would materially reduce the number of cases. Washing of infected material, previously subjected to a method of disinfection which inhibits the growth of, but does not destroy, the spores, will remove the inhibiting influence. The spores then recover their power of growth and might cause cases of anthrax. Some bloodstains are only partially disintegrated by washing. (580–6, 598–604, 608–10, 618–20, 629–30, 645–51, 665–78, 697–712, 719–30, 811–4, 928–30, 1011–6, 8654–5, 8684–6.)

G. H. Feather (E): Most East Indian wool is washed abroad, and bloodstains cannot, therefore, be found in it. Washing alone will not remove all dust from dusty materials. Some materials are found to be infected though they contain no bloodstains. In these, the infection has been distributed by washing. Witness is strongly opposed to any steeping of material before bloodstains have been removed. It might, however, be advantageous to steep material washed abroad. (4390–2, 4398, 4419–20, 4608–13, 4724–6.)

G. Ackroyd (E): Danger of anthrax primarily lies in blood. Witness believes that treatment of infected bloodstained material by a wet process spreads the infection to otherwise clean wool. Witness thinks that thorough washing of such contaminated material can remove the infection, but a far better safeguard is to remove the bloodstained portions before treatment by a wet process. Before 1905 it was considered that scouring removed infection, but if bloodstains be left in the material there will be greater danger of infection in processes after scouring than before, if the material be carded. (6315, 6319–21.)

Examination of skin Van mohair showed that it had been wet fellmongered (lime was present); the blood had been partially dissolved and was present, therefore, in the form of stains. Anthrax was cultivated from 35 samples, of which eight contained no blood. In the latter the cultivations were scanty, and the conclusion drawn was that the spores had been spread by the wet fellmongering process. In combing a lot of skin Turkey mohair, infected bloodstains were found in processes after washing, showing that scouring does not necessarily wholly dissolve the bloodclots. In material obtained by a wet fellmongering process there are usually certain characteristics which appear to indicate that blood was originally present.

Witness gives an analysis of cases in the Bradford district showing that where material is "carded" cases of anthrax occur more frequently in processes after washing than before (53 : 33), but when the material is "prepared" fewer cases occur after than before washing (5 : 16). He agrees that washing distributes the spores, but it is a cleansing process and

G. Ackroyd (E)—*continued.*

many spores must pass away in the washing liquid. If bloodclots are not present, the wool should be cleansed to a great extent from infection if the washing be efficient; if present, the area of infection is enlarged, but the spores at the original infected centre are lessened in number. Witness has come to the conclusion that, so far as mohair is concerned, removal of all bloodstained pieces and efficient washing of the lower qualities will generally prevent anthrax.

Any attempt at washing material in the country of origin is very dangerous unless bloodstains are first removed. The possibility that this may become a practice or that bloodstains may be picked out and washed as the result of regulations in this country should be carefully borne in mind. China camel hair and East Indian wool are both cleansed in the country of origin, but the former is apparently free from infection, while the latter is certainly infected, and the difference needs enquiry. Willowing is a dangerous process, but in some cases it enables subsequent washing to be more efficient. Experience has shown that danger is not removed by washing unless it is thorough and then only to a certain extent. Witness strongly urges the danger of permitting any process which destroys the indication of danger, *i.e.*, blood. (6408–11, 6445–542, 6558–68, 6584–625, 6636–41, 6645–68, 6880, 6916–21, 6963–4, 6991–3, 6996–7000, 7054–8, 7103–6, 7152.)

Witness received two lots of Turkey skin mohair for combing from which the bloodclots had been sorted out by skilled sorters. They nevertheless contained many indications of blood in the form of stained fibres and fibres apparently glued together. The material had apparently been removed from the skins by three processes (1) the wet lime process; (2) shearing; (3) pulling. All of it had, however, been through a wet process which had the appearance of an attempt at cleansing the material—possibly genuine or possibly an effort to remove indications of blood. The material was again examined in blending and bloodstains removed as far as possible. Samples visibly bloodstained and samples containing no visible blood proved to be badly infected. Samples of tops and noils after combing were also infected and contained no blood. This proves that infection may pass through to the tops even after the bloodstains have been removed and the material subsequently "thoroughly" washed. It appears to be a growing practice to wash bloodstained Turkey mohair (or submit it to a wet process) in the country of origin. The process may reduce the intensity of the danger (and thorough washing before combing will further reduce the risk), but it broadens the area of danger and is an undesirable practice. A method of disinfection is desirable for treatment of washed materials. (7985–8044, 8131–45.)

Witness concludes that (1) infection in wool or hair is primarily local and is confined to the bloodstained portions; (2) infection remains local till the material is treated by a wet process (*e.g.*, fellmongering, washing, steeping, &c.); (3) when treated by a wet process bloodclots are partially or wholly dissolved; (4) the infection is then transferred to other parts of the material and becomes general. (8161–225.)

T. Town (M): In the Commission Combing works, of which witness is manager, Persian wool is steeped. The whole bale with the bands broken is put in a tank of water and removed when wet, *i.e.*, in about half-an-hour. The bloodstains are not softened and witness considers the process of value in preventing anthrax. The material is examined for bloodclots at the end of the washbowl after steeping. The sense of touch is chiefly relied on, but the sorting cannot be as effective as it would be if the material were dry. (8962–9086.)

J. H. Halliday (M): Washing and steeping of infected material destroy bloodstains and cause infection to spread over the whole of the wool treated. In the works managed by witness, 14 cases of anthrax occurred during the period when bloodstains were sorted out of wool by skilled sorters. Of these, six (1 sorter, 1 willower, 4 washbowl feeders) were contracted in processes before and eight after washing of the material. The wool is willowed, and witness shows by demonstration that no process after washing is dusty. He points out that most of the cases after

J. H. Halliday (M)—*continued.*

washing occurred in the next process, and suggests that washing is favourable to the development of the spores. (5683–834, 5947–54, 5978–82, 6064–5, 6221–39.)

C. E. Biggin (M): Van mohair is steeped in the Commission Combing works managed by witness. The bales are immersed with the hoops on in a tank of disinfecting liquid. The liquid completely penetrates the bales in 20 to 30 minutes. (9277–93.)

"B. A." (W): If bloodstains once get into the washbowl they are destroyed during washing. It is not possible to find bloodstains in material washed abroad. (2137–43, 2311–3, 2524–7.)

"S. J." (W): Has steeped bales of Van mohair Even after steeping the bales for several hours with the hoops taken off dust rises from the middle of the bale. (4078–94.)

Infected Material—Varieties.

(*a*) General.

T. M. Legge (O): Witness gives a table (Appendix 2) showing the number of cases of anthrax reported to the Factory Department as occurring in each year from 1899 to 1913 in manipulation of different varieties of wool and hair. The totals are as follows:—

——	Persian Wool.	Van Mohair.	Mohair.	Turkey Mohair.	Cape Mohair.	Cape and Turkey Mohair.	Alpaca.
Alone	52	7	5	23	4	10	2
With others	51	6	8	4	6	—	2

——	Pelitan.	East Indian Cashmere.	Russian Camel Hair.	China Camel Hair.	Camel Hair.	East Indian Wool.	Australian (Colonial).
Alone	—	—	3	—	2	45	4
With others	—	—	7	3	9	68	5

——	Native (Home and Colonial).	Spanish.	Egyptian.	Chevrette (with Noils).	Not Stated.	Finished Tops.
Alone	1	—	—	—	12	2
With others	9	1	2	1	—	—

Witness has no more detailed classification than the above, but this is desirable and is being obtained in the more recent cases.

In the report of the Departmental Committee on Anthrax of 1897 a brief description is given of the classes of wool then considered dangerous. There is probably as much anthrax-infected material used outside the Bradford district as in that area, or even more, but quite possibly the material used in Bradford is more badly infected than that used elsewhere. (30–34, 115–21, 215–6.)

G. A. Taylor (O): The schedule of dangerous wools in the existing regulations is incomplete and it should be extended. It is necessary to state the quality in a classification of materials causing anthrax, because low qualities are more dangerous than the better qualities. It is also necessary to state the country of origin, and there is difficulty in obtaining this information unless a register is kept. The obligation of ascertaining the country of origin of all materials used should be placed on occupiers. The scheduled materials used in Bradford form a considerable proportion of the quantity of dangerous materials used in the country, but only a small proportion of the total quantity of material used in Bradford. (1135–40, 1189, 1209, 1695–6, 1926–8, 1951–67.)

W. S. Smith (O): Dust in some varieties of material is more dangerous than in others. The materials used in Bradford should be divided into two classes according to the method of sorting adopted. Each class requires a different type of sorting screen. Materials like mohair and alpaca which are sorted carefully for quality would form one class, while materials like Persian wool which are only looked over for foreign matter would form the other class. (7424–6, 7607–13.)

Sir S. Stockman (O): In practically every country of Europe cases of anthrax are expected to occur from time to time among animals. (10,046–57, 10,089–92, 10,129–34.)

F. W. Eurich (P): The object of the bacteriological examination of materials for the Anthrax Investigation Board has been to determine the degree of risk attaching to different varieties of materials, and the naked eye appearances which may be an index of the risk. In the six years 1908 to 1913, witness tested 4,745 samples, of which 311 were infected. He gives a classification of these (Appendix 5) which indicates generally the danger of the different materials. The following are the principal figures, but the table should be consulted for a more detailed classification:—

Material.	Number of Samples.		Per cent infected.
	Examined.	Infected.	
Alpaca	396	3	0·75
Camel hair	123	5	4·06
Unclassified mohair	467	8	1·71
Van mohair	386	36	9·3
Turkey mohair	553	60	10·8
Cape mohair	630	88	13·9
Cape wool	6	1	—
East Indian wool	172	18	10·46
Syrian wools	13	1	—
Persian wools	1,995	85	4·26
Khorassan wool	4	2	—

The majority of the samples were sent by various firms, some were sent by H.M. Inspectors of

F. W. Eurich (P)—*continued.*

Factories and some were selected by witness himself. Some were sent as a matter of routine and others when a case of anthrax occurred. The most dangerous materials in opinion of witness are skin Van mohair, Cape mohair thirds, inferior Turkey mohair and Persian wools. The figures given cannot be too closely compared, because some samples were selected haphazard, some where suspicion had been aroused, and in some cases a comparatively large number was taken from one consignment which proved to be badly infected. Instances are given of this (Q. 595). For close comparison also it is necessary to classify the materials in detail according to origin and quality. This is done in tables B to J (Appendix 5).

If samples of many varieties of materials at present thought to be free from infection were examined, it is possible they would be found to be infected. The samples examined have principally been samples of the more obviously dangerous scheduled materials, but the enquiry should be extended to other varieties, *e.g.*, East Indian wool, goat hair, camel hair, South American wool, Egyptian wool, &c. The evidence available is not sufficient to enable it to be said that any foreign material is free from danger. The difficulties of precise classification are and must remain great till the origin of the different materials can be more definitely ascertained. (501, 548–54, 566–73, 589, 595–7, 799, 1001–3, 8657, 8695, 8708–9.)

G. H. Feather (E): Witness considers all the wools in the schedule to the existing regulations to be dangerous, but would add Syrian wool and goats' hair. Fleece pieces are pieces which fall from fleeces during shearing. Matchings are collections of one quality of wool or hair. Britch matchings are matchings made of the low qualities from finer grades. (4373–9, 4543–52, 4572–3, 4631–3, 4677, 4681–2, 4719–23.)

G. Ackroyd (E): Before 1905 there were no bacteriological examinations of material of any practical value. The danger of materials was judged by experience and was often guesswork. Even now, it is often difficult to decide which material causes infection. The Anthrax Investigation Board have made great efforts to ascertain the materials with which any person suffering from anthrax had been in contact. The Committee should use as a basis for drawing up a list of potentially dangerous wools the experience of cases of anthrax and the cultivation of anthrax from materials. Any list prepared may have to be added to or modified from time to time. The Committee should devise means by which manipulation of materials may at any time be brought under, or be freed from, the operation of regulations. (6322–33.)

Witness put in tables (Appendix 4) showing the materials with which persons contracting anthrax in Bradford in the period 1906–1913 had been in contact. The principal figures are as follows:—

(1) Fatal Cases.

——	Mohair.	Mohair and Persian.	Persian.	Camel Hair.	East Indian.	English and Colonial.	Irish, New Zealand, South American.	Scotch Wool and Yorkshire Haslock.
Alone - -	9	5	4	1	—	1	1	1
With other material.	3	—	2	2	2	—	—	—

(2) All Cases.

(*a*) Preparing materials (21 cases):—

Mohair.	Alpaca.	New Zealand Slipe and Sidney Wool.	Irish, New Zealand, and South American Wools.
18	1	1	1

(*b*) Carding materials (86 cases):—

——	Mohair.	Mohair and Persian.	Persian.	Camel Hair.	East Indian.	Patagonian, Colonial, Italian.
Alone - - -	10	13	12	1	—	1
With others -	12	—	22	6	4	—

——	Chili, Buenos Ayres, and New Zealand.	English and Colonial (best).	Buenos Ayres Crossbred.	Scotch Wool and Yorkshire Haslock.	New Zealand Slipe and Sidney Wool.
Alone - - -	1	1	1	1	1
With others -	—	—	—	—	—

In the worsted industry, materials are divided into (*a*) "preparing" and (*b*) "carding" sorts. Some qualities of a particular variety of material may be "preparing" and some "carding" sorts (*e.g.*, about 10–20 per cent. of both mohair and alpaca are carded and the rest prepared). The distinction depends on the method of treatment before combing. Long materials are "preparing" and short materials "carding" sorts. Preparing sorts are always carefully sorted, but carding sorts are of lower quality

G. Ackroyd (E)—*continued.*

and are frequently not sorted. Mohair and alpaca are the principal preparing varieties. Generally speaking, carding varieties are more dangerous than preparing. The process is partly to blame, but carding sorts are frequently of low quality and often coloured so that they are more badly infected and detection of bloodclots is difficult. (6405–7, 6540–4, 6622, 6632–68, 6724.)

Anthrax is not confined to any one country, but precautions, which preserve the wool from infection, are taken in civilised countries. Probably only Algerian wool is quite free from anthrax. (6628–30, 8215–20.)

"B. A." (W): High-class materials are combed in some Commission Woolcombing works, but in others, low qualities only are treated. Witness thinks there are bloodstains in all varieties of material but in varying amounts. (2159–63, 2202–4.)

"C. W." (W): Skilled sorters always recognise the variety of material they are sorting. (5282–3.)

"G. J." (W): Considers foreign wool to be dangerous. All foreign wools are dusty. (5350, 5372.)

(*b*) Alpaca.

G. A. Taylor (O): Alpaca reaches this country in bales (not press packed) of rolled-up fleeces (not tied). It is difficult to pick bloodstains out of some alpaca owing to its colour. It is a very dusty material. (1197–8, &c.)

W. S. Smith (O): A very fine dust is given off in large quantities during opening of alpaca. (7426.)

F. W. Eurich (P): Anthrax was cultivated in the early stage of the investigation from the bloodstained dust produced in sorting alpaca. In the later stages it was cultivated from 0·75 per cent. of the samples of alpaca examined. The danger from alpaca is very small, but it is not wise to regard this material as being comparatively free from danger. In 1914 anthrax was cultivated twice from ordinary samples (1·8 per cent.), nine times from skin alpaca (24 per cent. of samples) and once from non-bloodstained alpaca dust taken from window bottoms. (554–5, 574, 8670–75.)

G. Ackroyd (E): Alpaca is a dusty material. About 85 per cent. of it is prepared and the rest carded. Up to the end of 1913 one case of anthrax only was traced to alpaca, but in many other cases it was manipulated with other materials by persons who contracted anthrax, though witness does not consider it the cause of infection. Certain precautions in the country of origin (Peru) to prevent packing of infected with sound alpaca have been and are being taken. Alpaca is said to have caused the first cases of anthrax from wool in this country. In the last eight years (to October 1913) anthrax has only been cultivated from six samples of alpaca. These may have been samples of Tacna or Callao alpaca, which are lower grades. Witness thinks there is little danger from ordinary alpaca, and if a little more care were exercised in Peru to exclude bloodstains, it might be removed from the dangerous list. Witness had 36 bloodstained samples of Tacna locks and seconds and Callao locks examined in 1914, and eight were found to be infected. (6416, 6634–5, 6669, 6738–49, 7041–6, 8201–14.)

J. H. Halliday (M): Considers alpaca may cause anthrax. (5602.)

"B. A." (W): Alpaca may cause anthrax. Alpaca thirds reach this country in bales of loose material which is bloodstained. Alpaca firsts and seconds have usually been sorted before reaching a Commission Combing works. Witness contracted anthrax when manipulating alpaca and Persian wool. (2085–6, 2105–16, 2315–9, 2490.)

"S. J." (W): Alpaca is likely to cause anthrax. (3668.)

"F. J." (W): Alpaca is a dusty material. First qualities and generally others arrive in this country in fleeces. It is necessary to shake alpaca before sorting in order to separate the qualities. It requires about two hours to open a bale of alpaca weighing 2 cwt. Even if alpaca were free from dust it would still be necessary to shake it before sorting. (4782–806, 5015–21.)

"C. W." (W): Alpaca reaches this country in bales which consist in some cases of fleeces and in others of locks and pieces. Alpaca is a dusty material. It must be shaken before sorting whether or not it is dusty. (5095–110, 5130, 5328–9.)

"G. J." (W): Considers alpaca to be a dangerous material. (5350–1.)

"A." (Sorter) (W): It is necessary to shake alpaca before sorting in order to separate the qualities. This renders sorting much easier and is not a question of shaking out the dust. It takes twice the time to sort alpaca which has not been skaken. (8771–93.)

Two Sorters (W) employed by Messrs. Christopher Waud & Co.: It is necessary to shake alpaca before sorting in order to get the fribs and shorts out. These would get into the sliver if not removed. Shaking also reduces the time required for sorting to a half or a third. This was supported by the employer (Mr. W. Waud), who demonstrated the object of shaking. Before exhaust screens and separate rooms for opening were required by regulations shaking of alpaca was done in the sorting-room and it was very dusty. Dust collected on the beams like snow on trees in winter. (9802–31.)

(*c*) Australian Wools (Australian, New Zealand, Tasmanian).

G. A. Taylor (O): Three hundred and fourteen million pounds of Australian and 189 million pounds of New Zealand wool were imported into this country in 1910, and most of that would be used in Bradford. About 30 million pounds of the really dangerous materials (Cape and Turkey mohair and Persian wool) are annually used in Bradford. (1695–6.)

Sir S. Stockman (O): Anthrax does not occur in New Zealand, but it does in Australia. (10,247–9.)

W. P. Norris (O): Gives details of 29 fatal cases of anthrax in human beings recorded by the Government Statistician as occurring in New South Wales between 1894 and 1904. 17 were cases among persons in contact with animals or animal products: 7 farm labourers, 4 graziers, 2 butchers, 1 shepherd, 1 drover, 1 produce dealer and 1 carrier. Cases also occurred in Australia in 1911 and 1912. Intestinal anthrax was contracted by a boy living in a district where fellmongering is carried on.

A large number of persons handle wool in New South Wales, but (quoting from a report of Dr. Cleland on cases of anthrax since 1850) "The noteworthy point in this connection is the lack of evidence of infection of any of the persons." Anthrax is enzootic along the old cattle tracks from New South Wales to Victoria, in a small district in Tasmania and in the Riverina district of New South Wales. This is the principal wool district and there were five outbreaks among cattle and eight among sheep between 1909 and 1912. Up to 20 years ago there were distinctly large outbreaks among sheep, but anthrax is less rife now than formerly owing to measures taken to control the disease, *e.g.*, education of persons dealing with animals in the symptoms of anthrax, destruction of carcases, preventive inoculation, &c. Other recorded outbreaks among animals are: six in Victoria in 1911–1913; one in Tasmania in 1912; one in South Australia in 1913–1914; 95 per cent. of Australia is free from anthrax. The risk of anthrax-infected material passing into commerce and being exported from Australia is very slight, though there may be collectors of small quantities of wool who would incidentally collect infected materials. The possibility cannot be denied, but it must be a very rare occurrence. New Zealand has been free from anthrax since 1907. (*See* Anthrax in Country of Origin.) (8276–84, 8294–314, 8320–22, 8333, 8341–2, 8387–99, 8410, 8414–6, 8437–40, 8450–7, 8463–504, 8523–4, 8529–34, 8547, 8594–7.)

F. W. Eurich (P): Has examined some samples of Australian and New Zealand wool, one of which was bloodstained, but has not found any to be infected. (945–7.)

G. H. Feather (E): Witness does not think any regulations whatever should apply to manipulation of Australian and Colonial wools. (4678–9.)

G. Ackroyd (E): Witness cannot explain fatal cases of anthrax where the only materials manipulated were English and Colonial wools in one, and Irish, New Zealand, and South American in the other. Witness put in a table giving details of cases occurring in manipulation of wools not usually regarded as dangerous. In five, Australian or New Zealand wool or both were being treated in conjunction with others. In one other case the only materials handled were New Zealand skin wool and Sidney wool. (6628–30, 6762–3.)

(*d*) By-Products (Noils, Waste, Doddings, &c.).

G. A. Taylor (O): "Noils" is the term used to describe the short fibres taken out of wool or hair in the combing process. Noils and waste are not worked up in Bradford, but are sold to and used by woollen manufacturers who buy from merchants who are not producers. The users, therefore, do not always know what they are buying, and it is held that they are not subject to regulations because by-products are not raw materials. Doddings, toppings, shearlings and clippings consist of wool, with excrement clinging to it, which is removed in sorting. Waste is the waste material produced by the carding engine. The bulk collects in the card wire and is removed in stripping. It consists of short fibre, with scurf, dirt, sand, any blood and infected matter missed by the sorters, and filth of all sorts removed from the wool by the process of carding. Witness has known cases of anthrax arise from the manipulation of all these by-products of combing and lays stress on the danger of infection from them. He thinks regulations should apply to them equally with raw wools. If blood be removed during sorting the noils and waste are not so dangerous, but the regulations should still apply to their manipulation. Waste willowing is a dusty operation. (1141–50, 1167–88, 1400–21, 1475–82, 1617–32, 1687–90, 1704.)

Sir S. Stockman (O): Shoddy and sweepings from dangerous wools are used as manure. Witness has traced outbreaks of anthrax among animals to such material used as litter before being put on the land. It is not at present treated in any way likely to destroy anthrax spores. If the material be allowed to putrefy before use, probably the spores would be destroyed. The best way to treat infected waste materials is to burn them, but witness inclines to the view that their use as manure ought not to be prevented if the farmer chooses to risk infection of his animals and the landlord permits possible infection of his land. They are chiefly used on arable land, *e.g.*, hop fields. (10,141–52, 10,159–69.)

G. H. Feather (E): Witness thinks there is no danger of infection from card waste, noils and other by-products of combing, and he thinks regulations should not apply to their manipulation. (4377–9.)

G. Ackroyd (E): Cases of anthrax have occurred among persons packing tops and noils, but witness thinks regulations should not apply to manipulation of noils, though it would depend on circumstances. The factories where it is done should be registered. If bloodstains are removed in sorting there will be no danger in noils. Witness gave details of two cases of anthrax in woollen factories which might possibly have been caused by mohair noils and mohair waste respectively. The shoddy (card waste) which collects in the card clothing is frequently the material from several different lots of wool, and may retain infection in the machine from lots finished some time before. Infection from bloodclots is much more likely to remain in the noil than in the top. In the carding process carding, and in the preparing process combing, are the cleansing processes, and noil from prepared wools is, therefore, more likely to be infected than from those carded since noils are a by-product

G. Ackroyd (E)—*continued.*

of the process of combing. Mohair noils are used for making teddy bears and furry hats.

Witness combed a lot of skin mohair which had been sorted twice in order to remove bloodstains. It had, however, been treated in the country of origin by a wet process, and was badly infected. Samples of the noils were found to be free from blood, but they were infected. (6641–4, 6704–7, 6724, 7107–8, 7158–64, 8016–30.)

J. H. Halliday (M): Witness has known cases of anthrax arise in manipulation of noils and of waste or shoddy, and thinks both potentially dangerous if derived from infected materials. He thinks the possible infection to be slight, however, and does not consider regulations should apply to these materials, nor that users should be required to give notice when commencing to use them. (5855–62, 5955–9.)

(*e*) Camel Hair.

T. M. Legge (O): Three cases of anthrax were contracted between 1899 and 1913 in manipulation of Russian camel hair alone, and seven cases in its manipulation with other materials. In manipulation of China camel hair, together with other material, three cases occurred in the same period, but none where it was treated alone. In manipulation of unclassified camel hair alone there were two, and with other material nine cases. (Appendix 2.)

G. A. Taylor (O): Russian and Pekin camel hair reach this country in bales of loose material. (1201–3.)

W. S. Smith (O): There is a good deal of dust in camel hair. (7426.)

F. W. Eurich (P): Witness examined a sufficient number of samples of only two varieties of camel hair — Russian (78 samples) and Mongolian (20 samples)—to enable him to arrive at an opinion of the danger of this material. Of the samples of Russian camel hair, 5·5 per cent. (four samples, all bloodstained) were infected, and this material certainly appears to be dangerous. The only other sample found to be infected was one (bloodstained) of Pekin camel hair (out of six examined). If a practicable method of disinfection were available, witness would suggest that Russian camel hair should be disinfected before use. None of the three samples of China camel hair examined, one of which was bloodstained, proved to be infected. (575, 621–6, 895, Appendix 5.)

G. H. Feather (E): Persons manipulating camel hair are liable to contract anthrax. Three samples of Russian camel hair examined for witness were found to be slightly infected. China camel hair is shipped from Tientsin, and Russian from St. Petersburg, Libau, Reval, and Odessa. It is always loose, *i.e.*, not in fleeces, but it is not so difficult to sort for bloodstains as locks. It is not short, and it is bulky. Bloodstains should be removed from camel hair. (4225, 4328, 4373, 4470–3.)

G. Ackroyd (E): One fatal case of anthrax in Bradford occurred in the period 1906–13 in manipulation of camel hair alone, and one when other material was also used. About the end of 1906 a group of seven cases occurred in Bradford which were very possibly due to Russian camel hair. In some works, however, where Russian camel hair is habitually used, no case of anthrax has occurred in the last eight years. The inference is that Russian camel hair is not very dangerous. Witness draws a distinction between China camel hair (except Pekin) and Russian. The former is not scheduled, and reaches this country much cleaner than the latter. He thinks regulations should not apply to China camel hair, as an encouragement to the shippers to cleanse the material thoroughly in the country of origin. The method of cleansing is apparently quite different from that used for East Indian wool. Syrian camel hair is mentioned as possibly causing two cases of anthrax. In 1913, one case occurred where Pekin camel hair was manipulated in conjunction with Russian goat hair. (6624, 6685–95, 6700, 6709–11, 6733–7, 6759, 7103–4, 8220.

J. H. Halliday (M): Witness considers Russian and Pekin camel hair may cause anthrax. Camel hair is very dusty. In the works managed by witness 18 cases of anthrax occurred between 1906 and 1913 in manipulation of Persian wool and camel hair. (5602, 5615, 5791–802.)

"B. A." (W): Russian camel hair reaches this country in bales of loose material. There is not much blood in camel hair. Where witness is employed, Russian camel hair is not sorted for bloodstains, but, in his opinion, it should be. Bloodstains can be picked out of loose material, like camel hair, but it is more difficult than in the case of fleeces. (2101, 2191, 2133–6, 2198–204, 2276–7.)

T. Larkin (W): Recognises Russian camel hair as a dangerous material. In the works where witness is employed Russian and China camel hair are not sorted. (2866–70, 2902–3.)

"W. R." (W): Witness has never seen Russian and Pekin camel hair sorted. (3295–7.)

"G. J." (W): Considers camel hair to be a dangerous material. (5350–1.)

Foreman and Six Skilled Sorters (W): It takes about 20 minutes to open a bale of Russian camel hair, and it is a dusty process. In opinion of all witnesses separate opening is unnecessary, and it would be better to open and sort the material in one operation. They sort Russian camel hair into qualities, and at the same time remove bloodstains. This takes five or six hours per bale, and about ½ lb. to 1 lb. of blood is found per bale. (9114–32.)

(*f*) Cashmere.

T. M. Legge (O): East Indian wool used in the woollen districts is not the same material as East Indian cashmere used in Bradford. No cases of anthrax are recorded as occurring in manipulation of East Indian cashmere. (67, Appendix 2.)

G. A. Taylor (O): East Indian cashmere reaches this country in press-packed bales, in which the fleeces are twisted up in the form of a rope. There are no figures as to the quantity imported. East Indian cashmere is very dusty, and the ropes have to be shaken loose. A separate opening room is, therefore, necessary for this material. Blood is easily seen in it. (1200, 1232–42, 1265, 1569, 1696.)

W. S. Smith (O): East Indian cashmere contains much fine dust. (7426.)

F. W. Eurich (P): Up to 1914 one sample (not infected) only of East Indian cashmere was examined, though this material is largely used in Bradford. In 1914, two samples of China cashmere, one of Syrian cashmere, and one of cashmere, were examined, but all were free from infection. The only sample of Russian cashmere examined and eleven samples of East Indian cashmere skin material (out of 43 examined) were found to be infected. (939–41, 8686–91.)

G. H. Feather (E): The regulations should apply to other cashmeres as well as East Indian cashmere, but witness has no experience of cashmere. (4716.)

G. Ackroyd (E): Witness refers to one case of anthrax where China cashmere and another where East Indian cashmere was being manipulated with other materials, but suspects Russian camel hair or East Indian goat hair to have been the cause of both cases. In another case East Indian cashmere was associated with Cape mohair, but the latter is considered to be the probable cause. In 1914, witness critically examined a lot of four bales of East Indian cashmere (weighing altogether 1,200 lbs.) in which the material was packed as ropes. It appeared to be shorn fleeces with which, in one of the bales, some skin material removed from the pelts by a dry process had been mixed. The whole of all the bloodstained fleeces (43) were picked out, kept intact and examined. The bloodstains from 11 fleeces (all skin fleeces) were infected. Other non-bloodstained parts of six of these 11 fleeces were examined, but all were free from infection. Dust from each of the 11 fleeces was examined and was infected in three cases. (6687–91, 6701–2, 8161–200.)

W. Root (E): Witness sees a good deal of the East Indian cashmere which comes on the market, but has never seen skin material of this variety. Witness employs women for sorting, each of whom sorts about 120 lbs. of East Indian cashmere per day. They find some bloodstains in it, but not many. (8959R–8960R.)

J. H. Halliday (M): Witness considers cashmere may cause anthrax. It is a dusty material and it is necessary to untwist the ropes in a separate room over an exhaust screen. (5602, 5615, 5622–5.)

"B. A." (W): East Indian cashmere is packed in bales in tails. Witness has never seen bloodstains in this material. A bale will weigh 3 cwts. The material is twisted up like hair ropes and it takes several hours to open a bale. (2098, 2153–4, 2469–51.)

"A Female Sorter" (W): Witness showed how East Indian cashmere must be opened. It is always received in ropes which have to be untwisted. This must be done before sorting and is a dusty process. (8927–51.)

(*g*) East Indian Wool.

T. M. Legge (O): Incidence of anthrax in factories outside Bradford, where East Indian wools are used, became acute in 1906. A certain quantity of low class short Persian wool comes through Indian ports where it is treated like and is correctly described under the trade name of East Indian wool. A certain number of cases of anthrax arising from East Indian wool may be due to this Persian material, but not the bulk of those in the heavy woollen districts. East Indian wool is peculiarly suited for the woollen trade and is not sorted or washed, but is willowed. In 1907 it was denied that East Indian wool was infected, and Mr. Webb of Karachi said he had not known a case of anthrax at that port during many years' experience. This has since been contradicted. It is a very dusty wool and the incidence of anthrax among animals in India is known. Since that date anthrax spores have been found in East Indian wool and 45 cases of anthrax have occurred in its manipulation alone, while in its manipulation together with other material there have been 68 further cases in the period 1899 to 1913.

As a result of continued incidence of anthrax from East Indian wool, Mr. Taylor and Mr. Verney carried out an enquiry and reported on its use generally. East Indian wool is washed in the country of origin, the bloodstains thus destroyed and the infection distributed over all the wool. It is, therefore, not generally possible to find bloodstains in this material. The dust is also infected. Although infected Persian wool may be sent here as East Indian wool, wool grown in India is also infected. (67–80, 85–6, 150–8, 200–1, 228–39, 310–4, Appendix 2.)

W. S. Smith (O): East Indian wool is a particularly dusty material. (7426.)

G. A. Taylor (O): The term East Indian wool is loosely used commercially to describe wool shipped from certain Indian ports. It is not necessarily Indian wool. A case is quoted where a sample of material bought as Kandahar (a variety of East Indian wool) was pronounced by an expert to be Persian wool. Nearly 60,000,000 lbs. reach this country annually in bales of loose wool. It is washed in the country of origin, the bloodstains thus destroyed and infection distributed over all the wool. It is a very dangerous material, the regulations should apply to its manipulation, and it should be disinfected. A classification of East Indian wools is desirable, but in the opinion of witness it is necessary for the Committee to take evidence in the country of origin and in the packing centres as to what actually happens. No reliable evidence can be got from any other source. (1189–90, 1207–8, 1564–9, 1616, 1808–13, 1940–4.)

W. P. Norris (O): Cases of anthrax among animals and human beings in Australia have been traced to infected bones imported from India. Both New Zealand and Australia prohibit importation of animal products from India, except under certain conditions, on account of the danger of introducing anthrax infection. (8494–506.)

F. W. Eurich (P): "East Indian" appears to be a term, applied to wool shipped from certain Indian ports, which has no geographical significance as to the actual origin of the material. Nearly all, but not quite all, East Indian wool has been washed before it is exported to this country. The bloodstains have thus been destroyed (though traces of blood can sometimes be found) and infection distributed generally throughout the material. Most of the infected samples examined were, therefore, free from blood. Between 1906 and 1913 witness examined 172 samples of which only 13 (two infected) were bloodstained. Of the remaining 159 non-bloodstained samples 16 (10·6 per cent.) were infected. East Indian wool is, therefore, a dangerous material.

In 1914, witness examined 57 samples of East Indian wool of which eight (all free from blood) were infected. The samples were described under the following names: East Indian wool, Kandahar (two infected), Bombay (two infected), Bikanir, Vicanere of various districts (one infected), Bibruck, Harnai (one infected), Joria of various districts, Jessulmere (district Rajputana), Marwar—district Rajputana—(one infected), Khorasan (one infected). Owing to the washing in the country of origin, East Indian wool of any particular variety is to a great extent homogeneous, so that bacteriological examination of samples (10 per cent. to 12 per cent. of which are found to be infected) gives an approximately true index of the danger of the material. Samples which may be considered suspect cannot usually be selected. Witness would like to have East Indian wool disinfected. (579–81, 666–7, 697, 846–8, 895, 910–2 978–80, 8682–6, Appendix 5.)

G. H. Feather (E): Two samples of East Indian wool (grey Kandahar and fawn Vicanere) examined for witness were found to be infected. Joria, Vicanere, Kandahar, Harnai, and Bibruck are varieties of East Indian wool, which is a term applied to all wool, except Persian wool, shipped from certain Indian ports. True Khorasan wool comes from Khorasan—a province of Persia—but is neither East Indian nor Persian wool as those terms are understood. There is, however, a variety which reaches Liverpool marked as East Indian Khorasan. Witness has never seen materials described and sold as East Indian which appeared to be Persian wool, and does not think Persian wool coming through India is ever sold as East Indian wool. If any be mixed with true East Indian wool it is not noticeable in Liverpool at the sales. About 99 per cent. of East Indian wool is washed before it reaches England, and it contains no visible bloodstains. Some East Indian wool is very dirty and some very clean, but it is quite different from Persian wool. (4328, 4384–93, 4526–8, 4569–71, 4577, 4713–4.)

G. Ackroyd (E): In the Bradford district, in the period 1906 to 1913, one case of anthrax (a washbowl feeder) was contracted in manipulation of East Indian wool by itself, and three where it was used together with other materials. Some of the materials known under this description are likely to cause anthrax. The term "East Indian" is applied to a class of materials containing many varieties. In Bradford they are usually carded and combed and used in conjunction with other materials for making worsted carpet and belting yarns. Details of the four cases in which East Indian wool was one of the materials manipulated are given. Persian wools are packed in Indian ports and sent here as East Indian wool, and witness cannot, from his experience, say that true East Indian wool is dangerous. The washing of East Indian wool in India is not comparable with the cleansing of China camel hair. The latter should be inquired into with a view to encouraging other shippers to adopt the same methods. (6326–7, 6624, 6634, 6669–732, 6750–5, 6976–82, 7103–4.)

N. Broome (E): East Indian wool cannot be treated in the same way as Persian wool, and witness expressed the hope that, if it be found necessary to schedule the former, only skin wool and low-grade wools will be scheduled. (10,434.)

J. H. Halliday (M): Witness considers East Indian wool may cause anthrax. He has found

J. H. Halliday (M)—*continued.*

infected bloodstains in unwashed East Indian wool, but this is unusual, as the great bulk of it is washed abroad, the bloodstains destroyed, and infection distributed over all the wool. The only method of preventing anthrax from East Indian wool is by action in the country of origin. (5602, 5947–54.)

"B. A." (W): Has not known cases of anthrax contracted in manipulation of East Indian wool, which is very dusty, and reaches this country in bales of loose material (*i.e.*, not in fleeces). Witness has never seen any bloodstains in East Indian wool. He considers the grey varieties dangerous (but not the white). (2087, 2117–20, 2153–4, 2196, 2307, 2490, 2613–8.)

"G. J." (W): All foreign wools are dangerous and all are dusty. East Indian is the worst. Witness is employed at a Commission Combing works where a great deal of East Indian wool is combed. (5350–1, 5372, 5382–9, 5480–1.)

(*h*) Egyptian.

T. M. Legge (O): A case of anthrax was notified in 1910 and another in 1913 in which Egyptian wool was one of the materials manipulated. (Appendix 2.)

F. W. Eurich (P): Witness did not examine a sample of Egyptian wool before 1914, though there is no reason why it should not be infected. A manufacturer, who bought a lot of Egyptian desert wool for the first time, sent him a sample in 1914, and it was crowded with anthrax spores. One other sample of ordinary Egyptian wool was examined with negative results. Manipulation of Egyptian is not, at present, subject to any regulations. (590, 8692–5.)

G. H. Feather (E): There are three varieties of Egyptian wool—ordinary Egyptian, Syrianised Egyptian, and Desert wool. The latter is a small proportion of the material reaching this country. Witness has never heard any danger suggested in Egyptian wool. (4717–8.)

G. Ackroyd (E): Witness gives details of several cases of anthrax in the Bradford district in which Egyptian wool was one of the materials manipulated. (*See* Anthrax—Incidence.) (6685, 6695, 6728, 6732, 6759.)

J. H. Halliday (M): Witness considers Egyptian wool may cause anthrax. (5602.)

"B. A." (W): Witness has not known cases of anthrax to be caused by Egyptian wool, nor has he ever seen bloodstains in this material. (2087, 2491.)

(*i*) English Wools (including Scotch and Irish).

T. M. Legge (O): A case of anthrax was reported in 1911 in which the only material manipulated was home-grown wool. There were nine other cases between 1899 and 1913 in which home-grown wools were among the materials manipulated. (Appendix 2.)

Sir S. Stockman (O): There are stringent regulations in England and Scotland administered by the local authorities, under an order of the Board of Agriculture, which require every case of anthrax among animals to be reported, and that the bodies of animals dying from anthrax, including the wool or hair, must be burned or buried. Farmers are not generally capable of diagnosing the disease. Unless anthrax were suspected, the body would be skinned and the skin and wool sold. It is not an uncommon practice to kill animals found to be ill and to send the carcase for sale. Recent instances were given where this had been done and where the skin and wool had gone into commerce. Witness considers there must undoubtedly be cases where English and Scotch wool, derived from animals which have died from anthrax, is sold with other skin material as an article of commerce, but the extent of the danger is slight. There are cases where anthrax is not reported, through ignorance and also by design. All persons who are caught not reporting plead ignorance, but, in most cases, the plea is probably not true. (*See* Anthrax in Country of Origin.) (9922–5, 9986–10,057,

Sir S. STOCKMAN (O)—*continued.*

10,089–97, 10,129–31, 10,206–7, 10,256–67, 10,283–8, 10,301–3, 10,320–7, 10,367–9.)

G. H. Feather (E): Witness thinks regulations should not apply to manipulation of English materials. Owing to the colour of English wools (white) dangerous wools (often coloured) could not be combed in the same factory. (4677–82.)

G. Ackroyd (E): Witness gives details of one fatal case of anthrax where the only materials manipulated were English and Colonial wool. One case also occurred in the manipulation of Scotch wool and Yorkshire haslock (skin wool) and two in the manipulation of English and Irish together with either colonial or South American wools. Details are also given of several cases where English, Scotch, and Irish were manipulated together with wools usually regarded as dangerous. Witness cannot explain cases where English and Colonial wool only are manipulated, but he remarks that anthrax is not confined to any one country, though precautions are taken in civilised countries to preserve most wools and textile materials from infection. (6628–30, 6680, 6695, 6704–14, 6753, 6759, 6762–3, Appendix 4.)

(*j*) Goat Hair other than Mohair and Cashmere.

T. M. Legge (O): There is a great deal of confusion between East Indian wool and East Indian goat hair. Several cases have undoubtedly been contracted among plasterers from East Indian goat hair used to bind the mortar. These are not included in the table put in by witness. (238–9.)

G. A. Taylor (O): Goat hair reaches this country in bales of loose material but no figures as to the quantity imported are available. It is dangerous, and regulations should apply to its manipulation. (1189–90, 1207–8, 1569, 1808.)

F. W. Eurich (P): There is no reason to expect goat hair to be free from anthrax. Very few examinations have been made, but in 1914 out of five samples examined one was found to be infected. (590.)

G. H. Feather (E): Witness considers goat hair to be likely to cause anthrax, and the code of regulations should apply to its manipulation but not to Continental goat hair, known as Chevrette, which is washed so clean that its inclusion would be futile. (4373–4, 4712.)

G. Ackroyd (E): There are many varieties of goat hair (in addition to mohair and cashmere). They are combed in certain Bradford factories. It is likely to be a dangerous material and regulations should apply to its manipulation. Details are given of cases of anthrax in factories where it is combed. No case occurred in its manipulation alone, but two groups of seven and three cases are described in which witness thought that either Russian camel hair or East Indian goat hair (most probably the latter) caused the infection. Details are given of one case in which Russian goat hair figured. (6683–94, 6709–12, 6728–30, 6756–61, 8220.)

J. H. Halliday (M): Considers that goat hair may cause anthrax. (5602.)

"B. A." (W): Goat hair reaches this country loose in bales. Witness has never found any blood in this material. (2117–20, 2187–97, 2491.)

T. Larkin (W): Witness has only once found bloodstains in goat hair, but has found pieces of skin in it. (2904–6.)

"W. R." (W): Considers goat hair to be a dangerous material, but it is usually blended without sorting. When pulling a blend of goat hair witness has known half a goat to be found, but that was a solitary instance. (3285–8, 3301, 3417–23, 3609–15.)

(*k*) Mohair.

T. M. Legge (O): In the period 1899–1913 the number of cases of anthrax occurring in the manipulation of mohair was as follows:—

—	Van Mohair.	Mohair.	Turkey Mohair.	Cape Mohair.	Cape Mohair and Turkey Mohair.	Pelitan.
Alone	7	5	23	4	10	—
With other materials	6	8	4	6	—	—

(Appendix 2.)

G. A. Taylor (O): Van mohair and Turkey mohair are received in this country in bales of "bumps," *i.e.*, part of a fleece loosely rolled up. Pelitan is a variety of Turkey mohair. Cape mohair comes packed loose (*i.e.*, not in fleeces) in bags. Normally about 11,000,000 lbs. of Turkey and about 19,000,000 lbs. of Cape mohair reach this country annually. (1191–3, 1199, 1205–6, 1569, 1696.)

Sir S. Stockman (O): There is a good deal of anthrax in South Africa among goats—much more than is reported. (10,096, 10,292–4.)

W. P. Norris (O): There are about 250,000 mohair and alpaca goats in Australia—most of these in Queensland, where anthrax is unknown. Importation of mohair into Australia would only be allowed subject to its disinfection in quarantine by the customs authorities. (8567–72, 8598–613.)

F. W. Eurich (P): Mohair is a dangerous material, and skin Van mohair is the most dangerous of all materials. Mohair is white and bloodstains can be readily distinguished in it. An analysis is given of the samples examined in the period 1906–1913 and in 1914. The following are the principal figures:—

—	Bloodstained Samples.				Samples not Bloodstained.				All Samples.			
	Total.		Infected.		Total.		Infected.		Total.		Infected.	
	1906–1913.	1914.	1906–1913.	1914.	1906 1913.	1914.	1906–1913.	1914.	1906–1913.	1914.	1906–1913.	1914.
Unclassified mohair	330	269	7	23	134	3	—	—	464	272	7	23
Van mohair	301	—	27	—	85	—	9	—	386	—	36	—
Turkey mohair	506	313	59	83	47	15	1	6	553	328	60	89
Cape mohair	550*	58	87*	4	80	4	1	—	630*	62	88*	4

* 137 from one bale, of which 59 were infected.

F. W. Eurich (P)—*continued.*

In considering these figures it is necessary to bear in mind that in some cases many samples were taken from one highly infected consignment. Skin Turkey and skin Van mohair are removed from the pelts by a wet process, or are treated by a wet process in the country of origin and the infection thus spread over the whole of the material. This accounts for the high proportion of infected non-bloodstained samples. Skin mohair is more highly and more frequently infected than other skin materials—possibly because it is usually derived from goats which have died from disease and not from animals killed for food. The higher qualities of Cape and Turkey mohair appear to be much less dangerously infected. Witness would prefer to have all inferior qualities of Cape and Turkey mohair treated by a method of disinfection. (576–8, 598–620, 895, 8658–69, 8729–30, 1020–4, Appendix 5.)

G. Ackroyd (E): (*See* Infected Materials—Skin Materials.) Mohair is a dry, sharp haired material, and this may partly explain the high incidence of anthrax from mohair. Van mohair possesses a peculiar acrid odour, which may denote something favourable to spread of anthrax. Compared with Persian wool or alpaca, mohair is not dusty. A case of anthrax occurred in witness's works in 1909 in manipulation of yellow inferior Turkey mohair, mohair dockings, medium Cape mohair and a mixed blend of mohair. Anthrax was cultivated from the yellow and the dockings, and from one of the other varieties. Bloodstains had been sorted out of all the lots, but it was shown that some which were infected had been missed. Too many were present to permit of all being removed. Bloodstains are most likely to be found in Cape and Turkey skin mohair, Cape mixed bales, and Turkey locks and inferiors. The better sorts of mohair and Cape winter mohair are almost entirely free from blood. Some firms using mohair have not had a case of anthrax in the last eight years, probably owing to the qualities combed.

Skin Van mohair and skin Turkey mohair appear to be removed from the pelt in the country of origin by the wet lime process or are treated by some wet process which wholly or partially destroys bloodstains and spreads infection. Ordinarily skin mohair contains 10–20 lbs. of bloodstains per 1,000 lbs. of material, but in one lot of Turkey skin mohair 35–40 lbs. were removed, and in a bale of Cape mixed mohair containing all qualities from good kid to Cape thirds about 300 lbs. per 1,000 lbs. were found. In both cases they were badly infected.

Witness points out that few cases of anthrax in manipulation of mohair after washing are recorded. There are indications of a revival of the practice of washing Turkey skin mohair in the country of origin and mixing it with shorn mohair. This is a dangerous practice and increases the difficulty of preventing anthrax. Some of the qualities of Turkey mohair are generally infected to some extent, but shorn fleece mohair is probably never infected. Most mohair is white and bloodstains are easily distinguished in it. About 85 per cent. is prepared and 15 per cent. carded. It is usually very carefully sorted.

Witness gives an analysis of all the cases of anthrax which have occurred in Bradford in the period 1906–1913 in manipulation of Turkey, Cape, and Van mohair, each of which has caused infection. Nine fatal and 21 non-fatal cases occurred in manipulation of mohair alone, and there have been 25 cases in which mohair was associated with some other material. (6334–7, 6342, 6367–77, 6405–7, 6416–17, 6428–31, 6445–544, 6622–7, 6632–763, 7047–52, 7105–6, 8016–30, 8042–3, 8138–54, 8220, Appendix 4.)

H. J. Foster (E): (*See* Infected Materials—Skin Materials.) Small quantities of skin mohair are found packed in even the best mohair. It is "salted" in, *i.e.*, wrongly put in by design at the collecting centres in the country of origin. Witness does not think it is done at Constantinople. (8856–74.)

E. B. Whitley (E): (*See* Infected Materials—Skin Materials.) There is skin material in many lots of Turkey mohair purchased. Most of it has been

E. B. Whitley (E)—*continued.*

clipped or pulled from the pelt. That removed in fellmongering is not usually mixed with fleece material. Witness has never seen skin material mixed with fleece Cape mohair as it is with Turkey mohair. Cape skin mohair is always fellmongered and packed separately. (9682–716.)

W. Waud (E): (*See* Infected Materials—Skin Material.) Witness buys mohair in Constantinople which comes direct from the country of origin, and also that which has been classed in Constantinople. The former frequently contains a proportion of skin fleeces, but the latter does not. Bloodstains are very rarely found in the mohair bought by the firm. (9832–906.)

W. H. Midgley (M): (*See* Infected Materials—Skin Material.) Mohair is sent from various districts to Constantinople. Some is classed there before being sent to Bradford, and some is sold and sent to this country in its original state. The latter frequently, and the former rarely, contains skin material. (8913–43.)

A. Drake (M): Turkey mohair is the hair of the Angora goat, and is produced in Asia Minor. The chief district is Angora, and others are Beybazar, Eskishier, Karahissar, Korich, Kastamboul, Yozgat, &c. The different varieties of Turkey mohair are known by the names of the districts in which they are produced. The goats roam over the country side, but are kept in their own districts. The flocks vary from 50 to 3,000. In winter, if the weather is severe, they are herded in primitive covered yards and fed on barley and hay. No precautions are taken to keep the yards clean.

Shearing commences in the middle of April and lasts a month. The hair is collected by dealers (chiefly Armenians) just as sheared, and some send it away as collected, while others mix with other collections and take off the coarser parts—the britch, skirtings, and dockings. It is then sold in the open markets of the interior to purchasers who mix and roughly grade the different lots, put the sound material into bags with the skin mohair and inferiors on top and send it to Constantinople. A bump of mohair is either the half or the whole of a fleece roughly rolled up. In Constantinople the material is sold and either shipped direct to this country or is taken by the buyer to his warehouse and classed before being sent here. No precautions against anthrax are taken, but witness thinks cases occur as he has known deaths and has seen one case of a sorter who had a pimple on his cheek. This man went to a chemist who put a red hot skewer through the pimple, but he died.

Many goats are killed for food both in the interior and in Constantinople. The principal cause of mortality is cold in severe winters. Witness has never heard of mortality from anthrax. The hair is usually clipped from dead animals if long, but if short, it is frequently, but not always, left on the pelt, which is then often used for rugs. Some of the dead animals are not skinned. In fellmongering some hair is removed by shears, some by lime, and some is pulled. Any hair from a dead animal is skin mohair. In a few cases farmers pack skin mohair separately, but usually it is mixed and sent to Constantinople with the shorn material. Generally, all mohair from the interior contains some skin material, but this depends on the mortality among the goats. It is sorted out in Constantinople, unless the lot comes to this country direct, which is now very frequently the case. If, however, it is long and fine, it is left with the shorn material, and great experience is required to detect it.

Mohair is graded in Constantinople into whites, greasy, discoloured, greys, yellows, pieces, inferiors, and locks. Of these, the long sound material is called "average" or "good average." The discoloured and locks are "inferiors," they contain much more skin material than "average" mohair, and are in pieces, not in bumps. The yellows are not inferiors, but consist of material discoloured by the goats lying down in urine when herded in yards in severe weather. Hair of animals dying in these yards is removed, but the body is left or buried in the yard. In some cases skin mohair is washed and packed in

A. DRAKE (M)—*continued.*

bales of sound material. Some mohair is sold as being free from skin material. There can be skin mohair in any quality, but some parcels are absolutely free.

Some Armenian firms in Constantinople do classing, but most of this is done by English firms. It would be very difficult to make an effective agreement with up-country collectors to keep skin material separate. They are ignorant, and the agreement would not be observed. English buyers should agree not to purchase mixed material. Regulations imposing duties on persons in this country who manipulate mixed material would discourage the practice. Van mohair never comes to Constantinople. It is sent down to Basra and shipped from there. The land in Asia Minor is owned by the Government, but there is no veterinary inspection. Some years ago buffaloes and cattle were inoculated to prevent disease, but witness thinks the disease was not anthrax. (9364–603.)

"B. A." (W): Van mohair reaches this country in bales of fleeces. Cape and Turkey mohair is not sent to Commission Combing works in the state it reaches this country. It has been sorted elsewhere. Witness has found a little blood in Cape and Turkey mohair. (2100, 2102–14, 2192–3, 2490.)

T. Larkin (W): Considers mohair a dangerous material. (2801.)

"S. J." (W): Thinks mohair and Van mohair likely to cause anthrax. (3668.)

"G. J." (W): Considers mohair to be a dangerous material. (5350–1.)

"F. J." (W): Some sorts of mohair are dusty, but mohair contains many short hairs which witness thinks are as dangerous as dust. Turkey mohair reaches this country in bags, and Cape mohair in bales. Mohair is less dusty and more locky than alpaca, and it is not necessary to shake it open like alpaca. Mohair seconds and thirds are usually combed in Commission Combing works, and mohair firsts by spinners. A bag of Turkey mohair weighs 1–2 cwts., and rather less than 1 cwt. can be sorted per day. A bale of Cape mohair weighs 3–6 cwts. (4808–14, 4860, 4893–4.)

"C. W." (W): Some mohair is dusty, but the material always contains many small fine hairs. About 1 cwt. per day can be sorted. Turkey mohair is more bloodstained than Cape. Bloodstains are easy to detect, because mohair is white, and are principally found in the lower qualities. Some mohair is washed abroad. Turkey mohair can be distinguished from Cape mohair. (5070–5, 5084–91, 5299–303.)

"Foreman and Three Skilled Sorters" (W): Witnesses rarely find skin material in Cape mohair, but much more frequently in Turkey mohair—usually in bumps. Long skin material of good quality would be sorted into the matchings and lower qualities thrown out. Inferiors are packed in some bags of Turkey mohair—usually at the top. Bloodstains are rarely found, and those found are usually in the form of a few stained staples. (9624–79.)

H. Barker (W): Bags of Turkey mohair frequently contain skin material, sometimes in bumps and sometimes a small quantity inside bumps of fleece material. The firm sometimes buys mohair guaranteed free from skin material, and such lots are always free from it. (9731–84.)

(*l*) Persian Wool.

T. M. Legge (O): Cases of anthrax were so frequently contracted in manipulation of Persian wool that in 1903 the Chambers of Commerce of Bradford, Halifax, Keighley, and Kidderminster issued a circular drawing attention to the very unsatisfactory condition of Persian wool sent to this country. Use of Persian wool in the heavy woollen district was discontinued on account of the high incidence of anthrax caused by it. A low quality variety of Persian wool is sent to this country through Indian ports, and is treated and classed as East Indian wool. In the period 1899–1913, 52 cases of anthrax were contracted in manipulation of Persian wool alone, and 51 in its manipulation together with other materials. Persian wool is not usually sorted into qualities, but it is looked over for extraneous matter. (29–40, 67–71, 328–9, Appendix 2.)

G. A. Taylor (O): Persian locks usually reach this country wrapped up in fleeces, which are contained in a press packed bale. Persian wool is so dangerous, its manipulation should be prohibited in any factory not licensed by the Chief Inspector of Factories. From half to one million pounds of Persian wool are imported annually. Bales of East Indian wool sometimes contain material which is apparently Persian wool. (1194–6, 1205, 1556–63, 1569, 1696, 1876–82, 1940–4.)

W. S. Smith (O): Persian wool is dusty. It is not usually sorted carefully into qualities, but is roughly looked over. (7426, 7608.)

F. W. Eurich (P): In the early investigations of witness two samples of bloodstained Persian wool and one sample of bloodstained dust from Persian wool were found to be infected. In the period 1906–13 the following results were obtained from samples examined :—

—	Unclassified Persian Wool.	Bagdad Wools.			Bussorah Wool.		Bushire Wool.	
		Unclassified.	Skin.	Not Skin.	Skin.	Not Skin.	Skin.	Not Skin.
Bloodstained Samples :								
Infected	14	9	24	28	2	6	—	1
Not infected	449	97	485	491	49	209	3	22
Non-bloodstained Samples :								
Infected	3*	1†	—	—	—	—	—	—
Not infected	95	7	33	29	—	14	—	—

—	Karadi Wool.	Awassi Wool.
Bloodstained Samples :		
Infected	—	—
Not infected	4	1
Non-bloodstained Samples :		
Infected	1	—
Not infected	2	—

* Two after washing. † Sample of tops.

F. W. Eurich (P)—*continued.*

The results are fully classified in several tables, which show locks and skin material to be most dangerous. Two samples only, both bloodstained, were found to be infected out of 107 bloodstained and two non-bloodstained samples examined in 1914. Persian wool, of which there are many varieties, is a dangerous material, but that which is not bloodstained very rarely contains anthrax. Persian wool is not washed abroad, and skin wool appears to be removed from the pelts in the country of origin of Persian wool by a process practically dry, so that the anthrax spores are not spread. A large proportion of the samples of Persian locks was found to be infected. Witness would like to have Persian wool disinfected before use if possible. The proportion of samples of Persian wool found to be infected in 1914 was much below the average. Very few samples of skin material were sent for examination, however. It is possible that there was less infection in Persian wool that year, but witness considered the samples examined to be too few to enable him to draw that conclusion. (554, 582–6, 627–58, 697–702, 712, 895, 1020–5, 8676–80, 8729, Appendix 5.)

G. H. Feather (E): Persons working among Persian wool are always liable to contract anthrax. The first case arising from witness's Persian wool occurred in 1906. Since then there have been 17 other cases. Sorting out of bloodstains was commenced in 1908, and special enquiry was made after a fatal case in 1911. It was found that infected bloodstains had been missed. Ten per cent. of the bloodstains found in the wool were infected. Ninety per cent. of the infected samples were from locks, and 10 per cent. (one sample) from skin pieces. If Persian wool were free from locks all bloodstains could be sorted out, but it is impossible to remove all from locks now sent to this country in Persian wool. The locks are wrapped up inside the fleeces and, in witness's opinion, are not derived from the same animal as the fleece.

Since 1911, 46 samples of Persian wool (all bloodstained) sent by witness proved to be infected, and of these, 37 were from locks and pieces, and nine from fleece and skin-fleece material. Witness gives tables showing that locks and skin material are much more heavily bloodstained than fleeces, but the skin material is frequently free from infection. He cannot say where the locks came from, but has heard they are imported into Persia. Persian wool does not resemble East Indian wool, but a certain amount of Persian wool (Bussorah) is shipped to this country from Indian ports (Karachi and Bombay) and is sold at the Liverpool sales. The chief markets for Persian wool (which comes from the Persian Gulf ports) are London and Marseilles, but the quantity reaching London is about four times that going to Marseilles. Persian wool is used chiefly for making hosiery and carpet yarns in England, and mattresses in Marseilles. (4224–36, 4261–358, 4373–9, 4384–5, 4541–52, 4569–70, 4574–8, 4685–711, Appendix 8.)

G. Ackroyd (E): Persian wool is certainly one of the most dangerous materials and it frequently contains material of low quality. On account of its colour and other characteristics the removal of bloodstains from it is very difficult and greater experience and knowledge are required by sorters than in the case of mohair. This probably accounts (together with the quantity of material dealt with) for the high incidence of anthrax from Persian wool in certain works where bloodstains are habitually removed. Witness thinks a process of disinfection, if possible, is desirable for these more difficult varieties. Persian wool is generally carded and it is not usually sorted into qualities. No firm habitually combing it in Bradford has escaped having cases of anthrax. Other materials are generally combed at the same time in the factories using Persian wool, so that there are comparatively few cases in the records which can be definitely set down as caused by Persian alone.

On account of the dry process of fellmongering used for removing wool from skins in the country of origin, witness thinks that bloodstains are the only

G. Ackroyd (E)—*continued.*

infected parts of Persian wool. Efficient removal of bloodstains should, therefore, prevent anthrax in its manipulation. Witness gives an analysis of all the cases arising in Bradford from use of Persian wool in the period 1906–1913. Four fatal and eight non-fatal cases occurred in its manipulation alone, and seven fatal and 27 non-fatal cases where it was being used together with other materials. It most frequently causes cases after it is washed. (6326–8, 6568–79, 6622–7, 6634–5, 6664, 6669–763, 6976–82, 8153–5, 8215, 8220, Appendix 4.)

W. Root (E): The most bloodstained material ever combed by witness was a lot of Bushire skin wool bought in London. It contained about half its weight of bloodstains. (8960c–8960w.)

J. H. Halliday (M): Witness thinks Persian and so-called Persian wool to be likely to cause anthrax. They are dusty materials. There were no cases of anthrax in the works managed by witness (in which for many years Persian wool and Camel hair have been the principal materials combed) till 1906. Since then, 18 have occurred. Since 1905, Persian wool has been "false packed," *i.e.*, a quantity of locks, pieces and lower-grade material has been mixed with the fleece material, and it has been heavily bloodstained. This is the explanation of the high incidence of anthrax since 1906. Some of the locks are of the same general type as the fleece wool, some are foreign to the wool in which they are packed, and all are of lower grade than the fleece wool.

Persian wool combed by witness is sorted into qualities by skilled sorters, but this is not usual in Commission Combing works. Since 1909, the sorters have removed bloodstains, but cases (14 in all) have occurred regularly since that date. The explanation is probably that some bloodstains were missed, but there is infection in wool apart from visible bloodstains, because these may become broken up. The average weight of bloodstains found per bale (336 lbs.) of Persian wool is ¾ lb., but some bales contain 20 lbs. On the average two-thirds of a pound were removed in the first sorting and one-tenth in the second. If false packing of Persian wool could be stopped, anthrax would be prevented, in the opinion of witness. (5602, 5615, 5626–32, 5663–9, 5791–823, 5941–6.)

"B. A." (W): Persian wools cause anthrax and are heavily bloodstained. They are dusty, and are sorted for bloodstains, but not for quality. Bussorah is packed in bales of tails, and Bagdad in bales of fleeces, which weigh about 3 cwt. Fleeces of Persian wool often contain locks and pieces packed inside. There is a great deal of excrement in some kinds, *e.g.*, in Bussorah. Some kinds of Persian wool are greasy and some dusty. They are not washed abroad. (2085–6, 2094–7, 2161–3, 2169, 2178, 2187–90, 2302–5, 2469–95, 2526, 2662.)

T. Larkin (W): Persian wool, including Bussorah and Bagdad, is a dangerous material. The bales weigh 3–3½ cwt. Persian fleeces frequently contain locks which are of colour different from that of the fleeces. They apparently are not wool from the same animal as the fleece. It is difficult to remove bloodstains from the locks. Persian wool, particularly the locks, is bloodstained. The amount of bloodstains varies from nothing to 25 lbs. per bale, the greatest weight being in the fleeces. Locks contain many very small stains. (2801, 2850–8, 2867–70, 2895–8, 2924–33, 3189–91.)

"W. R." (W): Persian wools are dangerous. Bloodstains are not easy to see, but can be felt in dark materials like brown or black Persian. It is not possible to remove all. Persian fleeces frequently contain locks. The latter are not badly bloodstained. (3285, 3343–6, 3358, 3368–9.)

"S. J." (W): Persian wools are likely to cause anthrax. They are very dusty. (3668, 3700, 3715.)

"G. J." (W): Persian wools are dangerous, and are the most dusty materials known to witness. (5351, 5372.)

"Foreman and Six Skilled Sorters" (W): Witnesses sort Persian wools (Bussorah and Bagdad) into qualities. They remove about 4 lbs. of bloodstains per bale of material. It is doubtful if all bloodstains can be picked out of coloured wool like Persian, but if plenty of time is allowed (as in the factory where they are employed) substantially all may be removed. Witnesses cannot explain cases of anthrax which have occurred in manipulation of Persian wool they have sorted. This material contains both skins with the wool on and locks which have been removed from skins by the lime process which, from the appearance of the locks, is a wet process. The locks are sometimes badly bloodstained, but the stains are never large, and are difficult to find and remove. The skin material found is allowed to go with the fleece material except that bloodstains are removed. (9100–78.)

(*m*) Tops and Yarn.

T. M. Legge (O): In the period, 1899–1913, two cases of anthrax occurred in the manipulation of finished tops. (Appendix 2.)

G. A. Taylor (O): Tops are the product of combing and are the raw material for spinning into worsted yarn. In the opinion of witness they are not free from danger. He has not personally known cases of anthrax to occur in their manipulation, but has known cases to arise from material after it has been carded. He thinks spinners should be required to provide lavatory accommodation. (1141–50, 1475–82.)

F. W. Eurich (P): In the period, 1906–1913, six samples of mohair tops, one of Persian, and three of camel hair tops, all free from blood, were examined, but were not infected. In 1914 seven samples of mohair tops were examined, all were free from blood, and four were infected. (Appendix 5.)

G. H. Feather (E): Witness thinks regulations should apply to manipulation of raw materials only. (4377–9.)

G. Ackroyd (E): In his analysis of cases of anthrax occurring in Bradford in the period, 1906–1913, witness records one non-fatal and two fatal cases among top and noil packers, and two fatal cases among spinners (using tops only). He considers there to be more likelihood of danger from noils than tops, but mentions that cultivations of anthrax have been made from the latter. In 1914, he combed a lot of Turkey mohair, from which the bloodstains had been twice sorted out, but which had been treated by a wet process and was known to be infected. Some bloodstains also remained in the material. He sent six samples of the tops produced in the combing for examination, and four proved to be infected, though they were free from blood. Witness considers this proof that tops made from infected material may be also infected, and it goes far to explain cases among spinners and in all processes after washing. (6641–4, 6738–41, 7158–64, 8016–30, 8042, Appendix 4.)

J. H. Halliday (M): Witness has known cases of anthrax to occur in the manipulation of tops. (5862.)

(*n*) Miscellaneous Materials.

(Spanish, Italian, Khorasan, Syrian, Yak, Cape, Buenos Ayres, Chile, Peru, Puntas Arenas, Russian, Falkland Islands, Oporto, Algerian.)

T. M. Legge (O): Enquiry as to incidence of anthrax in the felt district of Lancashire led to the discovery that *Cape wool* contained anthrax spores. This material was not previously suspected. East Indian wool used in conjunction with the Cape wool had been considered to be the cause of all the cases occurring in this district. In 60 cases of anthrax occurring at Mazamet in a period of 10 years, the infection was traced to South American wool, and South African wool, but principally to Spanish wool. The last was manipulated with other wools by a person who contracted anthrax in 1910. (82–4, 390–2, Appendix 2.)

G. A. Taylor (O): Australian, New Zealand, Cape, Canadian, Egyptian, Peruvian, Falkland Islands, Puntas Arenas, French, Spanish, Oporto, and Russian wools are used in Bradford. (1696.)

Sir S. Stockman (O): There is a good deal of anthrax in South Africa (much more among sheep than is reported) and preventive inoculation is practised to some extent. It is also practised in France, Germany, Hungary, and the Argentine. In South America anthrax is one of the plagues in certain districts, but those may be cattle districts. Witness could not say if sheep districts are affected. (10,096, 10,114, 10,289–94.)

The Algerian goat is insusceptible to anthrax, but is not immune. When imported into the anthrax districts of France, it was not resistant to the infection there. (10,370.)

F. W. Eurich (P): Witness has examined a few samples of *Syrian* wool. Two (both bloodstained) were infected with anthrax. There is no reason why other similar materials should not be infected if samples were examined. Of four samples of *Khorasan* wool examined, two proved to be infected. Both were free from blood. Witness also examined Chinese human hair, and was struck by the absence of all germs except dust organisms. One sample of Cape wool, of six examined, was infected. (590, 8732–7, Appendix 5.)

G. H. Feather (E): One sample of *fawn Syrian pieces* examined for witness was found to be infected. The manipulation of this material should be subject to regulations. *Khorasan* wool is not Persian, nor so-called Persian wool, although Khorasan (the district in which it is produced) is a province of Persia. True Khorasan wool is not a variety of East Indian wool. It is a material distinct from any other. There is, however, a variety of East Indian wool which is sold at the Liverpool sales as East Indian Khorasan. Witness thinks regulations should not apply to Khorasan till it is found to be infected. He has never heard of it being infected. It is not desirable that the regulations should apply to all "Foreign Wool." This would include Peruvian, Chili, Buenos Ayres, and South American crossbred wools, which are clean and free from danger. Peruvian wool comes in the same condition as alpaca. (4328, 4373, 4386–8, 4570, 4713–5, 4683–4.)

G. Ackroyd (E): In his analysis of cases of anthrax occurring in Bradford in the period 1906–1913, witness refers to several cases in which Kalmuck, Corsican, Turkey, Russian, Syrian, and Russian red lamb wool were manipulated with other materials. In no case was any of these materials considered to be the infected material, though Russian red lamb wool was suspected. Apparently no samples of these materials have been examined. Yak hair is the long rough hair of a species of goat. It is not dusty like Persian wool, nor harsh and dry like mohair. The anthrax Investigation Board recommended it should be included with goat hair for the purposes of regulations. (6669–763, 7114–20.)

Witness suggests that Algerian wool is the only wool quite free from anthrax. (6630.)

J. H. Halliday. (M): Syrian wool may cause anthrax and witness includes this material under the heading: "So-called Persian Wools." (5602–731.)

"B. A." (W): Syrian wool reaches this country in bales of fleeces, and witness has found it to be bloodstained. (2099, 2187–9.)

T. Larkin (W): Human hair reaches this country in bags of tails or knots. It sometimes smells badly. (2826, 3166–8.)

"S. J." (W): Witness thinks *Oporto* wool may cause anthrax. (3668.)

"C. W." (W): Yak hair is coarser than Mohair. It is like horsehair and is dusty. Witness looks on it as a dangerous material. Witness has also manipulated what are known as horse tails, though they are not real horses' tails. They have skin attached. (5282–96.)

International Action.

T. M. Legge (O): Witness was asked to join, and is a member of, an International Sub-Committee, appointed at the instance of the International Society for Labour Legislation (Basle) to consider and draw

T. M. Legge (O)—*continued.*

up general regulations for control of anthrax. These have been agreed on (a copy was put in), but have to be presented to the International Society. The Committee should consider the possibility of action by our Government in concert with Governments of other countries, and action might be taken through the International Society for Labour Legislation, at the meetings of which our Government is represented. (90–1, 212–4).

Sir S. Stockman (O): If a method, acceptable internationally and to the trades, can be found, it would be a very good arrangement to have a common understanding with other consuming countries as to disinfection of infected materials before they are allowed to enter the country. It is quite a matter for combination, and all civilised countries are ripe for it, but there are great difficulties, both as to disinfection and for trade reasons. The experience of the United States in the disinfection of hides is given as an instance. The producing countries are usually not sufficiently civilised to permit of action being taken in the countries of origin, either by the English Government alone, or in concert with other Governments. The establishment of an organisation through which the whole of the material must pass in the country of origin before export would not be effective. (10,272–82.)

F. W. Eurich (P): Representations by our Government to the Governments of wool producing countries are not likely to result in effective action. It depends so largely on the Government. In Persia, for instance, if laws for control of anthrax were passed they would probably not be enforced. If one could ensure proper administration, a law preventing packing of fallen fleeces with healthy fleeces would be a good thing. (827–9, 871–2, 986.)

G. H. Feather (E): It is desirable to take steps to secure joint action of all countries using dangerous wools, with a view to action in the countries of origin to prevent mixing of sound and infected materials. This action might be taken by International Conference, or through the International Society for Labour Legislation. Action by means of international combinations of traders has been tried and has failed, because there is no authority, such as could be exercised by a Government, to control the action of individuals. If all the Governments concerned took common action, individuals would have to obey the regulations of their respective Governments, and further, such action would have the desired effect of preventing the mixing of infected and sound material in the countries of origin, as the growers would take steps to make their goods saleable under the regulations. It would pay them to leave the infected material out, or pack it separately. Any action taken by one of the consuming countries alone would tend to divert the supply of wool from that country. Witness suggests that regulations already in force are not properly administered in some countries, and gives France as an instance. (4355–73, 4447–51, 4572–3, 4616–21, 4637–707.)

G. Ackroyd (E): It is desirable that the Committee should take steps to ascertain what measures can be taken in the country of origin of certain wools to prevent packing of infected with sound material, and, particularly, what can be done to prevent anthrax among the animals. The co-operation of all other consuming countries should be secured, and the same regulations should be in force in all countries using similar materials. (6891–6, 6994–5.)

J. H. Halliday (M): The effect of making stringent regulations in this country alone for preventing false packing of Persian wool might be to divert the supply to other countries. Efforts should be made to induce other consuming countries to adopt the same regulations as are applied in this country. (6137–41.)

Lavatories, Washing Conveniences, &c.

T. M. Legge (O): Section 75 of the Factory Act requires provision of washing conveniences where lead, arsenic, or other poisonous substance is used. Witness would hesitate to apply this section to works where there is risk of anthrax, but there has been no legal decision on the point. The present regulations require provision of washing arrangements for persons who handle unwashed wool. The object is to ensure removal of anthrax spores which may have lodged on the hands or under the nails. Persons who handle washed wool, *e.g.*, card room hands frequently contract anthrax, and it is desirable that the requirement be extended to all workers among dangerous materials. Opinion is growing in favour of a considered scheme of lavatories, cloakrooms, and messrooms for all large factories. Where lavatories are provided for one department only, there is liability that the conveniences may be used by persons in other departments and so cause overcrowding. (13–14, 373–81, 482–5.)

G. A. Taylor (O): Anthrax spores may lodge on any part of the body, or may be conveyed by the hands to any part of the body. Washing conveniences should, therefore, be provided for use of all persons working in factories where dangerous materials are used, including those engaged in combing and spinning and manipulation of tops. Every person should be required to wash hands, face, and neck before meals, and before leaving the works. The provision and use of washing conveniences should be required by regulations, even though administratively difficult to enforce. If the time required to wash in the suggested manner be considerable, more basins should be provided or reasonable time for washing allowed. If an occupier, after using due diligence, cannot enforce the regulations, he will be assisted by the Inspectors. (1479–83, 1518–20, 1603–12, 1673, 1871–2.)

F. W. Eurich (P): Persons may contract anthrax by the spores being rubbed through the unbroken skin, or by lodging on a cut or scratch or broken pimple, or by being conveyed to the mouth by eating with unwashed or unclean hands. A case was quoted of a man who contracted anthrax who did not wash on leaving work, or at home, and who also slept in his working clothes. The more cleanly the habits of any person are, the less the risk, to a certain extent, of contracting anthrax. (513, 839, 1034–5.)

W. Mitchell (P): (*See* Personal Hygiene.) Personal cleanliness is essential among persons handling dangerous material. It should be compulsory for all such workers to wash hands, face, and neck before meals and before leaving the works, and it would be an advantage if they could have a bath once a week. Sufficient basins, hot and cold water, soap, nail-brushes, and towels should be provided in every mill. Witness did not think each person need necessarily be supplied with a towel, but suggested it is a matter of common sense to change a towel when necessary. He quoted a case where it was stated that two towels were provided for 150 persons. In such a case it is impossible for the workers to be clean. (7282–94, 7330–1.)

G. H. Feather (E): Washing conveniences are necessary for use of workers among dangerous materials. Witness could not say what time should be allowed the workers for washing before meals, but pointed out that time is already allowed in some mills. Witness quoted a case of a man who died from intestinal anthrax supposed to be due to the fact that, though a very cleanly man himself, he dried his hands, before eating, on a towel soiled by a man who had previously washed, or merely rinsed his hands, very carelessly. He suggested for this reason that workers who did not scrupulously observe the regulations should be liable to a penalty. It was pointed out that the regulations in France require provision of a separate towel for each person. (4430–2, 4488, 4628–30, 4646–9.)

G. Ackroyd (E): (*See* Licensing.) Personal cleanliness is essential among all persons manipulating dangerous materials and washing of hands and face before meals and before leaving work should be

G. ACKROYD (E)—*continued.*

compulsory in some cases but not in all. Washing conveniences should be provided as conveniently as possible for the workers in all factor.es treating dangerous materials. Witness suggested that two minutes is sufficient for thorough washing. Time for washing should be allowed by the employer in some cases and where time is not allowed there should be a corresponding increase in the number of basins and washing facilities. The foremen should supervise the use of washing arrangements and there should be penalties for failure to use them properly. Provision of and use of washing conveniences is a matter which should be dealt with by means of a licence issued to factories. (6823, 6903–10.)

W. Root (E): Witness thinks it necessary that all workers manipulating dangerous materials should have conveniences for washing and he provides fixed basins with cold water, soap, nail-brushes, towels, &c., for his own workers. (8961F–61G.)

E. B. Whitley (E): Witness showed the Committee the washing arrangements provided in his works, consisting of nine basins with cold water, soap, &c., for 42 men. He thinks cold water may render chapping of the hands more likely than if warm water also were provided. The time usually occupied by the 42 men in washing is less than five minutes. (9611–12, 9680–1.)

J. H. Halliday (M): Personal cleanliness among workers, and provision of washing conveniences for their use, are essential in all factories where there is risk of anthrax. It is desirable to make it compulsory for all persons manipulating unwashed wool to wash hands, face, and neck (all exposed parts of the body), and for all other persons to wash hands and face before each meal and before leaving the works. There should be one basin for every six persons. The time allowed for meals is insufficient to enable workers to wash thoroughly in the meal-time (*e.g.*, in the breakfast half hour). Time for washing should therefore be allowed by the employer. No person ought to be allowed to return to work between washing and eating. For that reason the time for each worker to go to wash should be specified. Employers should have power to specify the time.

It might be necessary to stop some machinery when left by the worker, but not all. The cards could go on working. Machinery should be stopped as little as possible. Five minutes might be necessary for any person to wash thoroughly, but if each one went in turn at specified times, 10 minutes should be sufficient for all to get washed if sufficient basins be provided, and this time should be allowed by the employer. No one should be allowed to leave work to wash before mealtimes, except at his or her specified time. Witness instanced cases in his own works where some persons washed half an hour before the meal-time. Persons should not, however, be prevented from washing at other times. In order to permit of this, washing conveniences should be provided either in, or close to, each room in which persons work, though a general lavatory in a room to itself should also be provided. Witness pointed out that several changes in regulations have been made in this respect, and the existing regulations require washing conveniences to be outside workrooms. This, he thinks, wrong, as a spirit of cleanliness is engendered if persons can wash at any time without leaving their work. Towels should be changed daily, and each person should have a separate towel. (5864–86, 6013–31, 6062–3, 6142–7, 6193–209, 6240–53.)

T. Town (M): Witness showed the Committee the lavatory accommodation provided for the 24 male workers in a room used also as a messroom. It consisted of four basins, cold-water taps, nail-brushes chained to the wall, and towels. These conveniences are for use before meals and before leaving the works. There are also washing basins at different places in the workrooms, *e.g.*, in the washhouse, for use during working hours. A similar lavatory is provided for females. The nail-brushes are chained to the wall

T. TOWN (M)—*continued.*

because the men, especially those working at night, take away loose brushes. The females are cleaner than the male workers. A man is in charge of the lavatory and messroom for males, and his duties are to keep it clean and boil water for the workers. He has other duties, however, in the works. Witness quoted cases where men washed in water used previously by other men for washing, instead of getting fresh. No specific time is allowed for washing before meals, but no objection is taken to men taking time for this. They sometimes slip away without washing. (9008–39.)

C. E. Biggin (M): Witness showed the messroom and lavatory provided for males and females. It is in charge of a woman, who does nothing but look after it and mend overalls. The workers are strictly looked after in the matter of washing, and are allowed five minutes for it before meals and leaving the works. (9294–9.)

"B. A." (W): In the factory where witness was employed as warehouse foreman, he was instructed to see that the men washed efficiently, and to allow them such time as he thought necessary for washing before meals and leaving the works. The men will certainly use washing conveniences if properly arranged. They would use baths if they could get them. Witness has never known difficulty in getting men to wash. If 10 minutes were allowed for washing at each stop, one basin for every four men would be sufficient. If time be not allowed before each stop there is a rush to the basins, and men would neglect washing. Half an hour (the usual meal-times are half an hour for breakfast and three-quarters for dinner) is not sufficient to permit a man to wash himself thoroughly and get a meal. Witness always impressed on his men the necessity of keeping the finger nails clean, and, in his opinion, washing conveniences are necessary for all persons manipulating dangerous wool and they should include plenty of hot and cold water, soap, nail-brushes, and towels. (2329–39, 2528–31, 2605–10, 2619–25, 2735–6.)

T. Larkin (W): When commencing work in dangerous wools witness was warned to be careful as to cleanliness. In the factory where he is employed separate lavatories for males and females are provided, each containing six basins, and there are four basins on the stairs outside the workrooms. Half an hour is allowed for breakfast and three-quarters for dinner. This does not give sufficient time for washing efficiently and for eating. Time for washing is, therefore, allowed before each stop. There is no difficulty in getting persons to use the washing conveniences if time be allowed, but there would be difficulty if washing had to be done in the mealtimes. Witness thinks washing conveniences are essential, and he always washes hands and face and rinses his mouth before each stop. He could not say all workers do this, but all wash their hands. He cannot suggest any improvement in the lavatories provided, but would like to have a basin in his own workroom. (2874–6, 3020–40.)

"W. R." (W): There is always risk in manipulating dangerous materials, but cleanliness is the great thing. (3589.)

"S. J." (W): In the card and combrooms of the works in which witness is employed three basins and four towels are provided for 50 persons, the majority of whom are females. One basin is used by the males and two by the females. There is difficulty in getting a place for washing at the basins, and some therefore go without. Complaints are also made that the towels are wet. Two persons using one towel make it very wet. Witness does not suggest each man should be provided with his own towel, but he objects to use one after 20 others. Five persons to one towel is sufficient. The men grumble because they cannot wash properly, and in many cases they wash and go back to their machines before the stop. If proper provision be made there is no difficulty in getting men to wash.

Witness thinks that one basin and one towel should be provided for each five persons, and that

"S. J." (W)—*continued.*

five minutes should be allowed for washing before each stop. It should be compulsory for all workers to wash hands, face, and neck at each stop, but they would not require making. There is not time to wash in the breakfast stop (half an hour) or in the dinner stop (three-quarters of an hour), and, at present, one person looks after a machine while the other goes to wash. No specific time is allowed for washing. (3874–98, 4013–8, 4027–32, 4120–6, 4147–59, 4172–6.)

"F. J." (W): Witness thinks washing conveniences necessary for persons manipulating dangerous materials. They are not always used, as they should be, because of crowding. This is partly due to the fact that men cannot afford much time out of their mealtimes for washing, and partly because the basins are usually arranged in a continuous line, so that only one person can get at them at a time. If there were a space between each basin three persons could wash at once. (4934–8.)

"C. W." (W): Washing conveniences should be provided outside the workrooms for use of persons working among dangerous materials. Generally no time is allowed for washing before mealtimes, and it is not possible to afford much time out of the mealtime. There is therefore overcrowding, especially as one man only at a time can get to each basin if they are arranged in a line. If a space be allowed between the basins three persons could use one at the same time. If so arranged one basin is sufficient for every three persons, and a good long roller towel is sufficient for three persons also. (5209–18, 5249–52.)

"G. J." (W): In the washouse in which witness is employed no washing arrangements are provided. It is impossible to eat food without washing, as the men are thickly covered with dust. Each, therefore, obtains a bucket of water for washing. Witness has never known any one use the water from the washbowl, but has frequently seen persons wash shortly before the mealtime stop, and return to their machines and manipulate wool again before the actual stop. Washing conveniences are necessary in the washouse, and it should be compulsory for every person to wash hands, face, and neck before each stop. There would be no difficulty as to this on the part of the workers. (5459–71, 5543–4, 5575–82.)

H. Barker (W): In the sorting room of which witness is foreman there are four basins, with cold water only, for 15 men. Hot water is obtained from the cistern in winter time. (9719–21.)

Licensing and Centralisation.

G. A. Taylor (O): Witness suggests that, in order to concentrate the treatment of particularly dangerous materials like Persian wool in a few factories, all treatment of this material, whether by combers or others, should be prohibited, except on premises for which a licence has been obtained from the Chief Inspector of Factories. Witness regards this as a last resort, and it might be avoided if sorting out of bloodstains be relentlessly enforced. (1556–63, 1614–5, 1876–82.)

F. W. Eurich (P): Witness is of opinion that it is desirable to concentrate the treatment of specially dangerous materials into one factory and to require special precautions in that factory, including bacteriological examination of material and appointment of a medical expert. (912–7.)

G. Ackroyd (E): Witness is aware that two firms who comb a very large proportion of the most dangerous material (Persian) have continued to have cases of anthrax in spite of the fact that great precautions are taken in sorting out bloodstains. The difficulties in doing this in such a material are very great, and his own experience indicates that danger is increased where it forms a large proportion of the total of material combed. The proportion should not exceed 10 to 15 per cent. of the total. He is, therefore, not in favour of concentrating the treatment of such material or of bloodclots in a few factories. He is of opinion, however, that treatment of these materials and also disinfection of bloodclots

G. Ackroyd (E)—*continued.*

should be prohibited, except in factories licenced for the purpose. On application, the licence should be granted by the Home Office to all factories at present engaged in treating the particularly dangerous materials if certain suitable general conditions are observed.

The witness was not prepared to state what he considered to be suitable conditions, and he suggested this would have to be decided by the occupier on the one hand and the Home Office Inspectors on the other, but present knowledge is insufficient to enable the conditions to be made drastic at first. Such matters as keeping a register of names and addresses of workers, notification of and enquiry as to illness of workers, provision and use of overalls, cloakrooms, washing conveniences, and messrooms should be dealt with in the conditions of the licence. If the conditions were not observed the licence should be withdrawn. If cases of anthrax continued to occur, efforts should be made to prevent them (by alterations in the conditions of the licence) and if not persisted in the licence should be withdrawn. Experience of firms who do not have cases of anthrax (if there be such among combers of these classes of material) should be used as a guide to conditions to be observed. The conditions might ultimately be so stringent as to make the cost of manufacture prohibitive.

If the Home Office and the occupiers cannot agree as to the conditions there should be provision for an appeal to the Anthrax Investigation Board or a Committee of the Bradford Chamber of Commerce.

Power given to the Chief Inspector of Factories to issue on special conditions and withdraw (when necessary) certificates of exemption from any or all of a code of regulations might have the same effect as a system of licences. If that course be adopted the occurrence of cases of anthrax should automatically result in revision of the certificate. In the same way the code might apply to treatment of all wools and hair with provision for exemption of varieties free from danger from all regulations except a few simple ones designed as a warning against anthrax. The system of licensing or exempting from regulations under conditions would also permit of the adoption of new methods devised as a result of the acquirement of greater knowledge. (6551–4, 6571–78, 6790–1, 6807–17, 6854–76, 6881–7, 6897–907, 6915, 6983–8, 7124–32, 7137–9, 7151.)

Mechanical Conveyance of Wool.

T. M. Legge (O): Witness considers the report made by Mr. G. E. Duckering on dust in the air of factories where wool is treated, indicates that more consideration should be given to methods of automatic conveyance of wool from one process to another. (87.)

G. A. Taylor (O): Witness points out that the less wool is handled the less are the dangers of infection. For that reason he thinks mechanical conveyance of wool is desirable where its use is at all possible. Blowing of wool through ducts by means of a blast of air from a fan is a form of mechanical conveyance. It is, however, apt to be dusty, and in order to make it free from objection the receiving room must be entirely closed in and dust proof. (1382–5, 1521–6.)

F. W. Eurich (P): It is important that handling of dangerous materials should be reduced as much as possible by adoption of methods of mechanical conveyance and feeding, because operatives daily come into far too intimate contact with wool, *e.g.*, when bending down and picking up an armful of wool. (928–30.)

G. Ackroyd (E): The method of blowing wool from one part of the works to another may in some cases make the air dusty, and the arrangement should be such as to prevent this. (6837–40.)

T. Town (M): The less wool is handled the better, and witness is therefore arranging that material, after being looked over for bloodstains, can be placed as it is sorted on a travelling "brat" or lattice and so conveyed straight into the washbowl. (9064.)

"G. J." (W): Witness cannot see how a method of mechanical conveyance of wool could be applied in the washouse, but agrees that it would be advantageous if a method could be devised. (5490–7, 5583–7.)

Messrooms.

T. M. Legge (O): The existing regulations prohibit the taking of food in rooms where unwashed wool is manipulated, in order to prevent dust, which may contain anthrax spores, alighting on it and being eaten. The reason applies with equal force to rooms where washed wool is manipulated, and there should be messroom accommodation for all operatives working among dangerous materials—washed or unwashed. Flies may convey infection to food even at some distance from any place where dangerous material is manipulated. Witness does not, however, attach much importance to danger of conveyance of infection by means of food. If the danger were considerable many cases of intestinal anthrax would occur, but this is not the case. (375–81, 392–4.)

G. A. Taylor (O): The eating of food in any room, including combing rooms, where dangerous wools are manipulated, should be prohibited in order to prevent possibly infected dust or other material becoming deposited on the food. Messrooms should be provided for use of all persons, even if bloodstains have been removed from the material. Their use should be enforced by the occupiers of factories with full support of the Factory Inspectors. (1483, 1513–7, 1864–70.)

F. W. Eurich (P): Internal anthrax may result from the eating of food on which infected material has become deposited. (513.)

G. Ackroyd (E): Witness considers that eating of food in rooms, up to and including the cardroom, where dangerous material is manipulated is inadvisable. In some cases taking of food in these rooms should be prohibited and messrooms should be provided. (6901–2.)

J. H. Halliday (M): Witness considers there is danger from eating food in all rooms where dangerous materials are manipulated up to and including the cardroom, and messrooms should be provided for use of persons employed in these rooms. He considers there is no danger in eating food in combrooms except, possibly, in exceptional circumstances. He has known external anthrax contracted in combrooms, but thinks it largely surmise that internal anthrax can be contracted. One of his cardroom men contracted intestinal anthrax, although he never took meals in the cardroom. (5897–8, 6212–6.)

T. Town (M): Witness showed the Committee a room in his works which is used as a dining room and cloakroom for outdoor clothing, and as a lavatory, and is kept clean by one of the workmen. Witness tries to get his men to brush themselves before putting on their outdoor clothing. (9008–39.)

C. E. Biggin (M): Witness showed the Committee the washing and dining room provided in his works. It is in charge of a woman employed by the firm who does nothing but look after it, cook food for the operatives and mend overalls. (9294–9.)

"S. J." (W): In the works in which witness is employed no person ever thinks of taking food into or eating it in the cardroom. All food is placed and kept till required on the messroom table, and outdoor clothing is also hung in the messroom. The provision of messrooms is usual where dangerous materials are used, and they are a great benefit. (3899–907, 4135–41.)

"C. W." (W): Witness gets his meals in the dining room provided in the works where he is employed. Provision of messrooms is necessary for all workers among dangerous materials. (5219–20.)

"G. J." (W): Witness has his meals in the dining room provided, the arrangement of which is satisfactory. (5457–8.)

Museum of Safety Appliances.

W. S. Smith (O): Witness considers it desirable that a museum or permanent exhibit should be established in Bradford for showing (1) different types of dangerous materials, *e.g.*, bloodstains and skin wool of various types; (2) exhibits of satisfactory appliances for ventilation, dust collection, &c., so that persons who want to find out what is dangerous or what precautions are desirable could refer to standard types. (7824.)

Notification as to Use of Material.

T. M. Legge (O): Scheduled wools have in some cases been used without the knowledge of the Factory Inspector in factories where non-scheduled material only has usually been treated. Cases of anthrax have occurred in such cases, and witness is of opinion that it should be compulsory for every occupier to notify the Factory Inspector when commencing to use any scheduled materials. (257–65, 476–7.)

G. A. Taylor (O): Any person commencing occupation of a factory is compelled to give notice to the District Inspector, but when he first commences to use a scheduled or East Indian wool in an existing factory no notice is required. Unless a user voluntarily gives notice, the Inspector must find it out himself, which is often difficult, on account of the possibility that he may not see or may not recognise scheduled wool. Moreover, it frequently happens that an interval of two years passes between successive inspections of works. The occupier would, of course, be liable to prosecution if the regulations were not observed, but cases of anthrax may occur before any precautions are adopted. For these reasons, witness is of opinion that every occupier commencing to use (or re-commencing after an interval to use) scheduled wool should be compelled to give notice of his intention to the District Inspector. (1110–26, 1156, 1168–70, 1600, 1714–7, 1789–92, 1949.)

G. H. Feather (E): Witness is of opinion that everyone commencing to use scheduled materials should give notice of his intention to the Factory Department. Commission Combers and users of noils and by-products might have difficulty in knowing what the material is, but they can always find out from their customers or the merchants from whom the latter buy. Persons who do Commission Willowing of materials or by-products should also be compelled to furnish particulars periodically to the Factory Inspector of the kinds treated. (4379–87.)

G. Ackroyd (E): It is desirable to compel every person commencing to use dangerous materials or their by-products to notify the District Inspector of Factories. (6775.)

J. H. Halliday (M): Witness is of opinion that all occupiers of factories should be required to give notice to the Factory Inspector when commencing to use dangerous materials, but this should not extend to users of by-products. (5955–9.)

Opening and Sorting. (*See* Infected Material—(*a*) Skin Materials; (*b*) Bloodstains; (*c*) Varieties; Persons Skilled, &c.)

T. M. Legge (O): (*See* Regulations—Existing.) Special rules for sorting of wool were first established in October 1897. These were abrogated in December 1905, when the existing regulations came into force. Sorting of wool tends to diminish danger from anthrax. The definition of opening in the present regulations defines the first step preparatory to sorting. Opening in the sense of the regulations is a necessary step preparatory to sorting. The regulations prohibit the opening of wool (for the purpose of being sorted) by anyone "not skilled in judging the condition of the material." (*See* Persons skilled, &c.) The report of Mr. Duckering as to dust in the air in processes of treatment of wool indicates that the quantity of dust which may possibly be inhaled is less where opening and sorting are done in one operation than where these processes are done separately. It is only possible to judge

T. M. LEGGE (O)—*continued.*

condition, in the process of sorting, after the fleeces are opened.

The regulations do not require wool to be sorted, and they do not require anything to be removed if wool be sorted. They, however, require that no sorting shall be done except over an exhaust screen. The object of this is to cause removal by the exhaust draught of dangerous dust and particles of blood. This prevents contamination of air by dust, but does not remove all dust from the wool. Some materials are sorted carefully for manufacturing purposes, but in the case of Persian wool (the most dangerous of all) sorting is limited to picking out extraneous matter. In order to prevent contamination of wool by dust produced in sorting, the storing of bales of wool in sorting rooms is prohibited. Dust disseminated in sorting may certainly contain anthrax spores. The regulations also require the provision of a minimum cubic space (1,000 cubic feet) per person employed in sorting rooms for the purpose of preventing, as far as possible, dust produced by one man from affecting other men. Fresh air inlets must be provided in sorting rooms.

In the process of sorting, pieces of skin, scabs, and clippings are picked out, and these are required to be removed from the sorting room daily as they are held to be means by which infection is conveyed. It is important that all skin wool, fallen fleeces, and damaged wool should be sorted out, because these materials are most likely to be infected, and no one can tell whether or not they are infected. It is desirable and possible that bloodstained material should be removed from unwashed materials for the same reason, and instead of fallen fleeces it is desirable now to require the sorting out of bloodstains or bloodclots. (29, 38, 41–43, 87, 169–71, 268–90, 308–29, 334–48, 408–12, 436–43, 436–59, 463–5.)

G. A. Taylor (O): Witness understands the term "skilled sorter" to mean a person who has served an apprenticeship as a sorter. Different materials are differently treated. Alpaca is very carefully opened by the sorters themselves, and the method of opening has a direct bearing on sorting. Properly opened alpaca is much easier to sort than alpaca improperly opened. Mohair is not opened at all, but is sorted direct from the bag or bale. Persian wool is opened, but not usually by skilled sorters, and the opening is rough and extends only to the untying of the fleece. This opening does not affect, and has no relation to, the subsequent sorting, where this is done (which is very rarely). Opening of the bale is usually done by men, but opening of fleeces is frequently done by women. It is not possible to specify any fixed time for opening. It varies very widely with the type of material, and a bale may, in some cases, take two hours to open.

Usually mohair, alpaca, English wool and Colonial wools are the materials sorted by skilled men. East Indian wool, Persian wool, camel hairs and goat hairs are usually dealt with by unskilled men. Owing to the shaking necessary in opening alpaca and East Indian cashmere, and the consequent production of dust, witness thinks these materials should be opened in a room separate from sorting. All other materials, including Persian wool, should be sorted direct from the bag or bale without preliminary opening, unless it be in the form of ropes, or requires shaking before opening, because all dust, blood, and locks are safely wrapped up in the fleeces, and separate opening leads to hurried and careless work. If wool must, for any reason, be opened before sorting, it should be opened in a room to itself. An opening screen should not be allowed in a sorting room, because the sorting exhaust may draw the dust and so affect the sorters.

At present opening and sorting are done over exhaust screens, *i.e.*, wire screens through which a current of air is caused to flow away from the worker.

The original purpose of sorting was to classify the qualities yielded by different parts of the fleece, and it was purely a manufacturing process. Of recent years, at the instigation of the Anthrax Investigation Board and H.M. Inspectors, certain materials have been sorted solely for the purpose of removing bloodstains. This is not a manufacturing

G. A. TAYLOR (O)—*continued.*

process, but a precaution against anthrax, and a bonus is paid by some employers for all bloodstains removed. It is desirable that bloodstains should be removed from all materials in which they can be detected. When removed they should be temporarily placed in a receptacle and ultimately destroyed or disinfected. They cannot be picked out in opening because of the colour of many materials and of the impossibility of making the necessary careful search.

Sorting of every kind is a dusty process, and should be done over a screen provided with exhaust. It is desirable that a standard of exhaust should be prescribed. (*See* Standards—Exhaust.) The screens should be tested by taking readings of an anemometer placed on the top of the screen. In the opinion of witness this test gives a more reliable result than one made by placing the anemometer in the throat of a hopper, but it is occasionally affected by draughts if there be an open window near. Witness has, however, known cases where the screen has been in accordance with the standard at present laid down, when tested by placing the anemometer in the throat, though no draught was perceptible on the screen itself. Time should be allowed for carrying out structural alterations of systems already installed. Not more than one fleece should be on the screen at one time.

Sorting is paid for by both piece and day rates. The former tends to hurried work, but sorting out of bloodstains should be done slowly and carefully. It is necessary to employ persons for this who have been trained to recognise bloodstains. Witness suggests that the employment in sorting of persons skilled in recognition of bloodstains, and the effective removal of bloodstains, could be ensured by requiring the keeping of a register containing certain particulars. (*See* Register.)

There is less danger of anthrax from wool if bloodstains have been removed, but sorting itself, if the sorter merely sorts skilfully without taking out bloodstains, does not decrease the danger. It is not necessary to employ men skilled in sorting wool into qualities, solely for removal of bloodstains. An ordinary unskilled person, if trained to recognise bloodstains, is competent to remove them from wool. (*See* Persons skilled, &c.) If it be suspected that removal of bloodstains is being improperly done, the foreman should re-sort the wool and have the bloodstains removed. Witness proposes the following definition for sorting :—"Sorting shall include sorting for clots, classing, looking over for matter foreign to wool, and looking over for the removal of bloodclots and bloodstained material." Sorters wear overalls, and witness has seen dust on overalls worn. (1211–95, 1309–11, 1575–84, 1637–48, 1671–2, 1681–2, 1702–4, 1721–58, 1777, 1814–29, 1916–25, 1933–4, 1972–95, 2005–6, 2034–41, 2063.)

W. S. Smith (O): Opening and sorting are dusty processes and cause danger of anthrax; but, apart from this, witness considers them dangerous on account of the dust itself, which should be removed by exhaust. The conditions in which each of the processes is carried on are always practically the same, and it is, therefore convenient and desirable to prescribe by regulations exact details of the exhaust to be used. For both, he suggests standards. (*See* Standards—Exhaust, and Air Inlets.)

Mohair (except Van mohair and Pelitan) is not opened separately from sorting. In the opinion of witness opening in a separate room of mohair of all kinds, camel hair (unless in ropes), Persian, Egyptian, and Syrian wools, cashmeres (except East Indian cashmere), and goat hair is unnecessary. On account of the shaking necessary to prepare alpaca for sorting and to unwind the ropes of East Indian cashmere, these materials should be opened separately from sorting, as much dust is produced. He would divide materials into two classes : (1) those which need no shaking preparatory to sorting, and (2) those which need shaking. The former should be opened and sorted in one operation, and the latter opened over an exhaust screen in a room separate from the sorting room. Separate opening should be avoided if possible. It is an additional process, it may cause

W. S. SMITH (O)—*continued.*

distribution of infection, and is therefore undesirable. Discontinuance of separate opening would not increase danger in subsequent processes.

The existing regulations require an opening screen of 12 square feet area, with a draught of not less than 100 feet per minute at any point within 18 inches of the centre. The latter clause is unfair because, from slight causes, the draught at one point may fall below the standard, and the screen is then not in compliance with the regulations though, in fact, it is efficient. The majority of existing opening screens comply with another standard, which witness suggests in place of that now in force. (*See* Standards—Exhaust.) The regulations should also prescribe provision of air inlets in opening rooms so arranged as to permit a flow of air over the opener to the screen, without causing draughts. The hopper window and false ceiling used at present in some opening rooms is excellent. (*See* Standards—Air Inlets.)

For sorting, two types of exhaust screens are at present in use: (1) A screen of from 3 to 21 square feet in area placed 2 to 4 inches above the sorting bench and having below it, at a point near the front of the bench, a small hopper-shaped funnel 10 to 12 inches in diameter, connected to an exhaust duct; (2) Screens of 6 to 9 square feet in area, fixed in the sorting bench, having a hopper, of the same size at its widest part as the screen, connected to an exhaust duct. The former is used for sorting mohair and alpaca, which are passed in very small quantities at a time through the hands of the sorter in sorting out the qualities; and the latter, for sorting low grade materials, like Persian wool, in which the sorter handles whole fleeces at a time, and does not usually separate the different qualities.

Materials can be roughly divided into two classes based on the method of sorting: (*a*) Those sorted slowly and carefully into qualities and for bloodstains; (*b*) Those roughly sorted for removal of foreign matters and bloodstains. The exhaust screen first mentioned is suitable and sufficient for the fine sorting of materials, *i.e.*, sorted as in (*a*), but for materials rough-sorted as in (*b*), the screen mentioned second should be used. Witness suggested standards for both types. (*See* Standards—Exhaust.)

In many works the standard suggested is attained for fine sorting, but in many others defects of construction result in a decreased draught on many or all the screens. In one works the draught varied between 230 and 450 feet per minute at the point where the material is actually sorted, and the workers said their hands did not become cold. The low current observed in many cases in existing screens was usually due to the screen being too high above (3 inches or more) the funnel. Witness aims at making the draught effective over the part of the screen actually used in manipulation of material. He suggests that the draught should be measured by means of readings of an anemometer placed on the surface of the screen, because this is the point where the current of air is required, and where the dust is produced. Instances were observed in existing systems where the screens were in compliance with existing requirements, but no draught could be detected at the surface of the screen and dust could be seen rising. The object of allowing a clear space below the screen is to afford a collecting space for débris (not dust) from the wool. In the course of a day a considerable quantity is collected in this space. It should be swept into the exhaust funnel or removed by vacuum apparatus periodically.

The regulations should prescribe the provision of air inlets in sorting rooms. These should be behind the sorter and above his head—the hopper window and false ceiling is an excellent air inlet for this purpose—so that he is working in a slow stream of air. (*See* Standards—Air Inlets.)

Witness raised the point as to what is meant by storing wool in sorting rooms. This requires making clear, but he was apparently of opinion that bales of wool placed in the sorting room and allowed to remain there till the result of a bacteriological examination of the wool is obtained is not storing. In any case this should be allowed he thinks. Witness does not think it practicable to fix a standard of dust which might be allowed in the air of sorting rooms, chiefly on account of the difficulty of making the necessary tests. (7422, 7427–30, 7441, 7468–73, 7552–603, 7606–96, 7830–5, 7847–74.)

F. W. Eurich (P): (*See* Persons skilled, &c.) Witness is strongly of opinion that, where possible, bloodstains should be sorted out of wool before washing. It is not, perhaps, possible to remove all, but it is possible to remove the greater part. There would still be a possibility of contracting anthrax in manipulation of wool so sorted, but not a grave one. In many factories bloodstains are now removed—sometimes by skilled sorters. Cases of anthrax still occur, however, which probably indicates that some have been missed. An instance was given in which this was proved by re-sorting. In this factory re-sorting, to check the proper removal of bloodstains, is now done habitually (but cases of anthrax continue to occur). Bloodstains can be sorted out of skin wool, but this will not remove the danger if it has been obtained by a wet fellmongering process. If it be possible to sort out all skin wool from fleece wool as well as bloodstains, danger of anthrax would be small. (697–711, 719–30, 733–41, 799–815, 853–5, 908–9, 928–30, 985, 1017–27, 1040–52, 8742–6.)

W. Mitchell (P): Witness is aware that, in Bradford, bloodstains are now generally sorted out of wool, but has no means of judging whether this is effectively done. In any event, the incidence of anthrax has not been reduced. (7304–12.)

G. H. Feather (E): (*See* Persons skilled, &c.) Witness considers it possible for sorters to remove all bloodstains from Persian fleece wool, but not from locks. He is of opinion that sorting out of bloodstains is the best possible precaution against anthrax at present (unless the wool has been treated by a wet process), and he thinks this should be compulsory.

Witness strongly expressed the opinion that opening in a separate room is an unnecessary process, and that sorting and opening should be done as one operation, the bale being placed at the side of the sorting bench and the fleeces removed one by one to the sorting screen. Separate opening is a dusty process; there are two operations, therefore two risks instead of one, nothing is removed in opening, dust does not rise from fleeces till they are untied and unrolled, and there is nothing done in opening which cannot be equally well done in the sorting room. Witness was not in favour of a suggestion that where opening and sorting are done in one operation there should be an additional floor exhaust screen.

Witness thinks a greater proportion of Persian wool is sorted (including sorting for bloodstains as sorting) than 25 years ago. He considers the present form of sorting board to be satisfactory even for sorting direct from the bale. (4235–8, 4256–309, 4356–60, 4391–412, 4456–7, 4467–73, 4511–22, 4531–40, 4546–68, 4585–613, 4607, 4635–45.)

G. Ackroyd (E): (*See* Persons skilled, &c.; Infected Material—Bloodstains; Blending.) Generally speaking, witness considers separate opening of material to be unnecessary on the ground that prevention of anthrax is now no longer a question of dust but one of removal of bloodstains by the quietest method possible. If separate opening be required, there are two operations instead of one before bloodstains are removed, and therefore increased risk. It may be desirable to require separate opening of alpaca on account of the dust produced. (6777–82, 7074–9.)

Sorting is not defined in existing regulations, but witness understands it to mean separating wool into qualities, colours, and fibres of different lengths. In the time when anthrax was known as "woolsorters' disease," practically all wools then used were sorted, and sorting was more extensively and carefully done then than now. In recent years less and less sorting has been found necessary.

Removal of bloodstains is not true sorting, and witness terms it "looking over for bloodstains." Witness does not undertake woolsorting, but employs men, who are trained to recognise blood, to remove

G. Ackroyd (E)—*continued*.

bloodstains during blending. They are not skilled sorters, and bloodstains are sometimes missed by them. He considers the sorting out of bloodstains to be the greatest safeguard against anthrax. It should be compulsory, and he suggests that any firm doing this carefully might be relieved from the exact observance of other regulations. He is, however, aware that in certain works incidence of anthrax has not been reduced in spite of great care taken in, and inducements offered for, the efficient sorting out of bloodstains. This is due to the difficulties of the material and to the practice adopted in these works. Witness does not suggest that looking over for bloodstains during blending (for which exhaust is not necessary) should take the place of sorting where it is necessary to sort, but he regards it as a valuable check on the efficiency of sorting. Sufficient time, a good exhaust, and a good light are essential for efficient sorting, whether this be for qualities or only for bloodstains.

Sorting for qualities and for bloodstains are better done independently, but if sorting be necessary for any purpose they should be done simultaneously. Some qualities of material do not require special sorting for bloodstains over exhaust screens, and these could be dealt with merely by looking over for bloodstains during blending. Those which do should be named in a special schedule, *e.g.*, Persian wool, skin mohair, and locks, &c.

Mohair is generally sorted (into qualities), and a large number of sorters (skilled) is employed in sorting this material The incidence of fatal anthrax among them is high, possibly because of the sharp strong nature of the hair. It may, however, be apparent only, because of the minute nature of the sorting, or because so many sorters are exposed to the risk, or it may be due to scepticism as to the danger of blood. Sorting is the most dangerous process in the manipulation of "preparing" material. Nevertheless, some mohair contains very little blood, and in some mohair factories no cases of anthrax have occurred. It would be irksome to have severe regulations applying in such cases. A register of sorters, showing the kind, quality, and quantity of wool sorted by, and the quantity of bloodstains removed by each is necessary in the case of some materials and works, but not for all. The more sorting there is done, the greater the danger to sorters, but these should be trained to remove bloodstains immediately they are seen, and to handle the material quietly and gently. Mere sorting for quality, however minute and careful, will not reduce risk.

The present standard of exhaust for sorting screens is satisfactory. Sorting should cease when the fan stops, whatever the cause. The present regulation requiring damping of sorting-room floors with disinfectant is only of value because it produces a feeling of well-being. It is probably of real use in this way in preventing anthrax, though there is no disinfecting action. Witness thinks there is no general want of personal cleanliness among skilled sorters, though there may be in individual cases.

Witness does not believe it possible that efficient sorting out of bloodstains can be ensured administratively. But he also said that if sorting of material sent to Commission Combers has been inefficient, the fact should be shown by the comber in books which H.M. Inspectors could examine in order to enable them to correct the inefficient removal of bloodstains. It is not, however, possible to lay down a strict rule as to efficiency owing to variation in material. Sorting of Persian locks is a much slower and more difficult process than sorting of fleece wool. (6289–98, 6317–8, 6338–444, 6479–548, 6556–7, 6568, 6571–84, 6625, 6656–68, 6774, 6783–808, 6818–23, 6848–53, 6877–80 6915, 6924–59, 6989–90, 7001–66, 7093–8, 7105–6, 7151, 7985–8017, 8138–55, 8216–20, 8225–33, 8257–61.)

W. Root (E): In his factory witness uses an opening screen at a height of about 3 feet above the floor, and employs women to open East Indian cashmere. This screen is too high for efficient and comfortable working, and it is proposed to lower it. East Indian cashmere is received in twisted ropes, and these must be untwisted and shaken open, so

W. Root (E)—*continued*.

that opening of this material in a separate room is necessary on account of the dust caused. (8959P–Q, 8960Y–61E.)

Witness employs women for sorting, but they merely separate the material into colours and remove extraneous substances. They are not skilled sorters. They could not detect skin wool, but they can recognise, and they remove, bloodstains. They sort about 120 lbs. per day, but there is not much blood in East Indian cashmere, which is the principal material sorted. No record is kept of the quantity removed. (8959R–60W.)

W. Waud (E): The more time that is spent in shaking alpaca during opening the greater the ease of sorting. The material becomes open and loose instead of being tangled. The greater part of the dust should be shaken out in opening. (9821–2.)

N. Broome (E): In witness's factory bales of Persian wool are placed at the side of a bench in which is a number of exhaust screens, which comply fully with the standard laid down in the regulations for opening. The men employed are not skilled sorters. The fleeces are taken one by one from the bale, opened, examined for bloodstains on the screens, and the wool divided into two grades. The process is opening, and not sorting in the strict sense. The men have not been trained to recognise blood, but witness thought they could, in fact, do so. Very few bloodclots are found. (10,408–24.)

E. B. Whitley (E): Witness showed the Committee his sorting room (mohair). It was pointed out that the overalls of the sorters had dust deposited on the shoulders. This was said to be due to lifting mohair from the floor to the benches. They seldom find blood (perhaps once a week), but if they do, they place it among the hurdle dust below the tray, and afterwards take the dust away for burning. They can recognise bloodstains, and were taught by means of demonstrations by Dr. Eurich. Mr. Whitley showed the Committee some skin mohair which had been sorted out of fleece mohair. Sorters can readily be trained to recognise it, and this is necessary, because if an appreciable quantity be packed among the fleeces it is picked out and returned by the buyer. (9604–718.)

J. H. Halliday (M): Witness's evidence deals principally with Persian wool and Russian camel hair. These materials are opened by skilled sorters over an exhaust screen, which complies fully with the regulations, in a separate room. The process is rapid, takes 20 minutes per bale, and is very dusty in spite of the exhaust. Separate opening is an unnecessary operation, and sorting and opening should be done in one operation, except in the case of East Indian cashmere. Witness has little experience of alpaca. If it be necessary to shake any materials violently during opening, a separate room is necessary. Experimental determinations of dust in the air of his factory showed that in opening Persian wool and camel hair there were respectively 361 mgms. and 502 mgms. of dust present in 10 cubic metres of air. In sorting there were 65 and 70 mgms. respectively in 10 cubic metres, and when sorting and opening were done in one operation there were, in the case of Persian wool, 57 mgms., and in the case of camel hair, 82 mgms. of dust present in 10 cubic metres of air. The dust in opening and sorting done as one operation is, therefore, no greater than in sorting after separate opening, and the men would breathe very much less dust than if they opened and sorted the material separately.

It is not usual for wool to be sorted in Commission Combing works by skilled sorters, but in that managed by witness he employed from 7 to 12 in sorting Persian wool and Russian camel hair on large screens with powerful exhaust. Sorting is not less frequent or less thorough now than formerly. It is necessary that bloodstains should be removed from all the dangerous varieties of materials, and that persons engaged in removing them, whether skilled sorters or unskilled workers, should be trained in the characteristics. The sorters employed by witness undoubtedly

J. H. Halliday (M)—*continued.*

missed bloodstains when the sorting out of them was commenced. This was proved by re-sorting the sorted material and finding bloodstains. Check sorting was then instituted, with the result that less and less bloodstains were missed. Nevertheless, the incidence of anthrax was not reduced, though witness thought the cases were slighter. Witness would not like to suggest that re-sorting should be compulsory in all cases, though he regards it as essential (for Persian wool). A bale of Persian wool weighing 3 cwt. requires one hour for sorting if composed of fleeces, and four hours if composed of locks. It is impossible to expect a given number of sorters to keep a fixed number of cards working owing to variations in the time required for sorting different materials. Plenty of time is essential. Witness thinks there is always danger of anthrax, whatever care be taken in sorting.

Details of exhaust for sorting screens should be prescribed by regulation, and witness suggested a standard. He also thinks it a distinct advantage that floors of sorting rooms be sprinkled daily with a disinfectant, though he is aware it does not disinfect. (5612–99, 5770–807, 5842–50, 5965–99, 6032–46, 6070–8, 6136, 6159–87, 6217–39.)

"D." (M): East Indian cashmere is opened on a screen some distance above the floor. Witness considers it to be too high. Opening of this material is a dusty operation, and could not be done in the sorting room. The opening room was very dusty when the door was closed till an air inlet was provided. (8952–59B.)

T. Town (M): Witness showed the Committee the method of steeping Persian bales and then opening them and sorting them for bloodstains when wet. This is done at night as well as by day, and he thought it to be not much less effective than dry sorting by daylight. He considers sorting of wet wool to be much safer though, perhaps, more difficult. It is done by the washbowl feeder on a board at the side of the washbowl. It is proposed to erect a new sorting room and a new separate opening room with exhaust screens for opening wool and dry sorting out of bloodstains. At present there are no facilities in the factory for opening and sorting dry. Opening is a dusty process and should be done in a separate room. (8962–81, 9001–86.)

C. E. Biggin (M): Witness employs warehousemen to sort bloodstains out of wool. Skin wool is not picked out. The amount of bloodstains removed varies from one to four pounds per bale. (9318–27.)

J. Campbell (M): Witness showed his opening room to the Committee. One fan removes the dust in opening and sorting. (9095–7.)

S. Wade (M): Opening and sorting are best done as one operation because there is only one handling, and there is less dust and less danger than when the processes are separated. (9200–6.)

"B. A." (W): (*See* Persons skilled &c.) As warehouse foreman, witness is in charge of the opening and sorting rooms. Materials are not all treated alike. All bales, except Van mohair, go through the opening room, but some materials (Persian, alpaca, mohair) are sorted, while others (East Indian wool, camel hair, goat hair, East Indian cashmere) are blended direct from the opening room. The fleeces of Persian wool are thrown from the bale on to the exhaust screen, but they are not opened till they reach the sorting room. No attempt is made in opening to remove infected material, bloodstains, or anything else. (*See* Dusty Processes.) Opening is done as quickly as possible, and takes from 10 minutes in the case of a Persian or camel hair bale of 3 cwts. to three hours in the case of a bale of East Indian cashmere (which is in ropes, and must be untwisted) of the same weight. The dust in the air is removed by the exhaust, but there is much heavy dust remaining on the floor, which must be swept up, and only a small proportion of the dust is removed from the material.

Opening is done by regular men, but witness would not say these are skilled in judging the condition of the material. In his opinion, bales of such

"B. A." (W)—*continued.*

materials as Persian wool and camel hair should be opened and sorted in one operation as separate opening is a dusty and unnecessary process. Separate opening might, however, be optional. Alpaca and materials it is not proposed to sort should be opened in a room to themselves. When putting wool down the shoots from the opening room to the blending bins there is often a backrush of dust from the shoots in spite of the trap doors provided to prevent this. Opening must be done quickly in order to keep the cards supplied with material.

On reaching the sorting room the unopened fleeces are placed on the exhaust screen, opened out, examined by sight and touch for blood by warehousemen, bloodstains removed, and the loose wool placed on a truck. The dust produced in sorting is removed by an exhaust draught acting on a horizontal screen on which the wool is placed. Witness suggests that, if opening and sorting be done as one operation, there should also be a vertical exhaust screen in the face of the sorting bench in front of the bale beside the sorter. This would remove any dust produced in taking fleeces from the bale. It might make the sorter's legs cold, but this could be prevented by wrappings or by warming the room.

The fact that the safety of persons working in later operations depends on the efficiency with which bloodstains are sorted out is realised by the sorters but there have been occasions when witness has had to press men to hurry through the sorting. Usually wool is sorted much too quickly to enable all bloodstains to be removed, though witness cannot say, as a fact, that they are missed as he has never re-sorted any sorted wool. (2121–86, 2198–204, 2205–14, 2439–46, 2455–520, 2613–8, 2626–77, 2692–6, 2732–58.)

T. Larkin (W): (*See* Persons skilled.) In the Commission Combing works in which witness is employed, warehousemen open and sort Persian wool and goat hair for bloodstains. Mohair, alpaca and camel hair are opened and sorted by skilled sorters. One opener keeps four men sorting for blood employed, and the removal of infected material is left to the sorters. The material is shaken over the opening exhaust screen in order to remove as much dust as possible, but much remains. The exhaust is fairly satisfactory, but some dust is breathed. Unless wool be willowed, witness thinks separate opening necessary although, if wool be sorted and opened in one operation, there would be less dust in sorting.

A Persian bale, weighing 3 cwts., takes from half to one hour to open (it cannot be opened in 10 minutes if the fleeces be opened), and three to three and a half hours to sort if composed of fleeces. A bale of locks would taken 10 hours. It is impossible to fix any definite time for sorting. Sorting is a dusty process, although witness can suggest no improvement in the exhaust.

The sorters are never hurried, but are told to sort carefully and slowly. At times warehousemen sort wool into colours, but never into qualities. They understand that the safety of workers in subsequent processes depends on their efficiency. Witness has never known wool re-sorted to ascertain if all bloodstains are, in fact, removed. (2802–70, 2818–33, 2866–949, 3102–7, 3134–42, 3149–65, 3185–91, 3207–16, 3248–57, 3261–4.)

"W. R." (W): (*See* Persons skilled.) In the Commission Combing works, where witness is employed as a warehouseman, bales of wool are opened in the opening room, but the unopened fleeces are put into a truck and taken to the sorting boards (provided with exhaust) in a separate room and opened and sorted there. Half-an-hour is a reasonable time for the opening of a bale. Witness was shown how to recognise bloodstains and has been employed to sort them out of wool. The dangerous materials are ow usually sorted for blood, but except in the case of mohair, which is sorted by skilled sorters, this is generally done by warehousemen or unskilled men specially trained to recognise bloodstains. The exhaust provided at the sorting boards removes a great part of the dust caused by sorting but not by any means all. Witness has never known a case

"W. R." (W)—*continued*.

of anthrax among men employed to remove bloodstains, but has known cases of anthrax to occur in later processes in the manipulation of wool from which the blood had been removed. In his opinion this may be due to ineffective sorting caused by the men being hurried or to the fact that inexperienced men are employed.

In Commission Combing works there is great variety in the material combed, some materials being dangerous and some not. In a period where the non-dangerous varieties are being used the men trained to remove bloodstains are often discharged—generally, because there is nothing for them to do. When dangerous materials suddenly come in for combing, one of two things frequently occurs. Either the staff of experienced men is insufficient and they are pressed to sort a greater quantity than they can reasonably be expected to do, so that the machines can be kept running, or, if it be found impossible to get trained men, inexperienced hands are set to do sorting.

Sometimes unskilled men sort the material into colours as well as remove bloodstains. They cannot, however, recognise qualities nor the different parts of a fleece. (3291–417, 3304, 3318–25, 3329–82, 3427–502, 3512–4, 3526–60, 3578–92, 3617–21, 3637–41, 3646–63.)

"S. J." (W): In the Commission Combing works where witness is employed the machinery and equipment are the same as they were some years ago. The machines are now, however, driven faster, and a greater weight of wool is carded in proportion to the number of people employed, with the result that all work including that of sorting out bloodstains must be done faster and under greater pressure. Sorting is, therefore, less efficient, partly because the sorters get careless, and partly because they have not time to search thoroughly for bloodstains. Witness has noticed bloodstains occasionally among wool being fed into the cards, though they were supposed to have been removed. This might be an accidental occurrence, but he has not time to keep a look-out for bloodstains on the card feed. (*See* Carding.) (3763–89, 3790–804, 3827–51, 3929–39, 3958–74, 4005, 4019–26, 4033–9, 4045–50, 4065–76, 4095–8, 4127–31, 4157–60, 4205–10.)

"F. J." (W): (*See* Persons skilled, &c.; and Infected Material—Skin Material.) The dangerous materials usually sorted by skilled sorters are mohair and alpaca firsts, and some seconds. What sorting is now done in Commission Combing works is done by warehousemen, but it is not for qualities. Witness as a skilled sorter has to open the wool and then separate it into the desired qualities. The opening of alpaca, which is a dusty material, is intimately associated with sorting. It is necessary to shake it, partly in order to remove dust, but principally to get it into such a condition as to enable it to be sorted efficiently and quickly, *i.e.*, to clear the material from "bellies," "locks," and "insides." The more it is shaken in opening, the easier it is to sort, and the opening of a bale takes at least two hours. It is not possible to reduce this time and correspondingly increase the time spent on sorting. For alpaca, opening in a room separate from the sorting room is, therefore, essential. Fleece alpaca could not possibly be opened in the sorting room, though alpaca locks and seconds might be. Mohair is not opened separately, but is sorted straight from the bales. It contains a quantity of short hairs and these are breathed to some extent during sorting. It would be extremely undesirable to allow alpaca to be sorted straight from the bale. Dust is breathed in opening and it also settles on the overalls. Sorting of mohair and alpaca is always more or less dusty, though the exhaust removes a great deal of dust. Witness thinks the exhaust funnel or hopper should be larger for both opening and sorting. Witness is able to recognise bloodstains and removes all he sees when sorting. Every piece of wool is not, however, examined, so that some are certainly missed. It is not possible under any practicable circumstances to remove all bloodstains.

"F. J." (W)—*continued*.

Woolsorters are paid both by day and by piece work. Those who do the ordinary sorting are called "packmen," and are paid by the weight of wool sorted. Those who examine the matchings into which wool is sorted by the packmen are called "daymen" and are paid by the day. This examination is for the purpose of checking the proper sorting of the material, but the daymen are also supposed to check the removal of bloodstains. The price paid and the number of qualities made govern the rate of sorting. Usually a 2-cwt. bale of material would require two days. Since the amount earned depends on the rate of sorting, the temptation to neglect the removal of bloodstains is very considerable. It is possible to sort damp wool, but it is more difficult than to sort dry material.

In the estimation of witness a skilled sorter is a man who has acquired a definite knowledge which enables him to separate materials into different qualities, and who has obtained that knowledge by means of an apprenticeship which he has served in woolsorting. (4761–903, 4915–21, 4943–4, 4973–8, 4987–5003, 5011–22, 5034–7, 5053–6.)

"C. W." (W): (*See* Persons skilled, &c.) Mohair is sorted direct from the bales without first opening it in a separate room. This is a little dusty sometimes, but there are also many small hairs in mohair which tend to float in the atmosphere. A bale of 2 cwt. of mohair or alpaca requires 1½ to 2 days for sorting. Witness removes bloodstains during sorting and chiefly relies on sight for their detection, though he also uses the sense of touch. A small quantity of mohair is washed before it reaches this country. Alpaca must be shaken violently before it can be sorted, because the qualities are separated by shaking and locks and dust removed. This is always very dusty and is done, during opening, in a room separate from the sorting room. Witness would strongly resist a proposal to sort alpaca direct from the bale like mohair. It would have to be shaken out, and if this were permitted in the sorting room the air would become unbearably dusty. The more the material is shaken before sorting the more easily and certainly can it be sorted. The opening of an average bale of alpaca takes 2½ hours. Dust is breathed in opening. (*See* Standards—Exhaust.)

Witness looks for damaged wool, &c., in opening and has pointed it out to the foreman. Sometimes notice has been taken of it and sometimes not. In summer time there are enough opening boards, but in winter sorters try to take advantage of the daylight for sorting, and therefore open in the early morning and evening. There are then not enough screens. (5070.)

Witness considers present rates of pay, which are piece rates on the quantity sorted, are too low to permit skilled sorters to exercise sufficient care in removal of bloodstains. He thinks that if the rates were improved sorters would exercise more care, and there would be no attempt to get through as much material as is sorted at present in order to earn higher wages. A sorter's attention might, however, be so concentrated on the separation of the material into qualities as to make him neglect bloodstains. The material sorted by a skilled sorter (a packman) is examined by a dayman, but witness thinks this an inefficient check on removal of bloodstains. He has never known sorting to be continued when the exhaust fan connected to the sorting screens has ceased working for any reason. He thinks that sorters of dangerous materials should have a regulated period of work which should be shorter than at present (53½ to 55 hours per week). He bases this suggestion on the idea that long hours cause physical deterioration, and therefore greater susceptibility to anthrax. (5070–172, 5192–5, 5225–48, 5253–60, 5269–79, 5305–8, 5320–9, 5331–7.)

"A." Sorter (W): Witness showed the Committee why it is necessary to shake alpaca in opening in order to get the material loose and in condition for easy sorting. Shaking of alpaca is one of the most important things in sorting it. It would take twice as long to sort unshaken alpaca as to sort that which has been shaken. The material must be loose

"A." SORTER (W)—*continued.*

and free from locks. (*See* Persons skilled.) (8771–804.)

Mrs. "C." (W): Witness is employed in sorting East Indian cashmere. She removes britch ends, rough ends and bloodstains. She is not a skilled sorter. Witness was opening East Indian cashmere and showed the Committee how necessary it is to open the ropes of material in a separate room. It is a very dusty operation and much dust collects on the hair and overalls. (8927–51.)

Foreman and Six Skilled Sorters (W): (*See* Persons skilled, &c.) Witnesses principally sort Russian camel hair and Persian wool. They strongly emphasised their opinion that opening is an unnecessary process, because the material has to be handled several times, the process is dusty, many pieces fall about the floor, and pulling the loose entangled wool from the skeps makes sorting more dusty. They think bales of these materials should be placed at the side of the sorting bench and the fleeces or material lifted on to the bench and opened and sorted in one operation. The opening of a bale of Russian camel hair or Persian wool takes about 20 minutes, and this is done for the sorters by a warehouseman.

The exhaust draught at the sorting screens sometimes draws dust from other rooms, especially if the door be left open. They have no fault to find with the sorting screens, which are deep and good. (9100–93.)

Two Skilled Sorters (W): Alpaca has always been shaken before sorting in order to remove "fribs" or "shorts" and dust, and make sorting easier. If not opened in a separate room, it would have to be shaken in the sorting room as it was in the old days when, owing to dust collected on them, the beams of the room looked like trees after a heavy snowstorm. Sorting of alpaca cannot be done efficiently unless it be shaken. If one man takes 1½ hours in opening and another one hour for the same weight, the first will finish sorting sooner than the second, and the material will be better sorted. (9802–31.)

Overalls.

T. M. Legge (O): The object of requiring the wearing of overalls is to prevent the soiling and contamination of the clothes by dust. They are a very inefficient protection against anthrax, though desirable for preventing soiling and infection of clothing. Their principal defect is that they leave the face and neck unprotected. At present only sorters and persons who remove dust from dust collectors are compelled to wear overalls, and it might be desirable to extend the requirement to other persons. Provision should be made for the storage of overalls when not in use and for their cleansing. At present all that is required is that they must not be taken out of the works unless they have been steeped overnight in boiling water or a disinfectant. (358–63, 399–404, 419, 434–5.)

G. A. Taylor (O): In the course of his inspections, witness has often seen dust deposited on the overalls worn by openers and sorters, particularly on the shou ders, and many operatives have the habit of wearing their working clothes at home and sometimes sleeping in them. He has known anthrax to be contracted by members of a workman's family when washing his clothes. It is probable, therefore, that infected matter may become deposited on clothing. All operatives in processes up to and including carding should be compelled to wear close-fitting overalls buttoned closely at the neck. Women should also wear head coverings.

In many factories overalls are already provided by employers, and witness has never known any difficulty in getting operatives to wear them even when the weather is warm. The occupier of every factory in which dangerous materials are used should be required to provide and maintain overalls, and make provision for their storage when not n use and for their cleansing. This is necessary whether or not bloodstains are removed and the wool cleaned before blending. At present overalls are left lying about

G. A. TAYLOR (O)—*continued.*

anywhere, and that is very undesirable. It is also undesirable that the operative should be responsible for the cleansing of overalls. Divided responsibility often fails to achieve its object, and the occupier is the proper person on whom to place the responsibility of providing, maintaining, storing, and cleansing overalls. They should be washed once a week, and the dust which collects on them should be removed daily by shaking them over an exhaust screen. Witness sees no danger in or objection to doing this. Witness suggests that a boiler suit is the most suitable form of overall for men, and for women the overall should extend to the feet. Operatives ought not to be allowed to remove any overall from the works. (1300–5, 1491–505, 1517, 1677–8, 1760–4, 1835–42, 1905–11, 1935–7, 2021–9, 2034–41.)

G. H. Feather (E): Workers among dangerous wools are liable to get infected matter on their clothing, and so convey infection to their homes. It is not necessary for all operatives to wear overalls, but it is desirable that those employed in processes up to and including carding should. Witness was not prepared to say whether they should be provided by the employer or the operatives. (4423–9.)

G. Ackroyd (E): Wearing of overalls is not necessary for all operatives manipulating dangerous materials. A loose jacket is desirable for washbowl men, except in hot weather, and suitable clothing for warehousemen. Generally, these should not be provided by the employer. This is a matter which might form a suitable condition for a licence permitting an occupier to comb dangerous materials. (6835, 6897–8.)

J. H. Halliday (M): Wool comes in contact with, and may convey infection to, clothing of workers. Persons who handle raw materials, and especially operatives who work in dusty processes or in cleansing dust chambers or willowing machinery should, therefore, wear overalls. The occupier should provide and maintain and be responsible for the storage and cleansing of overalls, except those for sorters. The men employed in the card room—grinders and fettlers, &c.—should not wear overalls, on account of the danger of entanglement in the machinery. They should wear tight-fitting smocks. The female card minders and combroom hands do not need overalls at all, as cardrooms and combrooms, if like those in the factory managed by witness, are quite free from dust, though cases of anthrax occur in these rooms. The form of overall for card grinders might be a matter of opinion, but some grinders prefer to work in their shirt sleeves. (5887–96, 5900, 6210–1.)

"D." (M): The women openers and sorters employed in the factory managed by witness were all provided with head coverings, but refused to use them after the first fortnight. (8959B.)

T. Town (M): Operatives working among wool get grease and dirt on their clothing. They are supposed, and witness tries to induce them, to brush their clothing before going home, but they must take a certain amount of possibly infected dirt into their homes, and witness mentioned cases of anthrax occurring in workmen's families. It would, therefore, be an advantage if they wore overalls, provided these were of such a form as to be free from danger of becoming entangled in the machinery. The operatives would not supply them themselves, and it would be a great expense to the employer, as they do not last long. Witness was willing to supply one set of overalls if the operatives would supply one. It is possible that in warm weather the workers might refuse to wear them, and, in any case, it would be necessary to provide a room in which they could change. (9021–4, 9035–9.)

"B. A." (W): In manipulation of dangerous wool it is necessary to wear overalls, in order to keep dust and the nastiness of the wool from getting on the clothing. Witness has known cases of anthrax among members of a workman's family, not themselves employed among wool, caused by washing his clothes. In the factory where witness is employed

"B. A." (W)—*continued.*

the occupier provides and maintains overalls, and assumes responsibility for their cleansing. All the warehousemen wear overalls. They are kept buttoned up close to the neck even in warm weather, and witness has never heard the men object. It is much more difficult for women to keep their clothing clean than for men, owing to the shape of the loose skirt worn. (2411–27, 2571–5, 2611–2, 2771–6.)

T. Larkin (W): When witness first commenced working among dangerous materials he was warned always to wear overalls. Much dust becomes deposited on them, and he thinks overalls are necessary for the purpose of keeping infection from the clothing. His employer provides overalls, and they are washed once a week in the works by the men in charge of the washhouse. Each man has his own overall, which he shakes nightly over the opening screen. (2859–60, 2874–6, 3005–19.)

"S. J." (W): Card jobbers and grinders are not compelled to wear overalls, but they are liable to get infected matter on their clothing, and witness thinks overalls are therefore necessary. All operatives wear them in the works in which he is employed, and they are forbidden to enter the messroom when wearing them. (3874–82, 4165–7.)

"F. J." (W): All sorters wear overalls when at work, and witness considers them necessary. Each man provides and looks after his own. When not in use they are either hung up on the hooks where outdoor clothing is hung or are left lying in the sorting room. Witness has heard that some employers undertake the washing of overalls, and he thinks that overalls ought not to be taken out of the works till they are washed, owing to the danger that they may convey infection. (4922–33.)

"C. W." (W): Witness provides his own overall and wears it when at work. It is washed at home by his wife. When not in use it is left in the workroom. He is of opinion that overalls should be washed and disinfected in the works, and stated that Messrs. Foster's, of Queensbury, and Messrs. Benn's, of Black Dike, adopt this course. (5204–8.)

"G. J." (W): Witness considers the wearing of overalls in the washhouse to be necessary. Where he is employed overalls are provided by the employer and washed at her home by a woman paid by the firm. When not in use they are hung up in the washhouse. Sometimes they are wet, and it is necessary to dry them. There is a special place provided for storage of outdoor clothing, but not for overalls. (5444–56.)

Mrs. "C." (W): The overalls worn by witness (opening and rough sorting) reach from the neck to the feet and prevent dust getting on her clothing. Her hair gets somewhat dusty, and much dust collects on her overall. (8943–51.)

H. Barker (W): When cleaning out the dust chamber the men wear boiler suits and respirators. (9793.)

Personal Hygiene. (*See* Lavatories—Overalls.)

T. M. Legge (O): Witness is of opinion that any notice of warning as to anthrax and precautions against it should contain a recommendation that the finger nails be kept short. (420–2.)

F. W. Eurich (P): A cleanly body is usually more healthy than one which is uncleanly, and the chance of severe infection is to a certain extent, therefore, somewhat less. Washing of the hands will help to account for the fact that these are rarely the seat of nfection. An uncleanly person runs more risk of intestinal anthrax by transference of spores from his hands to his food than a cleanly person. Two cases of fatal internal anthrax were quoted where the patients slept in their working clothes. (837–9, 956–65, 1033–5, 1066–70.)

W. Mitchell (P): The class of operative employed in Bradford woolcombing mills is very dirty; they work, go home in, eat, and often sleep in the same clothes, and some of the houses in which they live are filthy. Their whole standard of personal hygiene requires raising. They were compared by witness, much to their disadvantage, with workpeople in the United States, who make an entire change of clothing and wash before leaving the mill. This is not the result of regulations, but because the personal standard is high. Training in personal hygiene can only be given by provision of facilities for keeping clean, and by encouraging a spirit of cleanliness—it cannot be given by regulations. At present the facilities provided in mills are very inadequate, a case being quoted where two towels were provided for use of 150 persons. (7282–94.)

C. E. Biggin (M): Persons employed are allowed time for washing and usually avail themselves of it but they require keeping up to it. (9294–9.)

"B. A." (W): There is difficulty in getting operatives to wash and to keep themselves clean unless time is allowed for doing this. Their mealtimes are too short to enable them to spend much time on personal hygiene. It is always impressed on men in his charge to take care of the finger nails. If time were allowed they would use baths or strip and wash. Witness does not consider it advisable to allow hair to grow on the face as it tends to collect dust. (2622–5, 2720–9.)

T. Larkin (W): Witness considers it advisable for operatives working among dangerous materials to be clean shaven. Hair collects dust, and many men have the habit of licking the moustache. (3069–83.)

Persons Skilled in Detection and Removal of Infected Material. (*See* Infected Materials—Skin Material, Bloodstains; Opening; Register.)

T. M. Legge (O): The existing regulations prohibit the opening of bales of wool by any man unskilled in judging the condition of the material. A person skilled in judging the condition of the material is understood in Bradford to be one employed in woolsorting and the term is analogous to that of a "competent person" frequently used in statutes. Witness suggests a person of one year's experience in sorting would be skilled in judging the condition. Material must be opened out in order for any person to be able to judge of its condition. Witness thought some months training would be necessary to enable men to acquire knowledge of the appearance assumed by blood in different varieties of material, but agrees that no official tests have been made on this point. (270–8, 408–13, 439–43, 469–75.)

G. A. Taylor (O): Mohair and alpaca are opened and sorted by skilled men who have served an apprenticeship as sorters. Persian wool, camel hair, goat hair, East Indian wool and similar materials are opened by warehousemen, who are not skilled sorters. Having in view modern knowledge as to blood being the source of infection in wool, witness is of opinion that all openers and sorters, whether skilled or not, should be trained in detection of bloodstains, and should remove them when noticed. The term "skilled in judging the condition of material" does not include ability to recognise bloodstains. Men need not be skilled sorters to enable them to recognise and remove bloodstains. Warehousemen and unskilled men can be trained for this in a few days by demonstrations of the characteristics of bloodclots. This has been done, and bloodstains are now being picked out by them with good results.

It is difficult to apply a test of any man's skill in this except by watching him, but witness suggested that it should be compulsory to keep in every factory a register showing the names of all persons employed to remove bloodstains, the quantities, sort, and quality of material examined by each person, the quantity of bloodstains or possibly infected materials removed and their treatment. It would then be possible to ascertain if one person were removing more bloodstains from any particular mark or variety of material than another, and to prevent the employment of incapable persons. The comparison would have to be made over considerable periods, because some bales of a particular lot might be comparatively free from blood. The sorted

G. A. Taylor (O)—*continued.*

material and that removed as blood should also be re-sorted by an overlooker.

If sorters are paid piece rates they may hurry the sorting in order to earn more, and if paid day rates the employer may press them. Ineffective removal of bloodstains may result in either case. Witness could not suggest any means of controlling this except by means of the register. The employment of untrained men in sorting for bloodstains should be prohibited, and some organisation should be devised for supplying trained men to employers, or a register of such men should be kept by some organisation. The trades unions and the employment exchanges were mentioned in this respect. (1210–16, 1261–8, 1575–83, 1651–4, 1671–2, 1681–4, 1756–8, 1765–6, 1777, 1883–5, 1902–3, 1916–20, 2068.)

F. W. Eurich (P): Blood on wool varies in colour and in some cases is difficult to distinguish, but the sense of touch can supplement that of sight and enable it to be detected comparatively easily after some experience. A "sorter" is usually understood to mean a man who has served an apprenticeship as a sorter. Such men should be taught during their apprenticeship to recognise bloodstains, and should remove them at the same time as they sort the material into qualities. Some materials are, however, not sorted by skilled sorters, and it is not necessary to employ highly skilled men for removal of bloodstains only. It is much easier to train anyone to recognise blood in wool than to train them to separate the various qualities, and an unskilled man of ordinary intelligence and conscientiousness should attain sufficient proficiency in a month to permit of him being trusted to remove bloodstains. Witness has frequently given demonstrations of the characteristics of and methods of recognition of bloodstains to men employed in sorting or looking over wool. He has not, however, tested them as to their proficiency in this. He mentioned one factory where all material is re-sorted for bloodstains by an overlooker to make sure that the sorters have missed none.

A table or register, showing (1) the quantity picked out by each man from weighed or known quantities of material, and (2) the quality of the material sorted, should be kept in every factory as a check on the individual sorters. The training of men in recognition of bloodstains should be compulsory and would be facilitated if a collection of non-infected bloodstains, which they could handle, were kept in every factory. It would be possible to test a man's knowledge by asking him to sort material containing known bloodstains. (706–11, 733–41, 849–55, 918–9, 923–30, 997–1000, 1026–7, 1040–59, 8742–6.)

G. H. Feather (E): Witness employs skilled sorters to sort his material (Persian wool and camel hair), and he commenced in 1908 to have bloodstains removed during the sorting. The sorters acquired knowledge as to their characteristics by experience and carefulness (at that time no one had any experience), and witness offered them a bonus for all bloodstains picked out. Previous to 1911 some were removed, but not very many. In that year a fatal case of anthrax caused witness and his brother to re-sort the uncombed part of the lot believed to have caused the infection, and infected bloodstains ($\frac{1}{2}$ lb. per 1,000 lbs. of wool) were found to have been missed by the sorters. The bonus to the sorters was increased to sixpence per pound of bloodstains removed, and the strictest supervision was and is exercised to encourage and enforce their efficient removal, but cases continue to occur. The skill of the sorters was not so great in the earlier years as in later years, but witness can only explain the occurrence of cases by supposing that some bloodstains are missed or that contamination by breaking up of the bloodclots occurs or there is infection in wool apart from bloodstains. He is of opinion that it is impossible to remove all bloodstains from Persian locks.

The only method of training men to recognise bloodstains is by showing them their characteristics and watching them carefully till they become

G. H. Feather (E)—*continued*

expert. An average man would learn in a week under proper supervision, but he would need longer than this to become fully experienced. Blood is easy to detect after a few weeks' experience. Men should be trained and kept in regular employment as experienced hands.

No time can be specified for efficient removal of bloodstains from material, as it varies enormously. Employers must have regard to the time spent, and there must be supervision as to this, but no man should be pressed or hurried in such an occupation. Efficient removal of bloodstains can only be ensured by care on the part of the sorter and allowance of sufficient time for sorting. In the experience of witness men employed to remove bloodstains are competent to do so, understand the importance of their work, and have sufficient time allowed. (*See* Bonus.)

It is not necessary to employ skilled sorters for removing bloodstains. An unskilled man after being trained in their detection is as good as, if not better than, a skilled sorter, because he has not his mind fixed on the separation of the different qualities of wool. Witness has employed both classes and found each satisfactory, judging by the quantities of bloodstains removed. Casual labour cannot be employed successfully in this occupation. (4256–309, 4356–60, 4391–3, 4402–12, 4511–22, 4546–68, 4588–602, 4639–45.)

G. Ackroyd (E): The Anthrax Investigation Board have, since 1907, by means of circulars, annual reports, and the Press urged users to remove all bloodstains from certain materials. In order to ensure that sorters and others should acquire the necessary skill and knowledge, the Board arranged that their bacteriologist should give to such persons demonstrations of the characteristics of bloodstains and of the readiest means of detecting blood in wool. The suggestion had no legal force, but was generally adopted, though even now witness is of opinion that much bloodstained material passes undetected, and the sorting is, in many instances, half-hearted. He thinks sorting out of bloodstains and the keeping of records should be compulsory.

Witness combs both sorted and unsorted mohair and alpaca, and a thorough search for bloodstains is made by the warehousemen engaged in throwing the material from the bales or sheets through a trap door on to a blend or, if it does not require blending, down the shoot leading to the washbowl. The sorted material from some works practically always contains bloodstains (sometimes more is picked out in the second looking over than in the original sorting), that from others only rarely. In the former case there is probably want of care and attention on the part of the sorters, or they think that a little blood does not matter. In one case, witness returned sorted wool for re-sorting because it contained many bloodstains, but even after the second sorting it still contained many, although sorted by skilled sorters. Two thirds of the material removed as blood in the second sorting proved not to be bloodstains.

Since 1908 witness has concentrated attention on removal of bloodstains, and has specially trained all his men in this. He has only had one case of anthrax since that year, but quoted many instances where bloodstains were missed in looking over and found in subsequent processes, some being infected. In some cases witness thought they were missed partly from carelessness on the part of his men and partly because there were too many in the material (mohair) to be removed, and he expressed doubt whether they could all be picked out unless extraordinary precautions and care were taken.

Witness thinks skilled sorters are at a disadvantage in removing bloodstains on account of their preoccupation in separating qualities. He trained his own warehousemen by example and precept, and it took some months to make them efficient. An ordinary unskilled person should be taught by demonstration of the characteristics of dried blood, and should learn to detect bloodstains in two weeks, but certainty could only be acquired by greater experience. Sufficient time must be allowed for removing blood

G. Ackroyd (E)—*continued.*

stains if it is to be efficient, but neither this nor efficient sorting can be administratively ensured. Witness believes it is as possible to remove all bloodstains as to do ordinary sorting into qualities. In both cases a second looking over is advisable, and in the opinion of witness neither can be effective without a check looking over.

He thinks the continued occurrence of cases of anthrax at Messrs. Crossley & Sons' factory to be due to the great difficulty of finding bloodstains in the material combed (largely coloured) and to ignorance of the great care required. Much more care and experience are necessary for finding and sorting out bloodstains in Persian and other coloured wool than in mohair, which is white, so that blood is easily visible. Witness thinks, however, that this could be done sufficiently well to prevent anthrax, but he cannot suggest how it and the employment of persons proficient in recognition of bloodstains can be administratively ensured. The keeping of a register showing the names of sorters, the kind, quality and quantity of material sorted, and the quantity of bloodstains removed by each, is necessary in some cases, *e.g.*, where skin Turkey mohair is used, but not in others (*see*, however, Q. 6941). Witness does not know of his own knowledge that piece rate wages of skilled sorters are sometimes so low as to involve hurried sorting and that warehousemen paid by the day are pressed to get through a large weight of wool, but both are wrong and should be prevented. He is at variance with the idea that this should depend on administration.

Skilled sorters require as much training as unskilled men to enable them to remove bloodstains, and demonstrations and the active interest of the operatives are really necessary. He does not think any test should be applied to a supposed bloodclot. If there be any doubt it should be treated as a bloodclot. A chemical test is impracticable, but a bloodclot clipped in two will usually show the characteristic blood colour.

A skilled sorter could usually, but not always, recognise and remove skin material when mixed with shorn material. In some varieties this is easy, but in some it is exceedingly difficult. Witness described a lot of skin Turkey mohair which had been sorted by skilled sorters and the bloodclots removed in sorting. When he received it subsequently for combing, it still contained a huge number of small bloodstains, but very few bloodclots. He considered it impossible to remove these by sorting or looking over though he tried to do it himself. Witness as far as possible keeps in employment the men he has trained for picking out bloodclots, as when experienced they are more reliable than newly trained men. He lays great emphasis on the *careful* sorting out of bloodstains. (6342–546, 6556–7, 6571–84, 6625, 6656–68, 6783–95, 6818–23, 6848–52, 6877–80, 6915, 6924–59, 7001, 7101–2, 7151–2, 7985–8045, 8138–55, 8216–20, 8225–33, 8257–61.)

H. J. Foster (E): Witness has only experience of skin material so far as it is salted in among fleece material in small quantities. This, if bloodstained or discoloured, can be picked out by sorters. If sorters are making many qualities (*i.e.*, sorting very carefully) all skin material might be detected and removed, but this could not be done if the sorting is only for bulk sorts. A search for skin material would make sorting very costly—probably it would be prohibitive. Skin mohair is frequently present in mohair in very small pieces. (8856–74.)

W. Root (E): Witness employs women for rough sorting. They would not be able to distinguish skin material, but can, and do, pick out bloodstains. No record is kept of material removed. Witness can distinguish skin material when mixed with shorn fleece material, and would consider anyone a very inexperienced wool man who could not do so. (8959R–8960W.)

E. B. Whitley (E): Witness showed the Committee some skin Turkey mohair, which had been clipped from the pelt, mixed with shorn material, and picked out by his sorters. He explained how it is possible to detect skin material even when clipped from the pelt or body. Fellmongered skin material is never mixed with shorn fleece material, but that clipped from the skin frequently is. All experienced sorters and wool buyers can pick it out whether it is mixed with good average or inferiors. (9682–718.)

W. Waud (E): Witness can himself detect skin material when mixed with fleece material, but was unable to say that all sorters can. There are, however, limits. Some skin hair is beautifully long and fine and silky, and it requires great knowledge and experience then to detect it, and witness might be in doubt whether or not it is skin. Probably hair removed from the body of an animal immediately or soon after death, whether it has been butchered or has died from rapid disease like anthrax, could not be distinguished from fleece mohair. Some people say skin material is not lustrous, but this is true in certain cases only. Some people also understand skin material to be hair from an animal which has died of disease, or which has been obtained from the pelt by fellmongering, and they exclude hair from butchered animals. If any person picked out the skin material in a lot of mohair it would probably represent the minimum quantity present. (9834–906.)

N. Broome (E): Witness does not employ skilled sorters to sort Persian wool. He thought the men employed understood the characteristics of bloodclots, but they have never received any training in their recognition. They very rarely find any. (10,408–23.)

J. H. Halliday (M): Witness employs skilled sorters for sorting (Persian wool and camel hair) and, since 1909, they have also removed bloodstains. The sorters were instructed by Dr. Eurich and himself in their recognition. It is not easy to detect bloodstains in dark-coloured wool. The length of training necessary depends on the capacity of individuals, but usually two to three months are necessary, and some skilled sorters are not then reliable.

Witness has also trained unskilled men to remove bloodstains. This takes a very considerable time, which he could not specify, but when trained they are as trustworthy as skilled sorters. Witness emphasised the difficulty of securing by administration the employment of proficient men only. The training of men in recognition of bloodstains and the employment of trained men only for removal of bloodstains should be required by regulations, but the result can only be attained effectively by proper supervision exercised by occupiers, managers, and foremen.

The effective removal of bloodstains can be secured by keeping daily records of each man's work, and by check sorting. Witness takes both these precautions. The quantity of bloodstains in a lot of wool would usually be spread throughout the lot, though individual bales might be uneven. The records for a lot, together with check re-sorting, would, however, show which men were efficient. (*See* Registers.) Witness considers re-sorting for bloodstains to be essential. During two years he found on the average that two thirds of a pound of bloodstains is removed in the first, and one-tenth of a pound in the check sorting, but the quantity removed in the second sorting gradually fell.

In 1911 witness thinks (and knows) bloodstains were missed by the sorters, but by 1913 he thinks substantially all were removed (though cases of anthrax still continued to occur). It is highly dangerous to cause or permit the hurrying of men sorting for bloodstains. Sufficient time must be allowed, and a bonus should be given for bloodstains removed. Small quantities of bloodstains can easily be missed when sufficient time or remuneration are not given for sorting. Witness had four cases of anthrax in the three years before, and 14 cases in five years after, commencing sorting out of bloodclots in 1909. There was no observable difference in the incidence in the years before and after 1909, but the cases were slighter in the later period. (5626–84, 5770–80, 5791–823, 5842–9, 5965–99, 6032–46, 6070–78, 6151–2.)

W. H. Midgeley (M): Witness is wool buyer for Messrs. J. Foster and Sons, Ltd., and, if on inspecting a parcel of mohair he finds skin material, the parcel is not bought. It is possible to distinguish between mohair removed from a dead animal and that shorn from a live one. Skin material can be picked out by sorters, and this is the only precaution which can be taken by a purchaser of mixed materials. (8813–43.)

T. Town (M): In the factory managed by witness Persian wool is steeped in water (this does not soften bloodclots), and is then looked over by unskilled men feeding the washbowl. Work is continued night and day. It is difficult to detect bloodstains in coloured wool, more difficult when it is wet, and nearly impossible at night when the material is wet, except by the sense of touch. (8962–81, 9040–86.)

A. Drake (M): Mohair before being classed in Constantinople usually contains skin material, and the classers remove it. The very good skin material is not, however, removed, and is sent mixed with the shorn material to this country. In some cases the inferior skin material is also left in, and in many cases persons in the country of origin "salt" skin material into bumps of shorn material. However packed, it can always be detected and picked out by an experienced buyer or a skilled sorter whether in good average or among inferiors. In buying mohair, bales are always examined, and an estimate made of the quantity of skin material it contains. (9394–418, 9437–65, 9488, 9547–68.)

"B. A." (W): (*See* Infected Material—Bloodstains.) In the works where witness is employed as foreman warehouseman the bales of wool are opened by warehousemen, who remove nothing in the process and are not skilled in judging the condition of the material. The wool is then sorted for bloodstains (but nor for quality) also by warehousemen. In doing this it is necessary to use both sight and touch. Witness says: "When a man is used to it he can detect bloodstains by the feel, but must still use his eyes and sometimes they can be seen, a dark red." It is not always possible to distinguish bloodstains by the outside appearance, but if cut in two the cut surface usually shows dark red. Witness was not taught to recognise bloodstains, but acquired the knowledge by experiment (by cutting and by crumbling the clots on white paper) and experience. Later he was present at a demonstration by Dr. Eurich, who sent him samples of bloodstains to examine. This was of great assistance. No one can be sure in all cases whether what he removes is blood or not. Sometimes blood is sticky and sometimes dry.

In regard to training men to recognise bloodstains, witness suggested that a novice should be taught by a skilled man for at least a week. He should then sort for himself, but should be carefully watched. Some men are quicker than others. Efficient removal of bloodstains can only be ensured by employing trained men, and allowing plenty of time to do it. At present sorting for bloodstains is done too hurriedly. The machines must be kept supplied, and, to do this, the sorters are often pressed to get through a lot of wool. It is not possible to fix any time for sorting a bale. Some bales are more difficult than others of the same material, and some materials can be sorted quicker than others. Loose wool is always more difficult than fleeces. Six or seven sorters are not sufficient to keep 14 cards running, and at least two hours are necessary for sorting a bale of Persian wool. In any event some bloodstains will be missed, however carefully sorting is done. Witness says: "There are times when you see what you think is bloodstain and it is paint." "There is many a time when you see what you think is paint and it is blood." Moreover bloodstains are frequently very small, and slight bloodstains are very easily overlooked. Methods of sorting cannot be so improved as to prevent this.

In Commission Combing works there are periods when materials free from danger are being combed. The men skilled in removing bloodstains are then discharged, and on resuming combing of dangerous

"B. A." (W)—*continued.*

materials, seven out of ten men engaged to remove bloodstains are inexperienced, though efforts are always made to get trained men, and particularly those previously employed. They are shown as well as possible how to detect and remove blood, but witness considers some organisation should keep a list of trained men, so that these only should be engaged. It is necessary that all warehousemen should be able to recognise bloodstains, because the exigencies of the work sometimes require the whole warehouse staff to be put on sorting out bloodstains.

A bonus is paid on the weight of bloodstains removed, and this has a good effect in making men careful. An unskilled man is in more danger from anthrax than a skilled man, as he does not know the necessity for care in handling the material. In training a new hand, the foreman shows him samples of bloodstains and goes through a few fleeces, cutting open any bloodstains found, and showing their characteristics. He is then told to show anything he considers suspicious to the foreman, and to pick out anything hard or sticky. (2126–7, 2174–7, 2213–314, 2379–85, 2397–406, 2428–41, 2455–61, 2490–527, 2558–70, 2580–3, 2602–4, 2613–8, 2654–77, 2687–91, 2737–58.)

T. Larkin (W): When witness first commenced to work among wool he was told to open bales of materials, including Persian wool. He did this alone, though he had no previous experience, and was, therefore, not skilled in judging the condition of the material. He was not told to look for anything in particular when opening. In the Commission Combing works where he is employed, warehousemen open and sort for bloodstains those materials, like Persian wool, which are not required to be separated into qualities. They are not hurried at all, and are allowed as much time as they may find necessary. After opening bales for a fortnight witness was allowed to help in the sorting for bloodstains. He was told to look for the dark red or black bloodclots, and was shown bloodstains and how to detect them by their feel. He uses the sense of touch and the sight in detecting them, and was able to do this in a week or two after starting. Any man of ordinary quickness can be trained to do it in a week or two, if employed exclusively in learning to do it. There are both bloodclots and bloodstains—the former being hard lumps and the latter just stains on the wool.

The material picked out is examined by the men in charge of the gang, and for all that is passed as being bloodstains a bonus is paid. It is impossible to fix any time for sorting a bale of wool as the material varies so greatly. Four or five men can keep eight cards working. Witness can detect fallen fleeces. They are dry and rotten and frequently badly bloodstained. If allowed plenty of time, witness thinks he could remove all bloodstains from wool. In the works where he is employed the same hands are always employed for picking out bloodstains. Temporary hands are never engaged. (2800–46, 2874–949, 3047–50, 3091–5, 3113–7, 3134–42, 3149–65, 3176–81, 3185–8, 3192–216, 3243–64.)

"W. R." (W): Witness understands the terms "damaged wool," "fallen fleeces," and "skin wool," and says he is able to recognise these and also bloodstains. Warehousemen are not supposed to be able to do this, and cannot recognise the different parts of a fleece. Warehousemen usually do all opening and sorting in Commission Combing works. Skilled sorters are seldom employed except to sort mohair. Witness relies on his sense of touch for picking out bloodstains, though he also uses his sight as well. Blood on dark brown or black wools is difficult to see but easy to feel. It is not possible to say what length of training is necessary to make men expert in detection of bloodstains. One man might learn in a week, another in a month, and some will never learn. The average warehouseman should be able to acquire the necessary skill in two to four weeks. Witness became expert in three to four weeks.

In some works dangerous wools are not always being combed. Untrained men frequently have to be engaged, in those periods when dangerous wools

"W R." (W)—*continued.*

are being combed, and taught the characteristics of blood. Efficient sorting out of bloodstains can only be ensured by regular employment of trained hands. Casual men, who may be discharged at any moment, have no interest in acquiring and maintaining efficiency. Warehousemen are paid by the hour, and some firms allow any time necessary for the removal of bloodstains, while others cause this work to be hurried in order to keep the machinery supplied. Bloodstains cannot be efficiently removed if the sorting be done quickly, though witness has never known a bale re-sorted to ascertain if this opinion is correct. He quotes his own experience that when pressed to get through a lot of wool the tendency is to let it go with no, or only casual, looking over. Witness is, however, of opinion, that even if skilled men are employed, and plenty of time is allowed, it is still impossible to pick out all bloodstains Re-sorting might help, but would not result in removal of all.

Some material can be more easily and quickly sorted than others. It would require three hours to sort an average bale carefully. Loose wool is more difficult to sort than fleeces. Witness very strongly emphasised the fact that he has worked with men who were supposed to be skilled in detection of bloodstains but who, as a mater of fact, could not recognise them. Witness has seen demonstrations of the characteristics of bloodstains, and thinks they are valuable. (3329–82, 3427–502, 3512–4, 3526–39, 3546–60, 3578–92, 3626–41, 3646–61.)

"F. J." (W): Witness understands the term "men skilled in judging the condition of material" to mean skilled sorters who have served an apprenticeship in sorting. Witness can recognise "damaged wool," "fallen fleeces," and "bloodclots." Both sight and touch are necessary for detection of the last, which are hard matted masses very difficult to see in dark coloured wool. He learned how to detect them by demonstrations made by Dr. Eurich after which very little more was required. An ordinary unskilled man should be able to acquire the knowledge and skill in a week or two if taught in the same way. It is not necessary to employ skilled sorters to pick out bloodstains only. Trained warehousemen can do it. It is not possible, however, to pick out all bloodstains, no matter what time is allowed and skill exercised, but the greater the time allowed for doing it the more nearly perfection will be approached. The wages paid at present do not permit of sufficient care being exercised.

Efficient removal of bloodstains can only be ensured by employment of men trained to do it, and by allowance of sufficient time for sorting. It is more difficult to find them in loose wool than in fleeces. Wools sorted by skilled sorters (packmen) are always looked over subsequently by another sorter (a day man), who serves as a check on removal of bloodstains. A permanent collection of bloodstains kept in the factory to which sorters could refer would be valuable. No means exist for testing the knowledge of men removing bloodstains, and the only possible means is by giving a man wool containing known bloodstains to sort, and observing how he does it. It would be costly to have general re-sorting and, in practice, the conscientiousness and sharpness of each man will have to be trusted. (4763–81, 4830–903, 4919–21, 4943–4, 4990–5, 5007–14.)

"C. W." (W): Witness remembers when skilled sorters did not know with certainty which were fallen fleeces and which not. There is better knowledge now. He is able to detect bloodstains and principally does this by sight, though, if he feels anything hard and bulky, he examines it. He was taught by means of a demonstration made by Dr. Eurich. Any ordinary person can, in this way, learn the characteristics of bloodstains in an hour or two. It is very difficult, if not impossible, to remove all bloodstains from wool, but at present many are missed for want of time to search thoroughly. The present rate of wages does not permit of a thorough search, and this applies to both day men and packmen. He has found bloodstains in material previously sorted by a

"C. W." (W)—*continued.*

packman and then by a day man. An unskilled warehouseman can be taught to recognise bloodstains and it is not necessary to employ skilled sorters solely to remove bloodstains. A skilled sorter may be so pre-occupied in separating the wool into qualities as to miss bloodstains. (5076–89, 5140–72, 5225–48, 5257–60, 5269–81, 5320–5, 5331–7.)

"A" (Skilled Sorter): Witness has no experience of, and could not pick out, skin material mixed with fleece material, but has no doubt that if shown skin material he could then recognise it and separate it from fleece material. (8794–804.)

Mrs. "C." (W): Witness is not a skilled sorter, but is able to recognise bloodstains, and is employed to remove them from wool. She does not know what skin wool is, and could not separate it, or wool removed from a dead animal, from fleece wool. (8927–42.)

Six Skilled Sorters and Foreman (W): Witnesses are employed principally in sorting Persian wool and Russian camel hair into qualities. They also remove bloodstains, and include under that head anything doubtful, and all dung. They are allowed any time necessary, and are instructed to remove everything suspicious. A bale of Persian wool (2–2½ cwts., fleeces) takes two to three hours, and a bale of camel hair (2–4 cwts., loose material) takes five to six hours for sorting. They are paid a rate per bale or per pack for sorting, and 6*d*. per lb. for all material removed as bloodstains. The work of removing bloodstains is adequately remunerated, so that they have no need to hurry. They are strongly of opinion that they remove substantially all bloodstains from the material, but that it is not possible to remove all. They cannot explain cases of anthrax which have occurred in manipulation of wool they have sorted. They understand what skin material is, and find both skin and skin locks among fleeces. These could be picked out if necessary. The bloodstains in these are small and the skin locks are often limy. It is more difficult to separate bloodstains from locks and loose wool than from fleeces. (9100–93.)

Two Sorters (W): Witnesses were under the impression that skin material is wool with skin attached. They are young sorters, only just out of their apprenticeship and cannot recognise wool removed from a dead animal. (9616–23.)

Foreman and Three Skilled Sorters (W): Witnesses can recognise skin mohair and pick it out when mixed with shorn material even when in very small quantities. Inferior mohair is not necessarily skin mohair, and the latter can be picked out when mixed with inferiors. All skilled sorters can do this, after a year or two of experience. It is distinguished by the way it drops to pieces. Skin material is not more bloodstained than other material. They have learned by demonstrations made by Dr. Eurich how to detect bloodstains. In mohair they are usually small—a few stained staples only. Bloodstains are dried and stiff and may or may not be red, and can be detected both by touch and sight. (9624–79.)

H. Barker (Foreman Sorter): Most skilled sorters can detect and remove skin material from mohair, and all can, if trained to do so, and watched till they are experienced. Witness's employer buys mohair on terms which permit of all skin material being returned to the seller, and it is his duty to go through it and pick out the skin material. It may be short or long, or of good quality or coarse, but all can be detected. It is slipey, will not hang together, and is usually bloodstained, and it can be distinguished from a poor bred fleece which has similar characteristics. Witness thought that the characteristics of skin material were due to chemicals used in removing it from the pelt, and could not say if mohair clipped from the pelt immediately, or soon after death, can be distinguished from fleece mohair. He thought it would have a lifeless appearance. Probably hair removed from the body of a healthy butchered animal, or one dying after a short illness,

H. BARKER (FOREMAN SORTER)—*continued.*

immediately after death could not be distinguished from fleece mohair. (9731–84.)

Placards—Illustrations of Anthrax, &c.

T. M. Legge (O): Witness strongly urges that regulations for manipulation of wool and hair should require—as the horsehair regulations do—the posting up and exhibition in every factory of a placard illustrating pictorially the early stages of the disease of external anthrax. The posting of a notice outlining the precautions which can be taken by workpeople, *e.g.*, keeping the nails short and clean, should also be obligatory. (386–7, 420–2.)

G. A. Taylor (O): A notice containing the address of the medical officer, appointed to examine persons who become ill or develope pimples when working amongst wool, should be posted in every factory. (1886–1901.)

Sir Stewart Stockman (O): The Board of Agriculture issues warning notices to farmers and butchers pointing out the symptoms of anthrax in animals, the precautions to be observed, and their duty when a case occurs. It is not compulsory to have these posted up on any premises. It would be an excellent thing if this were required by regulation and if coloured illustrations of anthrax pustules in various stages were also exhibited. Witness appeared in doubt as to which is the proper authority to require and enforce this—the Board of Agriculture, the Local Government Board, the Home Office, or the local authority. (10,000–2, 10,239–46, 10,360–6.)

F. W. Eurich (P): Witness drew attention to the placard illustrations of anthrax pustules, and criticised them severely. He pointed out that they show the disease at too advanced a stage, and quoted cases where persons with anthrax pustules did not seek medical advice because the appearance did not correspond with that of the illustrations. He also quoted cases where medical advice had been sought as a result of persons seeing the illustrations. He thinks the idea of exhibiting illustrations is good, but they should show the earlier stages and also aberrant forms of the disease, which are very common. The precautionary notices should also be improved, as they are at present in small print and appear unimportant. These notices should be exhibited, but witness strongly urged that verbal instruction as to symptoms and precautions should also be given because even when the attention of workers is called to notices posted up they are frequently not read, or are read only partially. (535, 539, 936–8, 974–7.)

W. Mitchell (P): Witness thinks the placard illustration of anthrax pustules at present exhibited in factories shows the local condition at too late a stage, and indicates too great an inflammatory reaction It is misleading, and workers seeing it are inclined to ignore small things. He quoted a recent case where the pustule was much bigger than those illustrated, but not nearly so inflamed. Exhibition of illustrations should be compulsory, but they should show the disease in its earlier stages. Anthrax pustules in the early stages are all very much alike, but develope differently. The illustrations should show a small pimple and not a big inflammatory area, though the latter might also be shown as indicating what may happen if the pimple be neglected. (7266–9, 7364–82.)

"B. A." (W): Witness has seen the placard, illustrating anthrax pustules, posted up in the works. He contracted external anthrax, but the pustule did not resemble those illustrated—it never got so far. The placard assists in warning workers of the consequences of neglect but it has a terrifying effect, and is not really helpful. Witness has read the regulations and also the precautionary notices, and has seen other men reading them, though he thinks some do not look at them. He thinks the more notices there are posted up the more likely they are to be read. (2323–8, 2704–16.)

T. Larkin (W): Witness developed an anthrax pustule, but had not seen, and has not since seen, the illustrations which he is told are posted up in the works, though he has worked there several years since his illness. He has read the regulations, but did not do so till after he had recovered. He thinks it desirable that every worker should be given a copy of the regulations. He has seen notices warning workers to report pimples or illness, and had read one before he contracted anthrax, though he did not obey it. (3056–68, 3096–101, 3220–8.

"W. R." (W): Witness has read the regulations but has never seen illustrations of anthrax posted up in the works where he is employed. Probably no one reads the regulations entirely, but he and other men read those particularly applicable to their own work. Probably men would read the whole if they had copies given to them. (3593, 3622–3, 3644–5.)

"S. J." (W): Witness contracted anthrax in the form of a pustule which did not resemble those illustrated in notices posted in the factory, and he thought it was not anthrax. The regulations are posted in the factory, but witness has not read them because they are posted too high to be legible. They should be put on the door so that everyone can see them as they come in, though it is not necessary to have copies in every room. He has seen and read notices that bloodstains are to be picked out and given to the foreman. (3864–6, 3989–4004, 4040–6, 4161–71, 4184–5, 4206–7.)

"C. W." (W): Witness has seen the placard, showing illustrations of anthrax pustules, and the regulations for wool sorting posted in works, and has read the latter. He has never seen them put in positions where they cannot easily be seen and read. (5261–8.)

Register—(*a*) of Materials; (*b*) of possibly Infected Materials; (*c*) of Persons Employed; (*d*) of Persons absent from Employment through Illness.

T. M. Legge (O): In factories where horsehair is used, the occupier is required to keep a register showing details relating to the material used. No difficulty has been observed, and witness thinks there should be a similar requirement in factories where wool is manipulated. (*See* Regulations—Administration.) (257–65.)

Under existing regulations it is impossible to enforce the efficient removal of possibly infected material, as no record of that removed is required to be kept. Witness thinks that a record of all material sorted out as being possibly infected (bloodstains, &c.) should be kept in every factory where wool is manipulated. (294–307.)

G. A. Taylor (O): In order to enable H.M. Inspectors to know, at the time visits are made, what materials are used in factories, every occupier of a factory in which wool or hair, whether scheduled or not, is manipulated should be required to keep a register showing the kind and amount of each variety of wool, hair, noils, or bye-products used, the country of origin, and the quality of the material, the names of persons engaged in sorting out possibly infected materials, the quantity sorted, and the amount of possibly infected materials removed by each sorter. The register should be kept in the factory, should contain no other matter, and the entries should be made as the material is used. The occupier can always find out the country of origin of raw wool, but there may be difficulties in the case of bye-products, *e.g.*, noils from blended materials.

Witness bases these suggestions on observations made when visiting works in all parts of the country, and on the difficulties of satisfactory inspection for the purpose of preventing anthrax in the absence of such a record. A record of the quality of the material is necessary because lower qualities are more frequently infected than better qualities. If an occupier uses one variety of material only, *e.g.*, English or Colonial wool, it would be sufficient if a general statement were entered in the register, but Commission Combers and occupiers using bye-products only should be required to enter in detail particulars of

G. A. TAYLOR (O)—*continued.*

all lots of material manipulated, whether they are English or Colonial or more dangerous varieties. If, however, a Commission Comber can only comb certain varieties because his machinery is unsuitable for other varieties, he should be permitted to make a general statement if he gives reasons. Witness quoted cases where scheduled wools had been manipulated in factories where non-scheduled wools only are usually combed. Small lots of wool might come into a Commission Combing works late in the day and be combed during the night. The necessary entries should then be made in the register next day.

Any person who deliberately sends material for combing under a false name should be liable to penalites. Witness was strongly opposed to the acceptance of verbal assurances that no scheduled material is used in any factory, and bases his opposition on cases where he himself has been misled by such verbal statements. It is not always possible for an inspector to see, or to recognise, materials in process of manufacture, but a register would give him the facts at once.

The object of requiring entries of the sorter's name, quantity of wool sorted, and infected material removed, is for the purpose (1) of ensuring the employment of trained men only, and (2) of checking the efficiency of sorting by comparison of the quantities sorted, and amounts of possibly infected material removed by various men. The comparison would have to be made over a considerable time, as an individual might have a run of difficult bales, or conversely, and reasonable allowance for this and for differing capacities must be made.

Witness also suggests the keeping in every factory of a health register, containing the names and addresses of all persons manipulating dangerous wool, the dates of absence due to illness, the nature of illness, and the date and result of medical examination. The object aimed at is to secure prompt medical attention by an appointed medical officer for the purpose of ensuring early diagnosis of anthrax. (*See* Addresses—Medical Examination.) In the case of absence of an operative from work, the occupier should be required to make enquiries as to the cause of absence, and to enter the result in the register. There may be difficulties due to men taking a day off, but witness refused to accept this as a reason for not keeping the register, on the ground that fatal results often follow delay in securing medical attention. (1135–40, 1154–73, 1209, 1575–83, 1600–18, 1658–61, 1702–4, 1767–9, 1789–1807, 1883–5, 1896–901, 1929–39, 1951–67, 1971, 2030–3, 2049–68.)

F. W. Eurich (P): A comparison of the quantities of bloodstains sorted out of similar materials in different factories would show whether the removal of possibly infected material is being done unsatisfactorily in any factory. The only method of securing control, and of making the comparison, is by requiring every occupier to keep a register showing the materials treated, their quality, and the quantity of bloodstains removed. (923–7, 1051–2.)

W. Mitchell (P): (*See* Address—Medical Examination.) In the small proportion of cases where the patient is too ill to go to witness's surgery for examination, the employers supply the name and address of the patient, and must, presumably, keep a register of addresses of their workpeople. Witness has only rarely had difficulty in finding the address supplied. (7352–9.)

G. H. Feather (E): Occupiers of factories would have no difficulty in keeping a register showing the country of origin of the wool or bye-products (noils, &c.) used. A Commission comber could obtain information as to the origin of wool from the owner; and a user of noils, from the person from whom he buys them. Witness keeps a record of all material sorted, showing the quality—skin wool, fleece wool, locks, &c.—the quantity of bloodstains sorted out, and the proportion of infected samples found. He placed extracts before the Committee, and thinks all persons manipulating possibly dangerous materials should be required to keep such a register. It

G. H. FEATHER (E)—*continued.*

entails a little difficulty and a small cost, but it is highly desirable.

Witness thinks it essential that inquiries should be made as to the cause of absence, or as to illness, of any worker among dangerous materials, and to make this efficient it is necessary to require the keeping of a register of names and addresses of all workers. It might be difficult to keep such a register accurate, because of the movement of workers to new addresses. (4378–83, 4323–51, 4406–7, 4670–6.)

G. Ackroyd (E): A regulation is desirable, if not too inquisitorial, requiring a register to be kept showing the names of sorters, the kind, quality, and quantity of wool sorted by each, and the quantity of bloodstains removed by each. This would, not, however, be necessary in all cases, *e.g.*, in works treating those qualities of mohair which contain little blood. The difficulty of securing efficient removal of bloodstains could probably be surmounted by requiring the keeping of such a register, and witness gave an illustration of the effect of the record obtained. (6941.)

The keeping of a register of names and addresses of all workers with a view to making enquiries as to the cause of absence from work is necessary in some cases. There might be some difficulty in keeping such a register owing to frequent changes of address of workers. Witness has kept a register showing the quantities of bloodstains removed from lots of material but has not kept it in detail. He thinks a detailed record might be an unnecessary labour in many cases, and therefore would prefer to make the keeping of registers a condition of a licence permitting the treating of possibly dangerous material. The register should be kept wherever skin Turkey mohair is dealt with. (6277–9, 6344, 6776, 6792–3, 6851, 6881–7, 6941, 6983–8, 7121–4, 8147–50.)

J. H. Halliday (M): Commission combers would have no difficulty in ascertaining the country of origin of material. When material comes in for combing it is given a lot number and the mark and number of the bale are also entered in registers. By means of the mark and number it is possible to trace the bale right back to the packing centre in the country of origin, though the marks are empirical, have no definite meaning, and are frequently changed. Witness has kept and thinks it should be compulsory to keep a detailed record of the marks of bales, kind, quality, and country of origin of wool, the sorters by whom it is sorted, the amount sorted, and the weight of bloodstains removed by each sorter. This does not involve much labour and is kept posted up by a clerk. He considers that efficient sorting out of bloodstains can only be secured by the keeping of such a register (together with check sorting), which enables one sorter to be compared with another. The keeping of the register should only be required in factories where dangerous materials are manipulated.

The employer should be required to keep a register of names and addresses of the workers so that enquiries as to absence can be made where necessary. (*See* Medical Examination.) The only difficulty is the indifference of the workers, which involves neglect in notifying changes of address. (5653–66, 5863, 5906–22, 6079–104.)

"F. J." (W): Witness knows no objection to regulations requiring occupiers of factories to keep a register showing the country of origin of wool, the names of all sorters and warehousemen and the quantity of bloodstains removed by each sorter. (4904–8.)

"C. W." (W): Witness sees no objection in requiring the keeping of a register showing the names and addresses of all workers, the kind, quality and amount of wool sorted by each, and the quantity of bloodstains sorted out by each. If comparison of the quantity of bloodstains removed were made over a sufficiently long period it would be possible to check inefficient sorting, but witness would prefer a check re-sorting as a more efficient method. (5198–201, 5269–81.)

"**B. A.**" (W): It is possible to keep a record of names and addresses of workers, and to make enquiries as to the cause of absence of workers. This was done in the works where witness was employed. (2702–3.)

Regulations—Administration of.

T. M. Legge (O): Statutory regulations are enforced under provisions of the Factory Act administered by the District Inspectors of Factories and their staffs. The administration of regulations forms a small part only of their duties, though it is expected that factories under regulations will be inspected four times a year. Inspectors are not expected to be able to recognise different varieties of wool though some familiarise themselves with their characteristics. They know the class of business done in any works but, if they cannot recognise different materials, must rely on information from both occupiers and workers (which may be and is sometimes misleading) in deciding whether regulations are applicable to manipulation of any material. The investigation of cases of anthrax occurring among females is carried out by women inspectors who have the same instructions as men inspectors. Probably the inefficiency of their investigations commented on by the Anthrax Investigation Board, was due to imperfect organisation and will be improved. The compulsory keeping of a register (open to inspection) of all materials used in the factory, showing particulars of amount, date of arrival, country of origin, condition (raw or prepared), date and particulars of disinfection, and the name of the person from whom purchased, would remove difficulties in regard to recognition of materials. (*See* Registers.)

Owing to absence of any requirement to notify commencement to use scheduled materials, cases of anthrax have occurred before H.M. Inspectors knew dangerous materials were being handled.

No record is at present required to be kept of "Persons skilled in judging the condition of the material" and there is no definition of this term. An inspector has no means, therefore, of knowing accurately whether any man is, in fact, skilled in accordance with the regulations. The terms "damaged wool," "skin wool," and "fallen fleeces" are not defined, and no record is required to be kept of such materials removed in opening. An inspector cannot therefore detect an infringement of this regulation. The term "properly constructed receptacle" for collection of dust is not defined, and is very unsatisfactory. Inspectors interpret it by consideration of the draught, settling space and amount of dust escaping, but in case of a difference of opinion there is no arbiter except a court. Witness considers four inspections of factories under regulations per year sufficient once every requirement has been complied with. The continued incidence of anthrax is not due to slackness in carrying out regulations but to their inadequacy. (181–2, 255–65, 270–6, 291–6, 349–51, 425–30, 476–7.)

G. A. Taylor (O): In the Bradford district there are about 2,000 factories and 2,000 workshops, and the Factory Act is administered by the district inspector (witness), assisted by one junior inspector, and one inspector's assistant. The woolcombing regulations apply to 38 factories and 10 workshops. The time which can be devoted to inspection of these is comparatively small and they are not all visited four times per year; 133 visits were paid to the 38 factories in 1913, and 94 in 1912. To the 10 workshops, 10 in 1913, and 16 in 1912. One factory was visited 20 times in 1913 and 13 times in 1912. There must be discrimination as to the respective dangers of the factories. The inspections of any individual factory not under regulations average about two in three years.

There are two codes of regulations which aim at preventing danger from anthrax and, in some instances, both codes are in force in the same factory. The regulations are enforced by means of tests of the exhaust and other mechanical arrangements, general inspection of the factory, enquiry and observation of

G. A. TAYLOR (O)—*continued.*

the workers when carrying on their work. Workshops where sorting is done are obliged to put in exhaust and power to drive it, but do not thereby become factories.

There is nothing to compel an occupier to give notice when commencing to use dangerous materials. The occupier would of course be subject to a penalty if the regulations were not observed. Witness ascertains what dangerous wool is being used by enquiry and examination of materials in use and has found cases where scheduled materials were used in factories not officially known to be subject to the regulations and without observing them. Inspectors are not officially expected to be able to recognise the different varieties of materials, but they cannot know what is being used unless they possess this knowledge. It is desirable that they should and some do take steps to acquire it. The acquirement is very difficult and has taken four years in the case of witness. The difficulties in this connection would be largely avoided if every occupier were required to keep in a register (used for no other purpose) a record of the materials he uses, but it is necessary that it be kept in every factory where any kind of wool or hair is manipulated. (*See* Register.) Witness gives reasons for and emphasises the necessity of this.

The difficulties are greater outside than in the Bradford District, *e.g.*, in the heavy woollen and felt industries, owing to the great variety in the materials used and the fact that material is bought, simply because it is suitable, without knowledge as to responsibilities attaching to its use and sometimes without knowledge of what is bought.

Witness has visited factories using wool in different parts of the country and gave instances of irregularities observed. In districts where the manipulation of wool is a subsidiary industry, the District Inspector has necessarily less knowledge of the peculiarities of the trade and the regulations are less well observed than in Bradford. It is desirable that Inspectors in these districts should be advised by an Inspector possessing the necessary knowledge. One Inspector could not possibly inspect all the works in the country in which wool is used. Inspectors should have power to take samples of materials and submit them to a referee whether or not there is a difference of opinion as to any variety. It is not desirable to appoint as Inspectors persons with special knowledge of the wool trade solely to examine the varieties of material used, but it is desirable that Inspectors should be able to recognise the different varieties. In every factory there should be kept a register containing (1) the names and addresses of all persons employed; (2) the names of those absent ill, details of illness and the date of attendance by an appointed doctor; (3) the names of all persons who sort out bloodstains; (4) the quantity of material sorted and of bloodstains sorted out by each person. These particulars are administratively necessary for the enforcement of the suggestions that (1) any person absent from illness shall be examined by an appointed doctor; (2) the persons sorting out bloodstains shall be skilled in their recognition; (3) sorting out of bloodstains shall be effectively done. From the point of view of administration, the appointed doctor should be under the control of the Factory Department.

The operatives should be required to observe regulations as well as occupiers. The occupiers must enforce the regulations in their factories, but if they fail after doing all they can the Inspector would then step in. Witness has heard it said that employers know when the Inspector is going to visit their factory, but it is usually untrue. (1081–139, 1154–8, 1176–9, 1543–7, 1556–9, 1576–83 1592–612, 1661, 1669–70, 1691–4, 1708–11, 1718–20, 1770–5, 1864–72, 1912–5, 1951–67.)

W. S. Smith (O): Witness holds the appointment in the Factory Department of Inspector of Dangerous Trades and his duties are (1) the supervision of the administration of the codes of regulations for dangerous trades; and (2) advising the inspecting staff generally in technical matters. It is usual to decide whether or not the air is dusty in any process

W. S. SMITH (O)—*continued.*

by making use of physical organs—the eyes, nose, and tongue—and by observing whether dust is deposited on clothing, on a notebook, or on fixed objects. Use of the physical senses leaves, however, considerable scope for the personal factor, and some Inspectors are stringent and others lenient. Apart from regulations, amelioration of dusty conditions can be secured by enforcing sections 1 and 74 of the Factory Act. It is better, however, to schedule dusty processes, and to prescribe standards of exhaust ventilation by regulations in order to secure uniform administration. Exhaust plants when badly constructed, require more power and are more expensive in upkeep than a properly designed plant, but it is not the duty of Inspectors to point this out if the standard required by regulations is attained. The standard is properly prescribed by regulations, but the method of attaining that standard should be left to occupiers.

Exhaust systems are tested by means of an anemometer, placed at some point at which air enters the system and from the reading of the instrument the quantity of air passing in at that point can be calculated. A method of test sometimes used at present is unsatisfactory, and the point and method of test should be prescribed by regulations.

The effectiveness of a dust collector can only be accurately determined by determinations of dust in air issuing from it, but this is very difficult. Inspectors can, however, usually judge by the accumulations of or absence of dust near the outlet. In the event of an exhaust system or dust collector not complying with the regulations, the Inspector would usually send a notice pointing out the contravention, but giving no details of the defective construction which causes it. Witness thinks it would be better if Inspectors would examine systems carefully and point out their defects. The standard of exhaust prescribed by the present regulations requires a certain volume of air to be drawn through sorting screens per minute. It is, however, administratively easier to enforce a standard of velocity at a particular point over a prescribed area, and this also usually ensures a more effective exhaust.

Grave difficulties arise in the enforcement of regulations when terms are not clearly defined. Thus, the terms "suitable air inlets," "willowing," "properly constructed receptacles" in the existing regulations are not defined, and "willowing" is used to describe two distinct processes in different branches of the wool trade. Care should, therefore, be taken to define or prescribe the meaning of all trade terms and other expressions of this kind used in regulations.

Visits of Inspectors to works can only be paid at long intervals. Witness, therefore, suggests a system of self inspection of works. (*See* Self Inspection.) Witness thought a standard prescribing the amount of dust which might be allowed to remain in wool or be allowed in the air is too difficult to administer. (7410, 7423, 7436–40, 7446–53, 7490–6, 7534, 7542–5, 7587–99, 7621–8, 7709, 7717, 7792–5, 7819–23, 7854–60, 7875–8.)

W. Mitchell (P): It is desirable for administrative reasons that the appointment of a doctor, whose duty is to examine persons who become ill when manipulating dangerous materials, should be under the control of the Factory Department rather than private employers. Difficulties arise between the doctor and private employers, and also because of professional etiquette where the appointment is not official. (7238–53.)

G. Ackroyd (E): The efficient sorting out of bloodstains, the allowance of sufficient time for doing this, and the employment of men skilled in their detection, cannot be administratively ensured, but witness suggests that licensing of factories combing very dangerous materials might have this effect. Certain methods adopted by witness in dealing with dangerous materials have been objected to by H.M. Inspectors, who were supported by the Home Office. The Anthrax Investigation Board, on the other hand, thought these methods (or some of them) justified. Provided the object aimed at be attained, witness suggests that occupiers should not be compelled to

G. ACKROYD (E)—*continued.*

observe exactly all the regulations. General safeguards only should be enforced. (*See* Regulations—Elasticity of.) It is advisable from an administrative point of view to require every person to notify H.M. Inspector when commencing to use dangerous materials; and to keep a register of the materials he uses if not too inquisitorial. Witness is, however, at variance with the idea that efficient sorting out of bloodstains, time allowed for it, and other matters should depend on administration. (*See* Licensing.)

If no cases of anthrax occurred in a particular factory, certain regulations should not be enforced. Witness also suggests that if he wanted to do something which, in his opinion, might decrease anthrax, but which was contrary to regulations, he ought to be allowed to try it and, meanwhile, be exempt from regulations. If any difference arose between the factory inspector and himself as to whether what he proposed was likely to prevent anthrax, the matter should be referred for decision to the Anthrax Investigation Board, or to a Committee of the Bradford Chamber of Commerce. Witness agreed that, in some circumstances, appeals might be frequent, and that what was proposed would, under the suggested arrangement, only be proved inefficient by cases of anthrax occurring. In later evidence witness agreed that the object he had in view might be attained by making regulations apply to all factories where any wool is dealt with and providing for exemption in certain cases under certain conditions, but he pointed out that if regulations are made too general they cease to be effective. (6420–22, 6435–42, 6547–54, 6775–6, 6788–93, 6814–6, 6851–76, 6983–4, 7068–73, 7109–13, 7125–32.)

"F. J." (W): Witness suggests that H.M. Inspectors should visit works under the regulations more frequently. The regulations are neglected in the long intervals between the visits. An inspector can only test the efficiency of a person picking out bloodstains by trying him with some. (4964–7, 4996–7, 5007–14.)

Regulations—Application of. (*See* Regulations—Existing.)

T. M. Legge (O): The regulations controlling wool processes do not apply specifically to all processes in manipulation of dangerous wools, but to certain specified operations and to processes incidental thereto. Cases of anthrax have occurred in processes not specified, *e.g.*, blending, pulling blends, and wool-running, for which the regulations do not prescribe any precautions. The application of the wool-combing code is limited to certain materials specified in a schedule attached to the regulations. Duties are imposed on occupiers and workers. Witness is of opinion that manipulation of bye-products and waste from dangerous materials should be controlled in the same way as manipulation of the raw materials from which they are obtained. (2–3, 15, 249–54, 267, 389.)

G. A. Taylor (O): (*See* Regulations—Administration, and Existing.) The products of combing are tops (the finished product of combing and the raw material of spinners), noils (the short fibre removed in combing, which is raw material for woollen manufacturers), and waste (chiefly from the carding engine). It is held that existing regulations do not apply to these materials, but, in the opinion of witness, all are still dangerous, and cases of anthrax have arisen in the use of each. The manipulation of noils and waste should be controlled by regulations; and in spinning (*i.e.*, use of tops), certain mild regulations, *e.g.*, requiring lavatory accommodation, should apply. The removal of bloodstains is not of itself a sufficient protection for persons handling tops, noils, and waste from dangerous materials. The material is certainly dangerous after it leaves the cardroom, and regulations should apply to the actual combing process.

All places where wool is manipulated, whatever the variety (except merchants' warehouses where sampling solely for purposes of sale is done), should be subject

G. A. TAYLOR (O)—*continued.*

to regulations. But in those where no other materials, except such as are recognised as being free from danger, are used, the only regulations which need be operative are those requiring the keeping a register (*see* Register) and the exhibition of a placard showing illustrations of anthrax, and giving advice as to medical treatment and the need for it. Certain exemptions might be allowed on fixed conditions, *e.g.*, if dusty wool be willowed efficiently there is no need for exhaust on the carding engines. Regulations imposing a duty on occupiers should also impose a corresponding duty on the workers. (1141–56, 1174–5, 1475–83, 1603–30, 1876–82.)

G. H. Feather (E): Witness is of opinion that regulations controlling the manipulation of wool should only apply to those materials named in a schedule attached to the regulations. English and Colonial wool should certainly be free from all regulations, including those requiring the keeping of a register and the exhibition of a placard illustrating the forms anthrax takes. Persons using these materials are not likely to use the more dangerous varieties, on account of the danger of coloured fibres getting among the white and spoiling the product. It is not desirable to apply regulations generally to all foreign wools. Foreign materials like Chile wool, Peruvian wool, and Buenos Ayres wool are clean and free from danger.

The system of having several schedules, dividing materials into classes of varying degrees of danger, should be abolished, and one schedule of materials subject to the whole code should be substituted. Witness suggested that all the materials named in the present three schedules, together with Syrian wool and all goat hair (except chevrette), should be included in one schedule, and the whole code of regulations should apply to manipulation of these materials, but to these materials only. They should, however, apply to every factory or place where they are treated in any way. Different regulations are not necessary for different materials. Witness pointed out that wool blending for sale, and commission and other willowing not carried on as a process of combing, are at present exempt, and cases of anthrax have arisen in these circumstances.

Witness thinks that noils and waste from dangerous wools are free from danger, and their manipulation should not, therefore, be controlled by regulations, which should apply to raw materials only. He also strongly urged that the regulations should apply equally to occupiers and workers, and he was unaware of the fact, which was pointed out, that the existing regulations do so apply. (4373–9, 4482–91, 4631–4, 4677–84.)

G. Ackroyd (E): Witness considers there is now sufficient knowledge of anthrax to warrant changed regulations, but still more information is desirable. Cases of anthrax have occurred in manipulation of both tops and noils, and anthrax has been cultivated from tops. He thinks, however, that there is not much danger from tops, but more from noils. Manipulation of noils should not at present, if ever, be controlled by regulations. He makes the same remark in regard to bye-products from dangerous wools generally, but he also says some suitable regulations might apply, and qualifies that by saying that he thinks many materials may be rendered harmless by careful sorting (for bloodstains), and that then the bye-products would also be harmless. Witness further qualified this by saying that all factories in which bye-products from dangerous wools are used should be registered, and that the application of regulations should depend on circumstances.

Witness divides the possibly infected materials into two classes or schedules—*i.e.*, those which are very dangerous and those slightly dangerous. Those in the first schedule, he thinks, should have bloodstains sorted out over an exhaust screen, and those in the second would be sufficiently freed from danger by looking them over and removing bloodstains during blending. The worsted trade draws its supplies of wool from all parts of the world, and it is possible that materials now regarded as free

G. ACKROYD (E)—*continued.*

from danger may in future become dangerous, that wools now regarded as dangerous may become free from danger, and that new supplies of dangerous materials may be obtained. Several (eight) cases of anthrax have occurred in manipulation of Colonial varieties, &c., and witness believes all wool and hair to be liable to infection (except Algerian wool). Nevertheless, he is against the suggestion that regulations should apply, in the first instance, to all wools and hairs, with provision for exemption for varieties now thought to be free from danger. The regulations should apply only to materials named in schedules which form part of the code. He qualified this, however, by saying that a few simple regulations requiring the exhibition of a placard warning workers as to the dangers and symptoms of anthrax, might apply to factories where only materials thought to be free from danger are treated. His position is that he is afraid that regulations, if made too general, will cease to be effective. (6309, 6643–4, 6767–74, 7093–8, 7107–13, 7124–32, 7158–64.)

J. H. Halliday (M): Card waste and shoddy from infected materials are potentially dangerous, and noils may also carry infection. Nevertheless, witness thinks regulations should not apply to manipulation of these materials, on the ground that the danger is remote. He has known cases of anthrax to arise in manipulation of tops and of noils and of waste, but they have been few.

Witness thinks that Australian and similar wools should be entirely free from any regulations whatever. Cases of anthrax have occurred in their manipulation, but they are so few that the expense of regulations controlling the use of these materials is not justified. (5855–62, 6099–107, 6137–41, 6191–2.)

Regulations—Elasticity of, and Exemption from.

G. A. Taylor (O): Regulations controlling the manipulation of wool cannot be of cast iron form, but must be so framed as to permit of modification according to the risk run.

The regulations should apply to all premises where wool is used, but those factories where Australian wool and similar materials usually free from danger are used, should be exempted from observance of all regulations except those requiring the keeping of a register of materials and the affixing of a placard warning workpeople as to the dangers and symptoms of anthrax. Witness was not in favour of granting to persons using really dangerous materials, exemptions which allow the use of other precautions, *e.g.*, disinfection. Such precautions are at present of too doubtful value to permit of this in his opinion. (1603–12, 1619–25, 1629, 1649–50, 1668–71.)

W. P. Norris (P): The disease of anthrax among animals in Australia is controlled by means of regulations or statutory powers. The practice is to avoid inelastic regulations and to give the responsible officers power to take any necessary measures. These must be within the ambit of the law, which, however, is not too precise to exclude a measure which may be plainly necessary in an emergency. This has worked well and witness gave illustrations. (8400–5.)

G. Ackroyd (E): Witness ascribes the immunity from anthrax in his factory to the practice of removing bloodstained material. He considers that if people adopt this process they should be exempted from the exact observance of other regulations. Provided the object aimed at be attained latitude should be given to firms and different methods of work allowed if there be sufficiency of light, air, and space in the factory. Almost all combers work differently and different precautions may be necessary in each case. Diversity will give experience of what is best. Certain general safeguards should be enforced but the regulations should contain such phrases as "adequate precautions," or "suitable means to prevent," or "as may be necessary adequately to prevent," or "if satisfied that safety is otherwise practically secured," which are used in the electricity regulations. In order to prevent abuse of this latitude each comber should be granted a licence permitting him to comb and this

G. ACKROYD (E)—*continued.*

should be withdrawn when abuses occur. (*See* Licensing.) Witness quotes his own procedure in which he took grave risks and used the method of looking wool over for bloodstains during blending. This was, in the opinion of some well qualified persons, an infringement of regulations, but his evidence is based on the knowledge gained in the process.

An experiment tried by one firm, of using an oil spray for floors instead of sweeping, resulted in prosecution, but should have received official sanction. Where a process is carried on without cases of anthrax arising provision should be made for the exemption from the regulations of that class of factory or process. Provision should be made in the regulations for inclusion of any material which may become dangerous, or exclusion of any material shown to be free from danger. Witness does not agree with the idea that precautions for preventing danger should be enforced by inspectors. Providing precautions are taken everyone should be allowed to take those which suit him best.

There is yet much to learn about anthrax, and the chief inspector of factories should have power to suspend any regulations and issue permits to work under certain conditions. Non-elastic regulations like the existing woolcombing code prevent progress and witness thinks they should be framed on elastic lines as in the electricity regulations. In the event of the occupier and the inspectors failing to agree as to what are adequate precautions there should be provision for appeal to the Anthrax Investigation Board or to a committee of the Bradford Chamber of Commerce. Witness strongly objects to the suggestion of making regulations apply to all materials, and then allowing exemption of materials shown to be free from danger. Materials should be placed in special classes according to their degree of danger, and the regulations should apply to those classes to meet the extent of the danger, *e.g.*, some materials require sorting over an exhaust screen, some are sufficiently safeguarded if bloodstains are removed in blending, while others require both processes.

Occupiers who can show that cases of anthrax do not arise in their factories should be exempted from observance of regulations other than those at present in force or from any regulations if they can show good reason. Everyone ought to be allowed to carry on any process, and be free from regulations, till it is proved to be dangerous. It was pointed out to witness that, so far as electricity is concerned, there are means of testing whether precautions taken are efficient, but as regards anthrax the only test of inefficiency is the occurrence of cases, but he thought this was no reason for not adopting the vague generalities of the electricity regulations.

In evidence on a subsequent day witness stated he had carefully considered the suggestions put to him in questions as to the application of the regulations to all premises where wool or hair is manipulated. He is of opinion that all wool and hair except Algerian wool is infected with anthrax to some extent. He is, therefore, of opinion that it may be desirable to apply the regulations universally, provision being made for the exemption of any factory from the observance of any or all the regulations. Those factories in which materials of very little danger are handled should be exempted from all except a few simple regulations, *e.g.*, all except one requiring the affixing of a warning placard showing the appearance of external anthrax, giving indications of the symptoms of the disease, and pointing out the necessity for immediate medical attention. Other factories should be exempted from the more stringent regulations according to the degree of danger attaching to the material in use, and the work habitually done in the factory. There should also be power to prescribe conditions under which exemption is allowed and to amend the conditions and the exemption. This method would provide for the elasticity witness considers to be necessary, and would attain the same object as the system of licensing he suggested. He outlined regulations which might be imposed, but suggested it should be obligatory on the Home Office to grant a certificate of exemption if requested to do so by the Anthrax Investigation Board or a committee of the Bradford Chamber of Commerce. (6545–55, 6764–73, 6783–5, 6790–3, 6807–17, 6846–76, 6941–59, 7067–73, 7093–8, 7109–39, 8147–9.)

Regulations—Existing. (*See* **Regulations—Administration.**)

T. M. Legge (O): There are two existing codes of regulations in force for the purpose of controlling the incidence of anthrax in wool processes. One, dated December 1905, is known as the Woolcombing and Woolsorting Regulations, and applies to processes of sorting, willeying, washing, combing and carding wool, goat hair and camel hair and processes incidental thereto. This was drawn up by the Home Office after conferences with, and on the recommendation of, the Bradford Chamber of Commerce and the unions representing the workers. The second code is one dated December 1908, which regulates the use of East Indian wool. At the time this was drawn up the Home Office had no proof that anthrax spores exist in East Indian wool, and the fact was strenuously denied by users at a conference held between the Home Office and the users when the suggested regulations were discussed. The use of East Indian wool was certified by the Secretary of State to be dangerous not because it contained anthrax, but on the ground that it is a dusty wool. Since that time anthrax spores have frequently been found in East Indian wool.

The reason for the increase in the incidence of anthrax is partly that cases are now better reported and partly because the existing regulations are unequal to the task of coping with the nature of the disease. All they can do is to tend to minimise the risk. It is a remarkable fact that the report of the Departmental Committee of 1897 lays great stress on anthrax in sorting and very little stress on anthrax in later processes. Anthrax now occurs more frequently in later processes than in the processes before washing, but witness stated he was extremely chary in saying that this is due to the protection afforded by the existing regulations to persons manipulating unwashed wool.

The existing regulations for woolcombing apply to certain specified processes and to processes incidental to them. No specific precautions are required for the incidental processes, but since they cannot be carried on unless the wool has previously been treated in accordance with precautions required, the workers in those processes are to that extent protected.

The existing regulations apply to manipulation of certain kinds of wool only, and these are named in several schedules which form part of the code. Inspectors are not expected to be able to recognise different varieties of wool, but unless they acquire this knowledge they have to rely on statements made to them, which may be misleading.

The present codes impose duties on both occupiers and workpeople. The definition of "opening" given in the woolcombing code was suggested by the Bradford occupiers, and the object is to define the first step preparatory to sorting, and to distinguish it from the mere breaking of the steel bands on the bale. It refers to the opening of the fleeces rather than the opening of the bale, but one merges into the other. (*See* Definitions.)

In the opinion of witness, regulation 1 requires both the opening of the bale and the opening of the fleeces to be done by a man skilled in judging the condition of the material. No man could tell by merely opening the bale whether material is likely to be infected. There is no definition of "man skilled in judging the condition of material." It is an expression analogous to "a competent person" used in Acts of Parliament. Any unskilled person who opens a bale is liable to a penalty under Regulation 17, and any damaged wool observed must be reported to the foreman, and must be damped with disinfectant and washed without being willowed (Regulation 3). The intention underlying the requirements in Regulations 1 and 2 as to steeping of bales was to prevent dust. More recent knowledge indicates that steeping

T. M. Legge (O)—*continued*.

may increase danger in later processes, but witness still thinks the danger in the early processes is decreased by steeping. Certain materials (Van mohair and Persian locks) *must* be steeped, but alternatives are allowed for other materials. The regulations do not prescribe any time during which steeping must be continued.

Regulation 2 provides that certain wools must either be steeped in water before opening, or be opened over an exhaust screen in a room where nothing else is done. This opening clearly means the opening of the fleeces after the bale has been opened. The exhaust screens are required for the purpose of preventing dust, and dimensions of screen and velocity of draught are prescribed. Witness thinks the prescribed velocity of draught, and the fact that there are no prescribed details of construction of the screen, to be unsatisfactory. The prohibition of other work in the opening room is a precaution against dust diffusion, but it may have the effect of causing hurried and careless work where sorters have to open their own fleeces.

Damaged wool, fallen fleeces, and skin wool are required to be damped with disinfectant when opened (Regulation 3), but, as a matter of fact, they are never picked out in opening. There is no definition of these terms, but such materials are more likely to be infected than fleece wool. It is the duty of the occupier to see that this regulation is observed. An Inspector cannot, however, say whether it is being carried out, unless he sees these materials removed, as no record of their removal is required to be kept. Damping with disinfectant is usually done with a watering can and is useless. After damping with disinfectant, the wool goes through the ordinary processes, and is still dangerous if originally infected. The regulations do not require any specific search to be made for damaged wool, fallen fleeces, skin wool, or infected materials. The duty of reporting it, if observed, is placed on the worker, who may or may not be skilled.

Regulation 4 prohibits the sorting of any material named in Schedules B and C, except over an exhaust screen, and details of construction, size and exhaust draught are prescribed. The sorting referred to is a manufacturing process of separating the wool into qualities and is not a search for possibly infected materials. The regulation does not require wool to be sorted, and it prohibits sorting of Van mohair, and Persian locks unless damp and after washing, and of damaged wool, except after washing. The washing prescribed increases the danger in the event of the wool being originally infected. The requirement of the use of exhaust screens in sorting is for the purpose of preventing the breathing by sorters of possibly infected dust.

Dust may be removed from wool by willowing. This is not required by the existing code, but if it be done Regulation 5 prescribes that it must be done in a certain way in a room where no other work is done.

Regulation 6 prohibits the storing of wool in a sorting room, but "storing" is not defined. This, and Regulation 7, requiring a certain cubic space per person working in a sorting room, are precautions against danger of infection from dust.

Witness knows no reason why Regulation 8 should require air inlets for sorting, willowing and combing rooms and not for other rooms. The regulations are inconsistent on the question of ventilation, and this needs enquiry.

Regulation 9, requiring wool bags to be picked clean and not brushed, is a precaution against dust. Pieces of skin, scab, clippings and shearlings are removed in sorting, and the requirement of Regulation 10 that they shall be removed daily and destroyed or disinfected is a precaution against the possibility of the conveyance of infection by these materials.

Regulation 11 requires dust from the exhaust systems to be collected in "properly constructed receptacles." This term is not defined, and is very unsatisfactory, as there is no arbiter, except a law court, in the event of a difference of opinion between occupiers and inspectors as to what constitutes a properly constructed receptacle. The object is to prevent discharge of possibly infected dust into the open air which might possibly cause infection of persons, animals and fields. Provision is made for cleaning exhaust screens and systems and removal of dust from the collectors. This cleaning is usually done with a brush which is very unsatisfactory and dangerous. Automatically self-cleaning dust collectors are now available.

The provision of overalls and respirators for, and the wearing of them by, men cleaning out dust collectors is required. The taking of them out of the works or warehouse is prohibited, unless they have been steeped overnight in boiling water or a disinfectant, but this treatment is not required if the overalls are kept in the works. No provision is required for their storage. The object of requiring wearing of overalls is to prevent contamination of clothing. Wearing of respirators over long periods is impossible, but for short operations their use is possible and desirable. It is essential that respirators should be kept clean and in order, otherwise they are a danger. The provision of overalls for men working in other processes is not required, but the men working in rooms where unwashed wool is manipulated must wear overalls (Regulation 21), though there is no regulation requiring their provision, maintenance, cleansing or disinfection. It might be desirable to require the provision and wearing of overalls in other processes, but witness would prefer regulations which so improved conditions as to make the wearing of overalls unnecessary.

Regulation 12 requires the floors of opening, sorting and willowing rooms to be sprinkled with disinfectant and then swept daily. These are rooms where raw materials are manipulated, but the floors of other rooms get equally dirty, and should be included in the scope of the regulation. The same remark applies to Regulation 13, requiring half-yearly cleansing and yearly limewashing of these rooms. There seems to be no particular reason for selecting these rooms for cleansing rather than requiring it for all rooms in which dangerous wools are manipulated. The word cleansed was intentionally used to allow alternatives to sweeping, *e.g.*, vacuum cleaning. Witness considers sweeping extremely dusty and dangerous.

Regulation 14 requires provision for persons employed in rooms where unwashed wool is manipulated of (*a*) prescribed washing accommodation; (*b*) suitable means for storing clothing removed during working hours; and (*c*) suitable meal rooms. It also prohibits (1) taking of food in these rooms; and (2) the employment in them of any person having an open cut or sore. The reason for requiring washing conveniences is because anthrax spores may lodge on the hands or under the nails; that for requiring (*b*) and (1) and (2) is to prevent deposition of dust or spores on outdoor clothing, food or wounds. The prohibition of eating food is extended to rooms where wool is carded or stored, and this followed a recommendation of a coroner's jury. These precautions are probably most necessary in rooms where unwashed wool is manipulated, but they are also necessary in rooms used for processes in treatment of washed wool.

Regulation 15 requires provision of requisites for treating slight wounds, but witness thinks some form of first-aid equipment should be required. (39–58, 79–80, 169–71, 181–2, 202–4, 249–485.)

G. A. Taylor (O): There are two existing codes of regulations which apply to the manipulation of certain raw materials. In some factories both codes are in operation. The regulations apply only to manipulation of those materials named in the schedules. The existing regulations are not adequate for dealing with the danger of anthrax, *e.g.*, they require the sorting screen to be so constructed as to permit of dust collecting under the screen being swept into the exhaust, but they do not actually require the dust to be swept into it, and there is no definition of terms used, *e.g.*, "damaged wool," "fallen fleeces," "skin wool," "properly constructed receptacle," &c. A

G. A. TAYLOR (O)—*continued.*

man "not skilled in judging condition of material" is prohibited from opening bales of wool, but there is no definition of the term used, and there is no indication of what condition he has to judge, nor, except by inference, what object is in view in judging the condition. It would be impossible, for example, to prosecute a man who was unable to recognise blood-stains, if engaged in opening bales. A man who buys and uses sorted wool, or partly treated wool, or by-products from scheduled materials, is held to be exempt from the regulations, because he is not using raw wool, but the danger is still present. (1100–26, 1592–9, 1644, 1651–4, 1702–5, 2007–20.)

W. S. Smith (O): The existing regulations require precautions to be adopted for preventing dusty conditions by provision of exhaust in specified processes—opening, sorting, and willowing; and generally by steeping of unopened bales of certain materials. There are many other dusty processes (blending, pulling, carding, &c.) which are not referred to at all in either of the existing codes. Generally speaking, the existing regulations as to exhaust are well observed, and they are effective so far as they go. Witness, however, suggests alterations both in the requirements as to construction of exhaust plants and of methods of testing their efficiency, with a view to improving conditions in certain classes of factories and for manipulation of certain classes of materials. The steeping of bales required by the regulations might be efficient if it were certain that the centre of the bale became wet, and if the wool remained damp through all subsequent operations, but it does not. On becoming dry it is as dusty as ever, and is additionally dangerous because spores have been spread over the wool in the course of steeping.

The existing regulations also require opening of wool to be done in a separate room. Witness regards this as an unnecessary operation which causes two handlings instead of one, and, therefore, increases the danger, though some materials (*e.g.*, alpaca and East Indian cashmere) must, for manufacturing reasons, be opened in a separate room. Witness is of opinion that the requirements of Regulation 8, as to provision of air inlets, should be extended to other rooms and processes in addition to those named. Also that undefined terms used in the existing regulations, such as "suitable air inlets," "proper dust collector," &c., cause grave difficulties in administration, owing to difference of opinion as to their meaning. If any such terms be used, their meaning should be clearly defined. (7444–53, 7461–3, 7472–3, 7548–77, 7598–9, 7605, 7672–6.)

Sir S. Stockman (O): The Board of Agriculture has issued an order (the Anthrax Order) imposing regulations for controlling anthrax among animals in Great Britain. This is administered and enforced by the local authorities. The owner of any animal found to be suffering from anthrax, and any veterinary surgeon who observes a case, is required to notify the fact to the police. The symptoms of the disease and the regulations are brought to the notice of owners of animals by pamphlets, and by publishing them. The owner of an animal suffering from anthrax, pending action by local authorities, is required to prevent access of other animals or fowls to it, or to any part of the premises which have been exposed to infection; to detain any diseased or suspected animal and any other animal in contact with it, or exposed to possible infection, and to disinfect any part of the premises where the diseased animal has lain, or where its blood has escaped.

On receipt of the notice the local authority is required to send an inspector, and if the inspector is not able to say definitely that the case is not anthrax, the premises must be put in quarantine and the whole carcase of the animal, including the wool or hair, must be burned or destroyed intact, or be buried in lime. Directions are given as to the disposal of carcases in the Order. The object of the regulations is to prevent the spread of anthrax among animals, but one of the effects is to prevent the possibility, except in rare instances, of infected wool getting into

Sir S. STOCKMAN (O)—*continued.*

commerce. The regulations in practically all civilised countries for prevention of anthrax among animals are very similar. (9986–10,003, 10,032–40, 10,098–111, 10,127–8.)

W. P. Norris (O): In Australia, regulations for prevention and control of anthrax are issued by the stock branch of the Agricultural Department so far as relates to animals and by the Health Department in respect of anthrax among human beings. The Agricultural Department have appointed a number of veterinary surgeons and stock inspectors, and the country police are required to keep watch on and report cases of anthrax which may arise among animals. The regulations, and the symptoms and dangers of anthrax, are brought to the notice of stock owners by Government announcement and by publication in the local and agricultural press and by leaflets and circulars issued direct to them. The regulations require all cases of anthrax to be reported by the owner or controller of the stock to the local police, who then make inquiry as to the facts. The premises are then put in quarantine, an area is defined and nothing is allowed to leave that area. The authorities then supervise everything and, if necessary, enforce preventive inoculation of surviving stock; destruction of the infected or suspected stock, and burning or deep burying of the bodies intact; disinfection of the premises, and burning of the pasture. Advice is also given to abstain from putting stock on to the infected ground for at least 12 months. The co-operation of stockowners is encouraged, and they have come to see that protection from anthrax and rigid control of outbreaks when they occur are in their own interest, but the watch kept by the local police ensures the reporting of outbreaks which, for various reasons, may not be reported by the flock-owner.

The method followed in Australia is to avoid rigid regulations and to give responsible officers power to take any measures necessary in an emergency. These must be within the ambit of the law, but are not precisely defined. The regulations are, however, explicit where possible, *e.g.*, animals suffering from disease must be killed by destruction of the nerve centres and not by blood letting.

For the purpose of preventing fresh introduction of anthrax into Australia there are regulations administered by the Director of Quarantine imposing restrictions on importation of all live animals and all animal products—hides, wool, hair, bones and animal manures. Animals are put into quarantine till all danger is past. Animal products must come from countries free from anthrax, or are liable to compulsory disinfection, or their importation is altogether prohibited, *e.g.*, in the case of bones from India. Notice of the intention to bring them into the country must always be given, they can only enter through certain ports where there is supervision, and they are only admitted in quarantine and after a declaration has been made that they did not originate from animals suffering from disease. Any treatment or disinfection must be carried out under official supervision.

There are no trade regulations dealing with prevention of anthrax among human beings in Australia. The principle followed is rather to prevent anthrax among animals in the country and to prevent importation of any materials which may be infected. Factory regulations are therefore unnecessary. (8285, 8345–8, 8369–416, 8460–504, 8511–5.)

F. W. Eurich (P): The ratio of cases of anthrax occuring among persons manipulating washed wool to cases occurring to persons manipulating unwashed wool is greater now than formerly. Witness thinks this is due to the protection afforded by the existing regulations to persons working among unwashed wool. They safeguard the latter but not the former. (890–3, 8726–8.)

G. H. Feather (E): In the opinion of witness the system in the existing regulations of having several schedules with different regulations applying to different materials is undesirable. Instead, there should be one schedule only, and the regulations

G. H. FEATHER (E)—*continued.*

should apply equally to all materials named in the schedule. (4631–4.)

G. Ackroyd (E): Witness assisted in the framing of the existing regulations which, broadly speaking, have not effected any decrease in the incidence of anthrax. At the time they were brought into force there was very little authentic data as to anthrax available, and they were largely based on personal experience and theories more or less plausible. (6296–305.)

J. H. Halliday (M): In opinion of witness, the reason for the higher proportion which the number of cases among workers in processes after washing bears to the total number of cases of anthrax reported now, as compared with the time before regulations were established, is that exhaust arrangements and improvements which have been provided, as required by the existing regulations, protect the persons engaged in processes before washing, but do not directly protect those who manipulate washed wool. (5978–82.)

"B. A." (W): The existing regulations are sufficient to prevent anthrax if they are properly observed. (2148–61, 2174–7, 2198–201, 2442–3, 2580–3, 2593–601.)

T. Larkin (W): The existing regulations are adequate, but witness suggested that dangerous wools ought to be willowed. (3108–12.)

"W. R." (W): The existing regulations are adequate for prevention of anthrax if they are properly observed, but witness suggested improvements in connection with blending and removal of bloodstains. The regulations are not fully observed at present, and witness gave instances in his experiences. The men have to obey orders or they are discharged. (3312–7, 3407–11, 3424–6, 3503–11, 3593–600, 3605–8, 3624–39.)

"S. J." (W): The only alteration in the existing regulations so far as carders are concerned which witness suggests is that washing should be compulsory. (3989–4004, 4172.)

Regulations—Reference of Factory Acts to.

T. M. Legge (O): Power to declare any trade a dangerous trade and to make regulations for controlling it is given to the Secretary of State by section 79 of the Factory Act. (*See* Dangerous Trades.) This section applies also to docks, wharves, quays, and warehouses. Previous to 1901 the Factory Act only gave power to make special rules for individual factories. Regulations differ from special rules in that they apply to trades and not to individual factories, so that an occupier commencing business in a dangerous trade automatically comes under the operation of the regulations. No inspector has power to allow modification of regulations, but in the case of special rules each factory might have different rules.

The Factory Act prescribes that the Secretary of State must bring the regulations he proposes in draft to the notice of those concerned, by publication or otherwise, as he may think fit, and must give time for objections to be made. Any objection must state in writing the regulation or part objected to, the grounds of objection and the omissions, additions or modifications suggested. The Secretary of State must consider all objections and may then modify the draft regulations if he thinks fit. The amended draft is then dealt with as if it were the original draft. If he does not amend the draft regulations he must, before making final regulations (unless the objection is withdrawn or appears to him to be frivolous) appoint a competent person to hold a public enquiry at which witnesses may be examined on oath.

The Secretary of State is not bound to accept the finding or conclusions of the person appointed to hold the enquiry. Hitherto, however, the Secretary of State has accepted the findings as a basis for regulations, but a case might arise at any time in which he did not do so. Any regulations proposed by the Secretary of State as a result of the Departmental Committee's enquiry would be subject to this procedure. The regulations made may apply to all the

T. M. LEGGE (O)—*continued.*

factories and workshops (or docks, wharves, quays and warehouses) in which the manufacture, machinery, plant, process or description of manual labour certified to be dangerous is used, whether existing at the time or afterwards established. They may also provide for exemption of any class of factories or workshops either absolutely or subject to conditions. (2–28, 460–2.)

F. W. Eurich (P): Under the Factory Acts applying to India, the word factory means "any premises wherein or within the precincts of which steam, water or other mechanical power or electrical power is used in aid of any process for or incidental to making, altering, repairing, ornamenting, finishing or otherwise adapting for use, for transport, or for sale any article or part of any article." (713–8.)

G. H. Feather (E): Witness pointed out that he had observed many glaring instances, of which he gave examples, of workers neglecting the observance of regulations and thus defeating the object of the precautions taken. He considered it a fatal defect of the existing regulations that no penalty attaches to workers who contravene regulations. It was pointed out to him that there were penalties, but witness emphasised the fact that he, in common with most employers, was quite unaware of the fact. In consequence the Chairman gave a short summary of the Factory Act in relation to contraventions of any regulation by whomsoever committed.

Section 85 of the Factory Act imposes a penalty, not exceeding 10*l*. for each offence, on any occupier, owner or manager bound to observe any regualtion who acts in contravention of or fails to comply with the regulation. The section also imposes a penalty not exceeding 2*l*. on any person other than the occupier, owner or manager who commits a similar offence, and at the same time one not exceeding 10*l*. on the occupier of the factory in which the offence has been committed unless he proves he has taken all reasonable means to prevent the contravention or non-compliance by publishing, and to the best of his power enforcing, the regulations. Section 86 requires notice, that regulations have been made and of the place where copies may be purchased, to be published in the London, Edinburgh, and Dublin Gazettes. Copies of the regulations must be posted in every factory to which they apply in a position where they can be conveniently read, and a copy must be given by the occupier to any person affected on his or her application. The penalty for non-compliance with this section is 10*l*., and for pulling down, injuring or defacing any regulation the penalty is 5*l*.

Section 140 of the Factory Act provides that where an offence, for which the occupier is liable to a penalty under the Act, has been in fact committed by some agent, servant, workman or other person, that person shall be liable to a like fine as if he were the occupier. Section 141 provides that where the occupier of a factory is charged with an offence which he alleges has been committed by some other person, he may lay an information and have the alleged actual offender brought before the Court at the time appointed for hearing the charge. If, after the commission of the offence has been proved, the occupier proves he has used due diligence to enforce the Act and that the offence was committed without his knowledge, consent or connivance, the other person shall be convicted, and the occupier shall be exempt from any fine.

Section 141 also provides that if it is made to appear to the satisfaction of an inspector at the time of discovering an offence that it has been committed by some person other than the occupier, that the occupier has used all due diligence in enforcing the Act, and that it was committed without his knowledge consent or connivance, and in contravention of his orders, the inspector shall proceed against the person he believes to be the actual offender without first proceeding against the occupier. (4488–92.)

Respirators.

T. M. Legge (O): Witness is of opinion that a respirator cannot be worn continuously by a workman

T. M. Legge (O)—*continued.*

for several hours without interfering with his breathing. When wearing a respirator, deep breaths must be taken and expired air re-breathed, and this makes work more difficult. For short spells of work not exceeding half-an-hour respirators are an efficient protection against inhalation of dust if properly worn. Respirators should be of the simplest type possible, and it is essential they be kept clean and away from possible infection. (467–8.)

F. W. Eurich (P): Witness considers the wearing light and efficient respirators by card grinders and those who work in the vicinity of shoots when the latter are being used should be enforced. (928–30.)

T. Larkin (W): Witness when blending wears a handkerchief tied round his nose and mouth, but it is not an efficient protection against dust, which gets down at the side of the nose. (3087–90.)

"C. W." (W): Wearing of a respirator may be some protection against dust, but is very inconvenient and objectionable, especially in summer. Witness has worn a handkerchief over his mouth and nose, but dust gets down the side of the nose. (5312–4.)

Samples.

G. A. Taylor (O): Any regulations for controlling the incidence of anthrax should give power to H.M. Inspectors to take samples of any materials used on any premises, whether or not there is a difference of opinion between an inspector and some other person. (1176–9.)

F. W. Eurich (P): Witness examined bacteriologically 4,745 samples of wool, hair and dust, and bases his conclusions on the results obtained. The samples were obtained in various ways. Some he collected himself, a greater number were collected by H.M. Inspectors of Factories, but most were sent by occupiers of factories. Most of the samples were sent for examination without any specific object, but some were samples of material in use at the time of the occurrence of a case of anthrax. There has been no definite system of sampling except in a few experiments by Mr. Ackroyd. (565–73, 666, 8710.)

Scouring.

T. M. Legge (O): Witness thinks Mr. Duckering's determinations of dust in the air are important as showing the danger of the washbowl in increasing risk in subsequent processes. (87.)

G. A. Taylor (O): Wool is scoured or washed in water contained in a machine fed by placing the wool on a travelling lattice which conveys it into the water. The wool is pulled in the blending bins and conveyed to the feed end of the washbowl, where it is tipped on to the floor. Feeding a washbowl lattice is a dusty occupation unless the wool has been willowed previously. Witness thinks that exhaust should be provided for the feed lattice of scouring machines. This is done already in some instances. The dust and dirt in the wool cause the water, which is usually changed once, occasionally twice, per day, and sometimes twice in three days, in the scouring bowls to become very muddy and dirty. If infected wool, or wool containing infected bloodclots, be washed, the spores of anthrax are spread over the whole of the wool washed in the same water. The temperature of the water varies from 100° to 140° F., and, after washing, the wool is dried, sometimes on screens in a current of air, and sometimes in special machinery. The temperature near the drying machine is often unduly high, but sometimes this is unavoidable. Witness considers the wool should be sorted for bloodclots and then willowed before it is scoured. (1318–28, 1352–76, 1674–7, 1996–2004.)

W. S. Smith (O): The operation of feeding washbowls with wool is dusty. Unless the wool be willowed before scouring, exhaust ought to be applied to the feed lattice of washbowls. Witness has seen this done. (7743–5.)

F. W. Eurich (P): Scouring is the only stage in the combing of wool at which disinfection could be

F. W. Eurich (E)—*continued.*

carried out conveniently. Some wools, *e.g.*, East Indian wool, are not washed in the course of manufacture into yarn. (908–12,985.)

G. H. Feather (E): Witness is of opinion that it is impossible to remove all dust from wool by washing unless the wool is willowed before washing. (4419.)

G. Ackroyd (E): Feeding the washbowls may be very dusty in the case of some materials. High temperature in scouring rooms by making workers less healthy may conduce to outbreaks of anthrax, but witness considers temperatures up to 90° or 95° to be reasonable. Ventilation of scouring rooms should be efficient and the washbowl feeder should wear loose overalls except in hot weather. Wool can be made free from much dust by efficient scouring, but witness avoided giving a direct answer when asked his opinion as to whether dusty unwillowed wool can be made free from dust by scouring as usually done. (6831–6.)

J. H. Halliday (M): The dust in the air during feeding of a washbowl with willowed Persian wool in the works managed by witness was 40 mgms. per 10 cubic metres of air, while in another works during feeding of the washbowl with similar Persian wool unwillowed it was 11 times as great. The washing water is changed three times per day. The washed wool is dried in a hot air machine. This causes the washouse to become unduly hot unless the ventilation is good. All washouses should be well ventilated. Witness considers that the comparatively high temperature of the scouring room renders the persons employed particularly liable to contract anthrax. He gave illustrations of several cases occurring in his own washouse. More cases occur among persons manipulating wool after it is washed than among those working among unwashed wool. (5734–42, 5773, 5821–34.)

S. Wade (M): Witness was questioned as to the reason for absence of dust in processes after washing in his works as compared with other works where somewhat similar wools are used. He could only say he had washed the dust out in scouring and knew no particular reason why other people could not similarly prevent dust. He does not provide exhaust on the washbowl feed lattice and said the dusty state of the air round this point at the time of the Committee's visit was exceptional. (9227–76.)

C. E. Biggin (M): It is impossible to wash all dust out of wool by scouring. Less dust is caused in subsequent processes where the wool is willowed before it is scoured. (9341–4.)

"B. A." (W): Germicidal liquids are used in the scouring bowls in works known to witness, but this precaution has been ineffective. (2371–83, 2590–2.)

T. Larkin (W): The man who feeds the washbowl also pulls the wool from the blend, and he thus breathes dust. (3182–4.)

"W. R." (W): The treatment of wool in the warm water of the scouring machine, in the opinion of witness, tends to make the anthrax spores more able to cause anthrax among human beings, and this he suggests is the explanation why more cases occur among persons working with washed wool than among persons manipulating unwashed wool. (3554–6, 3657–8.)

"S. J." (W): Scouring of wool is not itself sufficient to prevent dust in processes like carding which follow scouring. There is much less dust in carding if the wool be willowed before it is washed. Moreover, in the opinion of witness, scouring is less efficiently done now than formerly, and more dust is left in the wool, and this he suggested is the explanation of the increase in the incidence of cases of anthrax in processes after washing. More material is washed in a given time with proportionately less care now than formerly. The dust and dirt which remains is removed in carding, and proportionately more dirt and dust collect in the card clothing. In the opinion of witness willowing of dusty wools is to be preferred to washing, unless the wool is both willowed and washed. (3718–24, 3800–4, 3947–57, 4005–12.)

"G. J." (W): (*See* Dusty Processes.) Wool is scoured in a machine consisting of three vessels, each containing water, each having squeezing rollers at the end, and each having mechanism for causing the wool to pass through the water. The machine is fed by placing the wool on a travelling lattice which conveys it into the water of the first vessel.

The water in the washbowl gets very dirty and is changed every morning. It is impossible to remove all the dust from wool by scouring alone. Wool is scoured faster now than formerly, and is therefore less efficiently washed than formerly. More alkali and soap are used in the washbowls now than formerly.

Witness is of opinion that automatic means of conveying the wool from the blending bins into the washbowl are impracticable. Witness has used Sapon for washing wools, but it is unsatisfactory for some. The washhouse attracts flies, and there are many in that in which witness is employed. (5356–88, 5404–43, 5490–510, 5523–35.)

Self-Inspection.

T. M. Legge (O): The use of a form of respirator in certain processes is desirable, but there is danger in its use if not properly taken care of. Discipline and organisation are needed to ensure the proper carrying out of a regulation requiring the use of a respirator. (468.)

W. S. Smith (O): Visits of H.M. Inspectors of Factories to works are only paid at long intervals. In order to ensure the carrying out of the regulations in the intervals between these visits it is desirable to require the organisation of a proper system of self-inspection (*i.e.*, inspection by persons on behalf of the occupier) of works under regulations. In many works in this country and in America (of which instances were given) a voluntary system has been organised by which a person is appointed by the occupier to inspect the arrangements made for safeguarding health and life and limb.

This idea has statutory force in this country in the regulations for controlling the danger of lead poisoning and dust inhalation in potteries. In these a person must be appointed to inspect all departments under regulations and to see that the latter are observed. His name must be recorded in a register kept in the works, and he must be fully conversant with regulations applicable to the departments he inspects. He must keep a book in which he is required to record any breach of regulations or any failure of apparatus (fans, &c.), provided or needed for carrying out the regulations, which he may have observed or had brought to his notice. Accurate extracts must be made from this record weekly, and they must be signed by the occupier of the factory and displayed in the department concerned and in the messroom.

Heads of departments are, of course, in the ordinary way responsible to their employer for the efficiency of their departments and, in a sense, this results in self-inspection. It is, however, defective in that there is no statutory requirement to make the inspection and record the facts observed. (7819–23, 7938–45.)

Standards—Air Inlets.

T. M. Legge (O): Witness was unable to say why, in the present regulations, sorting, willowing, and combing rooms are deemed to require fresh air inlets and other rooms not. (341–2.)

G. A. Taylor (O): Witness has known occasions when tests of the efficiency of an exhaust system, made by placing the anemometer on the surface of a sorting screen, have given results with the windows closed differing from those obtained with the windows open. (1981–95, 2048.)

W. S. Smith (O): Proper fresh air inlets arranged so as to avoid a draught should be provided in all workrooms, and these are specially necessary where there is mechanical ventilation. Their position and size in relation to any exhaust draught or any outlets for air is important. The total area of the inlets should be at least three times the total area of the outlets to the open air or leading from the room to the exhaust system, or to fans or other means by which mechanical ventilation is provided. This relation was found to be necessary to prevent draughts, and was ascertained experimentally by the Departmental Committee which enquired into flax spinning. A smaller proportion resulted in perceptible draughts.

In the opinion of witness, the position of air inlets should be such that a current of fresh air flows from them over the worker. If exhaust or mechanical ventilation be provided, the position should be such that the workers work between the inlets behind them and the exhaust in front of them. Any dust or other impurities are thus swept away, and the workers are working in a slow stream of fresh air. Witness describes as ideal a system established in a Bradford factory, in which the upper portion of the windows is made to open inwards against the edge of a false ceiling leading to the centre of the room behind the men. Escape of air at the sides is prevented by side cheeks and the combination of hopper window and false or hollow ceiling permits a flow of fresh air to the centre of the room, and from thence over the workers to the exhaust system. The total area of the inlets so provided was from four to five times the total area of the outlets of the very powerful exhaust, yet no draught was perceptible.

Regulations should prescribe air inlets for all rooms whether or not exhaust or mechanical ventilation is provided. Standards can be laid down as suggested where there is exhaust or mechanical ventilation, but where there is none it is difficult to fix a standard. Tobin tubes or similar arrangements should be provided, but it is difficult to say more than that the area of the inlets should be ample. In all cases the inlets and outlets should be remote from each other in order to prevent short circuiting, and the inlets should be placed with direct reference to the points at which work is carried on. If this be at the sides of the room, the inlets should be in the centre. If work be done at the centre, they should be at the sides.

Undue lowering of the temperature—say, below 50° F.—can be prevented by warming the incoming air, but it is more important to avoid draughts. Means for preventing lowering of the temperature below 50° F. should be required by regulations, but an unduly low temperature is a variable quantity, since so much depends on the activity required by the work. Witness guarded himself from appearing to recommend the introduction of large volumes of cold air into rooms like combrooms, where a fairly high temperature is necessary from a manufacturing point of view. His evidence was directed to pointing out the relation between inlets and outlets necessary for the avoidance of draughts which, in his experience, are the cause of most complaints of low temperatures. (7497–523, 7774–80, 7786–91, 7838–41, 7922–37.)

"C. W." (W): Witness pointed out that in opening rooms if a window be opened to admit fresh air a kind of dusty whirlwind is caused which whirls the dust about in the air of the room. In order to avoid this, he suggested the advisability of requiring in opening and sorting rooms the provision of air inlets, covered with perforated metal, over the exhaust so that there would be a flow of air downwards to the exhaust screen. (5113–8, 5315–9).

"A" Sorter (W): During an inspection by the Committee, witness was working in a room provided with the air inlets by means of hopper windows and false ceiling described by Mr. W. S. Smith as an ideal system of air inlets. Some were closed and some open. Witness said each worker closed or opened the inlets according to whether he felt the atmosphere to be warm or cold. (8805–12.)

"Six Skilled Sorters" (W): Witnesses pointed out that if the doors of the sorting room where they are employed be opened, the exhaust provided for the sorting screens sometimes caused a flow of dusty air into the sorting room from other parts of the factory. There were no proper air inlets to the room. (9171–4.)

Standards—Cubic Capacity.

T. M. Legge (O): Regulation 7 of the existing code requires provision of a certain cubic space (1,000 cubic feet) per person engaged in sorting. It was probably intended as a means of preventing dust created by one sorter from affecting others. Draughts are also less perceptible in a large than in a small room. (337–40.)

W. S. Smith (O): If bales of wool be allowed to be stored in a sorting room this may interfere with the breathing space of the workers. Witness considers 250 cubic feet per person ample for sorting rooms, but it should be actual space, and any space taken up by materials or fixtures should be excluded in calculating it. (7982–3.)

G. Ackroyd (E): In sorting rooms or where blood-clots are sorted out of wool, there should be a sufficiency of light, air, and space, but witness was not prepared to suggest any standard. (6549–50.)

Standards—Dust Collectors. (*See* (1) Dust—Collection and Disposal of. (2) Regulations—Existing.)

T. M. Legge (O): The expression "properly constructed receptacle for collecting dust" is used in, but is not defined in the existing regulations, and causes difficulties of administration. There are now in existence dust collectors which automatically collect dust in bags and are self-cleaning. They were designed for and can be used in the wool trade. (349–57.)

G. A. Taylor (O): The present regulations require dust, removed from rooms by means of exhaust systems, to be collected in "properly constructed receptacles." This term is not defined, and in the past anything from which dust was not obviously escaping has been accepted as a properly constructed receptacle. This is not enough. Any collector used to separate dust from air extracted by exhaust should be so constructed that it not only separates and prevents the escape of dust, but also allows the deposited dust to be removed without necessity for men to come in contact with it or to enter the collector. In other words, the dust should be automatically removed from the collector, either directly or by means of a worm, into a bag or box which can be removed as a whole. There are collectors at present in use which do this, and the regulations should prescribe not only that dust collectors must be used, but that they must be automatically self-cleaning in such a way that the necessity to enter them will not arise. Exact details should be prescribed. Alternatively provision might be made for allowing dust to be automatically converted into and removed as sludge. (1533–9, 1874–5.)

W. S. Smith (O): (*See* Dust—Collection and Disposal of.) A dust collector is an essential part of every exhaust system. Witness has seen many types of dust collectors in use in connection with wool, including chambers of various sizes, chambers fitted with water sprays, cyclone collectors (metal cylinders into which the dust and air enter at a tangent to the circumference of the cylinder in such a way that the dust separates and is collected at the bottom while the air escapes at the top), bag filters (in which the dust and air are blown into a canvas bag or stocking which allows the air to pass through the material, but retains the dust, and in which mechanical shaking arrangements cause the dust to fall to the bottom where it is collected), a combination of chamber and water tank, water tanks, small dust boxes, and in some cases ordinary house chimneys.

The dust chambers and cyclone collectors were fairly satisfactory if of sufficient size, but sometimes they were too small in relation to the exhaust system and the volume of air discharged into them. The chambers fitted with water sprays, the combination of chamber and water tank, the bag filters, and the water tank were usually excellent. Dust boxes were usually not good, being too small for the work they were expected to do, but in some cases where used with centrifugal fans they were fairly efficient. Use of sewers or of chimneys (unless in connection

W. S. Smith (O)—*continued.*

with a fire) witness considers to be undesirable, apparently in the latter because he considers there is not room for the dust to collect, and it is therefore discharged, without being disinfected, into the open air.

All methods of dust collection are not suitable for every type of fan. A propeller fan is rendered useless by causing it to discharge into a small chamber or into bag filters or cyclone collectors. A large chamber is of no great advantage with a centrifugal fan, but bag filters or cyclone collectors are particularly suitable for this type of fan. Witness gave illustrations of use of wrong combinations and of the resulting effect on the exhaust. He considers any of the dust collectors named suitable for collection of dust in various processes in woolcombing if they be properly used only in connection with a type of fan suitable for the particular type of dust collector. He is of opinion that it is impossible to prescribe exactly the type of collector to be used. Each case must be considered on its merits. Nor is it possible to prescribe relative particulars of the size of the fan and dust collector. If the latter be too small in relation to the fan, or if collectors be improperly used, there will be inefficient working; dust will escape or the draught will be reduced, and in either case this should and would be pointed out by an experienced inspector. Regulations should require dust collectors to be self-cleaning, or that they should convert the dust into sludge before removal. (*See* Cleansing of Exhaust.)

In each type of collector there are essential features of construction which if neglected, as they often are, result in inefficient working. Dust collecting chambers must be of large size, have a large floor area, and one axis should be much longer than another. Thus a tower or chimney having very small floor space is useless, but a long room of large floor area, provided with baffles with the fan at one end and the air escape opening at the other, is excellent. With water sprays a smaller chamber can be used. Cyclone collectors and bag filters must be of large capacity in comparison with the volume of air discharged by the fan. For bag filters an automatic cleaning device is essential to prevent the fabric becoming silted up. Neither cyclone collectors nor bag filters are fit to be placed in a workroom unless completely closed in. Some dust escapes from the best. Witness had not considered the possibility of spontaneous combustion of dust resulting from use of sprays in dust chambers, but thought it likely it might occur. (*See* Definitions.) (7792–813, 7523–40, 7825–9, 7946–55.)

Standards—Dust in Air.

G. A. Taylor (O): A standard as to the amount of dust which should be allowed in the air of any room would be a very good thing. Tests of the air of the rooms could then be used as the means of judging if there be compliance with the rules. At present, the only work done on this question is that of Mr. Duckering. It might be a difficult standard to apply, but there are difficulties in connection with all standards. (1625–8.)

W. S. Smith (O): There must be some line of demarcation between conditions in relation to dust in the air which are innocuous and those which are dangerous, but it is one very difficult to ascertain and define. Inspectors generally judge of the conditions by superficial indication—by the senses—sight, smell, and taste, and by the deposit on one's note book, which is a very good test. These tests leave much to the personal factor, and the result is seen in the variations in the demands of individual inspectors. Tests as to the quantity of dust in the air could be made, and it would be possible to fix a standard based on the method of making these tests. An expert chemist is, however, required, and the method is tedious. Witness thinks we are not sufficiently advanced to adopt such a standard, though he would like to see it in use. For the present, however, he regards it as preferable to lay down standards for the mechanism, exhaust, &c., to be used for preventing dusty conditions and trust to experience that these

W. S. SMITH (O)—*continued.*

will give the results, as to freedom of air from dust, which are desired. (7431–40, 7450–3, 7717, 7764–5, 7854–61, 7875–8.)

Standards—Dust in Wool.

G. A. Taylor (O): In order to control the removal of dust from wool, witness would like to have a standard of cleanliness for wool, so that a test of the wool after willowing would show whether or not it had been willowed sufficiently well to comply with regulations. It might, however, be very difficult to apply. (1625–8.)

W. S. Smith (O): Witness does not think it possible to prescribe the use of any particular machine for removing dust from wool. The machines can usually be set to shake the wool for any required time, and it is frequently observed that the time allowed is too short to ensure removal of all dust. He also thinks it impossible to fix a standard as to the amount of dust which may be left in wool. All that can be done is to require that dust must be removed as far as practicable. Nor does he think it possible to use the method of dust determinations for testing the thorough removal of dust from wool. The administrative difficulties are too great to permit of either suggestion being adopted. It would, of course, be possible, apart from these, to use the test adopted by the Conditioning House for finding the amount of insolubles, &c., in wool. (7710–8, 7854–61, 7875–8, 7971, 7977–80.)

Standards—Exhaust.

T. M. Legge (O): Witness is not satisfied with the exhaust systems used at the present time in woolsorting, &c. The size and velocity of air may be sufficient, but the design is frequently wrong. He does not, however, consider himself sufficiently expert to make recommendations. (38, 285–9, 340, 444–7.)

G. A. Taylor (O): The regulations should prescribe a standard to be observed in connection with every exhaust system, *e.g.*, for opening and sorting, &c. Thus, for sorting, the regulations should prescribe the size of the screen on which sorting is done (he suggests the screen should be not less than 3 feet long and 2 feet deep), that under the whole area of the screen there should be a hopper with sides sloping gradually down into the main exhaust duct, and that the average velocity of the air passing through the whole area of the screen should be not less than 50 linear feet per minute. He strongly condemns the present regulations, which permit a large sorting screen with a tray underneath (which he considers especially objectionable) and a hopper only 10 inches in diameter with a tube of only 2 inches diameter leading to the exhaust duct. The draught should be operative over the whole screen, and the standard prescribed should enforce the provision of a minimum draught at the point at which it is required to be effective, *i.e.*, at the surface of the screen. He would not admit that cases might arise where the standard might be attained, but the exhaust be inefficient in causing removal of dust. His recommendations are made as the result of observation and experience in testing existing exhaust systems. (1248–60, 1286–8, 1637–46, 1945–8, 1972–95, 2007–20, 2069–74.)

W. S. Smith (O): Witness, for the purpose of giving evidence, visited many factories under the existing woolsorting and woolcombing regulations and tested the exhaust systems in use by anemometer. He also made superficial observations as to the quantity of dust in the air when the exhaust was working. He defines an exhaust system for removal of dust from air as a sufficiently good current of air applied by means of ducts and hoods so as to remove dust at the point of production and convey it away to some distance for collection.

Fans, mill chimneys, gas jets, steam jets and pumps may be used for causing a flow of air, but fans are the most generally useful. Of these, propeller fans and centrifugal fans are the only types which should be used—the former where there is no resistance to the flow of air and the latter where a resistance has to be overcome. Propeller fans move large volumes of air with small expenditure of power, but centrifugal fans are more suitable when the dust must be collected. Generally witness found that propeller fans installed in existing systems gave the best results (he examined 12 systems having centrifugal and 11 having propeller fans) in regard to actual draught at the point of production of dust, but there was no difference as far as could be seen in the condition of the air in the rooms. He does not think it possible to prescribe the means or the type of fan to be used for causing a flow of air in exhaust systems. So much depends on the circumstances of each case. Sometimes one and sometimes another method or type of fan has advantages.

Witness described some of the existing systems and pointed out the faults most generally observed—right-angled bends in ducts, avoidable constrictions in ducts, entry of subsidiary ducts into main ducts at right angles, constrictions in the hopper throats made for the purpose of causing equalisation of draught, fans discharging into dust collectors of unsuitable type, ducts small in relation to the size of the fans, absence of air inlets in the rooms, &c. He pointed out that bends should be a smooth curve with a large radius, subsidiary ducts should enter main ducts in a direction almost parallel with the axis of the latter (which causes equalisation of draught), the main duct should have a cross sectional area equal to that of the fan if of the propeller type, and to that of the fan inlet if the fan be of the centrifugal type.

Witness is averse from prescribing standards for these details. They are a question for the occupier and the ventilating engineer. If an occupier chooses to put down a badly designed plant he wastes power, but that is a question entirely for himself. The result desired should certainly be prescribed where possible, but the details of construction by which this result is to be obtained should be left to those concerned. The size and form of air inlets should be prescribed. (*See* Standards—Air Inlets.) A dust collector is an essential part of an exhaust system, but it is not possible to prescribe details of its construction. (*See* Standards—Dust Collectors.) The mechanical efficiency of an exhaust system can be ascertained, in terms of velocity of air or volume of air moved, by tests which witness described.

Opening, sorting, willowing, blending, and pulling, in some instances carding, card cylinder grinding, and card roller grinding, are dusty processes. For opening and sorting, where the conditions are nearly always the same, witness thinks standards should be prescribed for the exhaust systems. In the remaining dusty processes conditions vary so greatly as to make standards impossible. Each case must be judged on its merits.

Witness divides materials into two classes—in one he places those materials it is necessary to open before sorting, and in the other those it is not. He thinks the regulations should require the opening screen, where opening is necessary, to be not less than 10 square feet in area, over the whole of which the draught must be effective, and to have a length and breadth of not less than 3¼ feet. They should also require that, over an area included in a circle of 18 inches radius measured from the centre of the screen, the average velocity of the draught should be not less than 150 linear feet per minute, and that this should be tested by taking anemometer readings on the surface of the screen at the centre and at four other equidistant points in the circumference of this circle. Witness is strongly opposed to measuring the draught in the throat of any exhaust duct, because this gives no idea of the actual efficiency at the point where the draught is required, *i.e.*, on the surface of the screen. The position, form, and size of air inlets should also be prescribed; *i.e.*, the position such that air flows over the opener to the screen, the size three times that of the total area of all the throats to the main exhaust duct, and the form that of hopper windows and false ceiling. (*See* Standards—Air Inlets.)

W. S. Smith (O)—*continued.*

For the purpose of prescribing standards for sorting, witness also divides materials into two classes, the first of which includes all materials sorted minutely, like mohair and alpaca; and the second all materials roughly sorted, or sorted only for bloodstains, like Persian wool. For the first (careful sorting) class, he thinks the regulations should prescribe the use of the following arrangements—(*a*) a sorting screen of open wirework, with a clear space of not less than 1½ inches in depth between it and the work bench, the area of which shall not be less than 6 square feet and its length and breadth not less than 2 feet, (*b*) below the screen and opposite the centre of the working face there should be a funnel, measuring not less than 10 inches across the top, connected with a duct in which an exhaust draught shall be maintained of such a strength as to cause air to pass through the screen over the centre of the funnel at not less than 100 linear feet per minute, (*c*) all dust and refuse falling through the screen must be swept into the funnel or removed by a suction cleaner.

For the second class (rough sorting) he suggests the regulations should prescribe that the materials shall be sorted on an open wirework screen not less than 6 square feet in area and not less than 2 feet in breadth and length, having below it a hopper, of the same area at the top as the screen, connected to a duct in which an exhaust draught is maintained capable of causing air to pass through a circular area of the screen, of 12 inches radius measured from the centre, at the rate of not less than 100 linear feet per minute. His reason for suggesting two types of sorting screen is that in fine sorting small pieces of wool are slowly manipulated over a restricted area, but in rough sorting large masses of wool covering the whole area are roughly and quickly handled.

He found many screens of both types in use which would comply with his proposed standard. The change from the standard of the existing regulations is for the purpose of securing a proper draught at the point where it is required and measuring it at that point. It might be advisable to require the hopper in both cases to measure a certain height from its narrowest to its widest point in order to secure a sufficient slope in the sides. The shallower the hopper the more the draught is concentrated at a particular point. In both types the efficiency should be tested by means of readings of an anemometer placed on the surface of the screen. Currents of air in the room do not appreciably affect the readings of an anemometer placed in this position unless the arrangement of air inlets is defective. The minimum size of subsidiary ducts should be prescribed as 3 inches, but it is either unnecessary or impossible to prescribe other details of the exhaust system. If properly constructed, the ducts should not become choked when débris is swept into the hoppers, and this should be required to be done. The provision of air inlets is necessary in sorting rooms as in opening rooms, and the same requirements should be made as for opening.

It is not possible to prescribe details of exhaust for willowing machines, but the regulations should require all shake willows (not fearnought willows) to be completely closed in and to be provided with exhaust sufficiently efficient to prevent the escape of any dust into the room. In addition the feed and delivery lattices should be provided with exhaust. Air inlets to the room, of area three times the inlet to the exhaust fan, should be required, but their position and form are not very material since wherever placed a current of air would flow to the machine. Dust collectors are necessary in connection with exhaust applied to willowing machines, but details cannot be specified.

An exhaust system should be required for blending and pulling of wool which has not had the dust removed from it. It is not possible to prescribe details because the conditions vary greatly. The difficulties of providing exhaust for blending and pulling are so great as to be almost insuperable.

Provision of exhaust should be required at the feeding lattices where washbowls are fed with unwillowed wool. It is possible to require the cards to be covered and to require the application of exhaust. If dust be ineffectively removed from wool, or if it be insufficiently oiled, then provision of an exhaust system for carding should be required by regulations, but standards are not possible.

The regulations should require the prevention of dusty conditions in cylinder grinding. It ought not to be necessary to fix standards for this unless it is decided to have dust determinations and standards in regard to dust in the air. The regulations should require card roller grinding frames to be completely enclosed and the application of efficient exhaust, together with dust collectors. No standard beyond this requirement is necessary.

There may be cases where an exhaust system is in compliance with standards laid down and yet be ineffective. Witness thinks any difficulty in this respect may be avoided by defining an efficient exhaust draught as "An exhaust draught which effectually removes, as near as possible to the point of origin, the dust generated in the process." Use of the term "exhaust draught" so defined in conjunction with minimum standards would enable increased requirements to be made in the extraordinary cases where the general minimum standard failed to achieve the object desired.

There may be special or new dusty processes in individual works. To meet these cases an omnibus clause should be inserted in the regulations like that in the pottery regulations, *i.e.*, "In all processes the occupier shall, as far as practicable, adopt efficient measures for removal of dust, and for the prevention of any injurious effects arising therefrom."

It may be necessary in rooms where exhaust is provided to have special warming arrangements for heating the air as it passes through the air inlets, which, it is suggested, should be required under the regulations. (7414–22, 7436–7, 7449–547, 7569–696, 7710–74, 7781–95, 7814–23, 7836–41, 7865–74, 7922–37.)

G. Ackroyd (E): Witness thinks the standards fixed in the existing regulations for the exhaust systems for sorting and opening are satisfactory. (6568–70, 6796–7, 6945–59, 7080–5.)

J. H. Halliday (M): In the works managed by witness the exhaust system in use for sorting up to 1905 had funnels only 10 inches across. This system was unsatisfactory, and was replaced by one in which the hoppers below the screen were of the same size as the screen, which had an area of 11 square feet, and the velocity of the draught was very high. Witness thinks the sorting exhaust systems now in use can be improved, and suggests the following standard should be fixed by the regulations: Frontage of screen 3 feet, depth of screen 2 feet 4 inches, area of screen 7 square feet, velocity of draught not less than 50 linear feet per minute over any part of the screen within 6 inches from the centre. He further suggests that opening and sorting should be done together as one operation. (5690–6, 5709–19, 5762–6, 6123–8, 6136, 6184–7.)

C. E. Biggin (M): In the works managed by witness the propeller fan forming part of the sorting and opening exhaust system is 3 feet 6 inches in diameter. It discharges into a long pipe 14 inches in diameter leading to a small dust chamber into which the willow exhaust also discharges. The fan was not effective, and in order to increase its efficiency a relief pipe was taken from the fan through the roof. Some dust escaped through this on to the roof. (9300–17.)

"B. A." (W): Witness regards the existing standard for sorting screens as satisfactory, but in his opinion opening and sorting should be done as one operation, and in addition to the screen and draught now provided there should be a similar screen and draught in the vertical face of the sorting bench in order to remove dust produced in breaking open the bale and removing the fleeces. (2180–6, 2214–8, 2469–89.)

T. Larkin (W): Witness thinks the exhaust systems provided under existing regulations remove dust satisfactorily, but it is impossible to avoid breathing dust in opening. (3305–6.)

"W. R." (W): Witness does not admit that dust is effectively removed by existing exhaust systems. Though a good deal is removed some is breathed during sorting. (3329–36.)

"F. J." (W): Witness thinks that the existing exhaust systems for both opening and sorting would be improved if the hopper below the screen were wider. (4821–6, 4860–2, 4959–62, 4969–72.)

"C. W." (W): The hopper below the sorting screen should be wider than it is at present and the draught should be more powerful in some factories. (*See* Standards—Air Inlets.) (5113–8, 5305–8, 5315–9.)

"A" (W): Witness does not see how the existing standard of exhaust for opening can be improved. (8805–12.)

Foreman and Six Skilled Sorters (W): Prefer the sorting screens they now have to those at the works where they were previously employed. The hoppers of the latter are shallower than those of the former, and thus give a less efficient exhaust. (9171–4.)

Storing Wool.

W. S. Smith (O): Witness sees no reason why bales of wool should not remain in the sorting room while awaiting the result of bacteriological examination. He does not regard this as "storing wool in a sorting room," but the regulation should make clear what is meant by "storing." The possibility of an occupier filling too much of the space of a sorting room with wool should also be guarded against. The free space ought never to be less than 250 cubic feet per person working in the room. (7830–3, 7982–3.)

Temperature.

G. A. Taylor (O): In the rooms in which wool is washed and dried the temperature is often very high. This is to some extent unavoidable. The temperature in carding rooms is also sometimes high. (1371–5, 1840–2.)

W. S. Smith (O): Air inlets are necessary in all workrooms whether there is exhaust or not. If the atmosphere be cold the incoming air should be warmed. Witness regards 50° F. as a reasonable temperature of the air in all rooms where physical work is done. A temperature scale must be elastic. What is a reasonable temperature for certain forms of employment might be undesirable—too high or too low—for another. The great thing is to avoid draughts in all workrooms. Workers who feel a draught complain of cold even though the temperature is higher than in another room, without draughts, of which they do not complain. (7788–91, 7938–41.)

W. Mitchell (P): A high temperature in workrooms conduces to infection from anthrax because it causes perspiration and so renders the skin soft and suitable for growth of spores. Witness cannot suggest what should be regarded as a maximum temperature. (7327–8.)

G. Ackroyd (E): A high temperature is not a healthy working condition. Witness regards 90° to to 95° F. as a reasonable temperature in wool-washing rooms, but says he has not taken much notice of this. (6832–4.)

J. H. Halliday (M): In the works managed by witness, though all the dusty processes preceded scouring, out of a total of 18 cases of anthrax 8 occurred before and 10 after the washing of the material. He thinks the temperature in the scouring room, and in the processes immediately after, favourable to infection. Five cases occurred in these processes. (5821–34.)

T. Larkin (W): Witness got hot and perspired greatly when blending in a bin in which steam was admitted for the purpose of preventing dust. He thinks this condition predisposed him to infection from anthrax, and he contracted the disease. (2950–8.)

"A" (W): In the opening room in which witness is employed air inlets are provided but no heating arrangements. Workers close the inlets if they feel cold and open them when the atmosphere is warm. (8805–12.)

Treatment of Wool.

T. M. Legge (O): Some varieties of wool are treated differently from others in the course of manufacture, *e.g.*, the longer sorts are prepared without carding and the shorter sorts are carded. (266.)

G. A. Taylor (O): Different wools are treated differently in course of manufacture. Some materials like mohair and alpaca are rarely blended. Others, like Persian wool, are usually blended. Mohair is not opened, but alpaca is very carefully shaken open by skilled sorters before sorting. Persian wool is roughly opened and sorted by unskilled men. Opening of alpaca is necessary in order to facilitate sorting—it is a necessary manufacturing operation. Witness regards separate opening of Persian wool as being unnecessary, as it is only done to comply with existing regulations and serves no useful purpose in this respect. It is necessary to open alpaca and materials like East Indian cashmere, which are imported in the form of long twisted ropes, in separate rooms. Some materials are sorted, some are not.

The next operation after sorting is blending, which is usually done in an enclosed space called a bin. Dust is sometimes removed from the wool after blending by means of machines known as willows.

After blending, wool is pulled from the blend and fed into a washbowl in which it is scoured in soap and water at a temperature of 100°–140° F. The wool is dried usually in special machines, and is then conveyed in trucks or blown through tubes into the carding room.

In the cardroom the wool is first oiled either by hand or by machines, and the material is then carded. Carding removes dirt and some short fibre from wool. This is known as card waste, and is afterwards shaken in a shoddy willow and the valuable fibre thus separated from materials of no value.

After being carded wool is combed. The various classes of persons employed in the cardroom after washing are:—woolrunners, card feeders and back end minders, card grinders, card strippers and card jobbers, and in the combroom backwash attendants, gill box attendants, and comb attendants. (1210–95, 1312–474, 1592–9.)

G. Ackroyd (E): Material which comes to witness's works for combing in sheets he presumes to have been sorted. Whether in bales or sheets blending is unnecessary in many cases, and the material is at once thrown down a shoot to the washing machines, a lookout for blood being kept by those opening the bales or sheets. Material requiring blending is similarly thrown down a trapdoor on to a blend. If much blood be found in material not requiring blending it would be blended in order to allow of a more careful search for blood being made. Some materials are also willowed and steeped. All materials are washed and dried before being carded. Alpaca in sheets is sent straight to the washing machine. Alpaca in bales is opened, looked over for blood when being put through the trap on to the blend, sometimes willowed and then washed.

Preparing material after sorting is washed and dried. It is then put through the preparing machines which are large gill boxes. It is next combed, put through finishing machines and is then in the form of a top. (6349, 6365, 6642.)

J. H. Halliday (M): In the works managed by witness the materials go through the following processes in combing in the order named:—opening, sorting, blending, willowing, scouring, oiling and willowing, carding, combing, finishing. (5610–11.)

"W. R." (W): Bales of wool are opened in the opening room over an exhaust screen. The hoops are taken off the bale, the fleeces are put into a truck and removed to the sorting room or, if it is not to be sorted, are opened and put straight down the

"W. R." (W)—*continued.*

trap to the blending bins and washing machines. (3412–5.)

"S. J." (W): Dangerous materials are sorted, blended, washed, dried and then carded. (3680.)

"C. W." (W): Mohair and alpaca are sometimes, but not usually, blended. After sorting, they are usually packed up and taken to the washing machines. (5184–9.)

"G. J." (W): Before being washed wool is blended in a bin, and the material is pulled from this blend. (5345–6.)

Willowing—Removal of Dust from Wool.

T. M. Legge (O): (*See* (1) Blending. (2) Dusty Processes.) The exhaust screens (opening and sorting) do not remove the dust from wool, and the only effective method of doing this is by treatment in a willowing machine. The danger of dust in wool has been referred to repeatedly. The danger of infection was thought to be less in blending materials under the East Indian wool code of regulations than under the woolcombing code owing to the use of dust-extracting machines being more effective in the extraction of dust than exhaust screens. The Anthrax Investigation Board recommended, among other things, that. where sorting is not done, special measures should be taken for removal of dust from the wool. H.M. Inspectors were also instructed to press for use of dust-extracting machines or certain alternatives.

Outbreaks of anthrax in Lancashire and Kilmarnock were attributed to dust from wool in the process of removing it by means of antiquated willowing machines. Mr. Duckering's report on dust in the air in processes of wool manufacture indicated the importance of willowing as a means of preventing dust in blending.

Wool is not required to be willowed under existing regulations, but if it be willowed certain precautions are prescribed. It is desirable to remove dust from wool at the earliest stage possible and that this should be compulsory, but witness was unable to say if manufacturing processes would thereby be affected. It is infinitely preferable to remove dust from wool mechanically than to leave it in the wool and remove it from air by exhaust. The use of some machines for dust removal is dangerous to the workers. (81–3, 85–7, 133, 282, 320–33, 431–5, 480–1.)

G. A. Taylor (O): (*See* Dusty Processes.) The exhaust screens in opening and sorting do not effectively remove dust from wool, and even in the case of alpaca and East Indian cashmere which are violently shaken by hand in opening most of the dust remains in the material. The most effective means of removing dust from wool is by means of willowing machines. These can be so constructed as to prevent danger to the persons working them, but they may cause some damage to long fibred materials, and witness would not say, therefore, that all materials should be willowed. In the opinion of witness all dust should be removed from wool immediately after sorting, since when dusty wool is used all processes after sorting up to and including carding are dusty. If materials be not willowed after sorting then stringent precautions (which witness described) against dust should be required in blending, pulling, washbowl feeding, conveying materials to the card-room, carding, and card stripping and grinding. These would, however, be unnecessary if all the materials be willowed effectively. Witness has seen factories where wool is willowed and others where it is not. The difference in all the later processes as regards dust in the air is remarkable.

Willowing, whether of raw material or of waste, is a dusty process, but precautions can be taken, by enclosing the machine and providing it and the feed lattice with efficient exhaust, &c., to prevent the dust escaping into the air of the room. These precautions should be required for all willowing, whatever its purpose. Witness has known cases of anthrax among persons engaged in willowing waste materials.

Witness cannot see how a practicable standard could be fixed for the effective willowing of materials.

G. A. Taylor (O)—*continued.*

It would be so difficult of application it would break down in practice, whether it took the form of a standard as to the dust which was allowed to remain in the wool or of one as to the dust in the air. He suggests that the utmost which could be required would be that all wool and hair must be effectively willowed.

In some woolcombing factories wool is willowed twice, *i.e.*, before and after washing. Bloodclots should be removed from material before it is willowed. (1243–7, 1306–8, 1318–35, 1346–70, 1382–7, 1396–1404, 1419–22, 1444–72, 1625–8, 1706, 1751–88, 1843–5, 1851–61, 1996–2004.)

W. S. Smith (O): The dust produced in processes of manipulation of wool after the bloodclots have been broken down is likely to be dangerous. This applies especially to willowing, which should be scheduled as a dangerous process. The willowing machines should be required to have efficient exhaust and other arrangements (*e.g.*, be properly enclosed) for preventing a dusty atmosphere, but it is impossible to prescribe definite standards, because the conditions under which willowing is carried on vary so enormously. Witness considers it possible to prevent dusty conditions in many processes by using mechanical means for removal of dust from wool. The dust could be prevented in blending, pulling, feeding the washbowl lattice, carding and grinding card cylinders, by willowing all wool immediately after sorting, and it is desirable that this should be compulsory. If not it will be necessary to require exhaust arrangements for each of these processes, though the difficulties of providing efficient exhaust in blending, pulling and carding are very great.

Witness has seen wool and hair of the highest as well as the lowest qualities willowed immediately after sorting and has heard of no insuperable difficulties or objections. The only objection he has heard is of some loss of fibre, but he has seen effective devices in use for preventing this. The term willowing is not well defined. There are two kinds of willow in use: (1) a shaking machine, consisting of a lattice or quadrant fed cylinder in which a beater revolves which beats the wool and so causes removal of dust, and (2) a fearnought willow, which is a primitive carding machine in which the wool is oiled and opened out preparatory to carding. It is important that a distinction be drawn between the two varieties, only the first of which causes dust.

It is not possible to prescribe the exact type of machine to be used for removal of dust from wool, but witness described the defects he had observed in different machines at present in use, *e.g.*, use of the quadrant feed which allows dust to escape, absence of exhaust draught on feed and delivery lattices of modern willows, use of a paddle fan for causing an exhaust draught, allowing the wool to remain in the machine an insufficient time for effective removal of dust (the last is a fault of manipulation since the time can be varied at will). It is not possible, in witness's opinion, to prescribe standards as to the dust which may be allowed to remain in wool, or to enter the air. All that can be done is to require the wool to be freed from dust as far as practicable. (*See* Standards.)

Dust escapes from the willows principally at the feed and delivery lattices and at the dirt worm exit, and can be prevented by provision of exhaust at these points. Inlets for admission of air into willowing rooms are necessary. (*See* Standards.) The dust removed from willows by the exhaust should be discharged into efficient collectors, but the exact type should not be prescribed. (7422, 7427–9, 7445, 7468–70, 7697–765, 7854–61, 7879–907, 7977–80.)

F. W. Eurich (P): Intimate contact of persons with wool should be avoided in processes like willowing. (928–30, 1011–16.)

H. J. Foster (E): In the factory owned by witness's firm (Messrs. John Foster & Son, Ltd.) all qualities of mohair and alpaca are willowed. The process does not cause any damage whatever to the fibre. Witness was not prepared to say that no willowing machines cause damage to fibre nor that all

H. J. Foster (E)—*continued.*

wool and hair can be willowed without damage. All he can say is that the willows he uses causes no damage whatever to alpaca and mohair. There is a certain loss of short fibre, but the dust is passed through a device by means of which the short fibre is recovered. In order to collect the light dust which escapes from the machines at the point where the material is discharged additional exhaust is fitted over the discharge openings. There is no objection to willowing wool, and witness regards it as a satisfactory process. (8844–83.)

N. Broome (E): Witness uses two forms of willow and all his material passes through each: (1) a shake willow for removing dust, and (2) a tenterhook willow for opening up the material before carding. He has never heard it suggested that the former causes damage to fibre, and cannot see how it could possibly do so. The latter tends to break the fibre and may thus be damaging. The exhaust arrangements on willows are generally unsatisfactory. In his willow room the atmosphere was formerly very dusty, but he has prevented this by providing an additional exhaust at the point where the material is discharged and by providing a sloping grill on to which the material falls as it leaves the willow. (10,383–93.)

G. H. Feather (E): Unless wool be willowed, dust will arise in processes of manufacture after washing, however often the washing water be changed. The object of willowing is the removal of dust and dirt from the wool. It is essential to prevent a dusty atmosphere in every process, and any failure to remove dust from wool will result in a dusty atmosphere in the cardroom. Witness has not experience of all

J. Campbell (M)—*continued.*

materials, but he thinks if a proper willow be employed there should be no damage. There might be practical difficulties as to space for the machines if willowing of all materials immediately after sorting were required. (4253–5, 4413–22, 4525.)

G. Ackroyd (E): Witness willows some of the materials sent to him for combing. A dusty atmosphere is generally an indication that the material has not been properly cleansed. Willowing may be necessary for cleansing certain materials, but it is not wise to willow all materials, and witness would prefer a steeping process to willowing. Wool can be cleansed of much dust by steeping and efficient washing, and if so cleansed willowing is a disadvantage, because it tends to damage all materials. Willowed wool can be washed more cheaply than unwillowed. In some cases the advantages may outweigh the disadvantages, but witness considers willowing a mistake from the manufacturing point of view, and also to be a dangerous process from the health point of view. (6348–9, 6581–621, 6649–68, 6824–31, 6836, 6916–23, 6996–7000, 7011–27.)

J. H. Halliday (M): In the works managed by witness all really dusty materials, including Persian, East Indian, Syrian and Egyptian wools and Russian camel hair, are willowed after blending, for the purpose of removing dust and dirt from the material. Witness regards this process as essential if clean materials and freedom from dust in subsequent processes be desired. He gave the following figures obtained by determining the dust in the air in various processes of treatment of Persian wool, the quantity of dust being stated as milligrams in 10 cubic metres of air:—

—	Feeding Washbowl.	Carding.	Card Cylinder Grinding.	Card Roller Grinding.	Willowing.	
					Feeding.	Collecting.
Willowed Persian wool	40	14	27	115	—	—
Unwillowed Persian wool	460	182	2,728	2,359	(*a*) 218 (*b*) 456	86 —

In witness's opinion dust is a carrier of infection, and he thinks all dangerous wools might be willowed with advantage if dusty. It undoubtedly makes subsequent processes much more free from dust. Willowing does not cause any damage to materials in witness's experience. He cannot speak as to materials other than those he combs, but he cannot see how this process can possibly cause damage to fibre. A further advantage of willowing is that it protects the cards. His cards are not ground oftener than once in three months, but if willowing be omitted grinding once a month is necessary. Witness would regard willowing before blending as a great advantage, as it would prevent dust to a great extent in the latter process, but if done at this stage the great advantage of mixing resulting from willowing the blend would be lost. (5720–36, 5751–69, 6000–3, 6162–7, 6188–90.)

J. H. Stott (M): In the factory managed by witness a Creighton opener is used for willowing. It does not damage any material up to 7 inches in length, but for longer wool a larger machine would be necessary. There is very little loss of fibre and no dust escapes from the machine. It is all removed by exhaust applied to the perforated delivery rollers. (8908–26.)

T. Town (M): In the works managed by witness willowing is not done. He thinks willowing would remove much of the dust from wool but also much short fibre. Witness has, however, no experience of willowing. (8993–8, 9087.)

J. Campbell (M): Witness is quite satisfied with willowing as it is done in his works. It makes the wool quite clean, but the willow is defective because it allows much dust to escape into the air at the point where the wool is discharged. (9094.)

S. Wade (M): In the works managed by witness all material is shaken over the opening screen in order to remove as much dust as possible, but it is not willowed at any stage. There is much dust in the air during blending and feeding the washbowl but there is none in any process after washing. The wool in thin layers is oiled carefully before carding, but witness suggests that the true reason for the absence of dust in carding is that all dust remaining in the wool after opening and sorting is washed out.

Witness thinks willowing bad in principle. It breaks up bloodclots left in wool and so distributes infection, but even if bloodclots be first removed it is a very dusty and, therefore, dangerous process. It is true more men are exposed to dust in various processes in manipulation of unwillowed wool than would be so exposed if the wool were willowed, but witness considers this less dangerous than to expose the willower to the amount of dust produced in willowing, which is the dustiest process of all. He also said that willowing mats and felts the wool, and therefore causes damage to the fibre. He admitted, however, that he had very little experience of willows and willowing. (9200–76.)

C. E. Biggin (M): It is impossible to wash all dust out of really dusty wool and, in consequence, carding must be a dusty process unless other precautions are taken. If wool be willowed before washing, the washing water keeps much cleaner and there is less dust in carding. Another way of preventing dust in carding is, after washing, to willow and oil the material in a fearnought willow. The oil is so evenly distributed on the wool as to prevent the production of dust from portions not touched by oil which occurs at the lickers-in when material is oiled by hand and fed

C. E. Biggin (M)—*continued.*

straight into the cards. Willowing causes no damage whatever to the fibre, but witness was not prepared to say it would be advisable to put wool through a shake willow before washing and through a fearnought willow after washing. Every process *tends* to break the fibre to some extent. (9328–61.)

"B. A." (W): The only way of preventing dust in blending is to remove the dust from the wool before it is blended. The only way of doing this is by willowing it after sorting. The material, *i.e.*, the staple, is not damaged by willowing in the opinion of witness, but he has no means of demonstrating this. The workmen have often discussed the question of dusty processes, and there is a concensus of opinion that willowing the material immediately after sorting would very largely remove this nuisance. (2126–7, 2391–6, 2554–7, 2626–61, 2681–6, 2720.)

T. Larkin (W): If dust were removed from wool before blending this process would be free from objection. Witness thinks all materials should be willowed after sorting. This removes much dust from wool though not all of it. He has not much experience of willowing machines, but has seen camel hair willowed before blending, and the improvement is very great. (2847–8, 2862–70, 2889–92, 2997–3002, 3108–12, 3143–8, 3159–65, 3189–91, 3212–6, 3258–60.)

"W. R." (W): It is not possible to remove all dust from wool by opening over an exhaust screen. The more dust taken out of wool the less objectionable blending becomes. (3405–6, 3540–5.)

"S. J." (W): It is impossible to remove all dust from wool by washing. Witness has worked in works where the materials were willowed before washing and again willowed and oiled after washing, in other works where they were willowed before washing but not after, and in others where no willowing was done at any stage. In witness's opinion, dangerous materials can be made as clean by willowing as by washing, but the dust in the cardroom is very much reduced when they are willowed and washed and oiled. (3700–24, 3947–57, 3985–8, 4005–12, 4050–5, 4114–9.)

"F. J." (W): Alpaca is shaken over an exhaust screen in opening partly for the purpose of removing dust. The material is not, however, entirely freed from dust. Mohair, though sometimes dusty, is not, like alpaca, opened before sorting. (4789–828.)

"C. W." (W): Alpaca is shaken over an exhaust screen in opening partly in order to remove as much dust as possible. It still, however, contains much dust. It would be very costly, if not impossible to sort materials after they have been willowed. (5098–102, 5123–5.)

"G. J." (W): Witness is a washbowl minder. Washing as it is done at present will not remove all dust from wool. Witness has seen dusty wool willowed before blending and the dust thus taken out of the wool. Blending, pulling, feeding the washbowl and carding of the willowed wool were free from dust, and he thinks all materials should be willowed after sorting. Conditions would be much improved, and there would be no need for provision of steam jets, exhaust, &c., for prevention of dust in various processes. He is aware that feeding a willowing machine is dusty and objectionable work, but removal of dust from wool is the only satisfactory method of preventing dust in many processes. (5390–4, 5404–11, 5482–9, 5505–10, 5520–2, 5565–74.)

Witnesses.

T. M. Legge (O): H.M. Medical Inspector of Factories in the Factory Department of the Home Office since 1898. One of his principal duties is to deal with all reports on cases of anthrax in factories, &c. (1–485.)

W. P. Norris (O): Chief Medical Officer for the Commonwealth of Australia. Previously Director of Quarantine and Adviser on Public Health to the Commonwealth of Australia. Formerly Permanent Head of the State Health Department of Victoria. (8270–8614.)

W. S. Smith, B.Sc. (London), Whitworth Exhibitioner (O): H.M. Inspector for Dangerous Trades in the Factory Department of the Home Office for over six years. Had previously 13 years' experience as one of H.M. Inspectors of Factories. (7405–7984.)

Sir S. Stockman (O): Chief Veterinary Officer of the Board of Agriculture and Fisheries since 1905 and Director of Veterinary Research under the Development Commission. (9912–10,382.)

G. A. Taylor (O): One of H.M. Inspectors of Factories for over 21 years, of which last four and a half have been as Inspector in charge of the Bradford District. Also *ex officio* member of the Bradford Anthrax Investigation Board. (1078–2075.)

F. W. Eurich (P): Doctor of Medicine and Master of Surgery, Professor of Forensic Medicine, University of Leeds, Honorary Physician to the Bradford Royal Infirmary, Bacteriologist to the City of Bradford and to the Bradford Anthrax Investigation Board. Has experience of more than 100 cases of human anthrax. (486–1077, 8615–8766.)

W. Mitchell, M.B., C.M. (Edinburgh) (P): Medical practitioner in Bradford. Appointed by insurance companies, Woolcombers, Ltd., and other firms for the purpose of securing early diagnosis of anthrax, to examine all persons absent from work in dangerous wools or suffering from pimples or other suspicious affection. (7166–7404.)

G. Ackroyd (E): Senior partner of Messrs. George Ackroyd, Junior, Bingley, commission woolcombers, combing chiefly mohair and alpaca, but formerly combing also much Persian wool. Forty years personal experience of these materials. Member of the Bradford Anthrax Investigation Board. (6254–7165, 7985–8269.)

N. Broome (E): Director of Messrs. Edward A. Broome & Son, Kidderminster, worsted spinners, using principally Persian, East Indian and Colonial wools. (10,380–434.)

G. H. Feather (E): Director of Messrs. John Feather & Son, Ltd., top makers, Bradford, using Persian wool, camel hair, East Indian wool, Syrian wool, alpaca, English and Colonial wools. Twenty-six years personal experience of these materials. Member of Bradford Anthrax Investigation Board. (4216–742.)

H. J. Foster (E): Director of Messrs. John Foster & Sons, Ltd., Queensbury, spinners and manufacturers of mohair and alpaca. (8844–83.)

W. Root (E): Top maker, Bradford, using chiefly East Indian cashmere, Persian wools and goat hair. (8959c–61H.)

W. Waud (E): Director of Messrs. Christopher Waud & Co., Ltd., Bradford, spinners and manufacturers of mohair and alpaca. (9832–911.)

E. B. Whitley (E): Director of Messrs. Edward B. Whitley & Co., mohair merchants, Bradford. (9604–718.)

C. E. Biggin (M): Manager of Messrs. John Cure & Co., Ltd., Bradford (branch of Woolcombers, Ltd.), commission combers, combing principally Persian, East Indian, Egyptian, and other low foreign wools, mohair, alpaca, camel hair, &c. (9277–361.)

J. Campbell (M): Manager of Messrs. Campbell & Harrison, Ltd., Shipley (branch of Woolcombers, Ltd.), commission combers, combing Persian, East Indian, Egyptian, and other low foreign wools, and camel hair, alpaca, and mohair, &c. (9089–97, 9182–99.)

"D." (M): Manager of Mr. William Root's factory, top makers, Bradford, combing principally East Indian cashmere, Persian wool and goat hair. (8952–97.)

A. Drake (M): Agent and wool buyer for 19 years in Turkey for Messrs. Fisher Fox & Co., Bradford, mohair merchants. (9364–603.)

J. H. Halliday (M): Manager of Messrs. John Crossley & Sons, Ltd., Hebble Mill, Halifax, commission combers, combing chiefly Persian, Syrian, and East Indian wools and camel hair. Over 40 years

WITNESSES—*continued.*

personal experience of these materials. Member of the Bradford Anthrax Investigation Board. (5588–6253.)

W. H. Midgeley (M): Wool buyer for Messrs. John Foster & Sons, Ltd., Queensbury, spinners and manufacturers of mohair and alpaca. (8813–43.)

J. H. Stott (M): Manager of the Exchange Combing Co., Ltd., Bradford, commission combers, combing chiefly camel hair. (8884–926.)

T. Town (M): General manager and director of Messrs. C. F. Taylor & Co., Ltd., and of the Airedale Combing Co., Ltd., Shipley, combers and spinners of mohair, alpaca, Persian and East Indian wools, &c. (8962–9088.)

S. Wade (M): Manager of Messrs. J. & C. Crabtree, Ltd., Bradford (branch of Woolcombers, Ltd.), commission combers, combing chiefly Persian wool, mohair, alpaca, camel hair, &c. (9200–76.)

"B. A." (W): Wool warehouse foreman for 13 years in a commission combing works combing dangerous materials. (2076–789.)

H. Barker (W): Foreman sorter (skilled) employed by Messrs. George Armitage & Co., mohair merchants, Bradford. (9719–801.)

"C. W." (W): Skilled woolsorter for 33 years, including 5½ years' apprenticeship. Has sorted chiefly mohair and alpaca in various works, but has not been employed in commission combing works. (5050–337.)

Mrs. "C." (W): Female sorter (not a skilled sorter) employed in rough sorting and removal of bloodstains from East Indian cashmere, Persian wool, &c., in the factory of Mr. William Root, Bradford. (8927–51.)

"F. J." (W): Skilled woolsorter for 27 years, including an apprenticeship of three years. Has principally sorted alpaca and Turkey, Van and Cape mohair, also some Persian wool, &c. Has worked in commission combing works combing dangerous materials. (4743–5049.)

"G. J." (W): Wool washing machine minder. Eighteen years' experience, chiefly among Persian and East Indian wools, mohair, alpaca and camel hair, and all in commission combing works. (5338–587.)

T. Larkin (W): Wool warehouseman for two years in the commission combing works of Messrs. J. and C. Crabtree, Ltd., Bradford, combing dangerous materials. (2790–3272.)

"S. J." (W): Wool card jobber and grinder for 24 years, of which 10 years has been in commission combing factories combing dangerous materials. (3664–4215.)

A Sorter (W): Skilled sorter employed by Messrs. Fisher Fox & Co., mohair merchants, Bradford. (9362–3.)

A Sorter (W): Skilled sorter employed by Messrs. E. B. Whitley & Co., mohair merchants, Bradford. (9613–5.)

Six Skilled Sorters and Foreman (W): Skilled woolsorters who have all served an apprenticeship. Sorting principally Persian wool and camel hair in commission combing works. (9098–181.)

Two Sorters (W): Sorters serving their apprenticeship in the workshop of Messrs. E. B. Whitley & Co., mohair merchants, Bradford. (9616–23.)

Two Skilled Sorters (W): Skilled sorters employed by Messrs. Christopher Waud & Co., Ltd., mohair and alpaca spinners, Bradford. (9802–31.)

Three Sorters and Foreman (W): Skilled sorters employed by Messrs. E. B. Whitley & Co., mohair merchants, Bradford. (9624–81.)

"W. R." (W): General wool warehouseman since a boy in Commission Combing works, some of which combed dangerous materials. (3273–663.)

Woolcombing.

G. A. Taylor (O): The products of combing consist of tops and noils. Both may be still infected and have caused cases of anthrax. Persons working in combing rooms are liable to anthrax and should be provided with washing conveniences and cloak-rooms, and ought not to be permitted to take food or drink into or partake of them in combrooms. The walls, floors, &c., should also be cleaned by vacuum and not by brushing. Commission combers comb any material which is sent to them by the owners. They may not always know what the materials actually are and materials may be sent to them wrongly described. (1473–88, 1614–15, 1793–1801.)

G. Ackroyd (E): Broadly speaking, all varieties of worsted wools are combed by commission woolcombers, but specially fine qualities are rarely sent to them. They are combed by the spinners themselves. The machinery in any particular commission combing factory is only suitable for the particular class of material dealt in, and other varieties would not be accepted for combing. Dangerous and non-dangerous materials might, however, be combed by the same commission comber. The country of origin of materials sent for combing on commission is not always known to the commission comber, and he might have difficulty in ascertaining it, though witness considers this knowledge necessary in the case of scheduled materials.

Witness combs mohair and alpaca on commission, but the lots considered by him to be really dangerous only amount to 10 or 15 per cent. of the total. About three-quarters of the material is sorted before being sent to him for combing. He thinks all materials should be sorted by the owner, who should be responsible for the removal of bloodstains before they (the materials) are sent to commission combers, unless the latter have a sorting branch. It ought not to be expected of commission combers to remove bloodstains without remuneration. They should, however, be required to check the removal of bloodstains by looking the material over as it is being blended. This is always done in witness's works. If it be found that the removal of bloodstains has been done inefficiently this should be recorded, so that H.M. Inspector could take action against the firm or the sorters who are inefficient. Not all material requires a check looking over or even sorting for bloodstains at all, and the regulations should permit diversity of method. Witness points out, however, that as things are when removal of bloodstains is voluntary some people send him material for combing without attempting to sort out bloodstains and some remove them first. He comments on the unfairness of this. (6273–9, 6345–47, 6423–5, 6635, 6926–59, 7029–39.)

J. H. Halliday (M): Commission combing is a system by which the owner of a mill and combing plant combs wool which belongs to other people who remunerate him for doing so. Usually a commission comber owns none of the material combed in his works. Practically all varieties of combing materials are dealt with by commission combers. Dangerous and non-dangerous materials are combed in the same factory. In the commission combing works managed by witness there was a properly fitted up sorting branch, in which skilled sorters were employed. This is not general in commission combing works.

Commission combers would have no difficulty in ascertaining the country of origin of all materials combed. Witness has kept a register of all materials used for some time past and never had difficulty in getting information. There has been no increase in the quantity of material combed in commission combing works. (5597–608, 5626–30, 5863, 5934, 5983–92, 6153–8.)

"B. A." (W): In commission combing works there are periods when none of the dangerous varieties of material is being combed. Persons who have been employed in removing bloodstains from dangerous varieties and have acquired skill are then discharged. When the combing of dangerous materials is recommenced new and frequently unskilled bloodstain

"B. A." (W)—*continued.*

sorters have to be engaged and trained as well as possible in the circumstances. (2397–406, 2576–9.)

T Larkin (W): There is more anthrax in commission woolcombing than in woolsorting. This is due to ineffective looking over, and would be prevented to some extent if wool were sorted before being sent to commission combers. (3102–7.)

"**W. R.**" (W): There are more cases of anthrax in commission woolcombing than in woolsorting. Wool is usually in the bale when it reaches a commission combing works, and bloodstains are then sorted out by warehousemen. (3568–92.)

"**F. J.**" (W): Skilled sorters are now rarely employed in commission combing works—not so frequently as formerly. The lower qualities of material are usually combed at commission combing works. What sorting is done is rough sorting by warehousemen. In witness's opinion the reason why so many cases of anthrax occur in commission combing works is because of want of care and skill on the part of persons employed to remove bloodstains. Some spinners sort alpaca seconds still, but some now send them direct to commission combers without sorting. The risks are bound in this case to miss the sorter and are transferred to the combers. (4763–81, 4852–6, 4983–6, 5038–44.)

LIST OF APPENDICES.

APPENDICES.

APPENDIX I.

REPORT ON DETERMINATIONS OF DUST IN THE AIR IN THE PROCESSES PREPARATORY TO THE MANUFACTURE OF WOOL, GOAT HAIR, AND CAMEL HAIR.

By G. Elmhirst Duckering, Esq., one of H.M. Inspectors of Factories.

(Forwarded to the Committee by the Chief Inspector of Factories.)

To His Majesty's Chief Inspector of Factories.

Sir,

In accordance with the instructions contained in your letters of December 19th, 1912, and January 24th, 1913, I beg to report on an investigation as to the amounts of dust in the air at the breathing level of the workers in the principal preparatory processes in the manufacture of wool, &c.

The method used for ascertaining the quantity of dust in the air was that described on page 201 of your Annual Report for 1910.* The number of determinations made was 111, and of these 84 were made in five worsted works, using Persian wool, greasy Colonial wool, Cashmere, and Russian camel hair. Two of these works were engaged in "Commission combing," two in ordinary wool combing, and one was a sorting workshop. Seventeen determinations were made in two heavy woollen factories, using East Indian wool and cow and goat hair, one producing carpet yarns, and the other blanket yarns. The remaining ten determinations were made in two felt works, where East Indian wool is used.

The results are stated in Tables A to L under the heading of processes which are given in their natural order. The tables show the kind and condition of wool under treatment at the time the determinations were made, the manufacture, the weight of dust found in 10 cubic metres of air, the previous treatment of the wool, other determinations made in connection with the same consignment or blend of wool, and such details as are necessary to show the conditions existing at the time. In all cases the determinations were made at, or as near as possible to, the actual breathing point of the workers concerned.

Description of Processes and Discussion of Results.

Opening and sorting are usually the first processes in the preparation of wool for worsted yarn, but sorting is not done in heavy woollen and felt factories. Opening of scheduled wools, by which is meant the breaking open of the bales and the opening out of the fleeces, is at present done (as required by the regulations) in a separate room over an exhaust screen, which may be at the floor level or is sometimes raised about 3 feet above it. The wool, after opening, is thrown into trucks and removed to a second room, where it is sorted over exhaust screens raised about 3 feet from the floor.

Table A: Opening.—The results of determinations, made during opening, are given in Table A. Those obtained in 1, 2, and 3 (made in the same factory) appear to indicate that for loose wool (*e.g.*, camel hair) the air is less dusty where opening is done over floor screens than where raised screens are used. Raised screens are to be preferred, however, for Persian wool in fleeces on account of the stooping necessary where floor screens are in use.

As a rule opening of wools like Persian and camel hair is done by the sorters, and they regard it as an operation to be completed as quickly as possible. The wool is therefore treated very roughly. The exhaust is usually powerful, and the dust produced while the wool is over the screens is effectively removed. That produced in throwing it into trucks contaminates the air very considerably where there is a single screen only. Results of determinations 4, 5, and 10, however, show that it is possible, by provision of a duplicate exhaust sufficiently large, powerful, and well placed, to prevent the air at the breathing point of the openers from being unduly affected by the dust produced in opening

* Annual Report of the Chief Inspector of Factories and Workshops for the year 1910. [Cd. 5693.] Price 2*s.* 4*d.* Wyman and Sons, Ltd., Fetter Lane, London, E.C.

The average "dust figure" (by which is meant the weight of dust in ten cubic metres of air) found for opening in determinations 1 to 7, made where wool was being opened in accordance with the existing regulations, is 314 mgms., or excluding No. 5 (where the filter was placed at the breathing level over a second exhaust screen which was drawing the dust from the breathing point of the men opening and also from a shoot leading to the blending bin) it is 250 mgms., and the range is from 33 mgms., where a very powerful duplicate exhaust was in use, to 502 mgms. in the case of an ordinary exhaust.

Table B: Sorting.—In the sorting room the wool is sometimes sorted slowly and carefully by skilled sorters and sometimes is looked over, for bloodstains only, by warehousemen. It was observed, as in opening, that the dust produced while the wool is on the exhaust screen is effectively removed, and that that which contaminates the air is produced in removing it from and throwing it into trucks. The results of determinations made during sorting of wool, previously opened in a separate room, are given in Table B. The average dust figure found for sorting of Persian wool and Russian camel hair (items 11 to 16) is 88 mgms.; and the range from 59 mgms., where the exhaust was very good and the sorting (by skilled sorters) slow and careful, to 127 mgms., where the exhaust was not so good, the wool was only rapidly looked over for bloodstains by warehousemen, and the treatment rougher.

Table C: Opening and Sorting together.—The results of determinations made during opening and sorting done as one operation from the bale, placed and broken open at the side of the sorting bench, are contained in Table C. The average dust figure found for Persian wool and Russian camel hair in six determinations (22 to 27) is 79 mgms., and the range is from 44 mgms. to 133 mgms., these extreme figures being found during sorting of the same bale owing to the fact that air currents tended to cause dust to flow from the point at which the lower figure was obtained to that where the higher figure was found. The wool dealt with was exactly similar to that sorted, after previous separate opening, in determinations 11 to 16, bales of the same consignments being used. There is therefore no appreciable difference in the condition of the air during sorting of wool previously opened in a separate room (88 mgms.) and during sorting from the bale without previous separate opening (79 mgms.). The time occupied in sorting from the bale direct is slightly greater than when sorting a bale of previously opened wool, but it is less than the sum of the times occupied by separate opening and subsequent sorting. A sorter who opens his wool separately will therefore breathe more dust in the aggregate than one opening and sorting in one operation.

The floors tend to become slightly more dusty when the bale is placed for sorting at the side of the bench, but those of ordinary sorting rooms, where the loose wool is contained in trucks, are also dusty, and the difference does not appear to be material. In either case regular cleansing is necessary.

The dust removed in opening and sorting is a small proportion only of that contained in the wool, and its removal has apparently little effect (as will be seen later) in reducing dust in the air in subsequent processes.

Determinations 17 to 21 show that there is an appreciable quantity of dust in the air during sorting of greasy wools, and there is no doubt that this originated from the wool which was being sorted. That filtered from the air in 17, 18, and 19 consisted almost entirely of excrement.

Table D: Blending.—In the worsted trade blending of various wools follows sorting, the blending bins communicating with the sorting room by means of a shoot. In heavy woollen and felt factories it is usually the first process, though it may be preceded by willowing. Blending is done (1) on the open warehouse floor, (2) in closed bins, (3) in pens on the warehouse floor or elsewhere. Where dusty unwillowed wool is blended the process is always very dusty, the dust being caused to enter the air partly in pulling apart the matted wool and partly by the treading of the blenders on the surface of the blend.

Open floor blending appears to be the least dusty of the three methods noted, the average of three determinations (32 to 34) giving a dust figure of 443 mgms. In some cases wool is willowed before blending, and if this is thoroughly done it effectually prevents dust in the latter process, as determination 36 (47 mgms.) shows. In other cases the wool is passed through an opening machine, which is a kind of willow, but this does not prevent, in any marked degree, the production of dust during blending, as is shown by determination 35 (339 mgms.), during which wool similar to that blended in 36 was being dealt with.

Where blending in bins is done the wool is delivered into the closed bin till sufficient of one sort has collected, when delivery ceases, and one or more men enter the bin and spread the accumulated wool. The condition of the air when this is being done in a space so confined is appalling, and is without parallel in my experience, determination 28 showing the air to contain no less than 8,253 mgms. in 10 cubic metres.

Attempts are made to free the air from dust by introduction of steam into the atmosphere of the bin every two minutes or so during delivery of the wool. Sufficient time is allowed for the steam and dust to disperse before the entry of the spreader. So far as blending is concerned, however, this method is of small value, as is shown by determination 29 (5,084 mgms.), which immediately followed 28 (8,253 mgms.). The conditions in the two determinations were exactly the same except that steam was admitted into the bin during delivery of wool immediately preceding 29, but was not used before 28.

The air space of the room in which blending is done has some effect on the amount of dust in the air. Determination 31 (2,121 mgms.) was made during blending on the open floor of a room of small cubic capacity, and the conditions clearly approach those of bin blending.

Table E: Pulling Blends of Wool.—Wool, after blending, is pulled, *i.e.*, the worker takes a small section of the blend and pulls the wool from it in handfuls till the section is entirely removed. The object is to get a homogeneous mixture, and the process is very dusty, though the dust may be greatly reduced by willowing before blending. Excluding determinations 40 and 52, where the conditions were exceptional, the average dust figure found in 10 determinations during pulling of blends of unwillowed wool is 583 mgms., while that found in three determinations during pulling of blends of wool previously well willowed is 164 mgms.

Introduction of steam into the bins during blending makes the wool distinctly damp and reduces the dust in the air very considerably during pulling. The wool pulled in determination 39 (703 mgms.) had been treated in this way, while during 40 (3,595 mgms.) part of the same lot of wool was being pulled entirely dry. It should be noted, however, that three men were pulling in the latter case as compared with one in the former.

Table F: Willowing.—In the worsted trade willowing is not commonly done, but if done it follows pulling. In the heavy woollen and felt industries it is always done at this stage. The type of machine generally used is some form of shake willow with a single beater cylinder, having sometimes an automatic feed and delivery and sometimes a quadrant hand feed. All have some form of exhaust, but the commonest is by means of a fan driven off the beater spindle, and this is generally weak and somewhat ineffective. Exhaust by means of an independent fan is frequently very powerful, but only one case was noted where the willow was really effective in removing the dust from wool. It should be pointed out that this is of much more importance than provision of exhaust, since dust once separated from the wool ceases to affect the air in subsequent processes.

Excluding determinations 53 (1,475 mgms.), 56 (905 mgms.), and 66 (18 mgms.), which were afterwards found to be exceptional cases, the average dust figure found in eight determinations at the breathing point of men willowing wool not previously willowed is 323 mgms., and the range is from 209 mgms. to 456 mgms. The higher figures were found where the willow exhaust was weakest, and in these cases some dust undoubtedly escaped at the delivery opening, but the results are so curiously similar as to point to the conclusion that the dust in the air is produced principally by the handling of the wool in feeding the machines. The good effect of willowing before blending is indicated by determination 64 (118 mgms.), which should be compared with 59 (327 mgms.), where similar wool, which had not been willowed before blending, was being used.

In many cases wool is delivered to a point at some distance from the willow, and three determinations were made in such circumstances at the breathing point of men collecting the wool. In 57 (205 mgms.) and 58 (86 mgms.) delivery was by blowing direct from the willow, the exhaust in the former case being out of order. In 65 (1,232 mgms.) the willow used was modern and had an exceedingly powerful exhaust. The wool was delivered from the willow to a fan, through which it was made to pass, and thus blown to any part of the warehouse. This blower appeared to be much more effective in separating dust from the wool than the willow itself. The dust figure at the point of delivery is very high and is greatly in excess of that shown by determination 60 (289 mgms.) at the breathing point of the man willowing the same wool.

Willowing is very rarely done for the sole purpose of removing dust. The principal reasons for doing it are that the wool needs opening, *i.e.*, rendering loose, and that the various kinds of wool in a blend are most readily mixed by means of a willow.

Table G: Feeding the Washbowl.—In the felt and heavy woollen industries wool is not washed before carding, but in its preparation for worsted spinning it is always scoured (washed) in a washbowl consisting of three (or occasionally four) vessels arranged end to end, each being from 15 to 24 feet long, which contain a solution of soap and alkali in water. The wool is fed by hand on to a lattice at one end and caused to pass through each vessel in turn by means of rakes or rollers. The results of determinations made during feeding are given in Table G.

Determination 70 (460 mgms.) shows that this operation is dusty if unwillowed wool is used. This can be prevented by willowing, determination 69 (40 mgms.) being made during feeding with wool which was similar to that used in 70 but which had been willowed previously.

Exhaust is sometimes applied to the washbowl feed lattice, and this reduces the dust in the air, determination 71 (123 mgms.) being made with the exhaust stopped and 72 (69 mgms.) at the same point during feeding with similar wool but with the exhaust running.

It should be pointed out that the water in the washbowl is usually changed once, or at most twice, per day, and that the foreign matters (mineral, excremental, &c.) passed into it with dry dusty wool may amount to considerably more than two thousand pounds per day. The water, therefore, quickly becomes muddy, and it is obviously impossible that wool can be made clean by scouring under such conditions. The finer foreign matters are, to a considerable extent, distributed over the whole of the wool and so conveyed to the cardroom.

Table H: Carding.—In preparation for worsted spinning wool is dried, after scouring, and oiled (either in a special willow or on the card feed) and at once carded. In the heavy woollen trade it is oiled (by means of a "fearnought" willow) after willowing and at once carded, while in felt-making it is carded dry immediately after willowing. Carding may be a dusty process, though it should not be so. The results of determinations made at the breathing level in cardrooms are stated in Table H.

In a heavy woollen cardroom where East Indian wool, previously thoroughly willowed and machine-oiled, was being carded the mean of two determinations (82, 83) gives a dust figure of 4 mgms. In worsted cardrooms during carding of Persian wool, previously well willowed, scoured, and machine-oiled, the mean dust figure found in three determinations (73–75) is 14 mgms., while in another room in which similar Persian wool was carded which had been scoured and oiled by hand, but not willowed, three determinations (76–78) give an average dust figure of 182 mgms. In no case was grinding of the cards being done. In the two first-mentioned cases the dust consisted chiefly of vegetable débris and wool fibre, but in the last it was principally mineral matter. Scouring and oiling by hand, therefore, do not necessarily prevent dust in the cardroom.

In dry carding of East Indian wool, previously willowed (though not very effectively) but not scoured, the dust figure found in three determinations (84, 86, 87) is 92 mgms. Apparently, therefore, willowing by itself, if thoroughly done, is a more certain means of preventing dusty conditions in the cardroom than scouring in dirty water. It should, however, be mentioned that the cards in dry carding are usually enclosed.

It is necessary to bear in mind that more persons are employed in carding than in any previous process. A dust figure of 182 mgms. in the cardroom will therefore have a much greater total effect than even the high figures found in blending.

Table I: Combing.—Combing follows immediately after carding but is only done in the worsted industry. Table I shows that the process is not excessively dusty. It is worthy of remark, however, that the air during combing of unwillowed wool (determination 93 = 8 mgms.) is more dusty than when willowed wool is used (determinations 91–92).

Table J: Fettling (Stripping).—After being in use for some time the wire clothing of the cards becomes choked with dirt and short fibre separted from the wool in carding. The process of removing this by means of a hand comb is known as "fettling" or "stripping." Table J gives the results of determinations of dust at the breathing level of the fettlers as they sat on the top of the cards, *i.e.*, about 8 or 9 feet from the floor. They show that in itself the process is not dusty, the mean dust figure found in two determinations being 9 mgms., as compared with a figure of 16 mgms. for carding in the same room when no fettling was in progress. The wool used had been willowed, scoured, and machine-oiled. In another cardroom where similar wool had been carded which had been scoured and hand-oiled but not willowed, the dust figure found for fettling (during grinding of a card in the same room) is 224 mgms., the corresponding figure for carding, without fettling, but otherwise under the same conditions, being 209 mgms. It should, however, be pointed out that the fettlers have to strip the "bottom dividers," and to do this have to get underneath the card. They may, therefore, breathe more dust than is indicated by the determinations.

Table K: Grinding of Card Rollers.—The "worker" and "stripper" rollers arranged round the card cylinders have to be ground at intervals, and for this purpose they are removed from the cards and revolved after being fettled, in contact with an emery roller in a grinding frame. Results of determinations of dust, made at the breathing level near this machine, are contained in Table K. They show that the process is dusty. The mean dust figure found for grinding of rollers used for carding wool previously scoured, willowed, and machine-oiled, is 116 mgms., compared with one of 2,359 mgms. for grinding of rollers used for similar wool previously scoured and hand-oiled but not willowed.

In many cases exhaust is provided in connection with the grinding frames and they are enclosed. Determinations made at the breathing level near such a frame showed 2,359 mgms. of dust in 10 cubic metres of air when the exhaust was stopped and the cover open, as compared with 326 mgms. with the exhaust running and the cover closed. The results show the good effect of exhaust, but in this particular case it was very badly applied and inefficient.

Table L: Grinding of Card Cylinders.—Card cylinders have also to be ground at intervals, and this is done by running an emery roller in contact with the cylinder after fettling. Table L contains results of determinations made at the ordinary breathing level in the gangways round cards being ground. They show that under good conditions the air may be comparatively free from dust, but that in some circumstances the process is excessively dusty.

The results of four determinations during grinding in cardrooms, where the wool used had been willowed, scoured, and machine-oiled before carding, give a dust figure of 28 mgms., as compared with one of 14 mgms. for the same rooms when no grinding was being done. The difference of 14 mgms. appears to be due to true grinding dust. In a cardroom where similar wool was used which had been scoured and oiled by hand, but not willowed, before carding, the dust figure given by three determinations in similar positions is 2,728 mgms.

Determination 106 (6,935 mgms.) was made during the first 10 minutes of grinding and 107 (1,005 mgms.) was commenced at the same point one hour after the start of grinding. It is clear that grinding is more dusty at the commencement than later, but the assumption frequently made that all dust remaining in the card clothing after fettling, is thrown off in the first few minutes of grinding, is erroneous.

It is possible to remove the mineral matter left in the "clothing" of the cylinders, after stripping, by means of a vacuum apparatus, the nozzle being slowly traversed across the clothing. Determination 110 (40 mgms.) was made, after vacuum-cleaning the cylinders, at the same relative point at the commencement of grinding as 106 (6,935 mgms.), which was made in the same cardroom during grinding of a cylinder which had not been vacuum-cleaned. The card being ground in 110 was at the end of the room, while that being ground in 106 was in the centre, but the results show that it is possible in this way to prevent entirely the excessive dust of card-grinding where unwillowed wool is used.

Nature of the Dust.

In the course of the inquiry, opinions were frequently expressed as to the nature of the dust in the air during preparation of wool. This was particularly so in regard to cardroom dust. Thus suggestions were made that the only dust possible must be in the form of small particles of fibre, that mineral dust must necessarily be absent, that during grinding of the cards any dust produced by the process is so heavy that it could not affect the air, that all the dust produced in grinding card cylinders and rollers is thrown off in the first few minutes of grinding, and that after that the process is innocuous. It therefore appeared desirable to ascertain, by examination under the microscope, the nature of the dust filtered from the air in the determinations. After drying and weighing the filters, they were inverted and gently tapped till all, or nearly all, the dust was removed from the cotton-wool plug and collected in the inlet tube, which was kept stoppered till this was done. It was then possible to remove a sufficient quantity of the dust to a slide and mount it in Canada balsam, though considerable difficulties were encountered. This method is not entirely satisfactory, as many particles, apparently of animal or vegetable origin, are of the same colour and transparency as the Canada balsam, and are, therefore, very difficult to see under the microscope. This could, no doubt, be avoided by staining. Slides have been made of a large proportion of the samples of dust filtered from the air, and these, together with many of the samples not so used, have been preserved for future reference if necessary.

The dust filtered from the air is generally yellow or fawn in colour and of a light floury character. Exceptions were noted in sorting of greasy New Zealand wool, where the dust was dark green; in blending cow and goat hair, where the dust is white, and may possibly be lime used to remove the hair from skins; and in sorting certain kinds of greasy Australian wool, where it is red.

In processes of card-grinding, the dust when the quantity is large is grey or yellowish grey, but where the amount in the air is small, *i.e.*, where well-cleaned wool is carded, it is black. This is due to the fact that in the latter case the dust appears to consist almost entirely of particles abraded from the steel clothing of the cards or from the emery rollers, while in the former these are mixed with much yellow dust originating from the wool.

Microscopic examination of the dust shows it to consist in most cases of a mixture of transparent or semi-transparent mineral particles of various colours. The bulk of the particles are usually pale yellow, and others are red, grey, colourless, slaty blue, green, and black. They are in general rounded in character and sharp cutting angles are rare. Mixed up with the mineral part of the dust is much organic matter, apparently of animal and vegetable origin, which is frequently indefinite in character. In this connection the determinations made during sorting of greasy New Zealand wool afford some valuable information. The only wool treated during these determinations was wool of one lot which was naturally very greasy and was exceedingly clean. Indeed, an appreciable dust figure was at first sight surprising. There was, however, a considerable quantity of dark green dried excrement attached to the wool. On removing the dust from the filters it was at once obvious from its colour and appearance that it consisted of excrement. This was confirmed by microscopic examination. It appears fair to assume from these results that all dust from sheep wool, &c. will contain a greater or less proportion of excremental matter.

In addition to the more or less indefinite organic refuse, there were many objects of definite structure. These included cells, alone or in bunches, of many types, sizes, and colours, strings of cells (which may be moulds of secondary growth), remains of minute animals or parasites, and, in a few cases, minute parasites (apparently) which were uninjured. These are not definitely visible to the naked eye. In nearly all the samples small particles of wool fibre were present.

It is not necessary to describe the appearance of each slide in detail, but it appeared desirable to illustrate the nature of the dust, and for this purpose a series of photo-micrographs was prepared. The fields photographed were chosen with a view to showing the general character of the dust in the air throughout the different stages in the preparation of wool. Considerable difficulty was experienced in making the micrographs owing to the

[To face page 100.]

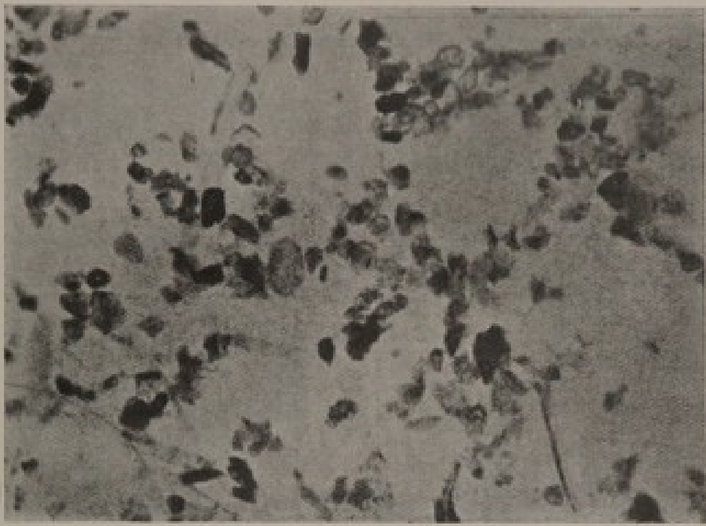

FIG. 1.
SORTING. (127 MGMS.) MAGNIFICATION × 75.

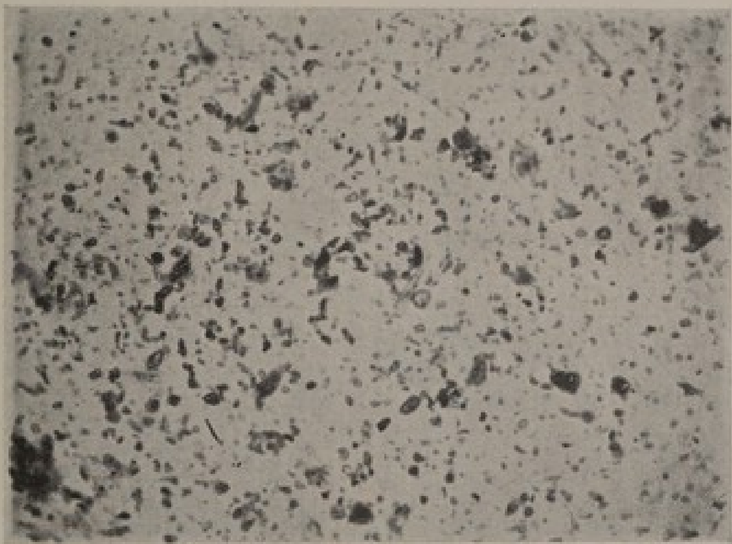

FIG. 2.
BLENDING. (8,253 MGMS.) MAGNIFICATION × 75.

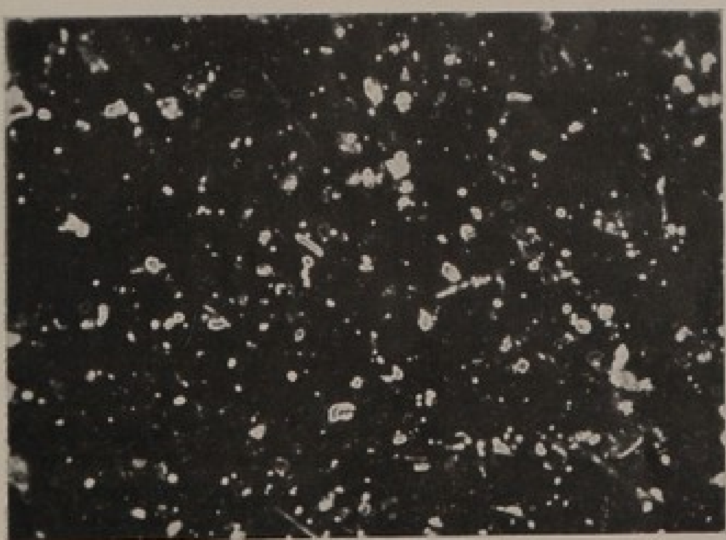

FIG. 3.
CARDING. (194 MGMS.) MAGNIFICATION × 75.
(Reflected light.)

a 31340

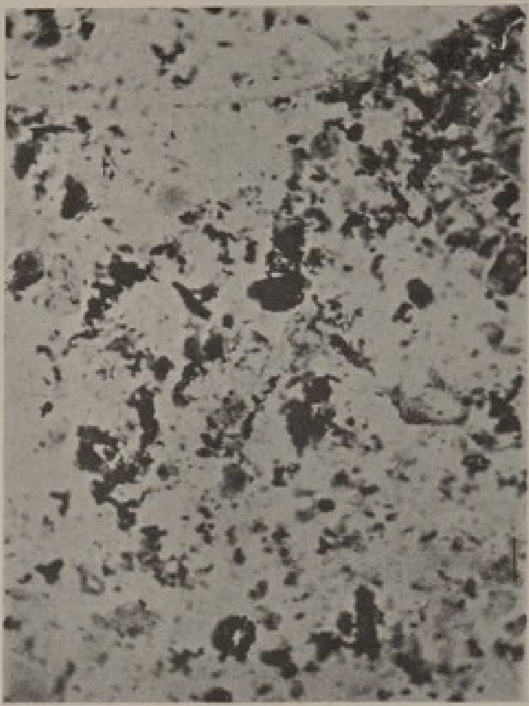

Fig. 4.

Ordinary Grinding of Card Cylinders.
(1,005 Mgms.) Magnification × 75.

Fig. 5.

Grinding Card Cylinders after Vacuum Cleaning. (40 Mgms.) Magnification × 75.

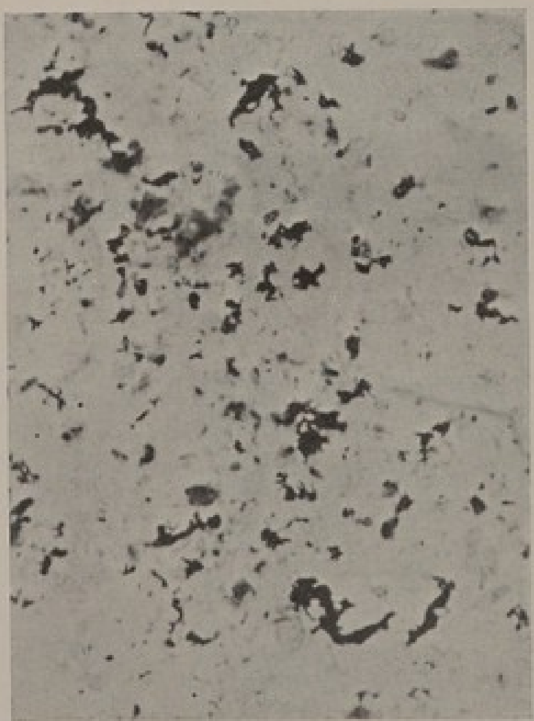

Fig. 6.

Grinding Card Rollers
(Unwillowed Wool. 2,359 Mgms. Dust.)
Magnification × 75.

Fig. 7.

Grinding Card Rollers.
(Willowed Wool. 119 Mgms. Dust.)
Magnification × 75.

transparency of many of the particles, which prevented them from appearing on the photographic plates.

Figs. 1 to 7 illustrate the character of the dust filtered from the air in the different processes. In each case the particles of dust are magnified 75 diameters.

Fig. 1 is a photo-micrograph of dust filtered from the air in determination 16 (127 mgms.) during sorting of grey Bagdad Persian wool. It will be observed that the mineral particles are very distinctly rounded. They are also comparatively large. A photograph of a different field on the same slide showed much organic matter.

Fig. 2 is a photo-micrograph of a field in a slide prepared from dust filtered from the air in determination 28 (8,253 mgms.) during blending of brown Persian wool in bins. The particles are very small and are rounded, while the dust is chiefly mineral.

Fig. 3 shows a photo-micrograph of dust filtered from the air during carding of Russian camel hair in determination 80 (194 mgms.). This dust is very transparent and difficult to photograph. It has, therefore, been photographed on an illuminated dark ground, *i.e.*, by reflected light. The particles are generally small and rounded, but there are some particles of grinding dust present which originated from a carding machine which was being ground 33 feet away from the point of the dust determination.

Figs. 4 and 5 show photo-micrographs of dust separated from the air during grinding of the cylinders of carding machines, both used for carding Persian wool and Russian camel hair in the same room. The dust shown in Fig. 4 (determination 107, 1,005 mgms.) was produced in grinding a carding machine, the clothing of which was full of dust in the ordinary way, while that shown in Fig. 5 (determination 110, 40 mgms.) was produced during grinding of a machine the clothing of which had been cleaned by means of a vacuum apparatus before grinding. It will be noted that much dust, in addition to the black grinding particles, is present in the former but is absent in the latter.

Figures 6 and 7 are photo-micrographs of dust filtered from the air during grinding of card rollers. In the former (determination 99, 2,359 mgms.) the rollers were used for carding unwillowed, and in the latter (determination 18, 119 mgms.) for carding willowed Persian wool. The dust shown in Fig. 7 (willowed wool) consists, as will be seen, almost entirely of black, spiky, grinding particles; but that in Fig. 6 (unwillowed wool) consists very largely of the dust usually found in wool, mixed with the black grinding particles.

Conclusions.

The inquiry shows that all processes in the preparation of wool, preceding the actual combing, are, or may be, dusty. The four great factors which tend to prevent dust are (1) willowing, (2) exhaust, (3) scouring (washing), and (4) oiling. Minor factors are the introduction of steam into the blending bins and the closing in of dust-producing machines. Scouring and oiling are clearly inefficient and uncertain, as they are at present done, if the wool is at all dusty. Exhaust cannot be applied in all cases in any way likely to be effective, *e.g.*, in blending, in pulling blends, and in carding, though it can be made effective in opening and sorting, in feeding washbowls, and in grinding. There is, however, no inherent difficulty in willowing. In the following Table the results of the determinations are summarised in such a way as to indicate the effects of willowing on subsequent processes. The mean of all the determinations in any process, where any of the three kinds of wool mentioned was used, is given as the dust figure for that process and wool.

Process.	Persian.		Russian Camel Hair.		East Indian.		Remarks.
	Willowed.	Un-willowed.	Willowed.	Un-willowed.	Willowed.	Un-willowed.	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	
Opening	—	361	—	296	—	—	
Sorting	—	98	—	69	—	—	
Opening and sorting together.	—	79	—	82	—	—	
Willowing before blending.	—	—	—	—	—	389	
Blending on open floors	—	—	—	367	193	1,357	
Blending in bins with steam.	—	5,084	—	3,673	—	—	
Blending in bins without steam.	—	8,253	—	—	—	—	
Pulling blends	—	1,330	—	299	275	702	
Willowing after blending.	—	716	—	905	118	282	
Feeding washbowl	40	460	—	123	—	—	
Carding oiled wool	14	182	—	72	4	—	
Carding dry wool	—	—	—	—	{ 120 { 79	— —	Once willowed. Twice willowed.
Fettling cards	9	224	—	—	—	—	
Grinding cards	27	2,728	28	—	—	—	
Grinding card rollers	115	2,359	119	—	—	—	
Combing	2	8	—	—	—	—	

The willowing machines observed were generally inefficient as dust separators and very considerable improvements appear possible. There can be, however, no doubt as to the advantage of willowing from the point of view of dust prevention. It appears both economically and hygienically unsound to have to provide means for removing dust from the air, or for preventing it getting into the air, at each separate stage in the preparation of wool. It further seems an inexplicable proceeding to put wool, mixed with from 30 to 50 per cent. of its weight of removable dust and dirt, into washing vessels when, on account of the expense, the washing liquid can only be changed infrequently. Willowing can, and should, be done immediately after sorting, or, if sorting is omitted, it should be the first process in preparing the wool for spinning, &c. If this is thoroughly done subsequent processes should be comparatively free from dust, and such devices as blowing steam into bins where blending is done, providing exhaust for the washbowl lattice, vacuum-cleaning the clothing of the card cylinders after stripping, &c., should be unnecessary.

I am, Sir,

Your obedient servant,

5th June 1913 G. Elmhirst Duckering.

TABLE A.—OPENING.

(Dust at the breathing level.)

NOTE.—The letters in column 2 of the following Tables distinguish the factory in which the determinations were made:—

Works A and B are Commission combing factories.
Works C produces carpet yarns.
Works D produces blanket yarns.

Works E is a wool-sorting workshop.
Works F and G are ordinary wool-combing factories.
Works H and I are felt-making factories.

—	Factory.	Manufacture.	Wool. Kind.	Wool. Condition.	Process.	Mgms. of Dust in 10 cubic metres of Air.	Exhaust Screen. Height above Floor.	Exhaust Screen. Area.	Exhaust Screen. Air Velocity.	Additional Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
							Ft.	Sq. Ft.	Ft. per Min.			
1	A	Worsted	Russian camel hair	Loose	Opening bales	502	3	$12\frac{1}{2}$	120	—	11, 12, 22.	One man each side of screen.
2	A	”	” ”	”	” ”	117	$\frac{3}{4}$	12	180	In shoot near	3, 32, 33, 42, 56, 57.	” ”
3	A	”	” ”	”	” ”	139	$\frac{3}{4}$	12	180	” ”	2, 32, 33, 42, 56, 57.	Opposite side of screen in 2.
4	B	”	” ”	”	” ”	33	Nil	32	260	As in 5 (cols. 10, 13).	5, 30, 41, 72, 79, 80.	Air supply flowed across this screen to screen in 5.
5	B	”	” ”	”	” ”	690	Nil	$12\frac{1}{2}$	210	As in 4 (cols. 10, 13).	4, 30, 41, 71, 72, 79, 80.	Air supply flowed to this screen over screen in 4 and much dust issued from shoot leading to the blending bin.
6	A	”	Brown Persian	Fleeces	Opening bales and fleeces.	407	3	$12\frac{1}{2}$	120	—	7, 13, 23, 53.	—
7	A	”	” ”	”	” ”	315		$12\frac{1}{2}$	120	—	6, 13, 23, 53.	Opposite side of screen in 6.
8	B	”	” ”	”	Fleeces thrown on screen, then to truck without opening.	139	Nil	32	260	—	9, 14, 15, 26, 27.	Same screen as in 4, but 5 not in use.
9	B	”	” ”	”	” ”	181	3	$12\frac{1}{2}$	210	As in 8 (cols. 10, 13).	8, 14, 15, 26, 27.	Same screen as in 5.
10	B	”	Grey Persian	”	” ”	51	Nil	32	260	As in 5 and 9 (cols. 10, 13).	16.	—

TABLE B.—SORTING.

(Dust at the breathing level.)

—	Factory.	Manufacture	Wool. Kind.	Wool. Condition.	Process.	Mgms. of Dust in 10 cubic metres of Air.	Exhaust Screen. Height above Floor.	Exhaust Screen. Area.	Exhaust Screen. Air Velocity.	Additional Exhaust.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
							Ft.	Sq. ft.	Ft. per Min.				
11	A	Worsted	Russian camel hair.	Loose	Sorting	59	3½	11	180	Eight similar screens.	Opening*	1, 12, 22.	Same room as 12 and 13. Six sorters.
12	A	„	„	„	„	80	3½	11	175	„	„ *	1, 11, 22.	Same room as 11 and 13. Six sorters.
13	A	„	Brown Persian	„	„	65	3½	11	125	„	„ *	6, 7, 13, 23, 53.	Same room as 11 and 12. Six sorters.
14	B	„	„	Fleeces	Opening fleeces and sorting for blood.	113	3	6	75	Six similar screens.	Fleeces thrown from bale to screen.*	8, 9, 15, 26, 27.	Two sorters. Same room as 15 and 16.
15	B	„	„	„	„	86	3	6	85	„	„ *	8, 9, 14, 26, 27.	„ „ „
16	B	„	Grey Persian	„	„	127	3	6	85	„	„ *	10.	Three sorters. Same room as 15 and 14.
17	E	„	Greasy New Zealand.	„	Opening and sorting.	47	—	—	—	—	—	18, 19.	64 sorters. Plenum ventilation not in operation. Dust excremental.
18	E	„	„	„	„	59	—	—	—	—	—	17, 19.	Side of same room as 17. Same conditions.
19	E	„	„	„	„	37	—	—	—	—	—	17, 18.	Same point as 17. Plenum ventilation in operation.
20	F	„	Greasy Argentine.	„	„	30	—	—	—	—	—	52, 90, 102.	14 sorters. Same room as 21.
21	F	„	Greasy Australian.	„	„	30	—	—	—	—	—	52, 90, 102.	Same room and conditions as 20.

TABLE C.—OPENING AND SORTING IN ONE OPERATION.

(Dust at the breathing level.)

22	A	Worsted	Russian camel hair.	Loose in bale.	Opening and sorting.	82	3½	11	130	Eight similar screens.	Nil	1, 11, 12.	Bale at side of bench. Five other men sorting opened wool.
23	A	„	Brown Persian	Fleeces in bales.	„	57	3½	11	125	„	„	6, 7, 53.	„ „ „

24	A	,,	Grey Persian	,,	,,	**44**	3½	11	125	,,	,,	25	Five men sorting from bale at side of bench.
25	A	,,	,,	,,	,,	**133**	3½	11	125	,,	,,	24.	Exhaust drew dust from trucks to this point. Same room and conditions as 24.
26	B	,,	Brown Persian	,,	Opening and sorting for blood.	**78**	3	6	75	Six similar screens.	,,	8, 9, 14, 15, 27.	Bale at side of sorting bench. Two sorters doing similar work.
27	B	,,	,,	,,	,,	**82**	3	6	85	,,	,,	8, 9, 14, 15, 26.	,, ,, ,,

TABLE D.—BLENDING.

(Dust at the breathing level.)

—	Factory.	Manufacture.	Wool. Kind.	Wool. Condition.	Process.	Where Blended. * = Steam-blown into Bin.	Size of Bin or Blend.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
							Feet.				
28	B	Worsted	Brown Persian	Loose	Spreading	Bin	21 × 12 × 11	**8,253**	Opening.* Sorting.*	29, 39, 70, 76, 77, 78, 93.	Steam not blown into bin. Seven minutes allowed for dust to subside before entry of spreader.
29	B	,,	,, ,,	,,	,,	,, *	,,	**5,084**	,, *	28, 39, 70, 76, 77, 78, 93.	Same point as 28, but steam blown in, and two minutes allowed for dust to subside before entry of spreader.
30	B	,,	Russian camel hair	,,	,,	,, *	,,	**3,673**	Opening*	4, 5, 30, 41, 71, 72, 79, 80.	Same point as 28 and 29. Conditions as 29.
31	D	Heavy woollen.	Fawn East Indian	Bales	,,	Small room	7 × 10	**2,121**	Nil	46, 61.	Room very small. Conditions, therefore, approach those of a bin. Side of blend.
32	A	Worsted	Russian camel hair	Loose	,,	Large warehouse	21 × 18	**365**	Opening.* Some sorted* also.	2, 3, 33, 42, 56, 57.	Centre of blend.
33	A	,,	,, ,,	,,	,,	,, ,,	,,	**370**	,, *	2, 3, 32, 42, 56, 57.	Side of same blend as 32.
34	C	Heavy woollen.	Cow hair and East Indian hair.	Bales	,,	,, ,,	21 × 14	**594**	Nil	43, 44, 67.	Side of blend.
35	I	Felt	White East Indian	Loose	,,	,, ,,	12 × 12	**339**	Opening. Willowing.*	49, 63, 86.	Willowing rapid and very inefficient. Side of blend.
36	C	Heavy woollen.	,, ,,	,,	,,	,, ,,	15 × 10	**47**	,, *	59.	Willowing was thorough. Side of blend.

TABLE E.—PULLING BLENDS.

(*Dust at the breathing level.*)

—	Factory.	Manufacture.	Wool. Kind.	Wool. Condition.	Process.	Where Blended. * = Steam-blown into Bin.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
37	A	Worsted	Grey Persian	Air-damped	Pulling and trucking.	Bin	471	Opening.* Sorting.* Blending.*	38, 54, 58, 69, 73, 74, 75, 91, 92, 94, 97, 98, 103	Small ineffective exhaust at top of bin.
38	A	„	„ „	„	„	„	550	„ *	37, 54, 58, 69, 73, 74, 75, 91, 92, 94, 97, 98, 103.	Same bin and conditions as 37, but in bin.
39	B	„	Brown Persian	Steam-damped	„	„ *	703	Opening.* Sorting.* Blending.	28, 29, 40, 70, 76, 77, 78, 93.	Steam blown into bin when blending. One man pulling.
40	B	„	„ „	Dry	„	Warehouse floor	3,595	„ *	28, 29, 39, 70, 76, 77, 78, 93.	Same wool as 39, but quite dry. Three men pulling.
41	B	„	Russian camel hair	Steam-damped	„	Bin*	265	Opening.* Blending.	4, 5, 30, 71, 72, 79, 80.	Steam blown into bin when blending.
42	A	„	„ „	Air-damped	„	Warehouse floor	333	Opening.* Sorting.* Blending.	2, 3, 32, 33, 42, 56, 57.	Blended several days.
43	C	Heavy woollen.	Cow hair and East Indian hair.	„	Pulling	„ „	901	Blending	34, 44, 67.	„ „
44	C	„	„ „	„	Trucking	„ „	628	Blending. Pulling.	34, 3, 67.	„ „
45	D	„	White East Indian	„	Pulling	„ „	585	Blending	60, 65, 82, 83.	Blended previous day.
46	D	„	Fawn East Indian	Dry	„	Small room	388	„	31, 61.	Willow with powerful exhaust running near. Blended just before pulling.
47	H	Felt	Black East Indian	Air-damped	„	Pen	1,006	„	62, 84.	Blended previous day.
48	I	„	„ „	„	„	„	609	Willowing.* Blending.	87.	„ „
49	I	„	White East Indian	„	„	Warehouse floor	151	„ *	35, 63, 86.	Blend contained greasy noils.
50	C	Heavy woollen.	„ „	„	„	„ „	158	„ *	51, 64.	Blended several days.
51	C	„	„ „	„	Trucking	„ „	185	Willowing.* Blending. Pulling.	50, 64.	„ „
52	F	Worsted	Greasy Colonial	„	Pulling and trucking.	Pen	14	Sorting. Blending.	20, 21, 90, 102.	Blend of wool sorted in 20 and 21.

Table F.—Willowing.

(Dust at the breathing level.)

—	Factory.	Manufacture.	Wool. Kind.	Wool. Condition.	Process.	Willow Type.	Willow Feed and Delivery.	Willow Exhaust.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
53	A	Worsted	Brown Persian.	Loose	Feeding	Multibeater	Lattice and blowing.	Powerful separate fan.	1,475	Opening.* Sorting.* Blending.* Pulling.*	13, 23.	Fan ducts found stopped up.
54	A	"	Grey Persian	"	"	"	"	"	218	"	37, 38, 58, 69, 73, 74, 75, 91, 92, 94, 97, 98, 103.	Same willow as 53.
55	A	"	Fawn Persian.	"	"	"	"	"	456	"	—	" "
56	A	"	Russian camel hair.	"	"	"	"	"	905	Opening.* Sorting.* Blending. Pulling.	2, 3, 32, 33, 42, 57.	Fan ducts partly stopped up.
57	A	"	"	"	Collecting	"	"	"	205	"	2, 3, 32, 33, 42, 56.	Same willow and occasion as 56.
58	A	"	Grey Persian	"	"	"	"	"	86	Opening.* Sorting.* Blending.* Pulling.*	37, 38, 54, 69, 73, 74, 75, 91, 92, 94, 97, 98, 103.	Same willow and occasion as 54.
59	C	Heavy woollen.	White East Indian.	Bales	Feeding and collecting.	Quadrant shake.	Hand	Weak fan in machine.	327	Nil	36.	—
60	D	"	"	Loose	Feeding	Auto. shake	Push and open lattice.	Powerful separate fan.	289	Blending. Pulling.	45, 65, 82, 83.	Modern machine. Wool delivered to blower.
61	D	"	Fawn East Indian.	"	"	"	"	"	209	"	31, 46.	Old machine with good exhaust.
62	H	Felt	Black East Indian.	"	"	"	Open lattice	Fan in willow	237	"	62, 84, 85.	New machine.
63	I	"	White East Indian.	Bales	"	Opening	"	"	452	Nil	35, 49, 86.	Old willow. Wool passed through rapidly.
64	C	Heavy woollen.	"	Loose	Feeding and collecting.	Quadrant shake.	Hand	Weak fan in willow.	118	Willowing.* Blending. Pulling.	50, 51.	Old willow. Wool willowed previously.
65	D	"	"	"	Collecting	Auto. shake	Push and lattice.	Powerful separate fan.	1,232	Blending. Pulling. Willowing.*	45, 60, 82, 83.	Wool blown to collecting point by blower.
66	G	Worsted	Cashmere	Bales	Feeding	"	Push and blowing.	"	18	Nil	88, 89.	Willowing slowly done.
67	C	Heavy Woollen.	Cow hair and E.I. hair.	Loose	Feeding and collecting.	Quadrant shake.	Hand	Weak fan in willow.	394	Blending. Pulling.	34, 43, 44.	Old willow. Woo. not previously willowed.
68	A	Worsted	Card waste	"	"	"	"	"	29	Opening.* Sorting.* Blending. Pulling. Willowing.* Machine-oiling. Carding. Stripping.	—	Dust contained some particles produced in grinding card rollers 40 ft. away.

Table G.—Feeding the Washbowl.
(Dust at the breathing level.)

—	Factory	Manufacture.	Wool. Kind.	Wool. Condition.	Process.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
69	A	Worsted	Grey Persian	Air damped	Placing wool on feed lattice.	40	Opening.* Sorting.* Blending.* Pulling.* Willowing.*	37, 38, 54, 58, 73, 74, 75, 91, 92, 94, 97, 98, 103, 104.	Wool in heap on floor.
70	B	"	Brown Persian	Steam damped	"	460	Opening.* Sorting.* Blending. Pulling.	28, 29, 39, 40, 76, 77, 78, 93.	Steam blown into bin when blending. Wool in heap on floor.
71	B	"	Russian camel hair.	"	"	123	Opening.* Blending. Pulling.	4, 5, 30, 41, 72, 79, 80.	Wool in heap on floor. Steam blown into bin when blending. Exhaust fitted to feed lattice but not used.
72	B	"	"	"	"	69	" "	4, 5, 30, 41, 71, 79, 80.	Same point and conditions as 71, except that lattice exhaust in use.

Table H.—Carding.
(Dust at the breathing level).

—	Factory.	Manufacture.	Wool. Kind.	Wool. Condition.	Position of Filter.	Cards in Room	Type of Feed to Card.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
73	A	Worsted	Grey Persian	Machine-oiled.	Doffing end	2	Hopper	12	Opening.* Sorting.* Blending.* Pulling.* Willowing.* Scouring. Oil Willowing.	37, 38, 54, 58, 69, 74, 75, 91, 92, 94, 95, 97, 98, 103, 104.	No grinding or stripping.
74	A	"	"	"	"	10	"	17	" "	" "	" "
75	A	"	"	"	Feed end	10	"	15	" "	" "	No grinding or stripping. Same room as 74.
76	B	"	Brown Persian	Hand-oiled.	Doffing end	16	Lattice	113	Opening.* Sorting.* Blending. Pulling. Scouring.* Oiling by hand.	28, 29, 39, 40, 70, 77, 78, 93.	No grinding or stripping.
77	B	"	"	"	"	16	"	232	" "	" "	No grinding or stripping. Same room as 76.
78	B	"	"	"	Feed end	16	"	201	" "	" "	No grinding or stripping. Same room as 76. Obvious spirts of dust at second licker-in.
79	B	"	Russian camel hair.	"	"	16	"	63	Opening.* Blending. Pulling. Scouring.* Oiling by hand.	4, 5, 30, 41, 71, 72, 80.	No grinding or stripping. Strong inward current of air at this point.

80	B	"	"	"	Doffing end	16	"	**194**	" "	" "	Card 33 feet away being ground after hand stripping.
81	B	"	"	"	"	16	"	**82**	" "	110, 111.	Card 30 feet away being ground after vacuum cleaning (*see* 110 and 111).
82	D	Heavy woollen.	White East Indian.	Machine-oiled.	"	6	Hopper	**2**	Blending. Pulling. Willowing.* Oil Willowing.	45, 60, 65, 83.	Three scribblers. Three finishers. Also two pairs mules.
83	D	"	"	"	Feed end	6	"	**7**	" "	45, 60, 65, 82.	" " "
84	H	Felt	Black East Indian.	Dry	"	6 (Tummers).	"	**120**	Blending. Pulling. Willowing.* Devilling.*	47, 62, 85.	Cards encased, but have poor exhaust.
85	H	"	"	"	Doffing end	"	"	**292**	" "		" " "
86	I	"	White East Indian.	"	"	9 (Tummers).	Lattice	**44**	Willowing.* Blending. Pulling. Devilling.*	35, 49, 63.	Cards encased, but have no exhaust.
87	I	"	Black East Indian.	"	Feed end	"	"	**114**	" "	48.	" " "
88	G	Worsted	Cashmere	"	Doffing end	14	"	**148**	Willowing.* Blending. Pulling. Scouring.	66, 89.	Cards encased. No exhaust. Grinding a card 15 feet away after vacuum stripping.
89	G	"	"	"	"	67	"	**99**	" "	66, 88.	Cards encased. No exhaust. Air humidified artificially.
90	F	"	Greasy. Botany.		—	18	—	**57**	Sorting. Blending. Pulling. Willowing. Scouring.	20, 21, 52.	Much combing machinery in room.

TABLE I.—COMBING.

(Dust at the breathing level.)

—	Factory.	Manufacture.	Wool.		Position of Filter.	Mgms. of Dust in 10 cubic metres of Air.	Previous Treatment of Wool. * = with Exhaust.	Other Tests for Same Wool.	Remarks.
			Kind.	Condition.					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
91	A	Worsted	Grey Persian	Sliver	Between gill boxes	**2**	Opening.* Sorting.* Blending.* Pulling.* Willowing.* Scouring. Oil willowing. Carding.	37, 38, 54, 58, 69, 73, 74, 75, 92, 94, 95, 97, 98, 103, 104.	Side of same room as 92.
92	A	"	"	"	Between combs	**3**	" " "	" "	Centre of same room as 91.
93	B	"	Brown Persian	"	" "	**8**	Opening.* Sorting.* Blending. Pulling. Scouring. Hand-oiling. Carding.	28, 29, 39, 40, 70, 76, 77, 78, 96, 99, 100, 105.	Centre of room.

TABLE J.—FETTLING (STRIPPING) CARD CYLINDERS.

(Dust at the breathing level.)

— (1)	Factory. (2)	Manufacture. (3)	Wool. (4)	Position of Filter. (5)	When Determination commenced. (6)	Mgms. of Dust in 10 cubic metres of Air. (7)	Previous Treatment of Wool. * = with Exhaust. (8)	Other Tests for Same Wool. (9)	Remarks. (10)
94	A	Worsted	Grey Persian	Over card	At start of fettling	6	Opening.* Sorting.* Blending.* Pulling.* Willowing.* Scouring, Oil willowing. Carding.	37, 38, 54, 58, 69, 73, 74, 75, 91, 92, 95, 97, 98, 103, 104.	No grinding in room. Same room as 74, 75, and 95.
95	A	,,	,,	,,	,,	12	,, ,, ,,	,, ,,	,, ,,
96	B	,,	Brown Persian	,,	,,	224	Opening.* Sorting.* Blending. Pulling. Scouring. Hand-oiling. Carding.	28, 29, 39, 40, 70, 76, 77, 78, 93, 99, 100, 105.	Grinding of a card in progress. Same room as 80.

TABLE K.—GRINDING CARD ROLLERS.

(Dust at the breathing level.)

97	A	Worsted	Grey Persian	Front of grinding frame.	At start of grinding	62	Opening.* Sorting.* Blending.* Pulling.* Willowing.* Scouring. Oil willowing. Carding.	37, 38, 54, 58, 69, 73, 74, 75, 91, 92, 94, 95, 98, 103, 104.	No exhaust, and frame not enclosed.
98	A	,,	,,	Back of grinding frame.	After grinding 30 minutes.	168	,, ,, ,,	,, ,,	No exhaust, and frame not enclosed. Same frame as 97 and 101.
99	B	,,	Brown Persian	Front of grinding frame.	At start of grinding	2,359	Opening.* Sorting.* Blending. Pulling. Scouring. Hand-oiling. Carding.	28, 29, 39, 40, 70, 76, 77, 78, 93, 96, 100, 105.	Exhaust fitted not in use and cover of frame open.
100	B	,,	,,	,,	,,	326	,, ,, ,,	,, ,,	Same frame as 99. Exhaust in use and cover closed.
101	A	,,	Russian camel hair	Back of grinding frame.	After grinding 80 minutes.	119	Opening.* Sorting.* Blending. Pulling. Willowing.* Scouring. Oil willowing. Carding.	108, 109.	Frame open and no exhaust.
102	F	,,	Greasy Colonial	Front of grinding frame.	At start of grinding	74	Sorting. Blending. Pulling. Scouring. Carding.	20, 21, 52, 90.	Grinding was very light.

TABLE L.—GRINDING OF CARD CYLINDERS.

(Dust at the breathing level.)

103	A	Worsted	Grey Persian	Doffing end	At start of grinding	34	Opening.* Sorting.* Blending.* Pulling.* Willowing.* Scouring. Oil willowing. Carding.	37, 38, 54, 58, 69, 73, 74, 75, 91, 92, 94, 95, 97, 98, 104.	Same point as 104.
104	A	,,	,, ,,	,, ,,	After grinding 40 minutes.	20	,, ,, ,,	,, ,,	Same point as 103.
105	B	,,	Brown Persian	,, ,,	After grinding 20 minutes.	246	Opening.* Sorting.* Blending. Pulling. Scouring. Carding.	28, 29, 39, 40, 70, 76, 77, 78, 93, 96, 99, 100, 106, 107.	Same card as 106 and 107.
106	B	,,	,, ,,	Side of card	At start of grinding.	6,935	,, ,, ,,	,, ,,	Same point as 107.
107	B	,,	,, ,,	,, ,,	After grinding 60 minutes.	1,005	,, ,, ,,	,, ,,	Same point as 106.
108	A	,,	Russian camel hair	,, ,,	At start of grinding	27	Opening.* Sorting.* Blending. Pulling. Willowing.* Scouring. Oil willowing. Carding.	101, 109.	Same card as 109.
109	A	,,	,, ,,	Doffing end	After grinding 105 minutes.	30	,, ,, ,,	101, 108.	Same card as 108.
110	B	,,	,, ,,	Side of card	At start of grinding.	40	Opening.* Blending. Pulling. Scouring.* Hand-oiling. Carding.	81, 111.	Cylinders vacuum cleaned before grinding. Same card as 111.
111	B	,,	,, ,,	Doffing end	After grinding 85 minutes.	29	,, ,, ,,	81, 110.	Cylinders vacuum cleaned before grinding. Same card as 110.

APPENDIX 2.

TABLES put in by and SUPPLEMENTING the EVIDENCE of DR. T. M. LEGGE.

The following tables, I.–V., are prepared from the reports received from certifying surgeons upon cases of anthrax notified in the period 1899–1913 in pursuance of s. 73 of the Factory and Workshop Act of 1901. In Table I. the cases (which are limited to the worsted, woollen, and felt industries) are distributed according to district; in Table II. they are distributed according to precise occupation, distinguishing those which occurred in processes (*a*) before washing, and (*b*) after washing, and the non-fatal from the fatal cases; in Table III. they are distributed according to the incidence in individual factories; in Table IV., as far as information will allow, according to source of origin of the materials handled: and in Table V. they are distributed according to the situation of the pustule.

ANTHRAX

Table I.—Cases of Anthrax (from Wool)

(The small Figures

	1899.		1900.		1901.		1902.		1903.		1904.		1905.		1906.		1907.		1908.	
—	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Bradford and District	15^{4}	2^{1}	7^{2}	1	3^{3}	1^{1}	4^{1}	–	11^{3}	4	8^{1}	–	20^{3}	5^{3}	13^{5}	3^{2}	10^{3}	3	7^{3}	1
Other West Riding	–	–	–	1	1	–	2	1	–	–	2^{1}	1	1	–	6^{1}	1	–	2	2	2
Lancashire	–	–	–	–	–	–	1	–	3^{1}	–	–	–	2	–	2	–	1	1	5	–
Liverpool	–	1	–	–	–	–	–	–	–	–	1^{1}	–	–	1	1	–	2	–	1	–
Other	–	–	–	1	2	–	3^{1}	1	6^{2}	–	2	2	1	4	1	1	1	3	–	–
	15^{4}	3^{1}	7^{2}	3	6^{3}	1^{1}	10^{2}	2	20^{7}	4	13^{3}	3	24^{3}	10^{3}	23^{6}	5^{2}	14^{3}	9	15^{3}	3

Bradford and District includes Bradford, Shipley, Bingley, Saltaire, Queensbury, Keighley, and Halifax.
Other includes Kilmarnock, Kidderminster, Witney, Glasgow,

Table II.—Cases (of Anthrax) distributed

(The small Figures

Process.	1899.		1900.		1901.		1902.		1903.		1904.		1905.		1906.	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Before washing :— Warehouse	–	–	–	–	–	–	1	–	2	–	2^{2}	–	–	–	2	–
Handling unopened bales	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Opening	1	–	–	–	1^{1}	–	–	–	1	–	–	–	2^{1}	2^{1}	–	–
Sorting	2^{1}	2^{1}	–	–	2^{2}	–	2^{1}	–	5^{1}	–	2	–	3^{2}	1	1	–
Willeying	3^{1}	–	–	–	2	–	3^{1}	–	2^{1}	–	1^{1}	1	2	–	7^{2}	–
Blending	–	–	–	–	–	–	1	–	–	–	2	–	1	–	–	–
Packing and carrying after blending.	–	–	–	–	–	–	–	–	–	–	1	–	2^{2}	–	4^{2}	–
Washing	3	–	1	–	–	–	–	–	1^{1}	–	1	–	2	–	1^{1}	–
Total before washing	9^{2}	2^{1}	1	–	5^{3}	–	7^{2}	–	11^{3}	–	10	1	12^{5}	3^{1}	15^{5}	–
After washing :— Willeying	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Woolrunning	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–
Wool drying and packing	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Carding	1	–	4^{1}	1	–	1^{1}	2	–	2	1	1	–	6^{2}	3	2^{1}	–
Card and comb grinding	2^{1}	–	–	–	–	–	–	–	–	–	1	–	1	–	–	–
Scribbling and condensing	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Gilling, drawing, preparing, back wash minding.	–	–	1^{1}	1	–	–	1	–	–	1	1	–	–	–	1	2^{1}
Combing and finishing	2^{1}	1	–	–	–	–	–	–	2	1	1	–	2^{1}	2^{2}	1	1
Pressing and packing tops	–	–	–	–	–	–	–	–	–	–	–	–	3^{1}	–	–	–
Spinning and yarn hanking	–	–	–	–	–	–	–	1	–	–	–	2	–	1	1	1^{1}
Yarn dyeing	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Weaving	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	1
Other	1	–	1	–	–	–	–	–	4^{2}	1	–	–	–	1	1	–
Total after washing	6^{2}	1	6^{2}	3	1	1^{1}	3	2	9^{4}	4	3	2	12^{4}	7^{2}	8^{1}	5^{2}
Totals	15^{4}	3^{1}	7^{2}	3	6^{3}	1^{1}	10^{2}	2	20^{7}	4	13^{3}	3	24^{9}	10^{3}	23^{6}	5^{2}

IN WOOL.

distributed according to District, 1899–1913.

indicate fatal Cases.)

1909.		1910.		1911.		1912.		1913.		Total.		Percentage of Cases to Total Cases, and of Deaths to Total Deaths.					
												Males.		Females.		All.	
M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	Cases.	Deaths.	Cases.	Deaths.	Cases.	Deaths.
14[2]	2	10[1]	5[2]	18[8]	1[1]	14[5]	1	19[2]	2	173[52]	31[10]	62·6	80·0	39·2	100·0	57·4	82·7
1	2	4	2	3	5	5	–	7[1]	4	34[3]	21	12·4	4·6	26·6	–	15·5	4·0
2	–	4	–	2	–	4	–	6[1]	–	32[2]	1	11·6	3·1	1·3	–	9·3	2·7
2	1	1	1	1[1]	1	1	–	–	–	10[2]	5	3·6	3·1	6·3	–	4·2	2·7
4[1]	–	–	1	1	3	4[1]	2	2	3	27[6]	21	9·8	9·2	26·6	–	13·6	8·3
23[3]	5	19[1]	9[2]	25[9]	10[1]	28[6]	3	34[4]	9	276[65]	79[10]	100·0	100·0	100·0	100·0	100·0	100·0

Other West Riding includes Dewsbury, Mirfield, Batley, Heckmondwike, Gomersal, Ravensthorpe, Leeds. London, Leicester, Galashiels, and Sedburgh.

according to precise Occupation, 1899–1913.

indicate fatal Cases.)

1907.		1908.		1909.		1910.		1911.		1912.		1913.		Total.		Percentage of Total Cases, M. and F.
M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	
2[1]	–	1	–	4	–	1	–	3[2]	–	2	–	–	–	20[5]	–	—
1	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	9·3
1	–	–	–	1	–	–	–	–	–	1	–	1	–	9[2]	2[1]	—
3	–	2	–	2	1	4[1]	1	5[3]	1	2[1]	–	4	1	39[12]	7[1]	12·7
–	–	2	–	3	–	5	–	4[1]	1	7[1]	1	4[1]	1	45[9]	4	13·8
–	–	–	–	–	–	–	–	1	1	1[1]	–	2	1	8[1]	2	—
–	–	–	–	1[1]	–	–	–	–	–	1	–	–	–	9[5]	–	5·4
1[1]	–	2[1]	–	2[1]	–	1	–	3	–	2	–	4	–	24[5]	–	6·8
8[2]	–	7[1]	–	13[2]	1	11[1]	1	16[6]	3	16[3]	1	15[1]	3	156[39]	15[2]	48·0
2	–	–	–	–	–	1	–	–	–	–	–	3	–	7	–	2·0
–	–	–	–	2	–	–	–	–	–	1	–	1	–	5	–	2·3
–	–	–	–	–	–	–	–	2[1]	–	1	–	–	–	3[1]	–	2·3
–	2	4[1]	1	2	–	3	2[1]	3[1]	–	2[1]	–	3	1	35[7]	12[2]	13·3
1	–	–	–	2	–	1	–	2[1]	–	2[1]	–	2	–	14[3]	–	4·0
–	1	2	1	–	2	1	1	–	3	1	–	1[1]	–	6[1]	8	4·0
–	1	–	–	1[1]	1	–	2	–	–	–	–	–	–	5[2]	8[1]	3·7
2[1]	1	–	–	–	–	–	1[1]	1	1[1]	2	–	2	–	14[5]	8[4]	6·2
–	–	1[1]	–	–	–	1	–	–	–	–	–	–	–	5[2]	–	1·4
–	4	–	–	–	1	–	2	1	3	–	2	1[1]	5	3[1]	22[1]	7·1
–	–	–	–	1	–	–	–	–	–	–	–	–	–	2	–	0·6
–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	4	1·1
1	–	1	–	2	–	1	–	–	–	3[1]	–	6[1]	–	21[4]	2	6·5
6[1]	9	8[2]	3	10[1]	4	8	8[2]	9[3]	7[1]	12[3]	2	19[3]	6	120[26]	64[8]	52·0
14[3]	9	15[3]	3	23[3]	5	19[1]	9[2]	25[9]	10[1]	28[6]	3	34[4]	9	276[65]	79[10]	100·0

Table III.—Distribution of Cases according to Factory.

Factory.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913. (Ten Months.)	Total.	Percentage of Total Cases.
1	1	4	1	2	3	1	11	7	2	3	5	2	5	4	5	56	15·8
2	—	—	—	—	2	—	2	1	—	3	1	3	2	3	6	23	6·5
3	—	—	—	—	—	—	—	1	2	—	1	6	6	2	4	22	6·2
4	1	—	1	—	4	2	6	2	2	1	—	—	—	2	—	21	5·9
5	—	—	1	4	2	1	1	1	1	—	2	—	—	—	—	13	3·7
6	—	—	—	—	2	—	2	1	1	—	2	1	—	—	1	10	2·8
7	—	—	—	—	—	1	—	1	2	1	1	1	1	1	—	9	2·5
8	—	1	—	—	2	2	2	1	—	—	—	—	—	—	—	8	2·3
9	—	—	1	3	—	—	—	1	—	—	—	2	1	—	—	8	2·3
10	—	—	—	—	4	—	—	—	1	—	—	1	1	1	—	8	2·3
11	—	—	—	—	—	—	—	—	—	—	—	2	1	1	3	7	2·0
12	7	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7	1·9
13	—	—	—	—	—	1	2	—	—	—	—	—	—	3	1	7	1·9
14	—	—	—	—	—	—	—	—	—	—	2	1	2	—	1	6	1·7
15	—	—	—	—	—	—	—	—	1	—	—	—	2	—	3	6	1·7
16	—	—	—	—	—	—	—	—	—	—	—	—	4	1	1	6	1·7
17	—	1	—	2	2	—	—	—	1	—	—	—	—	—	—	6	1·7
18	2	1	—	—	—	—	1	1	—	—	1	—	—	—	—	6	1·7
Two factories with five cases each																10	2·8
Three factories with four cases each																12	3·4
Seven factories with three cases each																21	5·9
Thirteen factories with two cases each																26	7·3
Fifty-six factories with one case each																56	15·8
Totals																354	—

Table IV.—Possible Distribution of Cases according to Material handled.

Wool.		1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913.	Totals.	Percentage of Total Cases.
Persian	Alone	1	1	3	8	5	2	7	5	2	—	2	2	10	2	2	52	14·7
	With others	9	2	1	—	3	—	5	4	1	—	5	6	4	4	7	51	14·4
Van Mohair	Alone	—	1	—	—	3	—	—	1	—	—	—	—	—	2	—	7	2·0
	With others	—	—	—	—	1	2	2	—	—	—	—	1	—	—	—	6	1·7
Mohair	Alone	2	—	—	—	2	—	—	1	—	—	—	—	—	—	—	5	1·4
	With others	2	—	—	1	—	1	2	—	—	—	—	—	—	1	1	8	2·3
Turkey Mohair.	Alone	—	2	1	1	3	1	1	1	3	2	1	1	3	2	2*	24	6·5
	With others	—	—	—	—	1	—	2	—	—	—	1	—	—	—	—	4	1·1
Cape Mohair	Alone	—	—	—	—	2	—	—	—	—	—	—	—	1	—	1	4	1·1
	With others	—	—	—	—	—	—	—	1	—	—	—	1	2	—	2	6	1·7
Cape Mohair and Turkey Mohair.		—	—	1	—	—	1	1	1	1	—	1	3	1	—	—	10	2·8
Alpaca	Alone	—	—	—	—	—	—	1	—	—	—	—	—	—	1	—	2	0·6
	With others	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	2	0·6
Pelitan	Alone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	With others	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
East Indian Cashmere	Alone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	With others	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Russian Camel Hair	Alone	—	1	—	—	—	—	—	1	—	—	1	—	—	—	—	3	0·8
	With others	—	—	—	—	—	—	—	1	4	—	2	—	—	—	—	7	2·0
China Camel Hair	Alone	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
	With others	—	—	—	—	—	—	—	—	1	—	—	1	1	—	—	3	0·8
Camel Hair	Alone	—	2	—	—	—	—	—	—	—	—	—	—	—	—	—	2	0·6
	With others	1	—	—	—	—	—	6	1	1	—	—	—	—	—	—	9	2·5
East Indian	Alone	1	—	—	—	4	2	3	1	2	5	5	4	4	8	6	45	12·7
	With others	—	—	—	1	—	2	3	8	6	7	5	6	6	9	15	68	19·0
Australian (Colonial)	Alone	—	—	—	—	—	—	—	—	2	—	—	—	—	1	1	4	1·1
	With others	1	—	—	—	—	—	—	—	—	—	3	1	—	—	—	5	1·4
Native (Home and Colonial)	Alone	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	0·3
	With others	—	—	1	—	—	1	—	1	—	3	1	—	1	—	1	9	2·6
Spanish.	With others	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	0·3
Egyptian.	With others	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	2	0·6
Chevrette.	With noils	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	1	0·3
Not stated.	Indefinite	1	1	—	1	—	1	—	1	—	1	—	1	1	—	4	12	3·4
Finished Tops		—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	2	0·6
Total Cases		18	10	7	12	24	16	34	28	23	18	28	28	35	31	43	355	—

* Skin Wool in one case.

Table V.—Situation of Pustule.

(The small Figures indicate fatal Cases.)

—	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.	1912.	1913 (Ten Months).	Total.	Percentage of Total Cases. M. and F.
Internal	2[2]	1[1]	1[1]	1[1]	—	1[1]	7[7]	6[5]	1[1]	2[2]	2[2]	1[1]	7[7]	3[3]	1[1]	36[35]	10·2
Erysipelatous	—	—	—	—	—	1	—	—	—	1[1]	1	1[1]	1[1]	1	—	6[3]	1·7
Crown of head, scalp	1	—	—	—	1	1	—	—	1	—	—	—	—	—	—	4	1·1
Forehead	—	1	1	1	1	3	2	—	1	4	—	3	1	4	3	25	7·1
Temple	—	—	—	1[1]	—	1	—	1	—	—	—	—	1	—	—	4[1]	1·1
Face	2	1	—	—	—	—	—	1	—	—	—	2	2	—	—	8	2·3
Nose	—	1	—	—	—	—	—	—	—	1	—	1	1	—	—	4	1·1
Cheek	—	—	—	1	2	1	6[1]	4	5	1	7	1	3	3	5	39[1]	11·1
Ear	—	—	—	—	1[1]	—	—	—	1	—	1	1	—	1	1	6[1]	1·7
Eyelid and eyebrow	2	1	1[1]	—	3[2]	2[1]	4	4	4[1]	1	1	1	1	—	4[1]	29[6]	8·2
Lip	—	—	—	—	1	1[1]	—	—	—	—	1	1	—	—	—	4[1]	1·1
Chin	1[1]	—	—	—	2	—	2[1]	1[1]	1	—	2	2[1]	2	2[1]	1	16[5]	4·5
Lower jaw	—	—	—	2	—	—	—	1	—	1	1	1	—	—	4[1]	10[1]	2·8
Neck	4	1[1]	2[1]	3	11[4]	3	6[2]	5[1]	1	4	3	2	8[3]	9[2]	11[1]	73[15]	20·6
Arm	—	—	—	—	—	1	1	—	2	1	1	2	—	—	3	11	3·1
Upper arm	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	2	0·6
Elbow	1	—	—	1	—	—	—	—	—	—	—	—	1	—	—	3	0·9
Forearm	3	3	1	1	1	1	3[1]	2	3	1	3	6	3	7	4	42[1]	11·8
Wrist	—	—	—	—	—	—	1	1[1]	1[1]	—	3[1]	—	—	—	1	7[3]	2·0
Hand	—	—	—	—	—	—	—	—	1	—	1	—	1	—	—	3	0·9
Hand and arm	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1	0·3
Finger	—	—	—	—	—	—	—	—	—	—	1	1	—	1	2	5	1·4
Shoulder	1[1]	—	—	—	—	—	—	—	—	—	—	2	—	—	—	3[1]	0·9
Back	—	—	1[1]	—	—	—	—	—	—	—	—	—	—	—	—	1[1]	0·3
Buttock	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	1	0·3
Leg	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2	0·6
Knee	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	0·3
Ankle	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	2	0·6
Foot	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1	0·3
Foot and arm	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	2	0·6
Indefinite	1	1	—	—	—	—	—	—	—	1	—	—	—	—	—	3	0·9
Total	18[4]	10[2]	7	12[2]	24[7]	16[3]	34[12]	28[8]	23[3]	18[3]	28[3]	28[3]	35[10]	31[6]	42[4]	354[75]	

APPENDIX 3.

APPENDIX 3.

CLASSIFICATION of the CASES of ANTHRAX according to the process and the wool manipulated. 1899 to 1913 inclusive.

Prepared by G. ELMHIRST DUCKERING, Secretary of the Committee.

In the following tables an analysis is made of all the cases of anthrax occurring in the manipulation of "wool" (including in that term hairs of the type of mohair, alpaca, camel hair, goat hair, &c.) on which reports have been made by H.M. Inspectors of Factories and the Certifying Surgeons in the years 1899 to 1913 inclusive. The method of arrangement of the statistics is intended to show the danger attaching to each class of wool during its manipulation in each process from opening the bale to spinning. For this purpose all the classes of material with which the persons contracting anthrax may have been in contact are recorded in column 1 of the tables.

It will be noted that no cases are attributed to conveyance of material from one process to another (woolrunning). Where a woolrunner has contracted the disease the case is recorded under the most appropriate heading, *e.g.*, a case occurring to a woolrunner conveying wool from a blend to the washbowl is put down as a case occurring in washing unless he was also pulling from the blend, when it is recorded under the heading of "pulling blends." Similarly a runner conveying wool from the drier to the carding machines has been included as a cardroom worker.

As far as possible the cases are arranged under the headings of the three great trade divisions of the wool industry, *i.e.*, worsted, woollen and felt.

It is necessary to use caution in drawing conclusions from the tables. In the main classes of material like mohair, alpaca, Persian, camel hair, and East Indian wool, where cases occur in the manipulation of these wools alone fairly frequently, it is possible to draw definite conclusions as to their danger since the number of cases occurring (except, perhaps, in the case of alpaca) overcomes the chance of error due to the possibility that the infection may have originated from some source other than the wool manipulated at the time the cases occur. Frequently, however, there is considerable difficulty in ascertaining exactly what classes of material have been handled by a worker contracting anthrax. In many cases also the material has all been used before the case is diagnosed so that no attempt to ascertain if the wool is infected is possible. Spores from infected material may remain in situations of potential danger to the workers long after the wool from which they originated has left the factory, *e.g.*, in the clothing of the carding machines and in dust which is allowed to collect about the factory. It may, therefore, happen that a case of anthrax will occur when the wools at that time passing through the factory are quite free from infection. The extent and method of use of any material must also be borne in mind. In some cases the supply of a particular variety of wool is so small as to make its use alone an impossibility, *e.g.*, Egyptian and Syrian wool, both of which have been found by Dr. Eurich to be infected. In other cases the character of the material is such that it is in practice always used blended with other wools, *e.g.*, mohair noils and other noils used in the woollen trade. Such materials may be and apparently are dangerous, but cases do not arise in which the infection can be traced to them alone since they are not used alone.

In Table I. those cases are tabulated in which mohair is one of the materials concerned. It will be noted that of the total cases, where the different varieties of mohair are used alone, over 63 per cent. occurred in sorting, while nearly 48 per cent. of the fatal cases also occurred in this process. In the manipulation of Turkey mohair 92 per cent. of the cases occurred among sorters. This would appear to be explained by two circumstances. Mohair is one of the highest grade materials used in the worsted industry and it is very carefully sorted into qualities, the whole of the material being passed through the hands of the sorter in very small quantities at a time. He must therefore come in direct contact with whatever infected material there is. While placing the sorter in a position of considerable danger, the care necessary in sorting ought to protect subsequent workers completely, assuming that the infected material is always bloodstained, since it should be quite easy to pick out all bloodstained material at this stage if this is at all possible. The fact that cases occur in subsequent processes, however, appears to indicate that this is not done, and indeed it is not a difficult matter to find small bloodstains among the matchings into which the wool is divided, in the case of many sorters. The second circumstance is that mohair is usually prepared and not carded. Preparing is a much less severe process than carding and the bloodstains would be less broken up and therefore there is less danger of infected material being widely distributed among the wool. There appears to be a certain amount of danger in every process in the manipulation of mohair.

Where Persian wool is associated with mohair as being one of the materials handled by workers contracting anthrax it will be observed that the cases in the cardroom begin to preponderate, 37 per cent. of the total occurring in this process as compared with 5 per cent. in Mohair alone (all the cases occurring during carding of mohair were caused by Van mohair) though in mohair alone the combroom cases occur more frequently.

In Table II. those cases in which Persian wool is concerned apart from mohair are tabulated. The processes of washing, oil willowing (willowing and oiling after washing), carding and combing are together responsible for over 40 per cent. of the total cases where Persian is the only wool used, for nearly 60 per cent. where Persian is associated with other wools, and for between 50 and 60 per cent. of the fatal cases in each case. It will be noted that the point of greatest danger in manipulation of mohair is in the warehouse processes, but in the case of Persian this is shifted to the manufacturing processes. Persian wool is typical of the low grade wools which are rarely sorted into qualities. They are now universally looked over in order to pick out bloodstained material (usually by warehousemen), but, even in cases where this is supposed to be done with extreme care, the whole of the wool is never passed through the hands of the workers as it is in the case of high grade material like mohair. Bloodstains are undoubtedly missed in mohair and they must be missed much more frequently in the case of low grade wools. Moreover mohair is a white material while Persian and low grade materials generally are frequently coloured in all shades from fawn to deep brown or black. In these it is frequently quite impossible to see the bloodstains so that it is necessary to rely solely on the sense of the touch. If infected material is missed in the warehouse processes it would in all probability in the case of coloured wools pass through to the combing processes generally, including carding. This probably explains why these processes are so much more dangerous in the case of Persian wool than in the case of mohair while the converse is true of the warehouse processes.

In Table III. the cases of anthrax arising in the worsted trade from East Indian wool and goat hair (*see* also Tables VII. and VIII.) are tabulated. The cases recorded in the table from the manipulation of East Indian wool alone are sufficient to indicate that this material is dangerous, but it is not used on a large scale in the worsted industry. East Indian goat hair used alone is responsible for one case, but this is one of the materials only rarely manipulated alone.

In Table IV., the cases arising in the manipulation of camel hair, and in Table V. those in manipulation of alpaca, are classified, while those arising in the manipulation of wools not usually regarded as dangerous are recorded in Table VI. It would seem from these statistics that alpaca is not more dangerous than English and Colonial wools, but it should be borne in mind that cultivations of anthrax bacilli have recently been made from alpaca (Eighth Report of the Anthrax Investigation Board).

In Table VII. and VIII. the cases arising in the woollen and felt industries respectively are classified. In both these trades East Indian wool is the principal material used a very large quantity being consumed. In the woollen trade 34, and in the felt trade 18 cases of anthrax have occurred where East Indian wool was the only material handled by the persons contracting the disease. The cases appear to occur in all the processes, but are most frequent in willowing and carding. Willowing in both trades and carding in the felt trade are usually exceedingly dusty processes. In the total under the heading of "warehouse" in Table VII., those cases occurring in the manipulation of East Indian wool in the Liverpool dock warehouses are included.

East Indian wool differs from most other wools in that it has usually been washed, before being exported to this country, in such a manner that bloodstains are destroyed as such, and the infection is distributed over the bulk of the wool. It will be observed that East Indian wool is frequently associated, in both the felt and woollen trades, with noils from dangerous wools, *e.g.*, mohair noils, Bradford noils, &c. Noils is the term used to describe the short fibre, &c., combed out of longer material. They are produced in large quantity as a by-product of the worsted trade, and form one of the principal raw materials of the woollen trade.

At least two cases occurred (*see* Table VII.) where cow hair was used. Enquiries at the source from which this material came show that cases of anthrax in the process of removing the hair from the skins are fairly frequent, and it seems probable, therefore, that the hair will be infected.

The total number of cases, from 1899 to 1913 inclusive, in the worsted trade is 243 (66 fatal), in the woollen industry is 79 (7 fatal), and in the felt trade it is 33 (2 fatal). The total in the three branches of the wool trade is 355 (75 fatal). Reference should be made to the classification of the cases reported to the Anthrax Investigation Board, which has been prepared by Mr. George Ackroyd. This covers the period during which bloodstains have been removed from the wool more or less systematically. It should be observed that many sorters have done this habitually for many years.

The small figures above and to the right of the figures in the tables indicate fatal cases.

WORSTED INDUSTRY.

TABLE I.—MOHAIR.

Wool manipulated. (1)	Raw Wool Warehouse. (2)	Opening. (3)	Sorting. (4)	Blending. (5)	Pulling Blends. (6)	Willowing. (7)	Washing. (8)	Oil Willowing.* (9)	Card Room. (10)	Comb Room. (11)	Waste Willowing. (12)	Top Warehouse. (13)	Spinning. (14)	Weaving and Dyeing. (15)	Mechanics, &c. (16)	Not employed in Factory. (17)	Carters at Wharf, &c. (18)	Total. (19)
Turkey mohair alone	—	—	23^{3}	—	—	—	—	—	—	2^{1}	—	—	—	—	—	—	—	25^{4}
Cape mohair alone	—	—	2	—	—	—	1	—	—	1	—	—	—	—	—	—	—	4
Turkey mohair, Cape mohair	—	—	5^{3}	—	—	—	---	—	—	2^{2}	—	1^{1}	2^{2}	—	—	—	—	10^{8}
Mohair alone	—	—	5^{2}	—	—	—	1^{1}	—	—	—	1^{1}	—	—	—	1	—	—	8^{4}
Van mohair alone	—	1	—	—	—	—	1	—	3^{1}	2	—	—	—	—	—	—	—	7^{1}
Van mohair, Cape mohair	—	—	1	—	—	—	—	—	—	1	—	—	—	—	—	1	—	3
All mohair alone	—	1	36^{8}	—	—	—	3^{1}	—	3^{1}	8^{3}	1^{1}	1^{1}	2^{2}	—	1	1	—	57^{17}
Mohair, Persian	—	—	1^{1}	—	1^{1}	—	3	—	2	—	—	1^{1}	—	—	1	—	—	9^{3}
Mohair, Persian, alpaca	—	—	—	—	—	—	—	—	2^{1}	—	—	—	—	—	—	—	—	2^{1}
Mohair, Persian, camel hair	—	—	—	—	—	—	1	—	1	2^{1}	—	—	—	—	—	—	—	4^{1}
Turkey mohair, East Indian wool, East Indian goat hair, Persian, English, Scotch.	—	—	—	—	—	—	—	—	1^{1}	—	—	—	—	—	—	—	—	1^{1}
Cape mohair, Persian, Syrian, East Indian goat hair, Corsican, Egyptian, Kalmuc, Scotch.	—	—	—	—	—	—	—	—	1	—	1	—	—	—	—	—	—	2
Van mohair, Persian, camel hair, alpaca	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Mohair, Persian, and other wools	—	—	1^{1}	—	1^{1}	—	4	—	7^{2}	2^{1}	2	1^{1}	—	—	1	—	—	19^{6}

Cape mohair, Cashmere -	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
Mohair, pelitan, Cashmere, camel hair -	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Turkey mohair, Russian camel hair -	—	—	—	1	—	1^{1}	—	1	—	1	—	—	—	—	—	—	—	4^{1}
Cape mohair, Russian camel hair -	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
Van mohair, camel hair -	—	—	—	—	—	—	2	—	—	—	—	—	—	—	—	—	—	2
Mohair, camel hair, East Indian goat hair	—	—	—	—	—	—	—	1	1	1^{1}	—	—	—	—	—	—	—	3^{1}
Cape Mohair, East Indian goat hair, Syrian, Corsican, Russian camel hair.	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Mohair, camel hair, alpaca -	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	1
Mohair, alpaca -	—	—	2^{2}	1	—	—	—	—	1	1	—	—	—	—	—	—	—	5^{2}
Total mohair alone and with other wools.	—	1	39^{11}	2	1^{1}	1^{1}	10^{1}	2	14^{3}	13^{5}	4^{1}	2^{2}	3^{2}	—	2	1	—	95^{27}

* This term is used to describe the process of willowing in a fearnought machine after washing, the wool being oiled at the same time.

TABLE II.—PERSIAN WOOLS.

Persian alone -	2	—	4^{1}	—	3^{2}	3^{1}	5^{1}	3^{1}	11^{4}	5^{1}	—	2^{1}	6	—	2	1	2^{1}	49^{13}
Persian, camel hair -	2^{1}	1	—	—	—	4^{2}	4	4	5^{1}	3	2	—	—	—	—	—	—	25^{4}
Persian, East Indian -	2	—	—	—	—	—	—	—	3^{1}	3	—	—	—	—	—	—	—	8^{1}
Persian, alpaca -	—	—	1	—	—	—	—	—	3^{1}	1^{1}	—	—	—	—	—	—	—	5^{2}
Persian, Egyptian -	—	—	—	—	—	—	—	—	—	1^{1}	—	—	—	—	—	—	—	1^{1}
Persian, camel hair, Egyptian -	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1
Persian, camel hair, alpaca -	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Persian, Egyptian, East Indian, Scotch -	—	—	—	—	—	—	1^{1}	—	—	—	—	—	—	—	—	—	—	1^{1}
Persian, East Indian goat hair, Syrian, Russian wool, Scotch.	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	1
Persian alone and with other wools and with mohair absent.	6^{1}	1	5^{1}	—	4^{2}	7^{3}	10^{2}	7^{1}	23^{7}	13^{3}	2	2^{1}	6	—	3	1	2^{1}	92^{23}
Persian, mohair, and other wools. (From Table I.).	—	—	1^{1}	—	1^{1}	—	4	—	7^{2}	2^{1}	2	1^{1}	—	—	1	—	—	19^{6}
Total Persian alone and with other wools.	6^{1}	1	6^{2}	—	5^{3}	7^{3}	14^{2}	7^{1}	30^{9}	15^{4}	4	3^{2}	6	—	4	1	2^{1}	111^{28}

WORSTED INDUSTRY.

Table III.—East Indian Wool and Goat Hair.

Wool manipulated. (1)	Raw Wool Warehouse. (2)	Opening. (3)	Sorting. (4)	Blending. (5)	Pulling Blends. (6)	Willowing. (7)	Washing. (8)	Oil Willowing. (9)	Card Room. (10)	Comb Room. (11)	Waste Willowing. (12)	Top Warehouse. (13)	Spinning. (14)	Weaving and Dyeing. (15)	Mechanics, &c. (16)	Not employed in Factory. (17)	Carters at Wharf, &c. (18)	Total. (19)
East Indian wool alone	1	—	5	—	—	—	3^{2}	—	2	—	—	—	—	1	1	—	—	13^{2}
East Indian goat hair alone	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
East Indian, Egyptian	—	—	—	—	—	—	—	—	1^{1}	—	—	—	—	—	—	—	—	1^{1}
East Indian, camel hair, alpaca	—	—	—	—	—	—	—	—	1^{1}	—	—	—	—	—	—	—	—	1^{1}
East Indian goat hair, Russian and China camel hair, Russian red lamb.	—	2^{1}	—	—	—	—	1^{1}	—	—	1^{1}	—	—	—	—	—	—	—	4^{3}
East Indian, Egyptian, Chili, Buenos Ayres, New Zealand.	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
Bradford Tops (chiefly East Indian)	—	—	—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	2
East Indian, Egyptian, New Zealand	1	—	2^{1}	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3^{1}
East Indian, Low Cape wool, Scotch	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—	1
East Indian alone, and with wools other than mohair and Persian.	2	2^{1}	7^{1}	—	—	—	6^{3}	—	5^{2}	1^{1}	—	—	2	1	1	—	—	27^{8}
East Indian with mohair, Persian, and other wools from Tables I. and II.	2	—	—	—	1	—	1^{1}	1	7^{2}	4^{1}	1	—	—	—	—	—	—	17^{4}
Total East Indian alone and with other wools.	4	2^{1}	7^{1}	—	1	—	7^{4}	1	12^{4}	5^{2}	1	—	2	1	1	—	—	44^{12}

TABLE IV.—CAMEL HAIR.

Russian camel hair alone	—	1	—	—	1^{1}	1	1^{1}	—	2^{1}	4^{3}	—	—	—	—	—	—	—	10^{6}
Russian camel hair, Egyptian	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	2
Camel hair, mohair, Persian, East Indian, and other wools. (From Tables I., II., III.).	2^{1}	3^{1}	—	1	—	5	8^{1}	6	11^{2}	8^{3}	4	—	1	—	1	—	—	50^{8}
Total camel hair alone and with other wools.	2^{1}	4^{1}	—	1	1^{1}	7	10^{2}	6	13^{3}	12^{6}	4	—	1	—	1	—	—	62^{14}

TABLE V.—ALPACA.

Alpaca alone	—	—	1^{1}	—	—	—	—	—	—	1	—	—	1	—	—	—	—	3^{1}
Alpaca, Egyptian	—	1	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	2
Alpaca, mohair, Persian, East Indian, camel hair and other wools. (From Tables I., II., III., IV.).	—	—	3^{2}	1	—	—	—	—	8^{3}	2^{1}	—	—	—	—	—	—	—	14^{6}
Total alpaca alone and with other wools.	—	1	4^{3}	1	—	—	—	—	8^{3}	4^{1}	—	—	1	—	—	—	—	19^{7}

TABLE VI.—OTHER WOOLS.

Home wool, colonial wool	2	—	—	—	—	—	2	—	3^{1}	1	—	1^{1}	—	—	—	—	—	9^{2}
Patagonian, colonial, Italian	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Spanish, Botany, Chilian	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	1
Waste (original wool unknown)	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1
Total other wools not usually regarded as dangerous.	2	—	2	—	—	—	2	—	4^{1}	1	—	1^{1}	—	—	—	—	—	12^{2}
Total cases for all wools 1899 to 1913.	10^{1}	6^{1}	54^{14}	2	6^{4}	10^{4}	38^{7}	9^{1}	48^{14}	34^{15}	6^{1}	5^{4}	12^{2}	1	6	2	2^{1}	243^{66}

WOOLLEN INDUSTRY.

Table VII.—East Indian Wool.

Material manipulated. (1)	* Warehouse. (2)	Blending. (3)	Willowing. (4)	Oil Willowing. (5)	Card Room. (6)	Spinning. (7)	Yarn Scouring, Dyeing, Printing. (8)	Winding, Weaving, &c. (9)	Cleaning out Dust Chamber. (10)	Waste Willowing. (11)	Occupier, Mechanic. (12)	Totals. (13)
East Indian wool alone	8^{1}	3	7^{2}	1	4	1	3	4	–	–	3	34^{3}
East Indian, Persian	1^{1}	–	–	–	–	–	–	1	–	–	–	2^{1}
East Indian, China wool	–	–	–	–	–	–	–	–	–	1^{1}	–	1^{1}
East Indian, Bradford noils	–	–	–	1	–	1	–	1	–	–	–	3
East Indian, Home noils	1	–	–	–	–	1	1	–	–	–	–	3
East Indian, Egyptian, Bradford (Persian) noils	–	–	–	–	1	–	–	–	–	–	–	1
East Indian, Syrian, Turkish, Egyptian, English, German, Oporto, Spanish, New Zealand, China wool, mohair noils	–	–	–	–	–	–	–	1	–	–	–	1
East Indian, New Zealand, English, shoddy	–	–	–	–	–	1	–	–	–	–	–	1
East Indian, Continental, English	–	–	1	1	1	1	–	–	–	–	–	4
East Indian, Continental, English, mohair noils	–	–	–	–	1	–	–	–	–	–	–	1
East Indian, Colonial, English	–	–	–	–	1	–	1^{1}	–	–	–	–	2^{1}
East Indian, Colonial, South American, China wool, Irish	–	–	–	–	–	–	–	–	1	–	–	1
East Indian, New Zealand, mohair noils	–	–	2	–	–	–	–	–	–	–	–	2
East Indian, mohair noils, chevrette, shoddy, mill waste, English	–	–	–	–	–	1	–	–	–	–	–	1
East Indian, mohair noils	–	–	–	1	1	–	–	–	–	–	–	2
East Indian, Cape wool, Egyptian, French, German, Oporto	–	–	–	–	–	–	–	1	–	–	–	1
East Indian, Algerian, Thibetan, Bulgarian (chiefly East Indian)	–	–	–	–	–	1	–	–	–	–	–	1
East Indian, foreign skin wool, oil bags, calf hair, waste	–	–	1	–	–	–	–	–	–	–	–	1
East Indian, Bradford noils, Russian fleece, Russian stockings, Hungarian, cow hair, English, Scotch, South American	–	1	–	–	–	–	–	–	–	–	–	1
East Indian, Continental hair, shoddy	–	–	–	–	–	–	–	1	–	–	–	1
East Indian, Bradford noils, black kid, shoddy	–	–	1^{1}	–	–	–	–	–	–	–	–	1^{1}
East Indian, China wool, New Zealand, Scotch, oil bags	–	–	–	–	1	–	–	–	–	–	–	1
White cow and calf hair, Russian stockings	–	–	1	–	–	–	–	–	–	–	–	1
Cow and calf hair, European goat hair, Bradford waste	–	–	–	–	–	–	1	–	–	–	–	1
Bradford noils, Home noils	–	–	–	1	–	–	–	–	–	–	–	1
Chevrette, mohair noils	–	–	–	–	–	1	–	–	–	–	–	1
Persian	–	2	2	–	1	1	–	1	–	–	–	7
English, Colonial (doubtful)	–	–	–	–	–	–	–	–	–	1	–	1
Not known	–	1	–	–	–	–	–	–	–	–	–	1
Totals	10^{2}	7	15^{3}	5	11	9	5^{1}	11	1	2^{1}	3	79^{7}

* Including cases in Liverpool dock warehouses.

FELT INDUSTRY.

TABLE VIII.—EAST INDIAN WOOL.

Material manipulated. (1)	Warehouse. (2)	Blending. (3)	Willowing. (4)	Card Room. (5)	Felt Finishing. (6)	TOTALS. (7)
East Indian, wool alone	1	2	7[1]	7[1]	1	18[2]
East Indian, Bradford noils.	–	1	–	4	–	5
East Indian, Persian, Bradford noils.	–	1	2	–	–	3
East Indian, Colonial	–	–	–	3	–	3
East Indian, Bradford noils, Colonial.	–	–	–	1	–	1
East Indian, Cape wool	–	–	–	1	–	1
East Indian, woollen mill waste.	–	–	1	–	–	1
East Indian, Bradford waste, crossbred noils	–	–	–	1	–	1
TOTALS	1	4	10[1]	17[1]	1	33[2]

APPENDIX 4.

ANALYSIS of CASES in BRADFORD DISTRICT.

Prepared by Mr. GEORGE ACKROYD.

During the eight years from 31st October, 1905, to 31st October, 1913, the Anthrax Investigation Board had 129 suspected cases of anthrax brought to their notice.

Nineteen of these cases proved not to be anthrax, or were doubtful, and they have not been taken into account in the yearly analyses.

Of the remaining 110 cases, two were from horse-hair factories.

The figures for the different years, together with the number of fatal cases (the internal form of anthrax being also noted), are given in the following table :—

TABLE A.

Year. (1)	Number of Cases. (2)	Doubtful. (3)	Authenticated. (4)	Non-fatal Cases. (5)	Fatal Cases. Total. (6)	Fatal Cases. Internal. (7)	Fatal Cases. External. (8)
1905–6	17	4	13	6	7	6	1
1906–7	12	2	10	7	3	1	2
1907–8	10	1	9	6	3	2	1
1908–9	18	6	12	10	2	1	1
1909–10	12	2	10	9	1	—	1
1910–11	19	—	19	11	8	5	3
1911–12	18	1	17	12	5	3	2
1912–13	23	3	20	17	3	1	2
Totals	129	19	110	78	32	19	13

TABLE B.

The occupations of the 32 fatal cases were as follows :—

Unwashed Wool.

—	Internal Cases.	External Cases.
Sorters	3	2
Wool runner or puller	2 (1 night)	—
Willower	2	—
Woolwasher	3 (1 night)	1 (night)
Total handling unwashed wool	10	3

Washed Wool.

Wool drier	1	—
Carders	4 (2 night)	3 (1 female).
Shoddy dust willower	—	1
Box minder	1 (female)	1
Comb minder	1	2 (2 females).
Top packer	—	2
Spinner	—	2 (1 female).
Total handling washed wool	7	11

Total internal	17
Plus "Not known"	1
Total external	14
	32
Total working at night	5
Total females	5

TABLE C.—The materials with which the fatal cases were in contact were as under:—

Material.	Before washing.	After washing.
(1)	(2)	(3)
Mohair	4 (1 external)	5 (2 females, 5 external).
Mohair and some other material.	1	2 (1 female, 2 external).
Mohair and Persian	1	4 (2 females, 2 external).
Persian and some other material.	2	—
Persian	—	4 (1 external).
Camel hair	1 (external)	—
Camel hair and some other material.	1	1
East Indian wool	1	—
East Indian and some other material.	1	—
English and colonial	—	1
Best Irish, New Zealand, and South American.	—	1 (external)
Scotch wool and Haslock (Yorks).	1 (external)	—
Totals	13 (10 internal, 3 external.)	18 (7 internal and 11 external) (15 females).
"Not known"	1	—

Out of the 107 cases (omitting one from "Angola waste"), 21 occurred in the preparing and combing processes and 86 in the carding and combing processes.

TABLE D.—The following table refers to the 21 cases from the "preparing" material:—

Before Washing.

Occupation.	Mohair.	Alpaca.	New Zealand Slipe and Sydney Wool.	Best Irish, New Zealand, and South American Wool.	Totals.
(1)	(2)	(3)	(4)	(5)	(6)
Sorters	14	—	1	—	15
Washbowl feeders	1	—	—	—	1
Totals before washing.	15	—	1	—	16
After Washing.					
Comber	1	—	—	—	1
Top or Noil Packer	1	—	—	1	2
Drawing or Spinning	1	1	—	—	2
Totals after washing	3	1	—	1	5
GRAND TOTALS	18	1	1	1	21

It will be noticed in Table D that 16 of these cases came in contact with the raw material and 5 after the washing process, but no case occurred between the washing and combing processes.

Six of the sorters and both the top or noil packers handled both preparing and carding materials, but the former predominated in each case.

TABLE E.—Analysis of the 86 Cases from the shorter or Carding Materials.

Occupations: Before Washing.

Occupations.	Mohair.	Mohair and —— †	Mohair and Persian.	Persian and —— †	Persian.	Camel Hair and —— †	East Indian and —— †	Unscheduled Materials.	Totals.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Sorters	3	—	—	—	2	—	—	2	7
Warehousemen	—	—	1 (foreman mechanic.)	1 (foreman.)	1	—	—	—	3
Wool pullers or runners	—	1	2	1	—	1	—	—	5
Willowers	—	—	—	1	—	2*	1	—	4
Washers	1	3	—	3	1	2	1	1	12
Packers before washing	1	—	—	—	1	—	—	—	2
						Total before washing			33

* One employed on camel hair alone.

† The symbol—indicates that one or more materials were manipulated in addition to that stated.

Occupations: After Washing.

Occupations.	Mohair.	Mohair and —— †	Mohair and Persian.	Persian and —— †	Persian.	Camel Hair and —— †	East Indian and —— †	Unscheduled Materials.	Totals.
Willowers after washing	—	2	1	3	—	1	—	—	7
Driers and woolrunners	—	—	—	1	2 (1 packer.)	—	—	—	3
Carders	—	3	2	9 (including 1 "unknown.")	2	—	1 jobber 1 fettler.	1	19
Card Grinders	—	—	2	1	2	—	—	1	6
Shoddy willowers	—	1	1	1	—	—	—	—	3
Box minders or ballers	1	1	1	—	—	—	—	1	4
Combers	1	—	2	1 (overlooker.)	—	1 (jobber.)	—	—	5
Finishers	1	—	1	—	1	—	—	—	3
Spinners	1 (overlooker.)	1	—	—	—	—	—	—	2
Top or noil packers	1*	—	—	—	—	—	—	—	1
						Total after washing			53
						GRAND TOTAL			86

* In this factory both preparing and carding materials are used, chiefly the latter, and it is so classed. Material, "Mohair alone."

Table E. refers to the occupations of the 86 cases where the materials were carded and combed.

It will be noticed that whereas with the longer or preparing materials, the proportion of workpeople contracting anthrax who came into contact with the materials in the raw state before they were washed, compared with those who came into contact with the same materials after washing is as 16 is to 5 (*see* Table D), the proportion with the carding or shorter sorts is as 33 is to 53, the larger number of cases thus actually occurring after the washing process.

In a measure this may possibly be accounted for by the number of cases amongst the sorters of the longer or preparing materials, the bulk of mohair being sorted and most of it prepared, though several of the sorters must also have handled carding sorts, but the difference in treatment will more probably give the real reason.

Table F. gives the materials which presumably conveyed the infection in each case, and is probably the most important of any and yet must be used with the greatest caution, for though anthrax is classed amongst the accidents to which the textile trade is liable, there is very rarely any actual indication of infection at the time of the contraction of the disease, or of the material causing the infection. We are thrown back upon presumption to decide which material has conveyed the infection. Sometimes this presumption is so strong as almost to amount to actual fact, but at other times it is very slight.

In addition to the 106 cases given there were two cases from horsehair factories, one case from angola waste, and one "unknown."

TABLE F.

Materials conveying Infection.

	Cases.	
Mohair alone	28	} 40
Mohair or some other specified material other than Persian	12	
Mohair or Persian		13
(In eight of these cases some other material also was handled.)		
Persian or some other specified material other than mohair.	21	} 33
Persian alone	12	
Total		86

	Cases
Camel hair	1
Camel hair with some other specified material apart from mohair or Persian.	6
Alpaca	1*
East Indian alone	1
East Indian or some other specified material apart from mohair or Persian.	3
Non-scheduled materials	8

* A spinner.

From this table it is evident that both mohair and Persian have been principal carriers of anthrax into the textile industry, for in 28 cases mohair was the only material and in 12 cases Persian was the only material upon which the persons contracting anthrax were employed.

Moreover, in five more cases only mohair and Persian were concerned.

Strictly Non-Scheduled Materials.—Apart from the two cases from horse-hair factories and case Number 19 (female), a waste sorter and puller, engaged on "angola (spinning and weaving) waste, principally shoddy waste," referred to in the annual report of the Anthrax Investigation Board for 1913, there were eight cases of anthrax reported to the Board during the eight years from factories not usually working any scheduled materials and using wools generally thought to be free from anthrax.

The following table gives these eight cases in detail :—

TABLE G.

Sorter	29 June 1909	Patagonian (60's merino) best colonial and medium Italian (unsorted).	A severe case.
"	17 October 1911	Scotch wool and Yorkshire Haslock.	No medical attendance.
"	October 1913	New Zealand Slipe and Sydney wool.	——
Washbowl feeder	31 January 1913	Chili, B.A., and New Zealand crossbred, good quality.	A mild case, not immediately recognised.
Card feeder	6 October 1908	English and colonial (best)	Internal.
Card grinder	17 July 1909	Medium English and colonial (sorted).	——
Box minder (female) previously employed as comber in low Persian.	7 February 1909	Good Buenos Ayres (crossbred) wool.	——
Top and noil packer	27 June 1908	Best Irish, New Zealand, and South American wools.	——

With the exception of the box minder, who had been employed a few days previously at another factory as a comber on low Persian wools, there is no indication of the probable source of infection.

Until greater knowledge of anthrax poisoning is acquired, such cases as these may be expected, for the history of anthrax constantly furnishes cases for which no trace of probable infection can be found.

The only reasonable hope of preventing such cases would seem to be in the prevention of anthrax amongst the flocks and herds from which the wool and hair used in the textile industry are derived.

APPENDIX 5.

Statistics prepared by F. W. Eurich, Esq., M.D. (Bacteriologist to the Anthrax Investigation Board).

Bacteriological Examination of Raw Material (Wool, Hair, &c.).

The object of the bacteriological examination of these materials has been two-fold: (1) to determine, if possible, the degree of risk attaching to the various kinds of wool and hair; and (2) to determine the value, if any, of naked-eye appearances, as an index of danger.

(1) During the first two years, 312 samples were tested; of these, 189 were samples of wool and hair, and 123 were samples of dust, mostly from suspected material. From these 312 samples, anthrax bacilli were cultivated four times only—twice from blood-stained Persian wool, and once from Persian wool dust, and once from alpaca dust—each of which gave reactions for blood. But, as the classification of the samples was unsatisfactory, and as my bacteriological methods had at first to be worked out and tested, I propose to leave out of consideration these results, and to base my conclusions upon the results obtained during the six following years.

In the course of these six years (1908–13 inclusive) 4,745 samples of wool, hair, and dust were tested for the presence of anthrax spores. A positive result was obtained on 311 occasions, *i.e.*, in 6·55 per cent. In addition, some isolated samples of English, Scotch, Australian, New Zealand, German, and other non-scheduled wools were tested—with negative results; they are not considered here.

The following table (Table A) gives a general grouping of the more important materials examined, and of the results obtained:—

Table A.—Materials examined.

Materials.	Total Samples examined.	Anthrax present.		Bloodstained Samples.			Samples not bloodstained.		
		Samples.	Per Cent.	Samples examined.	Anthrax present. Samples.	Anthrax present. Per Cent.	Samples examined.	Anthrax present. Samples.	Anthrax present. Per Cent.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Alpaca	396	3	0·75	365	3	0·8	31	0	—
Camel hair	123	5	4·06	81	5	6·1	42	0	—
Mohair (unclassified)	464	7	1·5	330	7	2·1	134	0	—
Van mohair	386	36	9·3	301	27	8·9	85	9	10·58
Turkey mohair	553	60	10·8	506	59	11·6	47	1	2·1
Cape mohair	630	88	13·9	550	87	15·8	80	1	1·25
Cape wool	6	1	—	1	1	—	5	0	—
East Indian wools	156	16	10·3	7	1	14·2	149	15	10·6
East Indian wools in blends	16	2	—	6	1	—	10	1	—
Cape and Turkey mohair	3	1	—	2	1	—	1	0	—
Syrian wools	13	1	—	13	1	—	0	0	—
Persian wools (unclassified).	544	17	3·12	449	14	3·10	95	3	3·15
Bagdad wools (unclassified).	104	10	9·6	97	9	9·27	7	1	14·2
Bagdad wools (not skin)	520	28	5·38	491	28	5·7	29	0	—
Bagdad skin wools	518	24	4·6	485	24	4·9	33	0	—
Bussorah wools (not skin)	223	6	2·69	209	6	2·8	14	0	—
Bussorah skin wool	49	2	4·08	49	2	4·08	0	0	—
Bushire wools (not skin)	27	1	3·7	22	1	4·5	5	0	—
Bushire skin wool	3	0	—	3	0	—	0	0	—
Karadi wool	6	1	—	4	0	—	2	1	—
Awassi wool	1	0	—	1	0	—	0	0	—
Khorassan wool	4	2	—	1	0	—	3	2	—

These figures do not give quite a true index of the relative danger, nor must they be compared too closely; (*a*) firstly, because some of the samples sent to me had been specially selected, while others had been taken haphazard; (*b*) secondly, it has happened that a series of samples from the same consignment, or taken from the same bale, has given positive results in very much larger proportion than the average. Thus, out of a consignment of 26 samples of East Indian wool, 6 (*i.e.*, 23 per cent.) contained anthrax spores; again, of 98 samples of Turkey skin mohair taken from 29 bags, 24 contained the spores of anthrax, and out of 137 samples, 123 of which were bloodstained, Cape thirds mohair mixed with skin mohair, taken from one bale, 59 (*i.e.*, 43 or 47·9 per cent.) gave a positive result; (*c*) thirdly, each kind of material must be classified according to origin and quality.

The following tables (Tables B to J) show such classification. No tabulation of the East Indian wools has been made as the samples belonged to wools of so many different sources and qualities that not more than two or three samples were found to represent the same species:—

Table B.—Unclassified Mohair.

Mohair	395	6	1·5	284	6	2·1	111	0	—
Mohair dockings	/15	—	—	15	—	—	—	—	—
Grey mohair	4	—	—	—	—	—	4	—	—
Grey mohair top	1	—	—	—	—	—	1	—	—
Inferior grey mohair	11	—	—	2	—	—	9	—	—
Scoured mohair	4	—	—	4	—	—	—	—	—
Washed mohair	20	1	5	19	1	5·2	1	—	—

Table B.—Unclassified Mohair—*continued.*

Materials.	Total Samples examined.	Anthrax present.		Bloodstained Samples.			Samples not bloodstained.		
		Samples.	Per Cent.	Samples examined.	Anthrax present.		Samples examined.	Anthrax present.	
					Samples.	Per Cent.		Samples.	Per Cent.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Mohair noil	5	—	—	—	—	—	5	—	—
Mohair top	3	—	—	—	—	—	3	—	—
Long preparing mohair	4	—	—	4	—	—	—	—	—
Mohair carding	2	—	—	2	—	—	—	—	—

Table C.—Van Mohair.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Van mohair	114	—	—	95*	—	—	19	—	—
Van mohair locks	1	—	—	1	—	—	—	—	—
Grey Van mohair	1	—	—	—	—	—	1	—	—
White Van mohair	1	1	—	—	—	—	1	1†	—
Van mohair top	1	—	—	—	—	—	1	—	—
Skin Van mohair	268	35	13·06	205	27	13·17	63	8	12·7

* 85 only slightly bloodstained.
† Only one colony obtained; probably contamination from sample of Persian.

Table D.—Cape Mohair.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Cape firsts	10	1	—	9	1	—	1	—	—
Cape mohair	335	22	6·5	283	22	7·7	52	—	—
Cape seconds	9	—	—	9	—	—	—	—	—
Cape thirds	32	1	3·1	31	1	3·2	1	—	—
Cape thirds (dockings)	15	—	—	15	—	—	—	—	—
Cape mohair (dockings)	40	—	—	33	—	—	7	—	—
Blue Cape mohair	1	1	—	1	1	—	—	—	—
First Cape blue mohair, damaged.	1	1	—	1	1	—	—	—	—
Cape winter mohair	4	—	—	1	—	—	3	—	—
Mixed Cape mohair	8	—	—	7	—	—	1	—	—
Dark grey Cape mohair	2	2	—	2	2	—	—	—	—
Cape seconds, skin	1	—	—	1	—	—	—	—	—
Cape thirds from pelt	2	—	—	2	—	—	—	—	—
Cape thirds, skin clipped	1	—	—	1	—	—	—	—	—
Cape skin mohair	32	1	3·1	31	1	3·2	1	—	—
Cape thirds, skin mohair	137*	59	43·1	123	59	47·9	14	—	—

* All from one bale.

Table E.—Turkey Mohair.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Turkey mohair	180	13	7·2	157	13	8·2	23	—	—
Turkey inferior	218	18	8·2	203	18	8·8	15	—	—
Turkey yellow mohair	2	—	—	—	—	—	2	—	—
Turkey yellow mohair, top.	1	—	—	—	—	—	1	—	—
Turkey mohair locks	7	—	—	7	—	—	—	—	—
Turkey mohair, fallen fleece.	1	—	—	1	—	—	—	—	—
Turkey mohair, washed and willeyed.	1	1	—	—	—	—	1	1	—
Turkey skin mohair	149	27	18·1	144	27	18·4	5	—	—
Turkey best kid skin	1	1	—	1	1	—	—	—	—

Table F.—Camel Hair.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Russian camel hair	78	4	5·5	54	4	7·4	24	—	—
China camel hair	3	—	—	1	—	—	2	—	—
Pekin camel hair	6	1	—	3	1	—	3	—	—
Mongolian camel hair	20	—	—	20	—	—	—	—	—
"Camel hair"	13	—	—	3	—	—	10	—	—
Camel hair, top and noil	3	—	—	—	—	—	3	—	—
Camel hair dust	1	—	—	—	—	—	1	—	—
Russian camel hair dust	1	—	—	—	—	—	1	—	—
China camel hair dust	1	—	—	—	—	—	1	—	—

Table G.—Unclassified Persian Wools.

Materials.	Total Samples examined.	Anthrax present. Samples.	Anthrax present. Per Cent.	Bloodstained Samples. Samples examined.	Bloodstained Samples. Anthrax present. Samples.	Bloodstained Samples. Anthrax present. Per Cent.	Samples not bloodstained. Samples examined.	Samples not bloodstained. Anthrax present. Samples.	Samples not bloodstained. Anthrax present. Per Cent.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
"Persian wool" - -	160	5	3·1	107	4	3·7	53	1	—
Brown Persian wool -	199	4	2·0	196	4	2·04	3	—	—
Brown Persian wool, washed, dried, and willeyed.	1	1	—	—	—	—	1	1	—
Brown Persian wool, washed and dried.	1	1	—	—	—	—	1	1	—
Fawn Persian wool - -	56	2	3·57	53	2	3·7	3	—	—
Fawn Persian wool, washed	1	—	—	1	—	—	—	—	—
Grey Persian wool - -	55	2	3·57	54	2	3·7	1	—	—
Grey Persian, washed -	1	—	—	—	—	—	1	—	—
Black Persian - - -	7	—	—	7	—	—	—	—	—
Brown and black Persian	3	1	—	3	1	—	—	—	—
Brown and grey Persian -	1	—	—	1	—	—	—	—	—
White Persian - -	1	—	—	—	—	—	1	—	—
Grey Persian, combed top	1	—	—	—	—	—	1	—	—
Black and brown Persian pieces.	1	1	—	1	1	—	—	—	—
Fawn Persian, combed top	1	—	—	—	—	—	1	—	—
Persian skin wool - -	30	—	—	14	—	—	16	—	—
Persian locks - - -	9	—	—	9	—	—	—	—	—
Brown Persian skin wool -	4	—	—	3	—	—	1	—	—
Persian noils - - -	1	—	—	—	—	—	1	—	—
Persian dust - - -	11	—	—	—	—	—	11	—	—

Table H.—Bagdad Wools (Unclassified).

Brown Bagdad - -	34	4	11·7	31	4	12·9	3	—	—
Fawn Bagdad - - -	25	2	8·0	25	2	8·0	—	—	—
Grey Bagdad - - -	6	—	—	4	—	—	2	—	—
"Bagdad wool" - -	5	—	—	4	—	—	1	—	—
Brown and black Bagdad	3	—	—	3	—	—	—	—	—
Brown and mixed Bagdad	2	—	—	2	—	—	—	—	—
Brown and grey Bagdad -	1	—	—	1	—	—	—	—	—
Grey and mixed Bagdad -	27	3	11·1	27	3	11·1	—	—	—
Combed top from brown Bagdad.	1	1	—	—	—	—	1	1	—

Table I.—Bagdad Skin Wools.

Fawn Bagdad skin fleece pieces.	1	—	—	1	—	—	—	—	—
Fawn Bagdad skin pieces	23	1	4·3	23	1	4·3	—	—	—
Fawn Bagdad skin matching.	1	1	—	1	1	—	—	—	—
Grey Bagdad skin pieces -	1	—	—	1	—	—	—	—	—
White Bagdad skin fleece pieces.	1	—	—	1	—	—	—	—	—
White Bagdad skin pieces	16	1	—	16	1	—	—	—	—
Brown Bagdad skin pieces	85	10	11·7	83	10	11·7	2	—	—
Brown Bagdad skin locks	3	—	—	3	—	—	—	—	—
Brown Bagdad skin wool -	70	4	5·7	65	4	6·1	5	—	—
Fawn Bagdad skin wool -	31	—	—	30	—	—	1	—	—
Fawn Bagdad skin fleece -	20	2	10·0	20	2	10·0	—	—	—
Grey Bagdad skin wool -	7	—	—	7	—	—	—	—	—
Grey Bagdad skin fleece -	40	1	2·5	36	1	2·7	4	—	—
White Bagdad skin wool -	7	—	—	6	—	—	1	—	—
"Bagdad" skin wool -	31	4	12·9	21	4	19·0	10	—	—
White Bagdad skin fleece	53	—	—	45	—	—	8	—	—
Brown Bagdad skin fleece	128	—	—	127	—	—	1	—	—

TABLE J.—BAGDAD WOOLS (NOT SKIN).

Materials.	Total Samples examined.	Anthrax present.		Bloodstained Samples.			Samples not bloodstained.		
		Samples.	Per Cent.	Samples examined.	Anthrax present.		Samples examined.	Anthrax present	
					Samples.	Per Cent.		Samples.	Per Cent
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Fawn Bagdad pieces	55	—	—	55	—	—	—	—	—
Fawn Bagdad fleece pieces	63	6	9·5	60	6	10·0	3	—	—
Fawn Bagdad locks	15	—	—	14	—	—	1	—	—
Fawn Bagdad britch matching.	6	—	—	6	—	—	—	—	—
Grey Bagdad locks	3	—	—	2	—	—	1	—	—
White Bagdad fleece pieces.	20	2	10·0	17	2	11·7	3	—	—
Grey Bagdad fleece pieces	1	—	—	1	—	—	—	—	—
Grey Bagdad pieces	8	—	—	8	—	—	—	—	—
Bagdad pieces	4	—	—	3	—	—	1	—	—
Brown Bagdad pieces	157	6	3·8	150	6	4·0	7	—	—
Brown Bagdad locks	82	13	15·8	79	13	16·4	3	—	—
Brown Bagdad fleece pieces.	40	—	—	36	—	—	4	—	—
Fawn Bagdad fleece wool	18	—	—	18	—	—	—	—	—
Grey Bagdad dockings	1	—	—	1	—	—	—	—	—
Grey bagaad fleece wool	14	—	—	12	—	—	2	—	—
White Bagdad fleece wool	1	—	—	1	—	—	—	—	—
Brown Bagdad fleece wool	32	1	3·1	28	1	3·5	4	—	—

APPENDIX 6.

REPORT submitted to the ANTHRAX INVESTIGATION BOARD for BRADFORD and DISTRICT by Mr. GEO. H. FEATHER on two cases of ANTHRAX which arose during the TREATMENT of PERSIAN WOOL.

Bradford, 12th May 1911.

The report I have to submit to the Board refers to two cases of anthrax (one fatal, one non-fatal)—Nos. 5 and 6—which occurred in January last.

These two cases arose from Persian wool, and as No. 5 was the first fatal case to my knowledge from any wool bought by our firm (who have been in this trade for over 40 years) and also the first fatal case at the combers (Messrs. John Crossley and Sons, Ltd., of Wheatley, near Halifax)—who have been combing these wools for 30 to 40 years—both firms were greatly concerned, and agreed, in consultation, to take further steps to prevent any blood-stained wool passing the machines.

This wool was blended in four blends, the first ¼-blend being in operation when the two men were attacked. No blood-stained wool was sorted out by the sorters in the first ¼-blend, although they had strict instructions to look for it and sort it out, and a premium given to them for finding it. Moreover they had found it in previous lots.

It was therefore determined to employ an overlooker for the sorters, whose sole duty was to see all wool as it passed from the sorters' hands and prevent any blood-stained escaping their notice. An extra premium was also offered to the sorters for all blood-stained wool removed by them. The britch sorted out from the first ¼-blend, being in matching and uncombed, was re-sorted and blood-stained wool found. The remaining three ¼-blends were sorted with these additional precautions, and 105 samples of blood-stained wool were sorted out, the weight being ·00049 per cent. of the bulk, or ·49 lbs. per 1,000 lbs., or in round figures, ½ lb. per 1,000 lbs. unsorted wool. Of the 105 samples, six were found by Dr. Eurich to contain no blood, leaving 99 samples actually blood-stained. All the samples were tested bacteriologically by Dr. Eurich, who found anthrax present in 10 samples, or, roughly speaking, 10 per cent.

These three ¼-blends were combed without any cases of anthrax occurring, therefore it is quite safe to say that had not the blood-stained been sorted out there might have been cases of anthrax, as in the first ¼-blend which went through the machines with the blood-stains left in.

This experience, in my opinion, entirely confirms the conclusions arrived at by Dr. Eurich in 1908, that blood-stained material and the dust arising therefrom were the means of spreading anthrax spores and the carriers of anthrax, and also confirms the advice given by the Board in their reports of that year and repeated in their reports of 1909 and 1910, that all blood-stained wool should be sorted out.

The weight of blood-stained is very insignificant, but the probabilities of anthrax from such a weight seem very great. The cost of sorting out the blood-stained, even with the extra cost of an overlooker for the sorters, is not very great, and could, in my opinion, be safely borne without doing any injury to the trade. Strict observations have been kept on this lot of wool as to where and what class of Persian wool (for there is more than one class) the blood-stained wool came from, and knowledge has been gained which is entirely at the disposal of the Board.

In concluding this report I would like to say that, although the sorters showed some negligence in the first blend, on realising the importance of their work, and by the appointment of the overlooker, they are now very vigilant, and have not much difficulty in finding blood-stained, even in dark-coloured wool.

I would also like to acknowledge the co-operation and determination of the combers (Messrs. John Crossley and Sons, Ltd.), who did all they could to remove the risk of anthrax, and who have been so impressed with the experience gained by the success attending this lot they they have decided to apply the same protective treatment to all future scheduled materials.

(Signed) GEO. H. FEATHER.

APPENDIX 7.

Circular Letter issued to London Wool Brokers by the Anthrax Investigation Board for Bradford and District for transmission to the Exporters in Persia, &c., of Persian Wool.

Danger arising from Bagdad and Persian Gulf Wools owing to Presence of Blood-clots, and Blood-stained Wool and Locks and Pieces being wrapped up in the Fleece.

Dear Sir, June 1911.

A fatal case of anthrax from Bagdad wool having occurred at a comber's works who had been combing these wools for 30 to 40 years, and who had never previously had a fatal case, it was determined by the firm who had bought the wool, and the combers, to have the cause strictly investigated.

This fatal case (along with one non-fatal) was infected by fawn Bagdad wool, and as only a quarter of the lot was in operation when the two men were attacked, there were three quarters of the wool still to sort and comb. It was therefore determined, although all necessary precautions had been taken, that an overlooker should be engaged to see that the sorters carried out the instructions of the Anthrax Investigation Board to sort out *all* blood-stained wool. No blood-stained wool had been sorted out of the first quarter blend, but under the supervision of the overlooker, and with the aid of an extra premium to the sorters, 105 samples (representing 105 bales) were sorted out of the remaining three quarter blends. Six of these samples were found by Dr. Eurich (bacteriologist to the Anthrax Investigation Board) to contain no blood, leaving 99 actually blood-stained. These were tested bacteriologically by Dr. Eurich, who found anthrax in 10 samples, or roughly speaking 10 per cent. Strict observations were kept as to what part of the wool the blood-stained was found, and in nine of the samples containing anthrax the blood-stained was found amongst the pieces or locks, which are *wrongly* placed inside the fleeces, the remaining infected sample being found on a skin fleece. It is the opinion of Dr. Eurich, as he had made the most perfect culture from some of them that he had ever seen, that had not this blood-stained wool been sorted out, in all likelihood cases of anthrax would have resulted. The remaining three quarter blends were combed, and no case of anthrax occurred.

In another lot of Bagdad wool, immediately following the above lot, a very badly blood-stained fleece was found, in fact so bad that the sorters were not allowed to sort it. It was unrolled and examined minutely by two members of the Anthrax Investigation Board, who found it to be of a very short staple, and whilst not being able to call it a fallen fleece, it had the appearance of being from a dead sheep, as the staple was of a dead or lifeless nature. This fleece was tested bacteriologically by Dr. Eurich and found to contain anthrax in abundance. No more blood-stained was found in that particular lot, therefore the presence of that one fleece was sufficient to affect a whole consignment and condemn as dangerous wool which, if it did not contain "blood-stained," might possibly become classed as non-dangerous.

The weight of the fleece, even with some foreign locks *wrongly* placed inside, was only 2 lbs.

The weights of blood-stained in five completed lots of Bagdad wool have been ascertained as under:—

¼ lb.	per 1,000 lbs.	unsorted	wool.
½ lb.	„	„	„
1·07 lb.	„	„	„
1·03 lb.	„	„	„
2·2 lb.	„	„	„

There has been a great increase of anthrax in Bradford and district from wools from Persian Gulf during the last five or six years, for there occurred:—

In 1906, six cases (three fatal).
„ 1907, four cases.
„ 1908, two cases.
„ 1909, five cases.
„ 1910, eight cases.

Up to May 1911, five cases (two fatal).

in which Persian wool has been worked.

The experience thus recently gained with Bagdad and Persian Gulf wools corresponds with that obtained from Turkey mohair, to which allusion was made in the report issued last year.

Anthrax was cultivated from eight different samples of blood-stained mohair, each taken separately, from a lot of Turkey inferior bags with which a workman, who had fallen a victim to anthrax, had come in contact.

As a consequence all users of this class of mohair are now having it looked over, for the purpose of throwing out all blood-stained hair before the mohair is put into work.

Whilst the danger from anthrax in the manufacturing processes is thus lessened, it is very evident that the value of Turkey inferior, and all similar sorts likely to contain blood-stained material, will fall considerably below the price they would otherwise command were the blood-stained material turned out instead of being mixed with the wool or hair sent to this country.

To a certain extent this is a repetition of what has happened to Van Mohair. That class of mohair commands now a much lower price than was formerly the case, in proportion to other classes of mohairs of similar quality owing to the restrictions under which alone it can now be worked.

It is, moreover, certain that if the present methods do not result in lessening the danger from anthrax, greater precautions will have to be taken, more onerous regulations will be enforced, and a restricted use of all Bagdad and Persian Gulf wools and of inferior mohair will follow.

The danger from blood-stained material arises as follows:—The blood of an animal dying of anthrax contains a large quantity of the anthrax bacilli. These upon exposure to the air develop spores, capable of germinating and producing anthrax—a sickness frequently fatal both to men and animals—months or years afterwards. These spores have a very strong vitality and are with difficulty destroyed. Hidden in the albumen of the blood they are found in the dried blood-clots and become attached (through the albumen) to the fibres of wool or hair, so that no washing or scouring process will entirely dislodge them, or indeed break up all the blood-clots. These contaminated fibres and the blood-clots are, however, separated, or more correctly, "torn asunder" in the subsequent process of carding, when the material is again in the dried state, and the spores or anthrax seeds are thus set at liberty, thrown into the air, and become a grave danger to the workmen.

The Anthrax Investigation Board are now quite satisfied that the danger from anthrax practically arises entirely from the presence of blood on the fibres of wool or hair, and they are convinced that if all the "blood-stained" could be thrown out, anthrax need no longer be feared. They therefore earnestly press upon all importers of Bagbad and Persian Gulf wools and of mohair the absolute necessity to—

1. Throw out all clots of blood and blood-stained material.
2. Discontinue the practice of putting locks and pieces inside the fleeces.

   N.B.—This is the cause of the greatest danger, nine-tenths of the anthrax cultivations having come from the locks and pieces.

3. Pack locks and pieces by themselves into special bales.
4. Cleanse wool from soil and sand as much as possible.

I am, &c.,
P. Anderson
(Secretary of the Anthrax Investigation Board).

APPENDIX 8.

Statistics relating to Bloodstained Wool. Prepared by Mr. George Henry Feather, Director of the firm of Messrs. John Feather and Son, Ltd., Bradford.

During 1911, 1912 and 1913 careful records were kept relating to the Persian wool combed for my firm. The object of this was to ascertain the source of the bloodstained and possibly infected material. The skilled sorters employed were instructed to keep the blood-stained material found in the locks separate from that found in the pieces and also from that found in the fleece wool itself.

Each lot of bloodstained wool, from locks, pieces, and fleece wool respectively, was weighed separately and careful record kept as to the wool in which they were found. The results are contained in the following tables, A to E. They clearly show that most of the bloodstained material is found amongst the locks and pieces which are wrongly packed inside the fleeces. Assuming, as seems clearly demonstrated by Dr. Eurich, that the danger lies chiefly in the bloodstained wool, it is clear that if locks and pieces were absent the danger of infection would be to a very large extent removed.

Table A.—Bagdad Fleece Wools.

Lot.	1. No. of Bales.	2. Net Weight.	3. No. of Blood-stained Samples.	4. No. of Bales containing Blood-stained Material.	5. No. of Bales free from Blood-stained Material.	6. Weight of Blood-stained Locks.	7. Weight of Blood-stained Pieces.	8. Weight of Blood-stained Fleece.	9. Weight of Bloodstained Material per 1,000 lbs. of Wool. Locks.	Pieces.	Fleece.
		Lbs.				Lbs. ozs.	Lbs. ozs.	Lbs. ozs.	Ozs.	Ozs.	Ozs.
1	28	9,104	16	9	18	5 12	—	—	10·08	—	—
	28	9,104	1	1		—	—	0 6	—	—	0·66
2	259	83,277	189	135	118	97 5	—	—	18·56	—	—
	259	83,277	8	6		—	—	4 8	—	—	0·86
3	109	35,539	26	25	68	—	15 14	—	—	7·20	—
	109	35,539	16	14		7 12	—	—	3·52	—	—
	109	35,539	2	2		—	—	1 4	—	—	0·56
4	110	35,610	36	27	42	—	27 6	—	—	12·16	—
	110	35,610	40	38		21 6	—	—	9·44	—	—
	110	35,610	6	3		—	—	8 12	—	—	4·0
5	9	2,687	1	1	6	0 8	—	—	3·04	—	—
	9	2,687	2	2		—	2 4	—	—	13·44	—
6	32	10,630	14	12	16	9 0	—	—	13·44	—	—
	32	10,630	4	4		—	1 0	—	—	1·60	—
7	75	24,938	39	31	41	16 0	—	—	10·24	—	—
	75	24,938	5	3		—	3 4	—	—	2·08	—
8	25	8,390	22	15	9	12 4	—	—	23·68	—	—
	25	8,390	1	1		—	0 2	—	—	—	—
9	473	157,475	398	315	106	158 10	—	—	16·16	—	—
	473	157,475	62	52		—	33 4	—	—	3·36	—
10	230	76,337	32	18	102	—	23 6	—	—	4·96	—
	230	76,337	152	110		68 3	—	—	14·24	—	—
11	46	14,434	20	17	8	12 2	—	—	13·28	—	—
	46	14,434	25	21		—	23 7	—	—	25·44	—
12	26	8,892	27	18	0	—	11 15	—	—	21·60	—
	26	8,892	14	8		4 0	—	—	7·20	—	—
13	6	1,764	13	6	0	5 7	—	—	49·28	—	—
	6	1,764	1	6		—	—	0 9	—	—	5·12
14	62	20,044	141	62	0	100 0	—	—	79·84	—	—
	62	20,044	4	62		—	—	1 4	—	—	1·0
15	22	7,494	42	21	1	11 4	—	—	24·0	—	—
16	273	90,118	115	100	93	48 4	—	—	8·48	—	—
	273	90,118	210	80		—	118 15	—	—	21·12	—
	273	90,118	2	80		—	—	0 12	—	—	0·13
17	253	82,016	137	111	96	68 12	—	—	13·28	—	—
	253	82,016	115	46		—	91 1	—	—	17·76	—
	253	82,016	2	46		—	—	0 12	—	—	0·15
18	12	3,575	5	3	9	1 12	—	—	7·84	—	—
19	91	28,719	83	81	10	23 12	—	—	13·12	—	—
20	24	7,883	15	8	16	—	1 10	—	—	3·36	—
21	7	2,381	10	5	2	4 11	—	—	31·52	—	—
22	68	22,688	58	29	39	23 11	—	—	16·64	—	—
23	183	61,037	96	56	91	31 0	—	—	8·16	—	—
	183	61,037	54	36		—	21 3	—	—	5·60	—
24	2	682	0	0	2	—	—	—	—	—	—
25	38	12,950	0	0	38	—	—	—	—	—	—
26	191	65,559	2	2	189	—	0 4	—	—	0·06	—
27	160	54,216	0	0	160	—	—	—	—	—	—
28	58	19,604	4	2	51	—	2 12	—	—	2·24	—
	58	19,604	9	5		7 11	—	—	6·24	—	—
29	40	13,073	25	17	19	7 14	—	—	9·60	—	—
	40	13,073	6	4		—	2 10	—	—	3·36	—
Totals	2,912	961,116	2,307	1,562	1,350	747 0	380 5	18 3	—	—	—

Bloodstained bales - - - - - - - 1,562 or 53·64 per cent.
Non-bloodstained bales - - - - - - 1,350 or 43·36 per cent.

Total bales - - - - 2,912

Bloodstained locks - 747 lbs. or 0·78 lbs. per 1,000 lbs. (total weight as above).
Bloodstained pieces - 380 lbs. 5 ozs. or 0·39 lbs. per 1,000 lbs. (total weight as above).

1·17 lbs. per 1,000 lbs. from insides of fleeces.

Bloodstained fleece 18 lbs. 3 ozs. or 0·30 ozs. per 1,000 lbs. from fleeces only.

TABLE B.—BAGDAD SKIN WOOLS.

Lot.	1. No. of Bales.	2. Net Weight.	3. No. of Blood-stained Samples.	4. No. of Bales containing Blood-stained Material.	5. No. of Bales free from Blood-stained Material.	6. Weight of Blood-stained Locks.	7. Weight of Blood-stained Pieces.	8. Weight of Blood-stained Skin Fleece.	9. Weight of Bloodstained Material per 1,000 lbs. of Wool. Locks.	Pieces.	Fleece.
		Lbs.				Lbs. ozs.	Lbs. ozs.	Lbs. ozs.	Ozs.	Ozs.	Ozs.
1	5	1,667	12	5	0	—	—	9 4	—	—	88·80
2	46	15,412	108	46	0	—	—	80 5	—	—	83·04
3	15	4,885	34	15	0	—	—	23 14	—	—	78·56
4	14	4,661	39	14	0	—	—	36 0	—	—	123·52
5	4	1,309	9	4	0	—	—	10 2	—	—	123·68
6 {	11	3,726	28	11	0	—	—	23 7	—	—	100·64
	11	3,726	12	11	0	—	8 13	—	—	37·76	—
7	3	1,024	7	3	0	—	—	5 6	—	—	84·00
8	52	17,615	127	51	1	—	—	101 5	—	—	91·68
9 {	31	10,529	66	31	0	—	—	58 6	—	—	88·16
	31	10,529	75	31	0	—	67 2	—	—	101·76	—
10	98	31,154	249	98	0	—	—	161 12	—	—	83·04
11 {	144	45,750	399	143	1	—	—	309 2	—	—	108·00
	144	45,750	3	143	1	—	0 12	—	—	0·26	—
12	15	4,982	35	15	0	—	—	21 10	—	—	69·44
13 {	7	2,221	10	6	1	—	—	12 9	—	—	90·40
	7	2,221	7	6	1	7 5	—	—	52·64	—	—
14 {	58	18,333	111	57	1	—	—	95 11	—	—	83·52
	58	18,333	60	57	1	59 12	—	—	52·16	—	—
15	74	23,846	220	74	0	—	—	290 14	—	—	134·72
16	4	1,237	10	4	0	7 14	—	—	101·92	—	—
17	5	1,675	11	5	0	—	—	7 6	—	—	70·40
18	4	1,367	11	4	0	—	—	6 12	—	—	79·04
Totals -	590	191,393	1,643	586	4	74 15	76 11	1,163 13	—	—	—

Bloodstained bales - - - - - - - - - - - - 586
Non-bloodstained bales - - - - - - - - - - - 4

Total bales - - - - - - - - - - - 590

Bloodstained locks - 74 lbs. 15 ozs. or 0·39 lbs. per 1,000 lbs. (total weight as above).
Bloodstained pieces - 76 lbs. 11 ozs. or 0·40 lbs. per 1,000 lbs. (total weight as above).

0·79 lbs. per 1,000 lbs. (total weight as above), from inside of fleeces.

Bloodstained skin fleece - 1,163 lbs. 13 ozs. or 6·08 lbs. per 1,000 lbs. from skin fleeces.

TABLE C.—BUSSORAH SKIN WOOLS.

Lot.	1.	2.	3.	4.	5.	6.	7.	8.	9. Locks.	Pieces.	Fleece.
1 {	7	2,109	14	3	0	—	—	18 12	—	—	142·24
	7	2,109	11	4	0	—	13 4	—	—	100·48	—
2	9	3,061	31	9	0	—	—	35 0	—	—	182·88
3 {	11	3,818	38	11	0	—	—	54 8	—	—	228·32
	11	3,818	2	11	0	—	0 10	—	—	2·56	—
4	5	1,736	2	1	4	—	0 8	—	—	4·64	—
Totals -	32	10,724	98	28	4	—	14 6	108 4	—	—	—

Bloodstained bales - - - - - - - - - - 28 or 87½ per cent.
Non-bloodstained bales - - - - - - - - - 4 or 12½ per cent.

Total bales - - - - - 32

Bloodstained pieces - - 14 lbs. 6 ozs. or 1·34 lbs. per 1,000 lbs. (total weight as above).
Bloodstained skin fleece - 108 lbs. 4 ozs. or 10·09 lbs. per 1,000 lbs. (total weight as above).

Table D.—Bussorah Fleece Wools.

Lot.	1. No. of Bales.	2. Net Weight.	3. No. of Blood-stained Samples.	4. No. of Bales containing Blood-stained Material.	5. No. of Bales free from Blood-stained Material.	6. Weight of Blood-stained Locks.	7. Weight of Blood-stained Pieces.	8. Weight of Blood-stained Fleece.	9. Weight of Bloodstained Material per 1,000 lbs. of Wool. Locks.	Pieces.	Fleece.
		Lbs.			—	Lbs. ozs.	Lbs. ozs.	Lbs. ozs.	Ozs.	Ozs.	Ozs.
1	7	2,427	8	6	1	—	4 14	—	—	32·16	—
2	64	21,722	47	33	31	—	36 6	—	—	26·56	—
3 {	6	2,141	3	3	} 2 {	—	4 2	—	—	30·72	—
	6	2,141	1	1		—	—	1 8	—	—	11·20
4	47	16,476	31	31	16	—	20 0	—	—	19·36	—
5 {	71	24,393	44	40	} 6 {	—	55 2	—	—	36·00	—
	71	24,393	30	25		26 12	—	—	17·76	—	—
6 {	5	1,735	1	1	0	—	—	0 12	—	—	6·88
	5	1,735	9	4	0	—	7 12	—	—	71·52	—
7	2	740	4	2	0	—	—	2 12	—	—	59·36
8	3	1,022	2	1	2	—	—	1 8	—	—	23·36
9	1	376	3	1	0	—	4 4	—	—	180·80	—
10	2	698	4	2	0	—	2 14	—	—	65·92	—
11	9	2,312	8	4	5	—	1 11	—	—	11·68	—
12	80	21,096	42	27	53	—	8 11	—	—	6·56	—
13	231	79,795	92	69	162	—	94 0	—	—	18·88	—
14	30	10,382	45	21	9	—	41 12	—	—	64·32	—
15	23	7,837	14	10	13	—	14 0	—	—	28·64	—
16	115	39,284	135	87	28	—	69 10	—	—	28·32	—
17	81	27,714	72	50	31	—	57 2	—	—	32·96	—
18	2	693	5	2	0	—	1 10	—	—	37·44	—
Totals	779	260,843	600	420	359	26 12	423 14	6 8	—	—	—

Bloodstained bales - - - - - - 420 or 53·91 per cent.
Non-bloodstained bales - - - - - 359 or 46·09 per cent.

Total bales - - - - - 779

Bloodstained locks - 26 lbs. 12 ozs. or 0·10 lbs. per 1,000 lbs. (total weight as above).
Bloodstained pieces - 423 lbs. 14 ozs. or 1·62 lbs. per 1,000 lbs. (total weight as above).

1·72 lbs. per 1,000 lbs.

Bloodstained fleece - 6 lbs. 8 ozs. or 0·40 ozs. per 1,000 lbs. (total weight as above).

Table E.—Bushire Fleece Wools.

1	15	4,233	3	3	12	—	0 8	—	—	1·92	—
2 {	137	38,916	24	24	} 75 {	—	—	10 12	—	—	4·48
	137	38,916	39	38		—	17 10	—	—	7·36	—
3 {	57	16,645	9	8	} 33 {	—	—	5 0	—	—	4·80
	57	16,645	16	16		—	7 0	—	—	6·72	—
4	3	920	3	3	0	—	2 4	—	—	39·04	—
5	9	2,312	8	4	5	—	1 11	—	—	11·68	—
6	80	21,096	42	27	53	—	8 11	—	—	6·56	—
7	38	10,043	18	12	26	—	5 11	—	—	8·96	—
8	4	1,254	1	1	3	—	0 2	—	—	1–60	—
Totals	343	95,419	163	136	207	—	43 9	15 12	—	—	—

Bloodstained bales - - - - - - 136 or 39·65 per cent.
Non-bloodstained bales - - - - - 207 or 60·35 per cent.

Total bales - - - - - 343

Bloodstained pieces - 43 lbs. 9 ozs. or 0·45 lbs. per 1,000 lbs. (total weight as above).
Bloodstained fleeces - 15 lbs. 12 ozs or 0·16 lbs. per 1,000 lbs. (total weight as above).

APPENDIX 9.

CIRCULAR signed by the CHIEF BUYERS of PERSIAN WOOLS protesting against FALSE PACKING of PERSIAN WOOLS.

TO THE IMPORTERS OF BAGDAD WOOL.

We, the undersigned buyers of Bagdad wools, most emphatically protest against the false packing of these wools, which has been worse than ever this season.

Owing to the large increase of anthrax arising from Bagdad wool, more drastic regulations have been issued in the last few years by the Government to the users, and, if this disease shows no abatement, still more drastic regulations may be expected which will tend to increase the cost of working, and thus make the wool of less value to the user.

We would therefore urge upon you the importance of at once altering the manner of packing, and keeping out all locks and *débris* which, in our opinion, are the direct cause of the increase of anthrax.

These locks (which contain all sorts of extraneous matter such as cotton, threads, and feathers, which it is impossible to sort out, and which is very detrimental to all users) could be packed separately and treated in a special and safer manner not needed for the bulk of the wool.

Further, the ends of the fleeces should not be tied into knots, and thus the expense of untying would be saved and all risk of damage avoided.

We do not desire to put undue pressure upon you, but we must add that if the method of putting the locks, &c., inside the fleeces continues, we shall have to take further steps by combination or otherwise for our protection.

SUGDEN KEIGHLEY & Co., LIMITED.
F. WHITE & CO.
S. FEATHER
(JOHN FEATHER & SON, LIMITED).
J. C. ICKRINGILL
(IRA ICKRINGILL & Co., LIMITED).
JOHN BRINTON
(BRINTONS, LIMITED), Kidderminster.
E. A. BROOME
(EDW. A. BROOME), Kidderminster.
T. & A. NAYLOR,
Kidderminster.
ALEX. WILSON & Co.,
Dunblane, Scotland.

March 1905.

APPENDIX 10.

NOTE supplied by Mr. GEORGE FEATHER as to the QUANTITY of BLOODSTAINS sorted out of PERSIAN WOOL by the SORTERS in the Factory of Messrs. CAMPBELL AND HARRISON, Ltd.

Material.	Period 1911–13. Pounds of Blood per 1,000 lbs. of Material.	Period May 2nd to October 31st, 1914. Pounds of Blood per 1,000 lbs. of Material.	Period from August 1915 to March 10th, 1916. Pounds of Blood per 1,000 lbs. of Material.
Bagdad fleece, locks, and pieces	1·191 (from 2,912 bales).	9·251 (from 1,417 bales).	8·30 (from 394 bales).
Bagdad skin fleece, locks, and pieces.	6·87 (from 590 bales).	27·05 (from 340 bales).	16·50 (from 175 bales).
Bussorah fleece, locks, and pieces	1·74 (from 779 bales).	9·09 (from 236 bales).	12·75 (from 396 bales).
Bussorah skin fleece, locks, and pieces.	11·43 (from 32 bales).	26·26 (from 51 bales).	56·47 (from 33 bales).

The reason for the increase may be that there is more blood in the material than formerly, but it is certainly due in some measure to the instructions given by Mr. Campbell and myself that everything which is doubtful is to be regarded as a bloodstain and must be removed. Consequently, sorters may have sorted out more, and also some which is not bloodstained. The increase in Bussorah may partly be accounted for by some of the material being heavier in grease. The decrease in the quantity of bloodstains removed from Bagdad skin wool, and, in a less degree, in Bagdad fleece wool, in the third period is worthy of remark. Skin fleeces are now often found in ordinary fleece bales, which might account for the decreased quantity found in the fleece material.

APPENDIX 11.

FORM of REPORT to the EMPLOYERS used by Dr. MITCHELL.

Copy of the form of report to the employers used by Dr. Mitchell, who is appointed by a large firm of woolcombers to examine any person employed by them in the manipulation of dangerous wool who is absent from work through illness or/who is found to be suffering from any affection, *e.g.*, pimples, which may prove to be anthrax. The procedure is as follows:— in the case of a person absent from work inquiries are made by a representative of the firm, and if the absent worker is found to be suffering from any ailment likely to be anthrax, Dr. Mitchell is at once notified and he then makes an examination. In the event of any person developing a pimple or other affection while continuing to work, he reports to the foreman and is sent to Dr. Mitchell for examination. The object is to ensure the early diagnosis and treatment of anthrax. (*See* Appendix 12.)

Medical Report for Woolcombers, Limited, Bradford.

Name
Age
Occupation
Variety of wool handled
Address
Employed by
When last at work
When notified to me
When called on or seen by me
Said to be suffering from
Name of medical man in attendance
Whether seen with own medical attendant or not
Married or single
Dependants
Pulse
Temperature { Mouth / Axilla / Rectum
Respiration
General symptoms :—
Pain ?
Difficulty of breathing ?
Feeling of tightness in chest ?
Cough ?
Rigors ?
Alimentary system :—
Tongue
Appetite
Nausea ?
Vomiting ?
Diarrhœa ?
Respiratory system :—
Condition of lungs
Expectoration ?
Cyanosis ?
Nervous system :—
Headache ?
Convulsions ?
Eye symptoms ?
Rigidity of limbs ?
Delirium ?
Coma ?
Skin :—
Is there any local sore or pustule? If so give position, appearance, &c.

Is there any œdema ?
Is there any reason to suspect anthrax, other than the fact that the patient works amongst dangerous wool ?
Is there any definite disease present by which anthrax can be reasonably excluded ?
Has the injection of anti-anthrax serum been advised ?
Was serum administered ?
How much ?
Was serum refused by patient ?

Remarks and account of any particular steps taken with regard to the case.

Bradford. 19 .

APPENDIX 12.

MEMORANDUM on the Diagnosis of EXTERNAL ANTHRAX, and Procedure followed by Dr. MITCHELL in EXAMINATION of PATIENTS, suffering from Suspicious ILLNESS or AFFECTIONS, sent to him by FIRMS with the object of securing early DIAGNOSIS of the DISEASE. (*See* Q. 7325, and Appendix 11.)

When an anthrax suspect presents himself for examination, I first consider the general condition of the patient on the lines drawn up on the form of report (Appendix 11). I am then in possession of the main facts of the case. Any local sore or pimple or pustule is then carefully examined by the naked eye. The condition may be obviously not due to anthrax, *e.g.*, the affection may be an ordinary furuncle or boil containing pus, which I evacuate in the ordinary way, and then cleanse the cavity with an antiseptic, apply a dressing, and afterwards refer to his panel doctor for further care, if necessary. I do this because it not only confirms the diagnosis, but this single attention is often all that is required to produce a cure, and the man is not then put to the inconvenience of going to his panel doctor after seeing me.

But supposing the local condition is not so obviously a simple boil. It may be that there is a slightly inflamed papule with a slight vesiculation on the summit, which may bear a close resemblance to cutaneous anthrax. In such a case, I would first slightly scarify the skin around the edge of the vesicular area, keeping close to it, and just going sufficiently deep to draw a very little blood. This is smeared *sec. art.* on a microscope slide, fixed by passing through a flame, then stained with methylene blue or Jenner's blood stain (methods given in all the text books), and afterwards examined by the microscope. If no anthrax bacilli are found, I should take a large Hagedorn needle, duly sterilised, and make a deep puncture straight down the centre of the papule, and then apply a little gentle pressure. Very often a small quantity of pus will be found to exude from the puncture, and will immediately settle the diagnosis as not anthrax. I used to make smears of such pus, and again examine microscopically, and usually found one of the staphylococci. The case is then disinfected as described above, and dealt with in the same way as an ordinary boil. But supposing I had not obtained any pus from the deep puncture, I would then inoculate culture tubes, and place in an incubator overnight. The next day the diagnosis is clear. If it were anthrax, I should then send for the man, or see him at once, and have him properly attended to. This has never happened to me.

Of course, if I thought the case was anthrax in spite of failing to obtain the bacilli at the first attempt, I should make repeated examinations of blood or serum from the suspected area before I quite satisfied myself that the affection was not due to anthrax. I should also make cultures.

In cases obviously anthrax, I still examine in the same way, and never notify as anthrax till I have proved the presence of Bacillus Anthracis. In all cases of anthrax, or of simple sores or boils of any sort, I disinfect the place, and apply a dressing before dismissing them from my consulting room.

In cases of men with chronic sores or pimples such as common acne, I usually advise the employers that they are not safe individuals to employ amongst dangerous materials.

WILLIAM MITCHELL.

APPENDIX 13.

In Appendix 13 is given a folio taken from the register kept by Mr. J. H. Halliday (Q. 5588–6253) for the purpose of checking the efficiency of the sorters in removing bloodstained wool; and also for the purpose of recording (1) the particulars of dangerous materials combed, and (2) the quantities of bloodstains removed by the sorters in the first sorting and in check sorting.

The statement gives the particulars of sorting of one lot of fawn Persian wool of a weight of about 32,000 lbs. Exactly half of the bales composing the lot contained bloodstained material and half were free from blood. The amount of blood present in individual bales ranged from 1 oz. to 4½ lbs. On only one occasion was there failure to find blood in check sorting in bales in which it was found in the first sorting. On one occasion also blood was found in check sorting, though none was observed in the first sorting.

The appendix is valuable evidence of (1) the irregularity with which blood occurs in Persian wool, (2) the extent to which reliance may be placed on sorters for removal of blood, and (3) the necessity of check sorting for the purpose of removing bloodstains. The sorters named were skilled sorters who had been specially trained to recognise and remove blood, and great efforts were made to ensure their efficiency. Probably the results represent the highest state of efficiency it is possible to attain. The material being sorted (fawn Persian) was not the most difficult material in which to find blood, nor was it quite the easiest.

In the following statement the initials of the sorters only are given, and the marks of the bales and the price paid for sorting have been withheld. With these exceptions it is an exact record of the actual result of sorting the lot named in the ordinary way, and is in no way different from the everyday results in this factory.

Week ending 18th November 1913. Sort.—Fawn Persian Wool. Lot 1361.

Sorting.						Check looking over.			
Sorter's Name.	Bale.		Price for Sorting.	Bloodstains removed.		Bloodstains removed.		Price for Sorting.	Sorter's Name.
	Mark.	Number.							
(1)	(2)	(3)	(4)	(5)		(6)		(7)	(8)
				lbs.	ozs.	lbs.	ozs.		
H. F. (10 bales).	—	202	—	0	0	0	0	—	A. P.
		196	—	0	0	0	0	—	S. E.
		1	—	2	10	0	6	—	"
		274	—	0	8	0	1	—	"
		252	—	0	0	0	0	—	"
		377	—	0	3	0	1	—	"
		255	—	0	0	0	0	—	"
		82	—	0	4	0	1	—	"
		27	—	0	0	0	0	—	"
		4	—	0	0	0	0	—	"
T. S (23 bales).	—	6,473	—	1	5	0	3	—	J. H. S.
		2	—	3	6	0	4	—	"
		109	—	0	0	0	0	—	S. W.
		367	—	0	0	0	0	—	J. H. S.
		276	—	0	0	0	0	—	S. W.
		513	—	0	0	0	0	—	J. H. S.
		2	—	1	6	0	2	—	"
		19,308	—	0	12	0	2	—	"
		333	—	1	0	0	3	—	"
		332	—	0	2	0	1	—	"
		480	—	0	4	0	1	—	S. W.
		267	—	1	14	0	3	—	J. H. S
		115	—	0	0	0	0	—	S. W.
		36	—	0	0	0	0	—	"
		19,310	—	0	0	0	0	—	J. H. S.
		20	—	0	0	0	0	—	A. P.
		395	—	0	4	0	1	—	J. H. P.
		139	—	0	0	0	1	—	J. H. S.
		200	—	0	0	0	0	—	"
		72	—	0	8	0	0	—	"
		47	—	0	5	0	1	—	"
		369	—	0	0	0	0	—	"
		469	—	0	6	0	1	—	"
J. H. S. (23 bales).	—	6,474	—	3	4	0	8	—	T. S.
		3	—	3	10	0	6	—	S. W.
		14	—	1	6	0	2	—	T. S.
		202	—	0	0	0	0	—	"
		35	—	0	0	0	0	—	"
		170	—	0	0	0	0	—	"
		473	—	0	2	0	1	—	S. W
		19,268	—	0	0	0	0	—	"
		232	—	0	4	0	1	—	"
		Carried forward	- -					—	

Sorting.					Check looking over.		
Sorter's Name.	Bale.		Price for Sorting.	Bloodstains removed.	Bloodstains removed.	Price for Sorting.	Sorter's Name.
	Mark.	Number.					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				lbs. ozs.	lbs. ozs.		
J.H.S.—*cont.*	Brought forward		. .				
		46	—	0 12	0 1	—	T. S.
		129	—	1 0	0 3	—	"
		278	—	0 0	0 0	—	"
		40	—	1 14	0 2	—	"
		451	—	0 8	0 1	—	"
		19,318	—	0 0	0 0	—	S. W.
		260	—	0 12	0 2	—	T. S.
		235	—	0 4	0 1	—	"
		19,299	—	0 0	0 0	—	"
		511	—	0 0	0 0	—	"
		342	—	0 8	0 1	—	"
		439	—	0 0	0 0	—	"
		340	—	0 12	0 5	—	"
		434	—	0 0	0 0	—	S. W.
T. O. (9 bales).	—	19,305	—	1 0	4 2	—	H. F.
		244	—	3 4	0 8	—	"
		64	—	0 0	0 0	—	"
		198	—	0 0	0 0	—	"
		467	—	0 4	0 2	—	"
		486	—	0 4	0 1	—	"
		192	—	0 0	0 0	—	"
		5,689	—	0 8	0 2	—	"
		450	—	0 0	0 0	—	"
S. E. (9 bales).	—	19,282	—	0 0	0 0	—	T. O.
		364	—	0 2	0 1	—	"
		243	—	4 7	0 4	—	"
		263	—	0 8	0 2	—	"
		512	—	0 8	0 3	—	A. P.
		277	—	0 0	0 0	—	T. O.
		35	—	0 0	0 0	—	"
		203	—	0 0	0 0	—	"
		433	—	0 8	0 1	—	"
S. W. (15 bales).	—	39,983	—	3 4	0 5	—	T. S.
		19,321	—	0 0	0 0	—	J. H. S.
		203	—	0 0	0 0	—	"
		259	—	0 4	0 1	—	T. S.
		256	—	0 0	0 0	—	"
		322	—	0 4	0 1	—	"
		122	—	0 8	0 2	—	"
		41	—	0 8	0 1	—	"
		302	—	0 0	0 0	—	J. H. S.
		193	—	0 0	0 0	—	A. P.
		124	—	0 0	0 0	—	"
		123	—	0 12	0 3	—	"
		492	—	0 0	0 0	—	"
		12	—	2 8	0 3	—	"
		264	—	0 0	0 0	—	T. S.
		610	—	0 6	0 1	—	S. W.
A. P. (6 bales).	—	191	—	0 0	0 0	—	T. O.
		19,300	—	0 0	0 0	—	S. W.
		9	—	2 0	0 2	—	"
		204	—	0 0	0 0	—	"
		203	—	0 0	0 0	—	S. E.
		120	—	0 0	0 0	—	J. H. S.
TOTALS	. .	96	bales.	51 12	6 15	—	

Summary.

48 bales free from blood.
48 bales contained 58 lbs. 9 ozs. blood.
Blood found in first time sorting = 51 lbs. 12 ozs.
Blood found in check looking over = 6 lbs. 15 ozs.
Bonus paid for removal of blood, 1*l*. 9*s*.

APPENDIX 14.

FORM of RECORD of DANGEROUS MATERIALS COMBED and of BLOODSTAINED MATERIAL REMOVED kept in the FACTORIES of MESSRS. WOOLCOMBERS, LTD.

J. & C. CRABTREE, LTD.

MONTHLY RECORD OF BLOODSTAINED MATERIAL FOUND.

Date posted by Branch ________ Date received at Head Office ________

Date of Commencement of Combing.	Date of Completion of Combing.	Combing Lot No.	Class of Material.	Preparing or Carding.	Sale Lot No. or any other Means of Identification.	Total Lbs. Weight of Material.	Total Lbs. Weight of Bloodstained Material found.	No. of Samples of Bloodstained Material sent to Dr. Eurich for Examination.	Was Anthrax cultivated from any of the Bloodstained Samples sent to Dr. Eurich? If so, state from how many of the Samples and the weight of each.	Total Cost of searching for Bloodstained Material.	Remarks.

________ Branch Manager.

All bloodstained material found must be sent to Dr. Eurich for examination.

One of these sheets to be filled in and posted to Head Office the last day of each month.

APPENDIX 15.

INFORMATION SUPPLIED BY R. H. REW, ESQ., C.B., ASSISTANT SECRETARY, BOARD OF AGRICULTURE AND FISHERIES, SUPPLEMENTING EVIDENCE GIVEN BY SIR STEWART STOCKMAN.

(*Q.* 10,021.)

MEMORANDUM.

The average number of sheep and lambs annually slaughtered in the United Kingdom, based on estimates for the years 1911–12 to 1913–14, is 11,532,083, the average number dying, during the same period, being 1,620,415, while the amount of wool obtained from skin fleeces in the United Kingdom in 1908 has been estimated at 23,437,000 lbs.

Information with regard to losses from anthrax and other diseases among sheep, goats and camels, in the foreign countries and British possessions specified, is fragmentary, but such particulars as are available may be summarised as follows :—

South Africa.—In the 12 months ended December 1912, 912,564 sheep and 273,288 goats died from diseases of all kinds (anthrax not distinguished).

In the 15 months ended March, 1913, 1,120 animals of all kinds died from anthrax (sheep not separately shown).

From August 1914 to January 1915, 475 animals died from anthrax (sheep not given separately).

Egypt.—In the year 1911 there were 218 cases of anthrax among sheep.

In the period May 1914 to January 1915, 164 sheep, 3 goats and 2 camels were reported as dying from disease. Of these, 97 sheep and 3 goats were affected with anthrax.

Russia.—In the period January–October 1914, the number of animals which died from anthrax was 43,446 ; from sheep-pox, 4,446 ; from foot and mouth disease, 4,362 ; and from rabies, 2,434 ; the kinds of animals not being specified.

India.—Sheep are included with "other animals" of which 56 died from anthrax and 15,302 from other diseases in 1910–11.

Persia.—No outbreaks of anthrax noted in Consular reports issued from January 1914 to date.

Argentina, China, Syria, Asia Minor.—No information available.

No information as to the seasonal prevalence of disease in any of the above countries is available.

APPENDIX 16.

SUPPLEMENTARY INFORMATION SUPPLIED BY SIR STEWART STOCKMAN.

Question 9962. *Cultivation of anthrax from grain and cake.*—(*a*) *See* Journal of Comparative Pathology and Therapeutics, 1901, p. 176. Certain cattle died of anthrax, and linseed cake on which they were fed was transferred to another farm, where also cattle died from anthrax. The cake was manufactured in England from linseed imported from Calcutta and Karachi. Samples of the cake were examined by Professor McFadyean, and a guinea-pig died after inoculation with material from it. Its blood gave pure cultures of anthrax bacilli. It was contended that heat of manufacture (temperature stated to be 280° F.) would kill possible spores in the linseed. Samples of cake and linseed were submitted to Professors Delépine, Klein, Sims Woodhead, and Muir, who obtained negative results. It was pointed out that negative results prove nothing and that one positive result does and should outweigh any number of negative results.

(*b*) Same Journal, 1905, p. 326. Fourteen horses died from anthrax, and oats on which they were fed were suspected. Samples were submitted to Professor McFadyean, who inoculated guinea-pigs, sheep, and a calf on two separate dates and obtained negative results, but on a third date inoculation with fresh material resulted in death of guinea pigs and a sheep. Cultures from the blood gave in each case pure growths of anthrax bacilli. As soon as the consumption of the particular lot of oats ceased anthrax among the horses also ceased.

Question 10,021.—I think it was arranged that you should write to Mr. Rew, Assistant Secretary of the Board of Agriculture and Fisheries about this. (*See* Appendix 15.)

Question 10,026.—Places within my knowledge where anthrax carcases were discovered on the market as it were. I find I have notes of the following, but I have not been keeping a note of every case of late :—

1911.—Abattoir, Glasgow ; Cattle Market, Islington ; Abattoir, Birmingham (3) ; Abattoir, Barrow-in-Furness ; Market, Dundee ; dead in railway truck, Birmingham.

1913.—Abattoir, Manchester (2).

1914.—Glasgow (3), one of which came from Ireland.

Question 10,083. *Statistics of Anthrax in Russia.*—I take it it will be sufficient if I give you the number of deaths stated to have occurred monthly during 1913 :—

January - -	861	July - - -	8,091
February - -	747	August - -	4,693
March - -	850	September - -	2,881
April - -	1,410	October - -	1,585
May - - -	2,274	November - -	1,153
June - - -	1,125	December - -	754

Question 10,262.—The number of cases of anthrax confirmed in sheep in Aberdeenshire was as follows :—
1911—1 ; 1912—0 ; 1913—0.

Question 10,374.—I find that no further legislation in relation to anthrax has been introduced into South Africa since 1911.

Question 10,115.—Mortality before, from and after preventive inoculation. I take it that it will be sufficient if I merely quote some examples which establish the case, and that the Committee do not require statistics relating to every year. As a matter of fact, the efficacy of the method having been proved the statistical returns have been given up in many cases.

The statistics refer to the Pasteur method of double inoculation :—

		Records were obtained of—
France.—1882 to 1893 :—		
Sheep inoculated, 3,296,815	-	1,750,000
Cattle „ 438,824	-	200,000

Mortality, from and after inoculation :—
Sheep, 0·94 per cent. of the inoculated animals.
Cattle, 0·34 „ „ „ „

These results were obtained in districts in which the annual mortality from anthrax varied from 5 to 10 per cent. before inoculation was employed.

Austria.—1882 to 1887 :—

Sheep inoculated - - -	350,000
Cattle „ - - -	130,000

Mortality, from and after inoculation :—
1 to 2 per cent. of the inoculated.

The mortality from anthrax before the introduction of inoculation was from 10 to 14 per cent.

Hungary.—1889 to 1893 :—

Sheep inoculated - - -	388,743
Cattle „ - - -	87,430

The mortality from and after inoculation was :—
Sheep, 1·28 per cent. of the inoculated animals.
Cattle, ·14 „ „ „ „

The mortality from anthrax before inoculation is not stated, but it was believed to be about 10 per cent.

It will be seen from the above that the method is a little less successful in sheep than in cattle.

Question 10,031.—In 1913 there were in Great Britain :—

Cattle - - - - -	6,963,854
Sheep - - - - -	23,931,412

APPENDIX 17.

ORDER OF THE BOARD OF AGRICULTURE AND FISHERIES.
(Dated 24th September 1910.)

ANTHRAX ORDER OF 1910.

The Board of Agriculture and Fisheries, by virtue and in exercise of the powers vested in them under the Diseases of Animals Acts, 1894 to 1910, and of every other power enabling them in this behalf, do order, and it is hereby ordered, as follows :—

Interpretation.

1. In this Order, unless the context otherwise requires—

"The Board" means the Board of Agriculture and Fisheries:

"The Act of 1894" means the Diseases of Animals Act, 1894:

"Animals" means cattle, sheep, and goats, and all other ruminating animals, and swine, horses, asses, mules and dogs:

"Disease" means anthrax, and "diseased" or "suspected" means affected with or suspected of anthrax :

"Inspector" includes Veterinary Inspector:

"Veterinary Surgeon" includes any veterinary practitioner qualified to be a Veterinary Inspector according to the Act of 1894 and any Order made thereunder:

"Carcase" means the carcase of an animal, and includes part of a carcase, and the meat, flesh, bones, hide, skin, hoofs, horns, offal, or other part of an animal, separately or otherwise, or any portion thereof:

Other terms have the same meaning as in the Act of 1894.

Notice of Disease.

2.—(1) Every person having in his possession or under his charge a diseased or suspected animal or carcase shall with all practicable speed give notice of the fact to a constable of the police force for the area wherein the animal or carcase is.

(2) The constable shall forthwith give information of the receipt of the notice to an Inspector of the Local Authority, who shall forthwith report the same to the Local Authority.

(3) The Inspector of the Local Authority shall forthwith give information of the receipt of the notice to the Medical Officer of Health of the Sanitary District in which the diseased or suspected animal or carcase is.

Precautions by Occupier in case of Suspected Anthrax.

3.—(1) The occupier of any premises on which there is a diseased or suspected animal or carcase shall—

(i) prevent access of animals or fowls to the diseased or suspected animal or carcase, or to any part of the premises which has been exposed to infection of disease from the animal or carcase; and

(ii) detain on the premises any diseased or suspected animal thereon and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard or field with the diseased or suspected animal or carcase

until it is certified under this Order that the animal or carcase was not diseased, or a Notice (Form A) is served on the occupier of the premises under Article 7 of this Order.

(2) The occupier shall also disinfect as soon as possible with chloride of lime any place where the carcase of a diseased or suspected animal has lain or where its blood has escaped.

Duty of Inspector to act immediately.

4.—(1) An Inspector of a Local Authority on receiving in any manner whatsoever information of the supposed existence of anthrax in any animal or carcase, or having reasonable ground to suspect the existence of anthrax, shall proceed with all practicable speed to the place where such disease exists, or is suspected to exist, and shall there and elsewhere put in force and discharge the powers and duties conferred and imposed on him as Inspector by or under the Act of 1894 and this Order.

(2) The Inspector shall forthwith serve a Notice (in the Form C set forth in the First Schedule hereto or to the like effect) on the occupier of any premises on which there is a diseased or suspected animal or carcase.

Veterinary Inquiry as to Existence of Anthrax.

5.—(1) A Local Authority, on receiving information of the existence, or suspected existence, of anthrax in any animal or carcase shall forthwith cause inquiry to be instituted by a veterinary surgeon as to the correctness of such information.

(2) The owner and occupier of any premises on which there is a diseased or suspected animal or carcase shall give all reasonable facilities for the inquiry by the Local Authority under this Article, and any person failing to give such facilities shall be deemed guilty of an offence against the Act of 1894.

(3) If the veterinary surgeon is satisfied at the time of his examination of the animal or carcase, by a microscopical examination of its blood on the spot or by other evidence, that the animal or carcase was not diseased, he shall forthwith give to the Local Authority a certificate to that effect, and the Local Authority shall, as soon as practicable, cause a Notice (in the Form D set forth in the First Schedule hereto, or to the like effect) to be served on the occupier of the premises on which the animal or carcase was.

(4) If the veterinary surgeon is not so satisfied he shall forthwith give to the Local Authority a certificate stating that the case is one of suspected anthrax. He shall also for the purpose of further investigation take and examine one or more samples of the blood or other

fluid of the animal or carcase, or of the tissue of the carcase, as may be necessary for that purpose, and as soon as may be after examination thereof forward to the Laboratory of the Board, Alperton Lodge, Wembley, Middlesex, such samples as may be required to enable a Veterinary Inspector of the Board to certify whether or not the animal or carcase was diseased, together with a report of his examination of the animal or carcase and of his further investigation.

Precautions by Local Authority in case of Suspected Anthrax.

6. Where the veterinary surgeon gives to the Local Authority a certificate that the case is one of suspected anthrax the Local Authority shall forthwith direct an Inspector to carry out such disinfection as the Inspector may think necessary; and in the case of a carcase shall forthwith cause the same to be destroyed in the manner prescribed by this Order.

Procedure consequent on Examination by Veterinary Inspector of the Board.

7.—(1) Where a Veterinary Inspector of the Board certifies that an animal or carcase was diseased, the Local Authority on receipt of the certificate shall forthwith cause a Notice (in the Form A set forth in the First Schedule to this Order or to the like effect) to be served by an Inspector on the occupier of the premises on which the animal is, or on which the carcase is or was at the time of the death of the animal, and on service of such Notice the premises within the limits specified by the Notice shall become an Infected Place for the purposes of this Order.

(2) A similar Notice may be so served on the occupier of any premises which in the opinion of the Local Authority have been infected with disease by the animal or carcase, or exposed to infection therefrom.

(3) The restrictions imposed by a Notice under this Article shall continue in force until such Notice is withdrawn by a Notice (in the Form B set forth in the First Schedule hereto or to the like effect) signed by an Inspector of the Local Authority and served on the occupier of the Infected Place.

(4) Where a Veterinary Inspector of the Board certifies that an animal or carcase was not diseased the Local Authority, on receipt of information to that effect, shall, as soon as practicable, cause a Notice (in the Form D set forth in the First Schedule hereto, or to the like effect) to be served on the occupier of the premises on which the animal or carcase was.

(5) A Notice (Form A) shall not be served in relation to a market-place, fair-ground, sale-yard, place of exhibition, knacker's yard, or slaughter-house except by direction of the Board.

Copies of Notices to be sent to the Board, &c.

8. An Inspector shall with all practicable speed send copies of any Notice served under the preceding Articles of this Order to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W., and to the police officer in charge of the nearest police station of the District, and in the case of Notices (Forms A and D), also to the Medical Officer of Health.

Rules affecting Infected Places.

9. The following Rules shall apply to an Infected Place:—

Rule 1. The occupier of the Infected Place shall prevent access of animals to the diseased or suspected animal or carcase or to any part of the premises which has been exposed to infection of disease from the animal or carcase.

Rule 2. Animals shall not be moved, or allowed to stray, out of or into the Infected Place except as expressly authorised by this Article.

Rule 3. Any horse, ass, mule, or dog which is not diseased or suspected may be moved out of the Infected Place.

Rule 4. Any animal which is not diseased or suspected may be moved out of the Infected Place to the nearest available slaughter-house under the supervision of an Inspector or other officer of the Local Authority for the purpose of being forthwith slaughtered, or with the permission in writing of such Inspector to some premises which shall thereupon be made an Infected Place by service of a Notice (Form A) under this Order.

Rule 5. Litter, dung, broken fodder, utensils, pens, hurdles, or other things shall not be removed from the Infected Place except with permission in writing from an Inspector of the Local Authority.

Disposal of Carcases.

10.—(1) A diseased carcase and any other carcase required by this Order to be destroyed shall be disposed of by the Local Authority as follows:—

(i) The Local Authority shall cause the carcase to be destroyed by exposure to a high temperature upon the farm or premises upon which the carcase is, or upon the nearest available premises suitable for the purpose; or

(ii) The Local Authority may, if authorised by licence of the Board, cause the carcase to be destroyed, under the supervision of an Inspector or other officer of the Local Authority, in the mode following: — The carcase shall be disinfected, and shall then be taken to premises approved for the purpose by the Board, and shall be there destroyed by exposure to a high temperature, or by chemical agents; or

(iii) Where the circumstances do not permit of the disposal of the carcase by either of the foregoing methods the Local Authority shall cause the carcase to be buried as soon as possible in its skin in some convenient or suitable place to which animals will not have access, and which is removed from any dwelling house, and at such a distance from any well or watercourse as will preclude any risk of the contamination of the water therein, the carcase being buried at a depth of not less than six feet below the surface of the earth, and with a layer of lime not less than one foot deep both beneath and above it. Where possible the place of burial shall be the farm or premises upon which the animal died or was slaughtered.

(2) A diseased or suspected carcase shall not be buried or destroyed otherwise than by the Local Authority, or be removed from the farm or premises upon which the animal died or was slaughtered except by Local Authority.

(3) Before a carcase is moved for burial or destruction under this Article, all the natural openings thereof shall be effectually plugged with tow or some suitable material soaked in a saturated solution of carbolic acid or other disinfectant equal in disinfective efficiency. In no case shall the skin of the carcase be cut nor shall anything be done to cause the effusion of blood, except by a veterinary surgeon acting under the directions of the Local Authority, and so far only as may be necessary for the purpose of microscopical or cultural examination: Provided that nothing in this paragraph shall prevent a veterinary surgeon on behalf of the owner of the carcase from taking a sample of the blood, or other fluid, or tissue, from the carcase for the purpose of microscopical or cultural examination in any case in which neither the history of the case nor any external lesions in the carcase indicate the existence of anthrax.

(4) A Local Authority may cause or allow a carcase to be taken into the district of another Local Authority to be buried or destroyed, with the previous consent of that Local Authority, but not otherwise.

Precautions to be adopted with respect to Milk.

11. The milk produced by any diseased or suspected cow or goat shall not be mixed with other milk, and all milk affected by this Article shall forthwith be boiled or otherwise sterilised, and any utensil in which such milk

is placed before being so treated shall be thoroughly cleansed with boiling water before any other milk is placed therein.

Digging up.

12. It shall not be lawful for any person, except with the Licence of the Board or permission in writing of an Inspector of the Board, to dig up, or cause to be dug up, the carcase of any animal that has been buried, whether under this Order or otherwise.

Cleansing and Disinfection in case of Anthrax.

13.—(1) The Local Authority shall at their own expense cause to be cleansed and disinfected under the direction of an Inspector, and in the mode provided by this Article—

(a) all those parts of any shed, stable, building, field, or other place in which a diseased animal has died or been slaughtered, or has been kept at the date of such death or slaughter;

(b) every utensil, pen, hurdle, or other thing used for or about any diseased animal or carcase;

(c) every van, cart, or other vehicle used for carrying any diseased animal or carcase on land otherwise than on a railway.

(2) Any part of a place or thing required by this Order to be cleansed and disinfected shall be cleansed and disinfected in manner following:—

(i) the part of a place or thing shall be thoroughly soaked or drenched with a four per cent. (minimum) solution of carbolic acid (containing not less than ninety-five per cent. of actual carbolic acid); then

(ii) the part of a place or thing shall, if the nature thereof so permit, be scraped and, where necessary, swept, and the scrapings and sweepings and all dung, sawdust, litter, and other matter shall be effectually removed therefrom; then

(iii) the part of a place or thing shall be thoroughly washed or scrubbed or scoured with water, and then thoroughly coated or washed with—

(a) a one per cent. (minimum) solution of chloride of lime containing not less than thirty per cent. of available chlorine; or

(b) a four per cent. (minimum) solution of carbolic acid (containing not less than ninety-five per cent. of actual carbolic acid), followed by a thorough sprinkling with limewash; or

(c) a disinfectant equal in disinfectant efficiency to the above-mentioned solution of carbolic acid, followed by a thorough sprinkling with limewash.

(3) The scrapings and sweepings, and the dung, sawdust, litter, and other matter removed under this Article shall forthwith be burnt or otherwise destroyed, or, if destruction is not practicable, be well mixed with quicklime and be effectually removed from contact with animals.

(4) The Local Authority shall at their own expense cause any litter, dung, or broken fodder which appears to them or their Inspector to be likely to spread disease to be disinfected thoroughly, or to be burnt or destroyed if it is in their or his opinion impracticable to disinfect the same thoroughly.

(5) Where the cost of disinfection has been increased by any wilful act or neglect on the part of the owner of the animal or carcase, the Local Authority shall be entitled to recover from the owner the additional cost so caused.

Facilities and Assistance to be given for Cleansing and Disinfection.

14.—(1) The occupier of any place, and the owner of any thing, liable to be cleansed and disinfected under this Order shall give all reasonable facilities to the Local Authority and their officers for that purpose, and any person failing to give such facilities shall be deemed guilty of an offence against the Act of 1894.

(2) The Local Authority may by Notice in writing signed by an Inspector and served on the occupier of any premises or the owner of any thing liable to be cleansed and disinfected under this Order require him to cleanse and disinfect the same in the mode provided by this Order but at the expense of the Local Authority, and any person failing to carry out the requirements of a Notice so served on him shall be deemed guilty of an offence against the Act of 1894.

Prohibition of Exposure or Movement of Diseased or Suspected Animals.

15.—(1) It shall not be lawful for any person—

(a) to expose a diseased or suspected animal in a market or fair, or in a sale-yard, or other public or private place where animals are commonly exposed for sale; or

(b) to place a diseased or suspected animal in a lair or other place adjacent to or connected with a market or a fair, or where animals are commonly placed before exposure for sale; or

(c) to send or carry, or cause to be sent or carried, a diseased or suspected animal on a railway, canal, river, or inland navigation, or in a coasting vessel; or

(d) to carry, lead, or drive, or cause to be carried, led, or driven, a diseased or suspected animal on a highway or thoroughfare; or

(e) to place or keep a diseased or suspected animal on common or unenclosed land, or in a field or place insufficiently fenced, or in a field adjoining a highway unless that field is so fenced or situate that animals therein cannot in any manner come in contact with animals passing along that highway or grazing on the sides thereof; or

(f) to graze a diseased or suspected animal on pasture being on the sides of a highway; or

(g) to allow a diseased or suspected animal to stray on a highway or thoroughfare or on the sides thereof, or to be on common or unenclosed land, or in a field or place insufficiently fenced.

(2) Notwithstanding anything in this Order an animal exposed or otherwise dealt with in contravention of this Article may be moved by or under the direction of an Inspector of the Local Authority to some convenient and isolated place.

Powers of Board of Agriculture and Fisheries.

16. Any powers by this Order conferred upon a Local Authority or an Inspector of a Local Authority may at any time be exercised by the Board or an Inspector of the Board respectively.

Local Authority to enforce Order.

17. The provisions of this Order, except where it is otherwise provided, shall be executed and enforced by the Local Authority.

Weekly Returns of Anthrax.

18. Where the existence of anthrax is certified under Article 5 of this Order by a Veterinary Inspector of the Board, an Inspector of the Local Authority shall forthwith make a return thereof to the Local Authority and to the Board, on a form provided by the Board, with all particulars therein required, and shall continue to so make a return thereof on the Saturday of every week until the disease has ceased.

Extension of certain Sections of Diseases of Animals Act, 1894.

19. Horses, asses, mules, and dogs (as well as the animals specified in the Act of 1894) shall be animals, and anthrax (that is to say, the disease called or known as anthrax, splenic fever, or splenic apoplexy of animals) shall be a disease, for the purposes of the following sections of the Act of 1894 (namely):—

Section forty-three (*Police*);

Section forty-four (*General Administrative Provisions*);

and also for the purposes of all other sections of the said Act containing provisions relative to or consequent on the provisions of those sections and this Order, including such sections as relate to offences and legal proceedings.

Presumption of Knowledge of Disease.

20. Where the owner or person in charge of an animal or carcase is charged with an offence against the Act of 1894 relative to anthrax, he shall be presumed to have known of the existence of that disease, unless and until he shows, to the satisfaction of the Court, that he had not knowledge thereof and could not with reasonable diligence have obtained that knowledge.

Offences.

21.—(1) If an animal or any thing is moved in contravention of this Order, or of a notice served thereunder, the owner of the animal or thing, and the person for the time being in charge thereof, and the person causing, directing, or permitting the movement, and the person moving or conveying the animal or thing, and the owner and the charterer and the master of the vessel in which it is moved, and the consignee or other person receiving or keeping it knowing it to have been moved in contravention as aforesaid, and the occupier of the place from which the animal or thing is moved, shall, each according to and in respect of his own acts and defaults, be deemed guilty of an offence against the Act of 1894.

(2) If a carcase is buried or destroyed or otherwise dealt with in contravention of this Order, the owner of the carcase, and the person for the time being in charge thereof, and the person causing, directing, or permitting the carcase to be so buried, destroyed, or otherwise dealt with, shall, each according to and in respect of his own acts and defaults, be deemed guilty of an offence against the Act of 1894.

Revocation of Order.

22. The Order described in the Second Schedule to this Order is hereby revoked.

Extent.

23. This Order extends to England and Wales and Scotland.

Commencement.

24. This Order shall come into operation on the first day of January, nineteen hundred and eleven.

Short Title.

25. This Order may be cited as the Anthrax Order of 1910.

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this twenty-fourth day of September, nineteen hundred and ten.

L.S.

T. H. Elliott,
Secretary.

FIRST SCHEDULE.

FORMS.

Form A.

[Articles 7 (1) and 9.]

Notice declaring Infected Place.

Anthrax Order of 1910.

To *C.D.* , of

I, *A.B.* , of , being an Inspector appointed by the Local Authority of the [county] of , hereby give you notice as the occupier of the undermentioned premises that, in accordance with the provisions of the Order of the Board of Agriculture and Fisheries under which this Notice is issued, the undermentioned premises become an Infected Place subject to the Rules printed on the back of this Notice.

Dated this day of , 191 .

(Signed) *A.B.*

Description of Infected Place.

The Rules in Article 9 are to be printed on the back of this Notice.

The expression "animals" in the Rules means cattle, sheep, and goats, and all other ruminating animals, and swine, horses, asses, mules, and dogs.

The Inspector is with all practicable speed to send copies of this Notice to the Board of Agriculture and Fisheries, to the police officer in charge of the nearest police station of the District, and to the Medical Officer of Health.

Form B.

[Article 7 (3).]

Withdrawal of Notice (Form A).

Anthrax Order of 1910.

To *C.D.* , of

I, *A.B.* , of , being an Inspector appointed by the Local Authority for the [county] of , hereby withdraw, as from this day of , 191 , the Notice signed by and served upon you on the day of 191 , relating to premises in your occupation at .

Dated this day of , 191 .

(Signed) *A.B.*

The Inspector is with all practicable speed to send copies of this Notice to the Board of Agriculture and Fisheries, and to the police officer in charge of the nearest police station of the District.

Form C.

[Article 4 (2).]

Notice to Occupier of Premises on which there is a diseased or suspected animal or carcase.

Anthrax Order of 1910.

To the occupier of

Take notice that by the above-mentioned Order you, as the occupier of premises on which there is an animal [a carcase] which is affected with or suspected of anthrax, are required—

(i) to prevent access of animals or fowls to the diseased or suspected animal [carcase], or to any part of the premises which has been exposed to infection of anthrax from the animal [carcase]; and

(ii) to detain on the above premises any animal thereon affected with anthrax or suspected of being so affected and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard, or field with the diseased or suspected animal [carcase]

until it is certified under the Order that the animal [carcase] was not affected with anthrax or a Notice (Form A.) is served on you under Article 7 of the Order.

The expression "animals" means cattle, sheep, and goats, and all other ruminating animals, and swine, horses, asses, mules, and dogs.

Dated this day , 191 .

Inspector of the Local Authority
for the County [Borough] of

The Inspector is with all practicable speed to send copies of this Notice to the Board of Agriculture and Fisheries, and to the police officer in charge of the nearest police station of the District.

FORM D.

[Articles 5 (3) and 7 (4).]

Notice to Occupier of result of Veterinary Examination.

To the occupier of

Take notice that the veterinary *surgeon directed by the Local Authority under the Anthrax Order of 1910 to examine [*Here describe animal or carcase*] has certified that it was not affected with anthrax, and for the purposes of the provisions of the Order referred to in the Notice [Form C] served on you it is to be treated as not being affected with or suspected of anthrax.

Dated this day of , 191 .

Inspector of the Local Authority for the County [Borough] of

The Inspector is with all practicable speed to send copies of this Notice to the Board of Agriculture and Fisheries, to the police officer in charge of the nearest police station of the District, and to the Medical Officer of Heath.

* *Where the examination is by a Veterinary Inspector of the Board the Notice should be altered accordingly.*

SECOND SCHEDULE.

Order revoked.

No.	Date.	Short Title.
5905	1899. 17th January -	Anthrax Order of 1899.

APPENDIX 18.

CIRCULAR to LOCAL AUTHORITIES in GREAT BRITAIN under the DISEASES OF ANIMALS ACTS, 1894 to 1910.

ANTHRAX.

24th September 1910.

I am directed by the Board of Agriculture and Fisheries to forward herewith copies of the Anthrax Order of 1910, which will come into force on the 1st January next.

It will be seen from the annual reports of proceedings under the Diseases of Animals Acts that during recent years the Board have been watching anxiously the returns received from local authorities as regards anthrax, and I am to call the special attention of your local authority to the Tables* which give (1) the number of counties in Great Britain from which anthrax was reported by inspectors of local authorities, the number of outbreaks reported and the number of animals returned as attacked in each year, 1887–1909, together with the corresponding figures for the first half of the current year; and (2) the number of outbreaks of anthrax in each county in Great Britain during each year from 1899 to 1909.

It will be observed that since the year 1899, when the Anthrax Order now in force was made, the number of outbreaks of anthrax reported by inspectors of local authorities has steadily increased, until in 1909 the total reached 1,317. The figures available for the first half of the current year show at the same time that a decrease in the number of outbreaks during 1910 is not to be looked for. In his recent reports the Chief Veterinary Officer of the Board has drawn attention to the difficulties met with in regard to diagnosis in anthrax, and has shown there is good reason for the belief that in the past cases have not infrequently been certified as anthrax, when a careful examination by highly skilled specialists has failed to reveal any positive diagnostic evidence of the presence of the disease. It is highly probable that the statistics available are to some extent misleading, and that the real position is not so unfavourable as it would appear to be.

At the same time the position revealed by the returns cannot be regarded otherwise than as unsatisfactory, and the time appears to the Board to have arrived when some further effort should be made to bring the disease under greater control. As anthrax is communicable to man and may prove fatal, and as the disease may be spread by the effusion of the blood of the diseased animal, which may also contaminate for an indefinite period the ground on which it is spilt, it is essential that nothing shall be left to chance in dealing with the carcase of a suspected animal. Experience has shown that in the majority of cases a satisfactory definite diagnosis cannot be made immediately by the veterinary surgeon on the spot. A careful microscopical examination of a sample of the blood of the dead animal is often necessary before a positive diagnosis can be arrived at, and to secure this an interval of time may be necessary. At the same time, unless the veterinary surgeon is satisfied from the history of the case, and an examination of the external lesions of the carcase, or from a microscopical investigation made immediately and on the spot, that anthrax does not exist, it is obviously important that precautions as regards the suspected carcase should be taken forthwith in order that no avoidable risks shall have been run in the interval, should the suspicion ultimately be confirmed.

The new Order is framed with a view to enable the veterinary officers of the Board to examine the evidence upon which the veterinary surgeon acting on behalf of the local authority has based his diagnosis, and if necessary to make further experimental investigations before any reported outbreak is finally accepted as an undoubted case of the disease, and for this an interval of time, which might in some cases extend to several days, is requisite. In these circumstances it is essential that any possible sources of risk should at once be removed. Accordingly, the new Order provides that in reported cases of the disease, if the veterinary surgeon employed by the local authority is not satisfied by his examination on the spot that the case is not one of anthrax, the carcase shall forthwith be destroyed by fire, or, if this is not feasible, buried with the usual precautions, and the place where the carcase has lain or where its blood has escaped should be disinfected at once by the local authority in precisely the same manner as if a positive diagnosis of anthrax had already been arrived at. Animals known to have been in contact with the dead animal are also treated temporarily as having been exposed to the risk of infection of anthrax, and kept under detention.

If the veterinary surgeon employed by the local authority is satisfied from his examination that anthrax

* *See* Transcript of Evidence, Q. 9922.

does not exist, the fact is to be communicated to the Board and to the occupier, and the notice of restriction served on him is to be withdrawn by the local authority.

Although where the veterinary surgeon is not so satisfied the carcase is to be destroyed, and the premises are to be treated for the purposes of preliminary disinfection as if the disease were present in that carcase, it is not until the diagnosis has been confirmed by the veterinary officers of the Board that the full provisions of the Order as regards the creation of an anthrax-infected place are brought into force. The forms provided by the Board upon which weekly returns as to anthrax are to be made by inspectors of the local authority are only to be used where the existence of disease has been confirmed in the above manner.

The veterinary surgeon, acting on behalf of the local authority, in dealing with a case of suspected anthrax is required to take and examine such samples of the blood or other fluid of the animal or carcase, or of the tissue of the carcase, as may be necessary for further investigation, and it is contemplated that he should himself arrive at an opinion as to whether or not disease exists and communicate it to the Board in the report he is required to make to them, but he will not embody the opinion in a certificate issued under the Acts. Some notes as to the equipment necessary for veterinary surgeons, the method of taking blood from the carcase of a dead animal, and the preparation of slides for microscopical examination, will be found in Appendix II. to this letter (Appendix 19). In order to facilitate the business of dealing with these reports and samples, it would be convenient that the specimen form given in Appendix III. (Appendix 20) to this letter should in all cases be followed by the officers of the local authority, to whom the necessary forms should be supplied by the local authority. The Board will be glad if your local authority will issue such instructions to the veterinary surgeons employed by them as will ensure that the above procedure is carefully carried out in each case.

The Order also provides that the owner of a suspected animal or carcase is at once to be served with a notice calling his attention to the precautions which the Order (Article 3) requires him to take, and that a copy of the notice is to be forwarded to the Board.

In view of the specially dangerous nature of the disease, the Board consider that the responsibility of securing the most thorough disinfection practicable should remain with the local authority, and as a rule it will probably be found more satisfactory that the work should, as heretofore, be carried out by the officers of the local authority.

To meet certain cases which have been brought to their notice, the Board have, however, in their new Order (Article 14 (2)) empowered the local authority to require the occupier or the owner himself to carry out the disinfection at the expense of the local authority. Where this procedure is followed the Board would suggest that precise instructions should be given to the owner in writing as to the methods of disinfection to be followed, including a description of those parts of the premises to which they are applied, the disinfectant to be used and the solution thereof, and also the materials and labour to be provided, in order that there may be no misunderstanding in connection with the settlement by the local authority of the cost of the disinfection after they are satisfied that it has been thoroughly carried out. Arrangements of this character have been adopted by the Board in connection with their administration of the Swine Fever Order, with satisfactory results.

The local authority may, under Article 13 (5) of the Order, recover from the owner of an animal or carcase any portion of the cost of disinfection when that has been increased by his wilful act or neglect.

Having regard to the characteristics of the disease and the extreme importance of the careful use of all possible precautions against injury to human beings or to animals in suspected cases of anthrax, it is to the public interest that any case of illness amongst animals which suggests the possibility of anthrax being present should be placed at the earliest possible moment under the control of a veterinary surgeon employed by the local authority concerned. It is only, therefore, in cases where a veterinary surgeon, acting on behalf of an owner of a sick animal, has satisfied himself that neither the history of the case nor any external lesions in the carcase of a dead animal indicate the existence of anthrax, that he would be justified in taking a sample of the blood or other fluid or tissue from such a carcase for the purpose of microscopical examination. In view of the importance of this matter the Board trust that members of the veterinary profession will carefully conform to this view, and thus assist the authorities in their efforts to combat this disease.

In issuing the new Order the Board desire to lay stress upon the fact that anthrax is a disease against which it is not practicable entirely to guard, on account of the multiplicity of the channels through which infection may be conveyed. Although the eradication of the disease cannot be aimed at, it is possible to bring it more under control. It is believed that the new Order will be of service in securing the collection of more trustworthy statistics to form a basis upon which to build up any other measures which further experience may indicate as likely to reduce the risk of infection, and the Board are satisfied that they may rely upon the co-operation of the agricultural community in carrying the new arrangements into effect.

APPENDIX 19.

NOTES issued by the BOARD OF AGRICULTURE AND FISHERIES, as to the EQUIPMENT of VETERINARY INSPECTORS, and the PREPARATION of SLIDES and SWABS.

(1) Veterinary inspectors should be provided with the following articles:—Cotton wool for plugging the orifices, disinfectants, small puncturing scalpels, forceps of a type which can be disinfected by boiling or heating, and a spirit Bunsen lamp. Cotton wool swabs on wire inside glass or metal tubes, the whole capable of being easily sterilised by dry heat in an ordinary oven.

(2) In the case of a cow or a sheep a small puncture or incision is to be made into a superficial vein so as to allow one or two drops of blood to exude.*

(3) From the blood which exudes blood-smears on slides should be prepared for microscopical examination. One or two small drops of blood should also be collected on the cotton wool swab, and the latter be returned at once to its glass or metal tube-holder, which should be immediately corked.

(4) An unstained blood smear together with a swab should be sent to the Board's Laboratory, Alperton Lodge, Wembley, Middlesex, and such information as may enable the Board to identify the specimens with the outbreak. The specimens should be marked "Anthrax, For diagnosis," and, to comply with the Post Office regulations, must be sent by Letter Post.

* In the case of animals, such as the pig and horse, it will usually be better for the purpose of diagnosis to take the material for the smears and swabs from the cut surface of a superficial lymphatic gland, such as the sub-maxillary.

APPENDIX 20.

COUNTY (*or* BOROUGH *or* BURGH) OF ....

DISEASES OF ANIMALS ACTS, 1894 TO 1914.

ANTHRAX ORDER OF 1910.

REPORT of VETERINARY SURGEON, acting on behalf of a LOCAL AUTHORITY, on a SUSPECTED OUTBREAK of ANTHRAX.

Full Name and Address of the Owner of the Animals. ....

Place where the suspected disease exists—stating Parish. ....

1. Is the case, in your opinion, one of Anthrax? ....
2. If not Anthrax, to what cause do you attribute death? ....
3. State Class of Animal, including age? ....
4. How long had the Animal been on the premises or farm? ....
5. Did the Animal die or was it killed? ....
6. If the Animal died, was there any cutting of the carcase? If so, by whom? ....
7. Was the diagnosis arrived at after a microscopical examination of material from the carcase? If so, by whom? ....
8. What interval had elapsed after death before the material was taken for microscopical examination? ....
9. State date of any previous outbreak of Anthrax on the same premises. If none, state "None." ....
10. Have there been any sudden or unexplained deaths on the premises or farm in the past? If so, had the Animal in the present outbreak access to the places where the deaths occurred? ....
11. Has any artificial feeding stuff or any foreign litter been used? If so, specify kind and origin. ....
12. Has any form of bone manure or other likely medium of infection been used in recent years? If so, specify kind and origin ....
13. State number of in-contact Animals living under the same conditions as regards food or litter. ....
14. Is any industry carried on in the neighbourhood that could spread Anthrax? Could the waste products reach the premises or farm? ....
15. Have any swine, dogs, or cats gained access to the carcase? If so, how many? ....
16. Is there any likelihood of any human beings contracting the disease? If so, give particulars. ....
17. Is the disease likely to be spread to the stock of adjoining owners? ....

REPORT as to MATERIAL sent to the LABORATORY of the BOARD as required by Art. 5 (4) of the ANTHRAX ORDER of 1910.

When material is forwarded from more than one animal the smear and swab from each animal should be identified by a number, and the information asked for regarding it should be written opposite the corresponding number on this report.

Number of the Smear and Swab.	Class of Animal from which the Smear and Swab were taken.	Date of Death.	The Material from which the Smear and Swab were made.	Date on which the Smear and Swab were despatched.

GENERAL REMARKS.

Give any further information as to the possible cause of the outbreak, such as feeding stuffs, artificial manure, or contact with other infective material, giving all information available as to the material suspected.

Signature of the Veterinary Surgeon ____________

Address ____________

____

Date ________.

This Report should be sent to the Chief Veterinary Officer, Laboratory of the Board of Agriculture and Fisheries, Alperton Lodge, Wembley, Middlesex. The envelope must be stamped.

FOR USE AT THE LABORATORY OF THE BOARD.

APPENDIX 21.

CIRCULAR to LOCAL AUTHORITIES in GREAT BRITAIN under the DISEASES OF ANIMALS ACTS, 1894 to 1910.

ANTHRAX.

10th February 1911.

I am directed by the Board of Agriculture and Fisheries to advert to their Circular Letter (No. A190/C) of the 24th September last as to the Anthrax Order of 1910, and I am to acquaint you, for the information of your local authority, that the experience of the working of the Order during the period it has been in operation suggests that the procedure indicated in the Order and in the circular letter referred to is not fully understood by many inspectors of local authorities and by veterinary surgeons employed by local authorities to inquire into reported outbreaks of anthrax.

The Board consider it desirable, therefore, to call the attention of your local authority to the following matters as regards which the proper procedure has in many cases been departed from, namely:—

ARTICLE 5 (4).

(*a*) The material submitted by veterinary surgeons for examination at the Board's laboratory has consisted of a stained slide only, instead of an unstained blood smear and swab.

(b) The package containing the material has given no indication as to the sender, or as to the name and address of the owner or occupier of the premises from which the material was taken.

In this connection, it may be noted that the postage of packages or letters addressed to the laboratory of the Board must, in order to comply with the postal regulations, be prepaid by the sender.

(c) The report of the veterinary surgeon has not been in the form shown on page 7 of the circular letter.

ARTICLES 7 AND 18.

Form A. (*Notice declaring an Infected Place*) has been served on the occupier of the premises, and a Return on Form No. A1/S. (*Statistical Return*) has also been sent to the Board, prior to the receipt of notice from the Board that the existence of anthrax has been confirmed by their officers at the laboratory.

I am to add that it would be of advantage, for the purposes of registration, that the name of the occupier of the premises concerned should be given on the copy of the Notice Form C. (*Notice to Occupier of Precautions to be taken*) and Notice Form D. (*Withdrawal of Notice Form C.*) sent to the Board in pursuance of Article 8 of the Order.

APPENDIX 22.

LEAFLET No. 28.—Issued by the BOARD OF AGRICULTURE AND FISHERIES.

ANTHRAX.

Anthrax is a contagious disease caused by a microbe, *Bacillus anthracis*. Human beings and all animals are liable to become infected. The disease, which shows itself suddenly, chiefly attacks cattle, pigs, and sheep, but horses are not uncommonly affected. It is often very quickly fatal, usually within forty-eight hours of illness showing itself, but in the United Kingdom it does not often spread with rapidity from animal to animal, though it may affect a number of swine at the same time if they have been fed on flesh affected with anthrax.

Symptoms.

Where an animal is attacked with anthrax its inclination is to separate itself from its companions. It stands almost immovable, with head depressed, and usually at the later stages of the disease declines every kind of food. If carefully watched, rigors, or shivers, will be seen to pass over the body; there may be swellings (around the throat—especially in horses and pigs) which are extremely hot to the touch, the eyes have a fixed and staring look, and, if carefully examined, a small quantity of blood may sometimes be found trickling from the nose, or upon the voided fæces of the living animal. Death follows as a rule very rapidly after these symptoms are observed. Cattle are most frequently attacked by this disease.

Post-mortem Appearances of the Disease.

Where an animal dies of anthrax there is generally, though not always, to be found almost directly after death a slight oozing of blood from the nostrils or some other of the external openings of the body. The carcase is swollen. The muscles may be infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged; it is softer and darker than normal, and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen in cattle is of great diagnostic importance, but in those districts where Red-water exists enlargement of the spleen may be due to this disease and not to anthrax. In such a case, however, the spleen substance has not the same fluid, tarry, appearance. In horses and pigs, and much less frequently in cattle, the spleen may be of normal size, although the animal has died of anthrax. The flesh is dangerous to animals and human beings.

Difficulty of recognising the Disease.

One of the greatest of the difficulties which present themselves in dealing with this disease is that the symptoms during life are not such as to lead a person who is unacquainted with anthrax to suspect the presence of the disease. Moreover, the death of the animal attacked often occurs when the owner or attendant is absent. It frequently happens that an animal which has sickened is killed, or that the carcase of an animal dead of anthrax is cut up, and the blood, which is the main source of danger, is freely spilt about the premises or on the soil. The disease is in this indirect manner spread to other animals, and in some cases the persons who have handled the carcase contract it. In every case of sudden and unaccountable death amongst stock the owner of the animal should await skilled opinion before disposing of the carcase.

Anthrax or Suspected Anthrax to be reported.

Every person in Great Britain having or having had in his possession or under his charge an animal (that is, a ruminating animal, pig, horse, ass, mule or dog) affected with or suspected of anthrax is required by law to give notice of the fact with all practicable speed to the Police. Failure to give such notice renders a person liable to a fine of 20*l.*, and in certain circumstances to a month's imprisonment with hard labour.

It is the duty of the Local Authority under the Diseases of Animals Act, on receiving such notice, to institute inquiries, and to make proper provision for the disposal of the carcase of any animal suspected of anthrax and for the disinfection of the premises upon which disease has existed or is suspected to have existed. The Inspector of the Local Authority is also required to give information to the Medical Officer of Health.

Precautions to be taken.

An owner of animals can do much to assist in preventing the spread of the disease amongst his stock, and it is clearly to his own interests that he should do so.

A sick animal should on no account be killed, but should be carefully isolated from all other animals. Should there be the slightest suspicion of Anthrax being present, the matter must, as before mentioned, be reported to the Police, and in the event of such an animal dying before the arrival of the veterinary surgeon employed by the Local Authority the carcase must not be dragged along the ground, but should be allowed to remain where it is, until the examination has taken place. It is essential that *the carcase of the animal should not be cut or opened*, and steps should be taken to prevent the escape of blood or of excretions which may contain blood. Any such blood should at once be destroyed and also any drops of blood which may have escaped from the carcase to the floor of the shed or to the soil, inasmuch as every drop of blood of an animal which has died of Anthrax contains large numbers of the bacilli which cause the disease, and from these very resistant spores may form. For the purpose of destroying the bacilli contained within the infected blood a strong solution of carbolic acid should be used, and all the external openings should be plugged with hay saturated with the same solution.

Under the Anthrax Order of 1910, which came into operation on the 1st January 1911, various provisions are required to be observed in connection with cases, or suspected cases of Anthrax, and it is advisable therefore that stockowners, butchers, and other persons dealing with animals should make themselves fully acquainted with these provisions, as any failure to observe them may render the offender liable to legal proceedings. The following provisions may, however, be quoted here.

Under the Order, the occupier of any premises on which there is a diseased or suspected animal or carcase must—

(i) prevent access of animals or fowls to the diseased or suspected animal or carcase, or to any part of the premises which has been exposed to infection of disease from the animal or carcase; and

(ii) detain on the premises any diseased or suspected animal thereon and any other head of cattle, or sheep, or goat, or swine which has been in the same shed, stable, building, yard or field with the diseased or suspected animal or carcase.

The occupier is also required to disinfect as soon as possible with chloride of lime any place where the carcase of a diseased or suspected animal has lain or where its blood has escaped.

A diseased or suspected carcase must not be buried or destroyed otherwise than by the Local Authority, or be removed from the farm or premises upon which the animal died or was slaughtered except by the Local Authority.

Animals with which a suspected animal has been in association should be carefully watched, and isolation at once adopted in the case of the appearance of symptoms similar to those of the suspected animal. Such precautions are particularly necessary in the case of milch cows affected or suspected of being affected. The milk of these cows may contain anthrax bacilli, and so be the means of infecting human beings. Article 11 of the Anthrax Order prescribes that the milk produced by any diseased or suspected cow or goat shall not be mixed with other milk, and that all milk affected by that Article shall forthwith be boiled or otherwise sterilised, and any utensil, in which such milk is placed before being so treated shall be thoroughly cleansed with boiling water before any other milk is placed therein.

General Observations.

It is important that it should be widely known that anthrax is due solely to the introduction of the minute germs or spores of anthrax into the blood of an animal or of man. The disease may therefore be introduced by any medium capable of conveying these germs or spores. Feeding stuffs brought on to a farm, or manures made from animal substances, may be vehicles of infection. If a stream becomes contaminated, as has been found to be the case where certain industries involving the use of the hides, hair, &c., of animals are carried on, the spores may be carried to the farm by the water. The spores of anthrax develop into bacilli which find their way into the circulation of an animal through a cut or abrasion.

Where infection has once been introduced upon a farm it has frequently been continued by the ignorance or carelessness of individuals, and in some cases farms have become permanently infected with anthrax.

It is a common practice amongst owners of stock to slaughter their cattle as soon as they present symptoms of serious illness, in order that the carcase and hide may be utilized. Where, as is not uncommonly the case, the sudden illness is due to the presence of anthrax, the greatest mischief is done by such a practice. The blood of the diseased animal is distributed on the ground, or it may be on the floors of the cattle-shed or upon the mangers, or is carried on the boots of the attendants to other parts of the farm or premises. The bacilli contained within the blood of a diseased animal will, when exposed to the air, multiply and produce spores which may become the means of infecting other animals at short or long intervals. Many cases have come under the notice of the Board from time to time of persons having contracted anthrax whilst engaged in slaughtering animals, or in dressing or otherwise handling the carcases of animals.

On the other hand the bacilli of anthrax die *if kept within the intact carcase* of an infected animal; no spores are formed; and experience has shown that, where the precautions recommended above have been scrupulously adhered to, the disease frequently ceases after the death of one animal on the farm.

Preventive Inoculation.

The Pasteur method of preventive inoculation has rendered great service in preserving stock on badly infected farms in various parts of the world. The method consists of injecting the animals with fixed doses of attenuated cultures of the *Bacillus anthracis*. Two injections at intervals of 12 days are performed. For the first injection a very attenuated culture is used (first vaccin), and for the second one employs a less attenuated culture (second vaccin). The immunity is established about 12–15 days after the second vaccin has been injected. In cattle it lasts about a year, and should be repeated after this period unless the ground has become purified. The great majority of cattle operated on show little more than a temporary indisposition with passing fever after the injection, which may be assumed to indicate a mild attack of anthrax. Occasionally, however, an inoculated animal may die of the disease as the result of the injection, and for this reason the animals while undergoing the process of immunization should be kept in a special paddock, or better still in sheds which can be disinfected in the event of an accident taking place. The operation should only be attempted by skilled persons, who will know the best way to prevent an accident, and guard against its consequences should it occur.

Since the operation is not altogether unattended by the possibility of loss, and since it incurs a certain amount of expense, one has to consider under what circumstances it will be worth while undertaking it. It will be obvious that on farms registering only one death annually it will hardly be called for, and that it would be folly to adopt it on clean farms.

It results from observations on several millions of cattle in various parts of the world that accidents occur in about 0·5 per cent. of the inoculated cattle taken all round, and that the operation may be expected to reduce the death-rate from anthrax on infected farms to about 1 per cent. or slightly under.

If a stockowner finds that his annual losses from anthrax amount to 2 per cent. he will possibly find it profitable to have recourse to preventive inoculation.

It should be understood, however, that since the number of animals dying of anthrax in one year will vary, and since the inoculation must be repeated annually, the estimation of annual losses must be based on two or three years' casualties.

A certain degree of temporary immunity can also be almost immediately conferred by injecting a dose of anthrax serum, and the injection produces no accidents. Where animals have been exposed to the risk of what might be called gross infection (for example when a carcase has been carelessly dealt with on a pasture) it is advisable to inject them immediately with serum, and remove them to another field.

Farmers invited to assist Public Authorities.

Stockowners are, therefore, earnestly invited to co-operate with the public authorities:—

(a) By reporting every case of sudden and unexplained illness or death, especially amongst cattle, to the Police;

(b) By isolating an ailing animal, and by protecting any suspected carcase from persons or animals pending the arrival of the veterinary surgeon employed by the Local Authority;

(c) By giving every facility to the officers of the public authorities in carrying out the precautionary measures enjoined by the Anthrax Order; and

(d) By affording such officers every assistance in their power in tracing the origin of the outbreak.

They are further strongly recommended to give positive orders to their servants that *under no circumstances is an ailing beast to be killed by them, or its carcase opened, where the cause of sickness or death is unexplained.*

The Board have prepared a short notice (A. 357/A) dealing with the principal points above set out, suitable for posting up in byres and sheds. Copies can be obtained gratis and post free on application to the Board.

4, Whitehall Place, London, S.W.,
September 1893.

Revised, January 1911.

APPENDIX 23.

Board of Agriculture and Fisheries.

DISEASES OF ANIMALS ACTS, 1894 to 1911.

Description of certain Diseases of Animals.

The following description of the diseases which are at present the subject of administrative action by the Board has been prepared by the Veterinary Officers of the Board with the view of assisting Inspectors, as well as stockowners, in Great Britain, to detect those diseases.

Anthrax.

Definition.—A contagious disease caused by a microbe—Bacillus Anthracis.

Animals affected.—Human beings and all animals are liable to anthrax. The disease is seen chiefly in cattle, pigs, and sheep, but not uncommonly in horses.

Symptoms.—The disease shows itself suddenly. It is very fatal, usually within 48 hours. It does not often in the United Kingdom spread with rapidity from animal to animal, but it may affect a number of swine at the same time if they have been fed on anthrax flesh or organs.

A beast which a short time before appeared to be well is found dead, or in a dying condition. Frequently blood oozes from the nostrils and the anus. In cattle there are no typical symptoms, but in horses and pigs the region of the throat is often found to be swollen.

Post-mortem.—The carcase is swollen. Blood is found around the nostrils and anus. The muscles are often infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged; it is softer and darker than normal, and its substance usually resembles tar.

In most parts of this country the enlargement of the spleen is of great diagnostic importance, but in those districts where redwater exists, enlargement of the spleen may also be expected. In this case, however, the spleen substance has not the same fluid, tarry appearance. The flesh is dangerous to animals and human beings. It is the height of folly on the part of a farmer to open an animal suspected to have died of anthrax, as he may thereby cause further infection of his premises. In cases of sudden death he should await a skilled opinion before disposing of the carcase.

APPENDIX 24.

Notice to Butchers, Slaughterers, Knackers, and other persons engaged in Great Britain in slaughtering Animals, or in dressing or otherwise handling Carcases of Animals.

ANTHRAX.

Cases come under the notice of the Board of Agriculture and Fisheries from time to time of persons having contracted Anthrax whilst engaged in slaughtering Animals, or in dressing or otherwise handling the carcases of Animals. In connection with inquiries made under the Diseases of Animals Acts, 1894 to 1903, into outbreaks of Anthrax, it appears from the reports of the Board's Inspectors as regards the outbreaks which occurred in Great Britain during the period from the beginning of July to the end of December of last year, that as many as twelve persons are known to have contracted the disease whilst so employed, and that six of these persons died, whilst in one case amputation of the arm became necessary.

The Board therefore think it desirable to warn persons against shedding the blood of an animal which appears to be ill from some unknown cause, and also against cutting or handling the carcase or skin of any animal which has died suddenly, until careful inquiries have been made with a view to see whether or not any symptoms* of Anthrax had been exhibited during life. Should there appear to be any reason to suspect the presence of Anthrax it is very desirable that the slaughter of the animal or the dressing of the carcase should not be commenced until steps have been taken to investigate the cause of illness or death, and that the owner should be warned of the grave risk to human life which might without such investigation be incurred.

If the course above indicated be followed in suspicious or doubtful instances, material assistance would thus be rendered to the respective Authorities concerned in dealing with this very dangerous disease in man and in animals.

T. H. Elliott,
Secretary.

Board of Agriculture and Fisheries,
4, Whitehall Place,
London, S.W.
10th October, 1905.

* The symptoms of Anthrax may be summarised as follows:—The disease shows itself suddenly. It is very fatal, usually within 48 hours. It does not often in the United Kingdom spread with rapidity from animal to animal, but it may affect a number of swine at the same time if they have been fed on anthrax flesh or organs. A beast which a short time before appeared to be well is found dead or in a dying condition Frequently blood oozes from the nostrils and the anus. In cattle there are no typical symptoms, but in horses and pigs the region of the throat is often found to be swollen.

After death the carcase is swollen. Blood is found around the nostrils and anus. The muscles are often infiltrated with blood at certain points. The lungs and glands are congested. The spleen is very much enlarged; it is softer and darker than normal, and its substance usually resembles tar.

APPENDIX 25.

NOTICE TO STOCK OWNERS.

ANTHRAX.

CAUTION AGAINST CUTTING CARCASES.

Every person in Great Britain having or having had in his possession or under his charge an animal affected with, or suspected of, anthrax is required by law to give notice of the fact with all practicable speed to the police.

Failure to give such notice renders a person liable to a fine of 20*l*., and in certain circumstances to a month's imprisonment with hard labour.

Where an animal is attacked with anthrax its inclination is to separate itself from its companions. It stands almost immovable, with head depressed, and usually declines every kind of food. If carefully watched, rigors, or shivers, will be seen to pass over the body; there may be swellings (around the throat—especially in horses and pigs) which are extremely hot to the touch, the eyes have a fixed and staring look and, if carefully examined, a small quantity of blood may sometimes be found trickling from the nose, or upon the voided fæces of the living animal, and death follows as a rule very rapidly after these symptoms are observed. Cattle are most frequently attacked by this disease.

In all cases where an animal is found to have died suddenly from an unknown cause it is most important that the carcase should in no circumstances be cut, until it has been determined that the animal did not die of anthrax. If the carcase were to be skinned or cut up, there would be a very great risk of communicating the disease, through the agency of the blood of the diseased animal, not only to other animals on the farm or on other premises where the animal may have died, but even to any persons who handled the carcase.

Where an animal dies of anthrax there is generally, though not always, to be found, almost directly after death, a slight oozing of blood from the nostrils or some other of the external openings of the body. Such blood should at once be destroyed and also any drops of blood which may have escaped from the carcase to the floor of the shed or to the soil, inasmuch as every drop of blood of an animal which has died of anthrax contains large numbers of the bacilli which cause the disease, and from these very resistant spores may form. For the purpose of destroying the bacilli contained within the infected blood a strong solution of carbolic acid should be used, and all the external openings should be plugged with hay saturated with the same solution.

After these directions have been carried out, great care should be taken to prevent any animal from approaching the carcase or the place where the animal has died until the officers of the local authority arrive and prepare for the disposal by burial or otherwise, of the carcase.

A leaflet on anthrax may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 4, Whitehall Place, London, S.W. 4. Letters of application so addressed need not be stamped.

SYDNEY OLIVIER,
Secretary.

Board of Agriculture and Fisheries,
4, Whitehall Place, London, S.W. 4,
March 1914.

APPENDIX 26.

Circular No. 4

LOUISIANA STATE LIVE STOCK SANITARY BOARD, BATON ROUGE, LA.

THE TURKEY BUZZARD AND CARRION CROW.

A MENACE TO THE LIVE STOCK INTERESTS OF THE STATE. CARRY AND SPREAD THE INFECTION OF CHARBON, HOG-CHOLERA, &C.

It has been satisfactorily determined that the turkey buzzard and carrion crow are capable of carrying and spreading the germs of some of our most fatal infectious diseases of live stock.

The germs of charbon have been found on their feet, on their beaks, and in what they throw up, after feeding upon a charbonous carcass.

It is firmly believed, also, by live stock sanitary authorities in the different Southern States, including our own, that the buzzard and the carrion crow are the most responsible agents in widely spreading the infection of hog-cholera.

The Southern States which previously had laws to protect the buzzard and carrion crow are now repealing them, and are legislating against these infection-carrying birds in the interests of their live stock industries.

Louisiana has never had any law protecting the buzzard and the carrion crow, although an erroneous impression to that effect has long prevailed among our people.

The Conservation Commission of Louisiana, which has the official control of bird life in the State, has already adopted a resolution declaring the buzzard and the carrion crow a nuisance and transmitters of disease affecting live stock, such as charbon, hog-cholera, &c., and a menace to the public welfare in general with a recommendation for their extermination, as note the following resolution adopted February 14th, 1913, to-wit:—

> "Be it resolved, that the Conservation Commission, acting under the powers invested in it by law, hereby declares the turkey buzzard or carrion crow to be a nuisance and a transmitter of disease, particularly those diseases to which live stock are subjected, and a menace to the public welfare in general; that this bird will no longer come under the protective laws of the State, and shall be subject to destruction at any time without fear or favour.
>
> "Be it further resolved, that the Louisiana State Live Stock Sanitary Board is given permission to recommend immediate and perpetual warfare on the turkey buzzard or carrion crow, and to take such steps as is deemed advisable to exterminate this pest propagator."

Every police jury, health, sanitary, or other local authorities as well as individuals, in the parishes, should take this matter up and assist in the extermination of this fruitful source of spreading the infection of our dangerous animal plagues, especially charbon and hog-cholera.

Outbreaks of hog-cholera are liable to occur at any time, and charbon may crop up on the appearance of a warm spell of weather in sections where it may previously have occurred; and it is the earnest desire of this Board to use every endeavour to prevent, through the medium of these scavenging birds, the further spread of these dangerous diseases.

We cannot afford to sacrifice our growing live stock industry to the Turkey buzzard and the carrion crow.

LOUISIANA HAS NO LAW AGAINST KILLING THE BUZZARD AND CARRION CROW. On the contrary, THEIR DESTRUCTION IS RECOMMENDED BY THE CONSERVATION COMMISSION OF LOUISIANA.

LOUISIANA STATE LIVE STOCK SANITARY BOARD,

DR. E. PEGRAM FLOWER,
Secretary and Executive Officer.

APPENDIX 27.

EXTRACT FROM "NEW ZEALAND GAZETTE," 26TH OCTOBER 1905.

REGULATIONS UNDER THE STOCK ACT, 1893, RESTRICTING THE IMPORTATION OF ANIMAL MANURES INTO NEW ZEALAND.

1. For the purposes of these regulations,—

"Animal manure" means manure composed of or containing any portion of the carcase of any stock as defined in "The Stock Act, 1893," and its amendments, and includes the bones, blood, and any other parts of such carcase in every case where the bones, blood, or other parts are suitable or intended for the purposes of manure, but does not include bone-char.

"Inspector" means an Inspector of Manure-sterilising appointed for the purposes of these regulations and acting in India or Australia, as the case may be.

2. The introduction into the Colony of New Zealand from any country or place other than India and the Commonwealth of Australia of any animal manure is hereby absolutely prohibited.

3. The introduction into the Colony of New Zealand of animal manure either from India or from the Commonwealth of Australia is hereby restricted by prohibiting the same unless the following conditions are faithfully complied with:—

(1) The owner or person in charge of the works at which animal manure in any form is manufactured or prepared for export to New Zealand shall, not less than twenty-one days before commencing operations, apply to the Inspector acting for New Zealand in the country in which the works are situated for a license to manufacture or prepare at the said works such manure for export to New Zealand. The application shall be in the form numbered 1 in the Schedule hereto, or to that effect.

(2) On receipt of the application the Inspector may visit the works, and may grant such license in the form numbered 2 in the Schedule hereto, upon being satisfied—

(*a*) That a separate building and plant suitable for the purpose are set apart solely for the grinding, conveying, screening, storage, &c., of animal manure after sterilisation.

(*b*) That the buildings, appliances, and surroundings generally are satisfactory.

(3) The license shall remain in force until cancelled by the Inspector, and he may cancel the same at any time if satisfied that the requirements of the last preceding clause of these regulations are not properly complied with, or that the owner or person in charge of the works has in any way failed to faithfully comply with these regulations in any respect.

(4) Before commencing or resuming the manufacture or preparation of animal manure for export to New Zealand seven clear days' notice must be given to the Inspector by the licensee.

(5) No consignment of animal manure shall be landed in New Zealand unless the said consignment is accompanied by a declaration in the form numbered 3 in the Schedule hereto, or to that effect, stating (*inter alia*) that the requirements specified in paragraphs (*a*) to (*i*) of this subclause have been faithfully complied with, viz.:—

(*a*) That any bones contained in the said consignment have been subjected to a temperature of at least 281 degrees Fahrenheit (equal to an indicated steam-pressure of fifty pounds per square inch) for not less than three hours, or crushed, and afterwards subjected to a temperature of at least 267 degrees Fahrenheit (equal to an indicated steam-pressure of forty pounds per square inch) for not less than two hours.

(*b*) That all animal ingredients, other than bones, contained in the said consignment have been subjected to a temperature of at least 267 degrees Fahrenheit (equal to an indicated steam-pressure of forty pounds per square inch) for not less than two hours.

(*c*) That the licensed building and machinery used in the manufacture and treatment of the said consignment have not, since the issue of the license, been used in the manufacture or treatment of any animal manure that has not been sterilised as aforesaid.

(*d*) That the said consignment has not been in contact after sterilisation with any animal manure which has not been sterilised as aforesaid, or with any other substance or matter likely to convey disease.

(*e*) That during its manufactnre or treatment the said consignment and the works were at all times open to inspection by the Inspector, or any officer authorised in that behalf by the Inspector.

(*f*) That the bags in which the said consignment is contained have never previously been used for any purpose whatsoever.

(*g*) That each bag is branded with the name of the works where it was filled, and also with the name and description of the manure with which it is filled.

(*h*) That all carts, trucks, barges, or other conveyances have been properly cleansed to the satisfaction of the Inspector before the said consignment was loaded therein.

(*i*) That no animal manure which has not been sterilised as aforesaid has been conveyed to the port of shipment or to the ship on the same cart, truck, barge, or other conveyance with the said consignment.

(6) The said declaration shall be signed by the owner or person in charge of the works where the said consignment was manufactured or prepared, and shall be delivered to the Inspector, or some officer authorised in that

behalf by the Inspector, in time to allow him to satisfy himself as to its accuracy.

(7) The Inspector or his officer, upon being satisfied that the foregoing requirements of these regulations have been complied with, and that the hereinafter-mentioned fee has been paid, shall countersign the declaration, and forthwith return it to the owner or person in charge of the works, to be by him forwarded to New Zealand with the consignment to which it relates.

(8) There shall be payable to the Inspector, on demand, for each ton or part of a ton (by weight) contained in the consignment to which the countersigned declaration relates a fee of two shillings and sixpence if in Australia, or of two rupees if in India.

(9) The countersigned declaration shall be delivered to an Inspector of Stock at the New Zealand port of importation before the consignment is landed.

(10) No consignment of animal manure shall be landed in New Zealand unless the said consignment is accompanied by a declaration in the form numbered 4 in the Schedule hereto with respect to each ship by which it was conveyed during any part of the voyage.

(11) The last-mentioned declaration shall in the case of each ship be signed by the master of the ship, and shall be delivered to an Inspector of Stock at the New Zealand port of importation before the consignment is landed.

4. If any person introduces or attempts to introduce into New Zealand any animal manure contrary to these regulations, then and in such case, and irrespective of any other penalty to which he is thereby liable, any Inspector of Stock shall have and may exercise all such powers of seizure and disposal as are contained in clause 53 of the general regulations hereinafter referred to.

5. Any person sending or causing to be sent any order for any animal manure to be imported into New Zealand from India or Australia shall at the same time forward by post a notice in the form numbered 5 in the Schedule hereto to the Secretary for Agriculture at Wellington, and also cause the Inspector in India or Australia, as the case may be, to be immediately notified of the purport of such order.

6. Any person intending to introduce animal manure into New Zealand shall give the Inspector of Stock at the port of landing not less than forty-eight hours' notice of his intention. The notice shall be in the form numbered 6 in the Schedule hereto, or to that effect.

7. The Inspector of Stock at the port of landing may submit samples of the manure to any analyst duly appointed under "The Adulteration Prevention Act, 1880," or "The Fertilisers Act, 1904," for report, and may detain the manure for a reasonable time pending inquiry or the report of the analyst. If in the opinion of the analyst the manure has not been treated as prescribed by these regulations it shall be treated, dealt with, or disposed of as the Minister directs.

8. All expenses of every description incurred in connection with the analysis, examination, treatment, or disposal of animal manure under the last preceding clause hereof shall be paid by the owner to the Inspector of Stock at the port of landing within twenty-four hours after demand.

9. Any person importing animal manure into New Zealand may be required by any Inspector of Stock to thoroughly disinfect any conveyance or vehicle in which such animal manure has been conveyed after leaving the ship.

10. If such requisition is not complied with to the said Inspector's satisfaction, he may himself cause the work of disinfection to be done at the expense in all things of the importer.

11. If the person liable to pay to the Inspector of Stock the expenses referred to in either clause 8 or clause 10 hereof does not pay the same, the amount may be recovered by the said Inspector as a debt, but without thereby relieving such person from his liability to penalties for breach of these regulations.

12. Any person committing in New Zealand a breach of these regulations shall, on conviction, be liable to a penalty of not less than five pounds nor more than five hundred pounds.

13. So much of the general regulations dated the thirtieth day of December, one thousand eight hundred and ninety-three, made under "The Stock Act, 1893," and published in the *New Zealand Gazette* of the fourth day of January, one thousand eight hundred and ninety-four, as is inconsistent with these regulations is hereby revoked or modified in so far as such inconsistency exists, but not further or otherwise.

14. The forms prescribed by these regulations can be obtained free of charge from the Secretary for Agriculture at Wellington, the Inspector of Stock at any New Zealand port, or any Inspector of Manure sterilising.

SCHEDULE.

FORM No. 1 (REGULATION No. 3 (1)).

Application for Licence to manufacture or prepare Animal Manure for Export to New Zealand.

In the matter of "The Stock Act, 1893" (New Zealand and the Regulations thereunder

To the Inspector of Manure-sterilising acting for New Zealand at . . . . . .

I, [WE] ——— hereby apply for a license to manufacture or prepare animal manure for export to New Zealand at the works herein described, viz.:—

Name of the works:

Location of the works:

Kind of animal manure proposed to be manufactured or prepared:

Particulars (including capacity) of plant available for crushing bones:

Particulars (including capacity) of plant available for sterilising animal manure:

Size of building to be set apart solely for the grinding, conveying, screening, storage, &c., of animal manure after sterilisation:

Particulars (including capacity) of plant in the said building:

Name of shipping port:

Distance of works from shipping port:

Means of conveying animal manure from works to port:

Signature of owner or person in charge of the works:
Address:
Date: , 19 .

FORM No. 2 (REGULATION No. 3 (2)).

License to manufacture or prepare Animal Manure for Export to New Zealand.

In the matter of "The Stock Act, 1893" (New Zealand), and the Regulations thereunder.

PURSUANT to the application of [*Licensee's name*], of , dated the day of . 19 , this license is hereby granted and issued to the said , in respect of the works described in the said application, and situated at .

This license is issued subject to the provisions of "The Stock Act, 1893," and the regulations from time to time in force thereunder, restricting the importation of animal manure into New Zealand, and is in force until cancelled by me.

Dated at , this day of , 19 .

, Inspector of Manure-sterilising acting for New Zealand.

FORM No. 3 (REGULATION No. 3 (5)).

Declaration to accompany Animal Manure exported to New Zealand.

In the matter of "The Stock Act, 1893" (New Zealand) and the Regulations thereunder.

I, , hereby solemnly and sincerely declare as follows:—

1. That the undermentioned consignment of animal manure has been duly treated as required by the above-

mentioned Act and Regulations at the works, at , of which I am owner or manager.

2. That the requirements specified in paragraphs (a) to (i) of clause 3 (5), of the regulations of the day of , 1905, have been faithfully complied with.

Particulars of Consignment.

No. of Bags.	Description of Manure.	Brands and Marks.	Name and Address of Consignor.	Name and Address of Consignee.

And I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of an Act of the Imperial Parliament entitled "the Statutory Declarations Act, 1835."

Signature:

Declared at , before me this day of , 19 .

The foregoing declaration is countersigned by me, at , this day of , 190 .

Inspector [or the Inspector's authorised officer].

FORM No. 4 (REGULATION No. 3, (10)).

Declaration by Master of Vessel respecting Animal Manure to be imported into New Zealand.

In the matter of "The Stock Act, 1893" (New Zealand), and the Regulations thereunder.

I, , master of the vessel " ", which is now lying at the Port of , do hereby solemnly and sincerely declare that the undermentioned consignment of animal manure was conveyed by the said vessel from the Port of to the Port of , and that during the time it was on board the said vessel, or being loaded into or unloaded from the said vessel, the said manure has not been brought into contact with any unsterilised animal manure.

Particulars of Consignment.

No. of Bags.	Description of Manure.	Brands and Marks.	Name and Address of Consignor.	Name and Address of Consignee.

And I make this solemn declaration conscientiously believing the same to be true, and by virtue of the provisions of an Act, &c. (as in Form No. 3 above).

FORM No. 5 (REGULATION No. 5).

Notice of Animal Manure ordered from India or Australia.

In the matter of "The Stock Act, 1893" (New Zealand), and the Regulations thereunder.

To the Secretary for Agriculture, at Wellington, New Zealand.

IN pursuance of regulations under "The Stock Act, 1893," I hereby give notice that I have this day sent or caused to be sent an order for animal manure to be imported into New Zealand in accordance with the following particulars:—

Name and address of person to whom the order was sent:
Kind of animal manure ordered:
Quantity ordered:
When the manure is to be shipped:
Port from which the manure is to be shipped:
Port to which the manure is to be shipped:
Particulars of any brands, marks, or numbers to be placed on the bags:

Signature:
Address:
Date:

FORM No. 6 (REGULATION No. 6).

Notice of Intention to introduce Animal Manure into New Zealand.

In the matter of "The Stock Act, 1893" (New Zealand), and the Regulations thereunder.

To the Inspector of Stock at .

TAKE notice that it is my intention to introduce into New Zealand from the Port of , per the vessel " " (expected to arrive at on the day of), the undermentioned animal manure, which has been treated as required by the Regulations under "The Stock Act, 1893":—

Kind of animal manure:
Quantity:
Particulars of brands, marks, or numbers:

Signature of owner or agent:
Address:
Date:

ALEX. WILLIS,
Clerk of the Executive Council

APPENDIX 28.

Inquest on Herbert Denby held in the Town Hall, Bradford, by the Bradford City Coroner on 27.11.12. Denby was a shoddy merchant's labourer and died from anthrax. The shoddy manipulated contained about 5 per cent. of material originating from dangerous wools. The conditions of willowing, &c., were very dusty.

Dangerous wools were only bought from one firm—the——Company—and this was the only firm manipulating dangerous wool from which purchases were made. Apparently some mohair waste got into the non-scheduled wool waste by error on part of sellers.

The jury returned a verdict of "Accidental death through anthrax contracted whilst at work." The conditions of work were held by the jury to be anything but satisfactory, and it was recommended to the authorities that compulsory rules somewhat similar to those for woolsorting should be made applicable to work of this kind; also that something should be done to trace the ultimate destination of wool waste or dirt.

APPENDIX 29.

STATEMENT of the CAPITAL and ANNUAL COST of MEASURES taken either in accordance with existing regulations or for the purpose of attempting to prevent risk from ANTHRAX and DUST; together with the ANNUAL COST of COMPENSATION to those who CONTRACT the DISEASE. The COSTS are those actually incurred by the OCCUPIER of one of the PRINCIPAL COMMISSION FACTORIES in BRADFORD.

CAPITAL COST OF MEASURES TAKEN FOR PREVENTION OF ANTHRAX AND DUST.

	£	s.	d.
One 70-inch Sturtevant Fan for sorting and opening boards -	40	0	0
10 sorting and 2 opening boards -	60	0	0
Cost of piping from boards to cyclone -	60	0	0
1 wool willow for wool after being sorted	120	0	0
Wool willow, partitioning off -	20	0	0
1 dust filter from wool willow	79	6	0
Dust filter, partitioning off -	5	0	0
Steam spray in blend bins -	9	0	0
1 No. 2 Sturtevant Fan for wash bowl feed	5	2	0
1 cyclone and pipe at feed of wash bowl -	5	0	0
2 oil motions at end of dryer -	8	0	0
1 shoddy willow -	120	0	0
1 No. 3 Sturtevant Fan at feed of shoddy willow -	8	0	0
1 cyclone pipe at feed of shoddy willow -	5	0	0
1 dust chamber at back of shoddy willow	3	0	0
1 dust chamber pipe outside from shoddy willow -	10	0	0
2 dust filters in card room -	20	0	0
Imperia Vacuum Co. installation for removing dust from card clothing and card room -	125	0	0
Shafting, pulleys, girders and fixing for wool willow -	26	0	0
Shafting, hanger's, plummer blocks, for wool willow -	9	12	0
2 26 × 6½ split pulley and striking gear -	5	10	0
1 cyclone by Spencer and Halstead -	118	0	0
1 flue door and frame at chimney bottom	6	0	0
1 laundry for washing towels and overalls	45	0	0
1 steep bowl for Van mohair and Persian locks -	70	0	0
1 hydraulic lift for same -	45	0	0
1 rake motion on steep bowl -	54	0	0
Steamer for disinfecting blood stains -	14	0	0
	1,095	10	0

ANNUAL COST OF COMPENSATION FOR AND OF REGULATIONS AND MEASURES FOR PREVENTION OF ANTHRAX, &c.

	£	s.	d.
Fans and upkeep and cyclone -	26	0	0
Boards and upkeep and cyclone -	10	0	0
Lavatories and upkeep extra, and soap and water -	3	15	0
Warehouse room for sorting and opening	8	0	0
Running of willows and filter -	20	0	0
Cost of illness through this cause -	22	2	6
Cost of deaths through this cause -	710	9	0
Cost of medical adviser -	13	2	6
Subs. to anthrax investigation -	10	0	0
Extra men required and extra time required to meet regulations in warehouse, washing and carding -	210	0	0
Disinfectant -	14	0	0
Flue cleaning -	4	10	0
Respirators—handkerchiefs -		4	0
Wage for laundry and soap -	36	7	6
Extra limewashing every 6 months instead of 12 months -	10	0	0
First aid -	2	0	0
	1,100	10	6

APPENDIX 30.

IMPORTS OF EACH DESCRIPTION OF WOOL.

A Return showing the total quantities of each description of Wool and Goat Hair, *i.e.* :—

1. Alpaca, Vicuna and Llama, .
2. Camels' Hair,
3. Mohair (Angora Goats' Hair),
4. Goats' Hair (other that Mohair),
5. Sheep's or Lambs' Wool,

imported into the United Kingdom during the years 1913 and 1914 from all countries which export Wool or Hair to this country direct.

ALPACA, VICUÑA AND LLAMA.

Countries whence Consigned.	Quantities. 1913.	Quantities. 1914.
	Lbs.	Lbs.
United States of America	31,364	9,922
Peru -	5,432,386	4,295,190
Chile -	338,908	199,247
Spain -	6,720	—
Total from Foreign Countries -	5,809,378	4,504,359
Total from British Possessions -	—	—
Total -	5,809,378	4,504,359

Camels' Hair.

Countries whence Consigned.	Quantities. 1913.	Quantities. 1914.
	Lbs.	Lbs.
Russia	4,862,363	1,864,911
Sweden	4,264	—
Germany	66,954	15,148
Netherlands	33,710	7,556
Belgium	13,193	3,064
France	32,908	3,941
Italy	11,206	37,554
Turkey, Asiatic	54,308	24,850
Egypt	37,872	42,486
Tripoli	113,766	47,090
China (exclusive of Hong Kong, Macao and leased territories).	3,337,306	2,266,064
United States of America	907,857	575,635
Total from Foreign Countries	9,515,707	4,888,299
British India	672	2,688
Straits Settlements and Dependencies (including Labuan).	—	16,500
New South Wales	3,418	—
Total from British Possessions	4,090	19,188
Total	9,519,797	4,907,487

Mohair (Angora Goats' Hair).

Countries whence Consigned.	1913.	1914.
	Lbs.	Lbs.
Russia	20,386	12,490
Germany	7,306	13,746
German West Africa	21,020	7,150
France	102,182	1,507
Belgium	3,778	—
Portuguese East Africa	—	3,150
Turkey, European	10,211,954	8,833,889
Turkey, Asiatic	190,406	173,950
Egypt	4,535	—
China (exclusive of Hong Kong, Macao and leased territories).	156,077	25,062
United States of America	22,008	74,592
Total from Foreign Countries	10,739,652	9,145,536
Cape of Good Hope	16,583,600	16,404,240
Natal	1,939,597	1,187,642
Rhodesia	—	262
East Africa Protectorate	—	1,344
British India	13,953	—
Western Australia	2,857	500
South Australia (including Northern Territory).	4,400	1,700
Victoria	2,431	2,640
New South Wales	15,088	9,098
Queensland	13,449	6,070
Tasmania	260	130
New Zealand	300	1,116
Total from British Possessions	18,575,935	17,614,742
Total	29,315,587	26,760,278

Sheep's or Lambs' Wool.

Countries whence Consigned.	Quantities. 1913.	Quantities. 1914.
	Lbs.	Lbs.
Russia	7,144,338	3,909,781
Sweden	6,381	59,756
Norway	30,229	6,586
Denmark (including Faroe Islands).	201,618	256,511
Iceland and Greenland	432,847	56,915
Germany	4,717,683	2,326,921
German West Africa	22,780	10,280
„ East Africa	—	4,100
German Possessions in the Pacific (including German leased territories in China).	—	20,035
Netherlands	345,861	239,920
Dutch West India Islands	640	1,344
Belgium	3,088,406	2,732,564
France	24,492,772	18,872,776
Algeria	38,921	134,400
French West Africa	80,555	159,530
Switzerland	4,936	—
Portugal	1,421,086	1,669,771
Portuguese East Africa	23,770	57,345
Spain	100,523	105,239
Spanish Ports in North Africa.	31,325	5,290
Italy	1,237,712	366,634
Austria Hungary	52,534	400
Greece	—	5,040
Roumania	—	2,300
Turkey, European	655,164	306,130
„ Asiatic	8,773,284	3,823,100
Egypt	4,112,081	4,196,348
Tripoli	23,510	17,490
Tunis	108,160	—
Morocco	292,549	316,680
Persia	1,864,720	1,037,596
China (exclusive of Hong Kong, Macao, and leased territories).	2,316,400	1,277,972
United States of America	2,582,876	4,726,658
Philippine Islands and Guam.	—	3,400
Mexico	59,360	—
Guatemala	—	1,000
Venezuela	17,799	—
Ecuador	2,240	336
Peru	5,281,190	2,866,450
Chile	24,286,912	18,007,066
Brazil	5,822	88,065
Uruguay	9,657,762	1,729,029
Argentine Republic	55,455,562	45,906,646
Total from Foreign Countries	158,970,308	115,307,404
Channel Islands	451	784
Cyprus	—	616
St. Helena	4,380	10,780
Cape of Good Hope	92,813,330	81,870,525
Natal	40,410,872	39,792,436
Rhodesia	—	2,148
East Africa Protectorate	202,857	179,192
Uganda Protectorate	1,008	75,031
British India	54,946,318	46,982,929
Straits Settlements and Dependencies (including Labuan).	161	28,634
Western Australia	24,802,033	20,065 636
South Australia (including Northern Territory).	27,737,097	21,537,885
Victoria	75,197,708	70 803,502
New South Wales	94,941,698	89,196,980
Queensland	41,080,481	33,447,403

Countries whence Consigned.	Quantities.	
	1913.	1914.
	Lbs.	Lbs.
Tasmania	1,319,463	4 181,739
New Zealand	181,181,381	184,607,963
Canada	724,019	51,520
British West India Islands.	95,612	20,909
British Guiana	1,124	100
Falkland Islands	6,150,514	4,454,000
Total from British Possessions	641,610,507	597,310,712
Total	800,580,815	712,618,116

Goats' Hair (other than Mohair).

	Lbs.	Lbs.
Russia	1,117,007	413,355
Germany	441,124	203,304
Netherlands	326,440	47,726
Belgium	682,348	55,509
France	313,057	210,790
Algeria	10,646	24,752
Spain	18,032	41,855
Italy	13,452	12,774
Austria Hungary	8,960	—
Turkey, European	3,136	4,480
" Asiatic	7,935	1,204

Countries whence Consigned.	Quantities.	
	1913.	1914.
	Lbs.	Lbs.
Egypt	19,002	28,297
Tunis	8,985	—
Morocco	14,609	10,028
China (exclusive of Hong Kong, Macao, and leased territories).	1,235,486	845,459
United States of America	810,048	1,130,932
Total from Foreign Countries	5,030,267	3,030,465
British India	2,061,813	2,111,192
South Australia (including Northern Territory).	784	—
New South Wales	2,640	3,360
New Zealand	—	400
Canada	20,160	—
British West India Islands.	—	280
Total from British Possessions	2,085,397	2,115,232
Total	7,115,664	5,145,697

S. Bozman,
Deputy Principal.

Statistical Office,
Custom House, London, E.C.,
2nd March 1915.

APPENDIX 31.

Extracts from a Letter addressed to Mr. Charles Henry Ickringill by his Buying Agent in Constantinople, in Response to an Enquiry as to the Production, Export, and Condition of Skin Turkey Mohair.

October 17th, 1914.

Skin mohair exported from Turkey is never washed. The reason why bloodstains appear from time to time in hair is that the skins are often soaked before the hair is cut from the pelts as cutting is thereby facilitated. The blood is, therefore, liable to spread and give the pink appearance about which you ask me. Another reason is that the hair is often damp when the animals are killed—the killing being chiefly done during the winter months.

The number of bales of skin mohair going out of Turkey we reckon to be about 3,000 bales. A fair quantity of this, in some years perhaps as much as 1,500 bales, is made up of the whole skin unclipped; which is sent to the United States for making up into rugs. Some 500 bales perhaps go into the better class ordinary run of hair. When the skin hair is long and fairly decent looking it is thrown in with the bulk and not sold as skin mohair at all.

Some 200 bales per annum we reckon are used with wool for making oriental rugs. The balance (upwards of 800 bales) all goes to Bradford.

Local Fellmongers.—These only treat those skins taken from the animals actually brought into Constantinople alive when meat is expensive. These are killed here to be sold for meat and the skins are then treated by the local fellmongers. In this case the pelts are chemically treated. I am sorry I do not know at the moment the chemicals used; it is generally, however, not lime. The treatment does not affect the skin nor the hair.

All skin mohair coming from the interior is packed and brought down to and bought on the Constantinople market exactly as it arrives. It is practically never treated here, no classing being done.

It sometimes happens that bloodstained hair in the ordinary run of mohair when being classed (as sometimes it is by some people here) is thrown out and shipped along with the yellows. Skins are never bundled in the interior and brought down here for treatment by fellmongers. The only skins treated here (as stated above) are those taken from the animals imported alive and killed on the spot.

APPENDIX 32.

Letter from Professor Sheridan Delépine supplementing his Report to the Disinfection Sub-Committee.

In submitting my Report I feel it my duty to express to the members of the Sub-Committee my personal views on certain administrative matters, the importance of which has been forced upon me by the experience I have gained during the past twenty-five years in connection with various investigations bearing upon the spread of anthrax.

The main recommendations which I desire to make are:—

1. That the operations contemplated by the Sub-Committee be conducted at central disinfecting stations specially adapted to the work in view, so situated as to facilitate the disposal of waste water and under the supervision of scientific experts responsible for the

results and, therefore, entitled to a reasonable controlling power.

2. Wool, hair and other products, coming from districts where anthrax is prevalent, should be treated at stations situated in, or close to, the infected districts before being shipped to England. These stations should be managed by or be under the supervision of British experts, or experts appointed by the British Government. The finding of suitable places for such stations might sometimes be a matter of difficulty on account of the political, commercial, climatic and other considerations, to which attention will have to be paid.

Disinfecting dangerous wool before it is shipped to Great Britain would protect the non-infected parts of cargoes against infection by the infected dust given off by infected articles when these are disturbed.

In the discussion of the method finally adopted by the Sub-Committee, I have not thought it desirable to make any suggestion as to possible alternatives. Some of the laboratory experiments detailed in Sections V. and VI. of my Report suggest that some important simplifications might be effected by the use of formal vapours at a temperature of 50° or 60° C.

APPENDIX 33.

Analysis of the Results of Bacteriological Examination of Materials in the Laboratory of the Bradford Anthrax Investigation Board.

Compiled by the Secretary of the Departmental Committee on Anthrax from the Annual Reports of the Board.

In this Appendix an analysis of the results of bacteriological examination of samples of wool, hair, dust and other materials in the laboratory of the Bradford Anthrax Investigation Board in the period November 1st, 1907—October 31st, 1917, is given. In it the samples examined are divided into two classes: (1) those visibly bloodstained and (2) those in which blood was not visible to the naked eye. Previous to 1917, no distinction was made in the published records between samples visibly bloodstained and those in which blood was not visible but was shown by chemical test to be present. In the following tables, therefore, a few of the latter description are included under the head of samples visibly bloodstained. The error introduced is, however, small. In the Report for 1917, they are separately recorded (twelve samples, of which six were infected) and are included in the analysis under the head of samples not visibly bloodstained. The heading "Found to be infected" means that anthrax bacilli were cultivated from the number of samples recorded under this head.

The materials examined have been arranged in classes of recognised varieties and sub-varieties. Where possible, the samples have also been arranged in descriptions which may give indications to experts of the grade or quality or origin of the material, *e.g.*, colour, &c. Results of examination of wholly or partly manufactured materials are recorded, where possible, in the class to which they properly belong, but are also included under a separate head and sub-head of manufactured material.

The samples examined have, with few exceptions, necessarily been recorded under the description furnished by the sender. In a large proportion this has, unfortunately, been meagre and insufficient. Thus the description "Persian wool" may include any grade of the materials known as Baghdad wool, Bussorah wool, Bushire wool, &c.; the term "East Indian wool" may cover materials of different descriptions and characteristics derived from districts many hundreds of miles apart; the description "Mohair" may apply to any grade of the hair of the angora goat derived from Asia Minor, or the Cape, or Natal, or Australia, &c. Before 1916 comparatively few samples of material free from visible blood were sent to the laboratory for examination.

Following the analysis is a summary of the results, in which the samples examined are arranged under a head indicating the variety, and sub-heads indicating the district of origin and the grade. This arrangement has, however, small value (though it should be of great service), owing to the fact that a very large proportion of the samples have been sent under general descriptions in which either or both the district of origin and the grade of material have been omitted. Any broad conclusions which might be drawn are, therefore, vitiated.

Though the number of bloodstained samples examined is fairly large, it is not possible to draw more than general conclusions from the results, because in many instances very large and disproportionate numbers of samples have been taken from particular lots of, or even single bales of, material. Thus the samples under the heads of Van skin mohair, Cape thirds skin mohair, Huariza alpaca, Tacna Llama, &c., were practically all taken from one lot (in the case of the material mentioned second—one bale) of the respective materials. These large numbers were taken for the purpose of elucidating special problems, and from that point of view had value, but the general effect is that they exercise a preponderating and undue influence on the collected results—whether or not a considerable proportion was found to be infected.

This does not apply to any considerable extent to the results of examination of samples not visibly bloodstained. The majority of this class has been collected in the past two years, and, as a rule, single samples only have been taken from each lot of material. Moreover, in the absence of blood there is nothing which can be used (as a general rule) as a guide in the selection of samples, so that their collection must necessarily be haphazard. The actual number of this class examined is, however, comparatively small in the case of most materials, and a large proportion has been collected in the investigation of cases of anthrax. The procedure followed has been to take one sample from each lot of material in use at the time of the investigation and to note which lots have been handled by the patient. In some cases the patient had not come in contact with the lots of material sampled, and in no case could he have handled the actual samples of raw material collected, though, where samples of wholly or partly manufactured materials were taken, some or all may have passed through his hands.

Cases of anthrax, of course, point to the use of infected material and, to this extent, many of the results recorded under the head "Not visibly bloodstained" may tend to indicate a wider infection than is in accordance with facts. More probably, however, owing to the impossibility of making any selection of non-bloodstained samples, and to the facts that the samples were taken *after* the cases had occurred when the actual material handled had passed beyond reach, that the actual samples collected cannot have been handled by the patient, that in many cases samples of lots with which he had not been in contact were found to be infected and, conversely, in others samples of lots handled were found to be free from infection, the results of examination of material free from visible blood tend to the conclusion that infection is even wider than is indicated by the collected statistics. This is supported by the fact that many instances have occurred in which lots of material, known from the results of examination to have been infected, have been manufactured completely without cases of anthrax occurring. On the whole it is probable that the results of examination of samples of non-bloodstained material recorded give a truer indication of the extent to which material of any variety may be infected than do those of examination of bloodstained samples.

It is not possible to give from the published statistics any indication of the concentration of infection, though this is shown to some extent by the abundance or scantiness of the growth of anthrax bacilli in the bacteriological examination. Abundant growths are obtained both from bloodstained samples and from those free from visible blood. They are more frequent in the former, however, than in the latter. In materials which are habitually washed abroad, *e.g.*, East Indian wool, it is only rarely possible to find samples visibly bloodstained.

TABLE I.

ANALYSIS OF RESULTS OF BACTERIOLOGICAL EXAMINATION OF MATERIALS.

Material.	Samples.					
	Visibly bloodstained.		Not visibly bloodstained.		Total.	
	Examined.	Found to be infected.	Examined.	Found to be infected.	Examined.	Found to be infected.
PERSIAN WOOLS.						
(1) *District of origin not stated.*						
Persian raw wool	144	7	51	—	195	7
" " white	3	—	7	1	10	1
" " fawn	58	3	4	—	62	3
" " brown	215	5	8	1	223	6
" " grey	74	3	3	—	77	3
" " brown grey	3	1	—	—	3	1
" " black	7	—	—	—	7	—
" " black brown	7	1	—	—	7	1
" skin wool and skin locks	32	—	21	1	53	1
" locks	7	1	1	1	8	2
" pieces	1	1	—	—	1	1
" scoured wool	1	—	4	2	5	2
" " locks	—	—	2	—	2	—
" shaken wool	—	—	1	—	1	—
" card sliver	—	—	1	1	1	1
" tops	—	—	5	—	5	—
" noils	—	—	1	—	1	—
" wool dust	—	—	12	—	12	—
Baghdad and Bussorah wool	—	—	1	—	1	—
(2) *Baghdad Wools.*						
Baghdad raw wool	60	2	10	1	70	3
" " white	2	—	1	—	3	—
" " fawn	84	2	8	—	92	2
" " fawn britch	6	—	—	—	6	—
" " brown	95	6	13	1	108	7
" " " Balboul	1	—	—	—	1	—
" " grey	27	—	6	2	33	2
" " mixed colours	33	3	1	—	34	3
" pieces and fleece locks	49	2	—	—	49	2
" " " white	17	2	3	—	20	2
" " " fawn	120	6	1	—	121	6
" " " brown	141	5	11	—	152	5
" " " grey	9	—	—	—	9	—
" locks	—	—	1	—	1	—
" " fawn	9	—	1	—	10	—
" " brown	90	13	4	1	94	14
" " grey	2	—	4	2	6	2
" skin wool	29	7	19	2	48	9
" " white	49	—	3	—	52	—
" " fawn	76	3	7	1	83	4
" " brown	205	7	13	—	218	7
" " grey	44	1	5	—	49	1
" skin locks and pieces	20	—	2	2	22	2
" " " white	18	1	—	—	18	1
" " " fawn	24	1	—	—	24	1
" " " brown	78	10	—	—	78	10
" " " grey	1	—	—	—	1	—
" willowed wool	1	—	—	—	1	—
" card sliver	—	—	1	—	1	—
" tops and rovings	—	—	7	3	7	3
Awassi wool, fawn	1	—	—	—	1	—
Karadi wool	3	—	—	—	3	—
" " fawn	1	—	1	—	2	—
" " mixed	—	—	1	1	1	1
(3) *Bussorah Wool.*						
Bussorah wool and fleece	32	3	10	2	42	5
" " " greasy	—	—	2	2	2	2
" " " white	18	—	2	—	20	—
" " " fawn	13	—	1	—	14	—
" " " " dockings	1	—	—	—	1	—
" " " brown dockings	—	—	1	—	1	—
" " " "	125	2	5	—	130	2
" " " " and grey	12	—	—	—	12	—

Material.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Total. Examined.	Total. Found to be infected.
PERSIAN WOOLS—*cont.*						
(3) *Bussorah Wool*—cont.						
Bussorah wool and fleece, grey	5	—	—	—	5	—
,, ,, ,, black	1	—	—	—	1	—
,, pieces	3	—	10	3	13	3
,, ,, fawn	2	—	—	—	2	—
,, ,, brown	43	3	2	—	45	3
,, ,, ,, grey	6	—	—	—	6	—
,, skin, wool and pieces	20	1	4	1	24	2
,, ,, ,, white	2	—	—	—	2	—
,, ,, ,, fawn	16	2	3	—	19	2
,, ,, ,, brown	23	1	2	—	25	1
,, ,, ,, grey	3	—	1	—	4	—
,, scoured wool	—	—	1	—	1	—
,, sliver	—	—	1	1	1	1
(4) *Bushire Wool.*						
Bushire wool and fleece	7	—	3	—	10	—
,, ,, ,, fawn	4	—	1	—	5	—
,, ,, ,, brown	4	—	1	—	5	—
,, ,, ,, ,, dockings	1	—	—	—	1	—
,, ,, ,, ,, and black	2	—	—	—	2	—
,, ,, ,, grey	3	—	—	—	3	—
,, ,, ,, yellow	1	—	—	—	1	—
,, pieces, brown	7	—	1	—	8	—
,, locks, ,,	5	—	—	—	5	—
,, skin wool, brown	1	—	4	—	5	—
,, ,, grey	5	—	2	—	7	—
EAST INDIAN WOOLS.						
(1) *District of origin not stated.*						
East Indian wool and blends	14	—	102	9	116	9
,, ,, ,, white	—	—	30	2	30	2
,, ,, ,, yellow	—	—	4	1	4	1
,, ,, ,, red fawn	—	—	1	—	1	—
,, ,, ,, black	2	—	13	1	15	1
,, ,, ,, grey	2	—	13	1	15	1
,, ,, ,, ginned	—	—	3	1	3	1
,, skin wool	1	1	4	—	5	1
Droppings from under machines and dust from East Indian wool.	—	—	13	3	13	3
East Indian card sliver	—	—	2	—	2	—
,, wool tops	—	—	3	—	3	—
,, ,, noils	—	—	3	—	3	—
,, ,, yarn	—	—	4	1	4	1
,, ,, waste	—	—	1	—	1	—
Vicanere and Kandahar blend	—	—	1	—	1	—
(2) *Joria.*						
Joria and real joria	2	—	37	3	39	3
,, ,, white	—	—	4	—	4	—
,, ,, yellow	—	—	3	—	3	—
,, ,, fawn	—	—	5	—	5	—
,, ,, black	—	—	5	—	5	—
,, ,, grey	1	—	10	—	11	—
,, ,, ginned	—	—	3	—	3	—
,, skin, wool, black	2	—	—	—	2	—
(3) *Vicanere.*						
Vicanere wool	—	—	64	7	64	7
,, ,, white	2	1	34	2	36	3
,, ,, yellow	9	1	26	3	35	4
,, ,, brown	—	—	2	—	2	—
,, ,, black	—	—	3	—	3	—
,, ,, grey	—	—	25	2	25	2
,, ,, red	—	—	2	—	2	—
,, ,, ginned (yellow)	—	—	1	—	1	—
,, skin wool	—	—	2	2	2	2
,, wool top	—	—	1	1	1	1

Material.	Samples.					
	Visibly bloodstained.		Not visibly bloodstained.		Total.	
	Examined.	Found to be infected.	Examined.	Found to be infected.	Examined.	Found to be infected.
East Indian Wools—*cont.*						
(4) *Kandahar.*						
Kandahar wool	—	—	42	10	42	10
" " greasy	1	1	1	—	2	1
" " unwashed	—	—	1	1	1	1
" " white	—	—	6	3	6	3
" " yellow	—	—	2	—	2	—
" " brown	—	—	1	—	1	—
" " black	—	—	1	1	1	1
" " grey	—	—	21	3	21	3
" " red	—	—	1	—	1	—
" " dyed	—	—	1	—	1	—
" skin wool (white)	—	—	1	1	1	1
(5) *Harnai Wool.*						
Harnai wool	—	—	9	1	9	1
" " brown and black	1	—	5	1	6	1
" " grey	—	—	4	—	4	—
" " red	—	—	2	—	2	—
(6) *Herat Wool*, grey	—	—	1	—	1	—
(7) *Cabūl Wool*, grey	—	—	1	—	1	—
(8) *East Indian Khorasan.*						
Khorasan wool (one sample may have been true Khorasan)	1	—	3	2	4	2
" " white	—	—	1	1	1	1
" " yellow	—	—	1	—	1	—
" " red	—	—	1	—	1	—
" " grey	—	—	6	1	6	1
(9) *Marwar.*						
Marwar wool	—	—	1	—	1	—
" " white	—	—	1	—	1	—
" " yellow	—	—	1	—	1	—
" " brown	—	—	1	—	1	—
" " grey	—	—	4	1	4	1
(10) *Bicanere.*						
Bicanere wool	—	—	8	1	8	1
" " white	—	—	1	—	1	—
" " grey	3	1	5	—	8	1
(11) *Bibruck.*						
Bibruck wool	—	—	3	—	3	—
" " white	—	—	2	—	2	—
" " grey	—	—	1	1	1	1
(12) *Pakpathan.*						
Pakpathan* wool, grey	—	—	1	—	1	—
" " red	—	—	1	—	1	—
(13) *Damani.*						
Damani wool, red	—	—	3	—	3	—
" " grey	—	—	2	—	2	—
(14) *Jessulmere.*						
Jessulmere wool, white	—	—	1	—	1	—
" " grey	—	—	1	—	1	—
(15) *Bombay.*						
Bombay wool, white	—	—	1	1	1	1
" " black	—	—	1	1	1	1
" " grey	—	—	1	—	1	—

* A sample of Pakpathan has been found to be infected in the current year (1918).

Material.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Total. Examined.	Total. Found to be infected.
East Indian Wools—*cont.*						
(16) *Madras.*						
Madras wool, black	—	—	1	—	1	—
,, ,, grey	—	—	2	—	2	—
,, ,, locks	1	—	—	—	1	—
(17) *Tussor Wool,* black	—	—	1	—	1	—
(11) *Bibani Wool*	—	—	1	—	1	—
Syrian Wool.						
Syrian wool	3	—	4	1	7	1
,, ,, grey	1	—	—	—	1	—
,, ,, coloured	3	—	—	—	3	—
,, skin wool, grey	1	—	—	—	1	—
,, ,, ,, fawn pieces	8	1	—	—	8	1
,, fleece wool tops	—	—	1	—	1	—
Goat Hair (other than mohair).						
Goat hair (origin not stated)	2	—	6	—	8	—
,, noil	—	—	1	—	1	—
,, tops	—	—	3	—	3	—
East Indian goat hair	—	—	17	6	17	6
,, ,, white	—	—	17	7	17	7
,, ,, grey	2	1	33	12	35	13
,, ,, black	—	—	26	5	26	5
,, ,, Madras	1	1	1	—	2	1
,, skin goat hair, grey	—	—	2	1	2	1
,, goat hair tops	—	—	1	1	1	1
Russian goat hair	4	1	1	—	5	1
Egyptian goat hair, black	2	—	—	—	2	—
American goat hair	—	—	1	—	1	—
Chevrette	—	—	6	—	6	—
,, brown	—	—	2	—	2	—
,, black	—	—	2	—	2	—
,, grey	—	—	4	—	4	—
,, American	—	—	4	—	4	—
,, French	—	—	2	—	2	—
Cashmere (origin not stated)	2	—	1	—	3	—
,, East Indian	15	1	3	—	18	1
,, ,, ,, white	—	—	2	—	2	—
,, ,, ,, skin	37	11	6	—	43	11
,, ,, ,, noil	—	—	1	—	1	—
,, China	—	—	2	—	2	—
,, Syrian	—	—	1	—	1	—
,, Russian	—	—	1	1	1	1
Egyptian Wool.						
Egyptian wool and fleece	—	—	13	—	13	—
,, ,, ,, ,, fawn	—	—	4	1	4	1
,, ,, ,, ,, brown grey	—	—	1	—	1	—
,, ,, ,, ,, black	—	—	9	2	9	2
,, ,, pieces	—	—	4	—	4	—
,, ,, ,, fawn	—	—	4	—	4	—
,, ,, ,, brown	—	—	3	—	3	—
,, skin wool	—	—	3	2	3	2
,, ,, ,, black	—	—	1	1	1	1
,, ,, ,, pieces	—	—	1	—	1	—
,, wool noils	—	—	1	—	1	—
,, desert wool	—	—	1	1	1	1
,, Bedouin wool	—	—	1	—	1	—
Mohair.						
(1) *District of Origin not stated.*						
Mohair	540	26	117	1	657	27
,, long preparing	2	—	2	—	4	—
,, carding	1	—	—	—	1	—
,, grey	10	—	—	—	10	—

Material.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Total. Examined.	Total. Found to be infected.
MOHAIR—*cont.*						
(1) *District of Origin not stated*—cont.						
Mohair, inferior	18	2	5	—	23	2
,, coarse fleece	10	—	—	—	10	—
,, dockings	16	—	3	—	19	—
,, toppings	—	—	1	—	1	—
,, dust from	—	—	5	1	5	1
,, water in which dust from collected	—	—	1	1	1	1
,, water in which washed	—	—	1	—	1	—
,, washed (scoured)	178	6	1	—	179	6
,, dyed	—	—	1	—	1	—
Skin mohair	45	17	13	—	58	17
Mohair card sliver	1	—	—	—	1	—
,, tops	—	—	6	—	6	—
,, noils	—	—	6	—	6	—
Turkey and Cape mohair	1	—	1	—	2	—
Mohair sorter's apron	—	—	1	1	1	1
Turkey inferior mohair, and Cape mohair dockings	1	1	—	—	1	1
(2) *Turkey Mohair.*						
Turkey mohair	248	17	25	—	273	17
,, ,, preparing	2	—	—	—	2	—
,, ,, middle carding	1	—	—	—	1	—
,, ,, dark	1	—	—	—	1	—
,, ,, brown	—	—	1	—	1	—
,, ,, black	—	—	1	—	1	—
,, ,, yellow	—	—	2	—	2	—
,, ,, inferior	199	17	10	—	209	17
,, skin mohair	390	107	10	—	400	107
,, ,, ,, washed	6	—	—	—	6	—
,, ,, ,, best kid	1	1	—	—	1	1
,, mohair fallen fleece	—	—	1	—	1	—
,, ,, locks	7	—	—	—	7	—
,, ,, scoured	4	—	—	—	4	—
,, ,, willowed	1	1	—	—	1	1
,, ,, tops	—	—	7	4	7	4
,, ,, noils	—	—	2	2	2	2
(3) *Van Mohair.*						
Van mohair	96	1	19	—	115	1
,, ,, white	—	—	4	2	4	2
,, ,, grey	1	—	1	1	2	1
,, ,, black	—	—	1	—	1	—
,, skin mohair	206	27	64	9	270	36
,, mohair locks	1	—	—	—	1	—
,, ,, scoured	—	—	1	—	1	—
,, ,, tops	—	—	1	—	1	—
(4) *Cape Mohair.*						
Cape mohair	398	28	57	—	455	28
,, ,, firsts	9	1	1	—	10	1
,, ,, ,, blue, damaged	1	1	—	—	1	1
,, ,, seconds	10	—	—	—	10	—
,, ,, thirds	93	2	—	—	93	2
,, ,, ,, dockings	15	—	—	—	15	—
,, ,, mixed	7	—	1	—	8	—
,, ,, middle (medium)	1	—	1	—	2	—
,, ,, winter	4	—	5	—	9	—
,, ,, Port Elizabeth mixed	25	—	—	—	25	—
,, ,, low (inferior)	3	—	—	—	3	—
,, ,, blue	1	1	—	—	1	1
,, ,, grey	5	2	—	—	5	2
,, ,, East London firsts	1	—	1	—	2	—
,, ,, Basuto	7	—	—	—	7	—
,, ,, Natal, mixed	5	—	—	—	5	—
,, ,, dockings	33	—	7	—	40	—
,, ,, dippings	—	—	1	—	1	—
,, skin mohair	315	5	14	—	329	5
,, ,, ,, seconds	1	—	—	—	1	—

Material.	Samples.					
	Visibly bloodstained.		Not visibly bloodstained.		Total.	
	Examined.	Found to be infected.	Examined.	Found to be infected.	Examined.	Found to be infected.
MOHAIR—*cont.*						
(4) *Cape Mohair*—cont.						
Cape skin mohair thirds	81	42	3	—	84	42
„ „ „ „ (clipped from pelt)	3	—	—	—	3	—
„ „ „ Basuto, blue	1	—	—	—	1	—
„ mohair, washed	7	1	—	—	7	1
„ „ dust from	—	—	5	—	5	—
(5) *Pelitan (Gingelline).*	—	—	1	—	1	—
CAMEL HAIR.						
(1) *District of Origin not stated.*						
Camel hair	4	1	10	—	14	1
„ top and noil	—	—	3	—	3	—
„ noils	—	—	1	—	1	—
„ dust from	—	—	1	—	1	—
(2) *Russian Camel Hair.*						
Russian camel hair	55	4	26	—	81	4
„ „ thirds	—	—	2	—	2	—
„ „ dust from	—	—	4	—	4	—
(3) *China Camel Hair.*						
China camel hair	2	—	4	—	6	—
„ „ washed and willowed	—	—	2	1	2	1
„ „ tops	—	—	1	—	1	—
„ „ dust from	—	—	1	—	1	—
(4) *Pekin Camel Hair.*						
Pekin camel hair	3	1	4	—	7	1
„ „ washed	—	—	1	—	1	—
(5) *Mongolian Camel Hair*	21	—	—	—	21	—
ALPACA.						
Alpaca	845	7	76	3	921	10
„ fleece	9	—	28	2	37	2
„ white	6	1	7	—	13	1
„ fawn	2	—	4	—	6	—
„ brown	—	—	5	1	5	1
„ black	3	—	10	1	13	1
„ grey	10	3	3	2	13	5
„ mixed colours	2	—	—	—	2	—
„ seconds	18	—	—	—	18	—
„ coarse	23	—	3	—	26	—
„ pieces	3	—	8	—	11	—
„ locks	1	—	1	—	2	—
Skin alpaca	92	10	1	—	93	10
„ fleece	3	—	—	—	3	—
Alpaca, dust from	—	—	9	1	9	1
„ water after washing in	—	—	1	—	1	—
„ scoured	4	—	—	—	4	—
„ card sliver	2	—	—	—	2	—
„ top and noil	—	—	1	—	1	—
„ noils	—	—	8	3	8	3
Arequipa alpaca	44	—	—	—	44	—
„ coarse fleece	1	—	1	—	2	—
„ seconds	2	—	3	1	5	1
Huariza alpaca	112	3	13	—	125	3
„ skin alpaca	2	—	—	—	2	—
Callao alpaca	2	—	—	—	2	—
„ white	1	—	—	—	1	—
„ Llama	1	—	1	—	2	—
„ pieces	1	—	1	—	2	—
„ seconds pieces	3	—	—	—	3	—
Tacna alpaca	1	—	—	—	1	—

Material.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Total. Examined.	Total. Found to be infected.
ALPACA—*cont.*						
Tacna Llama	170	—	—	—	170	—
Chala alpaca	1	—	—	—	1	—
Llama	2	—	—	—	2	—
,, fleece	1	—	1	—	2	—
Villon negro	1	—	—	—	1	—
BY-PRODUCTS, WASTE MATERIALS, &c.						
(1) *Noils.*						
Noils	1	—	5	—	6	—
,, brown	—	—	7	2	7	2
,, mohair	—	—	6	—	6	—
,, Turkey skin mohair	—	—	2	2	2	2
,, alpaca	—	—	8	3	8	3
,, East Indian	—	—	3	—	3	—
,, East Indian cashmere, Persian, camel hair, brown Egyptian, Bradford, Cape Botany, foreign, English down, crossbred, Colonial crossbred, Scotch, strong kempy, goat hair, East Indian and Scotch crossbred and down, blend—one of each.	—	—	16	—	16	—
(2) *Waste.*						
Waste	—	—	2	—	2	—
,, Bradford card	—	—	4	1	4	1
,, Cardigan jacket, new clippings	—	—	4	2	4	2
,, shoddy—pulled new clippings from Cardigan jackets and army blankets.	—	—	1	1	1	1
,, coloured	—	—	2	—	2	—
,, hard	—	—	4	—	4	—
,, pulled worsted yarn	—	—	2	—	2	—
,, ,, hosiery	—	—	4	—	4	—
,, spinners	—	—	2	—	2	—
,, brush	—	—	3	—	3	—
,, American	—	—	2	—	2	—
,, Angola, Spanish wool blend, pulled Bradford, brown, white, mohair, shook mohair, grey, garnetted, blended, pulled, crossbred card—one sample of each.	—	—	11	—	11	—
(3) *Shoddy.*						
Shoddy, *i.e.* pulled material	—	—	25	3	25	3
,, pulled oil bags	—	—	2	—	2	—
,, ,, Cardigan jacket clippings, &c.	—	—	1	1	1	1
,, ,, khaki material	—	—	4	—	4	—
,, ,, fancy stockings	—	—	3	—	3	—
,, ,, stockings	—	—	3	—	3	—
,, ,, serge	—	—	3	—	3	—
,, ,, rags	—	—	2	—	2	—
,, ,, coat linings, hair cloth, carpets, blankets, knits—one sample of each.	—	—	5	—	5	—
CATTLE HAIR.						
Cow hair	—	—	2	—	2	—
,, English	—	—	2	—	2	—
,, Hungarian	—	—	1	—	1	—
,, brown	—	—	5	—	5	—
Cattle hair	—	—	1	—	1	—
Calf hair	—	—	5	—	5	—
,, English	—	—	1	—	1	—
,, American	—	—	2	—	2	—
Hair, American brown	—	—	1	—	1	—
,, brown	—	—	10	—	10	—
,, brown kip	—	—	1	—	1	—

Material.	Samples.					
	Visibly bloodstained.		Not visibly bloodstained.		Total.	
	Examined.	Found to be infected.	Examined.	Found to be infected.	Examined.	Found to be infected.
MIXTURES.						
Blends (found to be infected) of :—						
Persian skin fleece, East Indian wool, East Indian goat hair.	—	—	2	2	2	2
Vicanere, Scotch skin brokes	—	—	1	1	1	1
East Indian wool, English wool, Continental wool, waste, noils.	1	1	—	—	1	1
East Indian wool, Egyptian wool, black kid hair, noils, shoddy.	—	—	1	1	1	1
Blanket border blend. (East Indian wools, &c.)	—	—	1	1	1	1
East Indian wool, Persian wool, goat hair	—	—	1	1	1	1
Blends of Persian and other wools	—	—	3	1	3	1
English skin wool, Buenos Ayres skin wool	—	—	1	1	1	1
Blends (not infected), containing East Indian wool (26), Persian wool (3), goat hair (1), English wool (10), Scotch wool (4), Irish wool (1), Welsh wool (1), New Zealand (6), Botany (1), China wool (1), Egyptian (5), alpaca (2), cattle hair (4), Cape wool (2), Italian skin wool (1), Hungarian wool (1), German skin wool (1), low foreign wool (3), skin wool (1), Russian wool (1), waste (9), shoddy (6), noils (2), mohair noils (3), oil bags (2), chevrette (1), britch carding (1), crossbred (1), skin mohair (1), and possibly other materials.	2	—	47	—	49	—
DUST.						
Dust	—	—	6	—	6	—
„ from mohair	—	—	5	1	5	1
„ „ Cape mohair	—	—	3	—	3	—
„ „ alpaca	—	—	9	1	9	1
„ „ Persian wool	—	—	11	—	11	—
„ „ „ skin locks	—	—	1	—	1	—
„ „ East Indian wool	—	—	2	—	2	—
„ „ camel hair	—	—	1	—	1	—
„ „ Russian camel hair	—	—	1	—	1	—
„ „ China camel hair	—	—	1	—	1	—
„ „ horse hair	—	—	8	5	8	5
„ „ water in which collected	—	—	1	1	1	1
„ „ warehouse	—	—	1	—	1	—
„ „ willow	—	—	1	—	1	—
„ „ below sorting board	—	—	1	—	1	—
„ „ bottom dividers of card	—	—	1	1	1	1
HORSEHAIR.						
Horsehair	—	—	1	—	1	—
„ Indian	—	—	1	—	1	—
„ South American	1	—	1	—	2	—
„ dust from	—	—	8	5	8	5
MANUFACTURED AND PARTLY MANUFACTURED MATERIALS.						
(1) *Scoured Materials.*						
Scoured mohair	170	6	1	—	171	6
„ Turkey mohair	4	—	—	—	4	—
„ „ skin mohair	6	—	—	—	6	—
„ Van mohair	—	—	1	—	1	—
„ Cape mohair	7	1	—	—	7	1
„ skin mohair	1	—	—	—	1	—
„ Persian wool	1	—	3	2	4	2
„ „ locks	—	—	2	—	2	—
„ Bussorah wool	—	—	1	—	1	—
„ China camel hair	—	—	2	1	2	1
„ Pekin camel hair	—	—	1	—	1	—
„ alpaca	4	—	—	—	4	—
„ Khorasan (white)	—	—	1	1	1	1
„ Oporto fleece wool	—	—	1	1	1	1
„ Cape wool	—	—	1	—	1	—
Dyed mohair	—	—	1	—	1	—
„ Kandahar	—	—	1	—	1	—

Material.	Samples.					
	Visibly bloodstained.		Not visibly bloodstained.		Total	
	Exa- mined.	Found to be infected.	Exa- mined.	Found to be infected.	Exa- mined.	Found to be infected.
MANUFACTURED AND PARTLY MANUFACTURED MATERIALS—*cont.*						
(2) *Card Sliver.*						
Card sliver, mohair	1	—	—	—	1	—
„ „ brown Baghdad	—	—	1	—	1	—
„ „ Bussorah	—	—	1	1	1	1
„ „ brown Persian	—	—	1	1	1	1
„ „ Egyptian, shoddy	—	—	1	—	1	—
„ „ East Indian	—	—	1	—	1	—
„ „ carpet blend	—	—	1	—	1	—
(3) *Tops and Rovings.*						
Tops, mohair	—	—	2	—	2	—
„ Turkey skin mohair	—	—	6	4	6	4
„ Van mohair	—	—	4	—	4	—
„ Persian wool	—	—	3	—	3	—
„ Baghdad wool	—	—	7	2	7	2
„ goat hair	—	—	3	—	3	—
„ black East Indian goat hair	—	—	1	1	1	1
„ grey Persian and White East Indian wool	—	—	1	1	1	1
„ black Vicanere wool	—	—	1	1	1	1
„ "Grey" top	—	—	1	1	1	1
„ White East Indian wool	—	—	2	—	2	—
„ Syrian wool, camel hair, alpaca, China camel hair, Australian, Blend (English, Irish, New Zealand, Botany)—one sample of each.	—	—	6	—	6	—
(4) *Yarn.*						
Yarn, composition unspecified (most contained East Indian wool).	—	—	15	2	15	2
„ East Indian wool	—	—	4	1	4	1
„ East Indian, English, and Welsh wool blend	—	—	1	1	1	1
„ East Indian, Egyptian, and Scotch wool blend	—	—	2	1	2	1
„ East Indian wool, Bradford waste blend	—	—	2	2	2	2
„ East Indian wool, Bradford waste, noils, blend	—	—	1	—	1	—
„ East Indian wool, cattle hair blend	—	—	1	—	1	—
„ East Indian wool, pulled stockings blend	—	—	1	—	1	—
„ East Indian wool, cow hair, waste, blend	—	—	1	—	1	—
„ East Indian wool, pulled hosiery blend	—	—	1	—	1	—
„ Bussorah, Cape merino, shoddy, blend	—	—	1	1	1	1
„ pulled rags	—	—	1	—	1	—
„ East Indian wool, English wool, New Zealand wool, shoddy, blend.	—	—	2	—	2	—
(5) *Cloth.*						
Felt	—	—	1	—	1	—
Army grey blanket	—	—	1	—	1	—
Blanket cloth, unfinished	—	—	1	—	1	—
„ „ finished	—	—	1	—	1	—
Cloth	—	—	1	—	1	—
„ Russian	—	—	6	—	6	—
„ Italian	—	—	6	—	6	—
CAPE WOOLS.						
Cape wool, white	—	—	1	—	1	—
„ grey	—	—	3	—	3	—
„ coarse native	1	1	—	—	1	1
„ Botany noil	—	—	1	—	1	—
„ medium scoured	—	—	1	—	1	—
Cape skin wool	—	—	2	—	2	—
„ wool, piece of skin	—	—	1	—	1	—
MISCELLANEOUS MATERIALS.						
Oporto wool (scoured)	—	—	2	1	2	1
Corsican wool	—	—	2	—	2	—
Puntas Arenas wool	—	—	2	—	2	—
Spanish wool	—	—	2	—	2	—

Material.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Total. Examined.	Total. Found to be infected.
MISCELLANEOUS MATERIALS—*cont.*						
South America wool	—	—	2	—	2	—
French white pieces	—	—	3	—	3	—
,, skin wool	—	—	1	—	1	—
China wool	—	—	3	—	3	—
Iceland wool	—	—	2	—	2	—
Russian fleece wool	—	—	2	—	2	—
Low foreign wool	—	—	3	—	3	—
Slipe wool	7	—	—	—	7	—
Skin wool	3	—	2	—	5	—
Mud from washbowls	—	—	4	—	4	—
Earth and blood	2	—	—	—	2	—
Dried blood and scurf	2	—	2	—	4	—
Angora wool, Hungarian, German, West African, North African, coarse fleece, brown clips, Bokhara, Garanza, brown grey, low grey, Peruvian wool, Peruvian skin wool, Balkan yellow skin wool, crossbred wool, Chinese human hair, grease, oakum.—one sample of each.	1	—	18	—	19	—
HOME WOOLS.						
English wool	—	—	4	—	4	—
,, ,, Yorkshire	—	—	1	—	1	—
,, ,, Lincoln	—	—	1	—	1	—
,, skin wool	—	—	3	—	3	—
,, ,, Shropshire down	1	—	—	—	1	—
,, haslock	—	—	4	—	4	—
Locks—English, Devon, Lincoln	—	—	5	—	5	—
Irish wool	1	—	—	—	1	—
Welsh wool	—	—	1	—	1	—
,, ,, tail	—	—	1	—	1	—
Scotch wool	2	—	2	—	4	—
,, skin wool	—	—	1	—	1	—
,, haslock	1	—	5	—	6	—
,, brokes, locks, Britch, &c.	—	—	9	—	9	—
AUSTRALIAN AND NEW ZEALAND WOOLS.						
New Zealand wool (fleece and lamb)	—	—	8	—	8	—
,, slipe	—	—	4	—	4	—
,, crossbred dead wool	1	—	—	—	1	—
,, toppings	—	—	1	—	1	—
Australian wool	—	—	2	—	2	—
,, ,, tops	—	—	1	—	1	—
Botany wool	—	—	1	—	1	—

TABLE II.

SUMMARY OF THE RESULTS OF BACTERIOLOGICAL EXAMINATION OF MATERIALS.

Materials.	Samples. Visibly bloodstained. Examined.	Visibly bloodstained. Found to be infected.	Not visibly bloodstained. Examined.	Not visibly bloodstained. Found to be infected.	Totals. Examined.	Totals. Found to be infected.	Proportion found to be infected (per Cent.).
PERSIAN WOOLS.							
Unclassified Persian raw wool	511	20	74	2	585	22	3·8
,, skin wool and skin locks	32	—	21	1	53	1	1·9
,, locks and pieces	8	2	1	1	9	3	—
Baghdad raw wool	308	13	39	4	347	17	4·9
,, skin wool and skin locks	544	30	49	5	593	35	5·9
,, locks and pieces	437	28	25	3	462	31	6·7
Karadi and Awassi raw wools	5	—	2	1	7	1	—
Bussorah raw wool	207	5	21	4	228	9	5·9

Materials.	Samples.						
	Visibly bloodstained.		Not visibly bloodstained.		Totals.		Proportion found to be infected (per Cent.).
	Examined.	Found to be infected.	Examined.	Found to be infected.	Examined.	Found to be infected.	
Persian Wools—*cont.*							
Bussorah skin wool and skin pieces	64	4	10	1	74	5	6·8
" locks and pieces	54	3	12	3	66	6	9·1
Bushire raw wool	22	—	5	—	27	—	
" skin wool	6	—	6	—	12	—	
" locks and pieces	12	—	1	—	13	—	
East Indian Wools.							
Unclassified East Indian raw wool	18	—	167	15	185	15	8·1
" " skin wool	1	1	4	—	5	1	
Joria raw wool	3	—	67	3	70	3	4·3
" skin wool	2	—	—	—	2	—	
Vicanere raw wool	11	2	157	14	168	16	9·5
" skin wool	—	—	2	2	2	2	
Kandahar raw wool	1	1	76	18	77	19	24·7
" skin wool	—	—	1	1	1	1	
Harnai raw wool	1	—	20	2	21	2	9·5
Herat raw wool	—	—	1	—	1	—	
Cabul raw wool	—	—	1	—	1	—	
Khorasan raw wool	1	—	12	4	13	4	
Marwar raw wool	—	—	8	1	8	1	
Bicanere raw wool	3	1	14	1	17	2	
Bibruck raw wool	—	—	6	1	6	1	
Pakpathan raw wool	—	—	2	—	2	—	
Damani raw wool	—	—	5	—	5	—	
Jessulmere raw wool	—	—	2	—	2	—	
Bombay raw wool	—	—	3	2	3	2	
Madras raw wool	1	—	3	—	4	—	
Tussor raw wool	—	—	1	—	1	—	
Bibani raw wool	—	—	1	—	1	—	
Goat Hair (other than mohair and Cashmere).							
Raw goat hair (origin not stated)	2	—	6	—	8	—	
" East Indian goat hair	3	2	96	31	99	33	33·3
" Russian goat hair	4	1	1	—	5	1	
" Egyptian goat hair	2	—	—	—	2	—	
" American goat hair	—	—	1	—	1	—	
" Chevrette	—	—	20	—	20	—	
Cashmere.							
Raw cashmere (origin not stated)	2	—	1	—	3	—	
" East Indian cashmere	15	1	5	—	20	1	
" " " skin cashmere	37	11	6	—	43	11	23·6
" China cashmere	—	—	2	—	2	—	
" Russian cashmere	—	—	1	1	1	1	
" Syrian cashmere	—	—	1	—	1	—	
Egyptian Wool.							
Egyptian raw wool (including pieces)	—	—	40	4	40	4	10·0
" skin wool	—	—	5	3	5	3	
Syrian Wool.							
Syrian raw wool	7	—	4	1	11	1	
" skin wool	9	1	—	—	9	1	
Mohair.							
Raw mohair (origin not stated)	543	26	119	1	662	27	4·1
" inferior grades	56	3	9	—	65	3	4·6
Skin mohair	45	17	13	—	58	17	29·3
Turkey raw mohair	250	17	25	—	275	17	6·2
" " inferior grades and coloured	208	17	14	—	222	17	7·7
" skin mohair	391	108	11	—	402	108	26·9
Van raw mohair	98	1	25	3	123	4	3·2
" skin mohair	206	27	64	9	270	36	13·6
Pelitan raw mohair	—	—	1	—	1	—	
Cape raw mohair	463	33	65	—	528	33	6·2
" " inferior grades	155	2	9	—	164	2	1·2
" skin mohair	401	47	17	—	418	47	11·2

Materials.	Samples.						
	Visibly bloodstained.		Not visibly bloodstained.		Totals.		Proportion found to be infected (per Cent.).
	Exa-mined.	Found to be infected.	Exa-mined.	Found to be infected.	Exa-mined.	Found to be infected.	
ALPACA.							
Raw alpaca	1,039	14	146	9	1,185	23	1·9
" inferior grades	52	—	17	1	69	1	1·4
Skin alpaca	97	10	1	—	98	10	10·2
Llama alpaca	174	—	2	—	176	—	
CAMEL HAIR.							
Camel raw hair (origin not stated)	4	1	10	—	14	1	
Russian raw camel hair	55	4	28	—	83	4	4·8
China raw camel hair	2	—	4	—	6	—	
Pekin raw camel hair	3	1	4	—	7	1	
Mongolian raw camel hair	21	—	—	—	21	—	
CAPE WOOLS.							
Cape raw wool	1	1	6	—	7	1	
" skin wool	—	—	2	—	2	—	
HOME WOOLS.							
English, Scotch, Irish and Welsh raw wools.	3	—	24	—	27	—	
English, Scoth, Irish and Welsh skin wool and haslock.	2	—	13	—	15	—	
AUSTRALIAN AND NEW ZEALAND WOOL.							
New Zealand raw wool	—	—	8	—		—	
" skin wool and slipe	1	—	4	—	5	—	
Australian raw wool	—	—	3	—	3	—	
CATTLE HAIR.							
Cow and calf and cattle raw hair	—	—	31	—	31	—	
HORSEHAIR.							
Raw horsehair	1	—	11	—	12	—	
MIXTURES.							
Blends of materials	3	1	57	8	60	9	15·0
MISCELLANEOUS MATERIALS.							
Various materials. (*See* detailed list)	15	—	50	1	65	1	1·5
PARTLY OR WHOLLY MANUFACTURED MATERIALS.							
Scoured materials	193	7	16	5	209	12	5·9
Card sliver	1	—	6	2	7	2	
Tops and rovings	—	—	37	10	37	10	27·0
Yarn	—	—	33	8	33	8	24·2
Cloth	—	—	17	—	17	—	
BY-PRODUCTS, WASTE MATERIALS, &c.							
Noils	1	—	47	7	48	7	14·6
Waste materials produced in course of manufacture.	—	—	41	4	41	4	9·8
Shoddy (*i.e.*, pulled rags, &c.)	—	—	48	4	48	4	8·3
DUST.							
Dust produced in manufactures. (In most of the infected samples blood could be detected by chemical test, though not visible.)	—	—	53	9	53	9	17·0

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Report of the Departmental Committee appointed to Investigate the Danger attendant on the Use of Paints containing Lead in the Painting of Buildings. Introductory; Summary of Evidence; Analysis of Evidences—Extent of Lead Poisoning Evil—Action taken by Foreign Governments—Methods of dealing with Lead Poisoning; Recommendations; Memorandum by Mr. W. G. Sutherland, and notes thereon; Table of Information supplied by users of Leadless Paints.

[Cd. 7882] of Session 1914–16. Price 1*s.* 2*d.* (1*s.* 6*d.*)

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Appendices :—Summary of Information as to cases of Poliomyelitis occurring in 1914 and 1915; Report on the Work of the Inspectors of Foods; Report on the Work of the Board's Pathological Laboratory; Report on the Operations of the Government Lymph Establishment; Vaccinal Condition of Small-pox cases during 1914, 1915 and 1916; Circulars, Memoranda, and Orders, issued by the Local Government Board in 1916–17, relating to Questions affecting the Public Health.

[Cd. 8767] of Session 1917–18. Price 4*d.* (5½*d.*)

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DEPARTMENTAL COMMITTEE ON ANTHRAX.

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO

PRECAUTIONS FOR PREVENTING DANGER OF INFECTION FROM ANTHRAX IN THE MANIPULATION OF WOOL, GOAT HAIR, AND CAMEL HAIR.

Vol. III.—Summary of Evidence and Appendices.

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DEPARTMENTAL COMMITTEE ON DISINFECTION OF HORSEHAIR.

REPORT

OF THE

DEPARTMENTAL COMMITTEE

APPOINTED TO INQUIRE AS TO THE

PRACTICABILITY OF DISINFECTION OF HORSEHAIR.

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STATEMENT OF THE COST OF THE COMMITTEE.

The following is a statement of the cost incurred by the Departmental Committee on Disinfection of Horsehair :—

	£	s.	d.
1. Experimental apparatus, &c., and travelling expenses of members of the Committee and witnesses	131	19	8
2. Printing and publishing the Report of the Committee	42	0	0
Total	173	19	8

TABLE OF CONTENTS.

REPORT

OF THE

Departmental Committee on Disinfection of Horsehair on the Experimental Work carried out with a view to applying to Horsehair the method devised for the Disinfection of Wool.

The Right Honourable EDWARD SHORTT, K.C., M.P., His Majesty's Principal Secretary of State for the Home Department, Home Office, London, S.W.1.

SIR,

WE have the honour to report as follows on the experimental investigation as to the practicability of applying to horse hair the method devised for the disinfection of wool :—

INTRODUCTION.

On the presentation to the Secretary of State of Volume 1 of the Report of the Departmental Committee on Anthrax,* in which the experimental work undertaken in devising a successful method for the disinfection of wool was described, the Secretary of State, by letter, drew the attention of the Chairman to the unsatisfactory position in relation to horsehair, and asked if the Committee would be willing, after such further inquiry as might be necessary, to advise him as to the practicability of disinfection of horsehair. The members having agreed to this proposal, the Committee was reconstituted for the purpose of the suggested inquiry, the following representatives of the horsehair industry being appointed as additional members of the Committee :—

(1) Albert Webb, Esq. (Managing Director of Messrs. Edward Webb and Sons (Worcester) Ltd., Horsehair Manufacturers).

(2) J. Williams, Esq. (Managing Director of The Ripley Manufacturing Co., Ltd., Horsehair Manufacturers).

1. SCHEME OF THE EXPERIMENTS.

The inquiry has been conducted on lines similar to those of the wool inquiry. These having already been fully described need only be briefly referred to.* The condition of the material (horsehair) to be disinfected was first investigated in order to ascertain the difficulties likely to be encountered. Standard infected test material was then prepared resembling in its condition as nearly as possible the hair met with in practice.

Hair, having samples of the infected test material among it, was treated in a small experimental plant, and after bacteriological examination of the test samples had proved the destruction of all anthrax spores to be complete, was first examined by experts and subsequently manufactured in order to ascertain the effect of the process on the hair from the commercial aspect. Finally, experiments were made to ascertain if machinery could be used for disinfection without causing manufacturing difficulties.

2. BACTERIOLOGICAL EXAMINATION AND CONTROL TESTS.

The general bacteriological examination of all samples was made by Dr. F. W. Eurich in the Public Health Laboratory of the Bradford City Council by cultural methods exactly similar to those used by him in the wool inquiry.† In order, however, to test the method of disinfection still more stringently, and to secure outside independent observation on the efficiency of the experiments, Dr. Arthur Eastwood, Bacteriologist to the Ministry of Health, was asked through the Local Government Board (now the Ministry of Health) if he would undertake a control examination of all samples used in the experiments. His department being willing, Dr. Eastwood consented to do this, and one-half of every sample was, therefore, sent to his laboratory, where he submitted it to tests both by cultural methods and by animal inoculation. Dr. Eastwood's report is given later (page 12).

* Report of the Departmental Committee appointed to inquire as to precautions for preventing danger of infection by anthrax in the manipulation of Wool, Goat Hair, and Camel Hair, Vol. I., Report of the Disinfection Sub-Committee [Cd. 9057]. Price 1s. Published by H.M. Stationery Office, Imperial House, Kingsway, London, W.C.2.

† Page 11 of Vol. I. of the Report of the Committee. See footnote above.

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3. Consideration of Material to be Disinfected.

In order to acquire information as to the condition of horsehair normally used in manufacturing processes, inquiries were first made among users. Considerable quantities of ordinary Siberian mane and tail hair, which are representative of all imported hair, were then obtained from manufacturers and closely examined in the laboratory The mane hair consisted of loose locks, but the tails were in bundles usually containing two or three tails tied tightly together at the butts by hair or string. The hair was taken straight from the bales for the purpose of this examination.

3 (a). Siberian Mane Hair.

The mane hair submitted was first examined by a hair expert and sorted into two portions, viz., "clotted" mane hair and ordinary mane hair (*i.e.*, not "clotted" hair). The two portions were then carefully examined in the laboratory. Both were dirty, though that described as "clotted" hair was decidedly worse than the ordinary hair. Small blood clots were present in both portions, but these were different in form from those met with in wool. Instead of, as in wool, forming a hard mass of fibres glued together the blood was loosely attached to comparatively few hairs in the worst instances, and was generally rather of the nature of more or less extensive stains. Apart, however, from a few small blood clots it was impossible from visible indications to say with certainty that the hair was bloodstained. Almost all of it was stiff and hard to the touch; in many instances a few hairs were glued together, and most of it was distinctly stained though not certainly by blood. The general impression gained from the visual examination was that nearly the whole of the hair was probably bloodstained to some extent.

Representative samples taken from both portions ("clotted" and ordinary) of the mane hair under examination, after being carefully scrutinised, were chemically tested to ascertain if blood were present, and cultures were then made. In no case was it possible to cultivate anthrax, but all the cultures yielded an abundant growth of other organisms. The following results were obtained:—

Results of Examination of Siberian Mane Hair.

(a) "*Clotted*" *Mane Hair.*

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood. + = Blood present. ++ = Strong Blood reaction. — = Blood absent.	Result of Culture Test. + = Anthrax scantily cultivated. ++ = Anthrax cultivated in quantity. — = Anthrax not cultivated.
1	Black lock	Hair stained, small bloodclot attached - -	+	—
2	Grey lock -	Hair glued together and stiff. Discolouration suspiciously like blood.	++	—
3	Dirty white lock	Hair stained. Stains suspiciously like blood -	+	—
4	Brown black lock.	Hair neither stiff nor visibly stained - - -	+	—
5	Grey lock -	Hair stiff, but nothing definitely like blood visible.	+	—
6	Dirty white lock.	Hair matted and stiff. Distinctly stained - -	+	—
7	Black lock	Hair matted and stiff. Distinctly stained - -	Doubtful	—
8	Black lock	Hair clean and neither matted nor visibly stained	—	—
9	Grey lock -	Hair slightly matted and slightly stained, but blood doubtful.	+	—

(b) *Mane Hair, not "Clotted" Hair.*

10	White lock	Fairly clean. Not matted or stiff. Not stained. Not glued.	+	—
11	Grey lock	Matted and burry. Dirty, not glued. Tips rather stiff	—	—
12	Chestnut lock.	Slightly glued and stiff. Tips faintly blood-stained.	++	—
13	Black locks	Some tips glued and stiff. Locks matted - -	+	—
14	White locks	Few of tips glued and stiff - - - -	++	—
15	Black lock	Neither matted nor glued, nor stiff - - - -	—	—
16	Brown black lock	Part stained, matted, glued, and stiff - -	+	—
16 (a)	Brown black lock	Part not glued nor matted, nor stained - -	—	—
17	Grey lock	Not glued or stained. Small piece of pelt attached to butts.	—	—

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood. + = Blood present. ++ = Strong Blood reaction. − = Blood absent.	Result of Culture Test. + = Anthrax scantily cultivated. ++ = Anthrax cultivated in quantity. − = Anthrax not cultivated.
18	Brown lock	Blood clot attached to part of hair, but hair loose and open.	++	—
18 (a)		Part of hair not visibly stained	++	—
19	Black brown lock	Some tips slightly glued and stiff	++	—
19 (a)		Rest of hair fairly clean and not obviously stained.	Doubtful	—
20	Grey lock	Very coarse hair. Slightly glued and stiffened	+	—
21	White, brown, and black locks.	Hair matted but not glued. Some distinctly stained.	+	—
22	White, grey, and black locks.	Some hairs distinctly bloodstained	++	—
22 (a)		Some hair not visibly stained	—	—
23	Black lock	Some tips glued and harsh	+	—
24	Brown and black locks.	Hair matted, but neither stiff nor glued	+	—
25	Brown, white, and grey locks.	Tips appeared to be stained	+	—
26	Grey and black locks.	Some of tips distinctly stained	++	—
26 (a)		Rest of hair free from obvious staining	+	—
27	Chestnut lock.	Tips glued and stiff	++	—
27 (a)		Butts neither glued nor stiff	+	—

3 (B). *Siberian Tail Hair.*

The Siberian tail hair obtained for examination was, as in the case of the mane hair, first examined by a hair expert, who separated it into three portions: (*a*) stained tails, (*b*) matted tails, (*c*) ordinary tails. The part separated as stained tails consisted of tails on which there was a clearly obvious stain. The matted tails consisted of hair which had become felted together, and some of them contained much fæcal matter. The tails of each portion were carefully scrutinised in the laboratory, representative samples chemically tested to ascertain if blood were present on the hair, and cultures made from them. The results were as follows:—

RESULTS OF EXAMINATION OF SIBERIAN TAIL HAIR.

(a) *Stained Siberian Tails.*

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood. + = Blood present. ++ = Strong Blood reaction. − = Blood absent.	Result of Culture Test. + = Anthrax scantily cultivated. ++ = Anthrax cultivated in quantity. − = Anthrax not cultivated
28	White tail	Parts bloodstained and covered with caked dirt	+	++
28 (a)		Parts free from visible stains	—	++
29	Black tail	Middle portion stained and caked	++	—
29 (a)		Flags and butts not obviously stained	—	++
30	Black tail	Many parts stained and glued and stiff	—	—
30 (a)		Parts not obviously stained	Doubtful	—
31	Grey tail	Bloodstained tips of one small lock	++	—
31 (a)		Bulk of tail normal and not stained	—	—
32	Grey tail	Part stained from butts to tips	++	—
32 (a)		Part of tail free from obvious staining	+	—

(b) *Matted Siberian Tails.*

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood.	Result of Culture Test.
33	Black tail	Middle part of tail felted and matted. Not glued or stiff.	—	—
33 (a)		Tips free and open. Not stained	—	—
34	Grey tail	Middle part felted and matted. Not glued	—	—
34 (a)		Tips free, but slightly stained. Not glued	—	—
35	Black tail	Middle part matted. Not glued or stiff	—	—
35 (a)		Tips free. Not stained or glued or stiff	—	+

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood. + = Blood present. ++ = Strong Blood reaction. — = Blood absent.	Result of Culture Test. + = Anthrax scantily cultivated. ++ = Anthrax cultivated in quantity. — = Anthrax not cultivated.
36	Black tail	Middle part felted and matted. Not obviously stained.	—	++
36 (a)		Tips free and neither glued or stained	—	++
37	Brown tail	Middle part matted but not stained or glued	—	—
37 (a)		Tips open and free and neither stained nor stiff	—	—
38	Black tail	Middle part matted, but neither glued nor stiff	—	—
38 (a)		Tips open and free, stained, but not stiff	—	+
39	Brown black tail.	Middle part matted, stiff and stained, and very dirty.	—	—
39 (a)		Tips stiff and stained, but doubtful if blood-stained.	—	+
40	White tail	Middle part slightly matted, but clean	+	+
40 (a)		Tips free and open, but slightly stained	+	+
41	Grey tail	Middle part matted and very dirty. Not glued or stiff.	+	++
41 (a)		Tips dirty but free, and not glued or obviously bloodstained.	+	+
42	Grey tail	Middle portion matted, but clean	—	—
42 (a)		Tips free and clean. Under a magnifying glass, a deposit could be observed on the hair.	—	+
43	Black tail	Middle part matted, but clean	—	—
43 (a)		Tips free and clean	—	—
44	Black tail	Middle part matted, but clean	+	—
44 (a)		Tips free and clean	—	+

(c) *Ordinary Siberian Tails.*

Sample. No.	Sample. Nature.	Result of Scrutiny.	Result of Chemical Test for Blood.	Result of Culture Test.
45	White tail.	Flags obviously bloodstained, but quite free and not glued.	++	—
45 (a)		Parts dark stained, doubtful if by blood, not stiff.	—	—
45 (b)		Parts free and open and not obviously stained	+	—
46	Grey tail	Part stained but not glued or stiff and quite free	+	—
46 (a)		Parts not obviously stained	+	—
47	Black tail	Flag end of tail harsh but not matted or glued	+	—
47 (a)		Butt end of tail, not stained and free and open	+	—
48	Chestnut tail.	Tips, quite free and to the naked eye quite clean	+	—
48 (a)		Middle part, free and to the naked eye quite clean.	+	—
49	Grey tail	Tips free and open. Not stained	+	—
49 (a)		Middle part, twisted (not matted) and rough and harsh.	+	—
50	Black tail	Tips, rough and harsh to the touch but no staining visible to the naked eye.	—	—
50 (a)		Middle portion, free and apparently clean	+	—
51	Grey tail	Tips obviously bloodstained	++	+
51 (a)		Butts free from stains	—	—
52	Black tail	Tips, not obviously stained. Apparently clean	++	—
52 (a)		Middle part, not obviously stained	—	—
53	Grey tail	Tips obviously bloodstained but not glued	++	—
53 (a)		Middle parts, dark coloured and glued and stiff	Doubtful	—
53 (b)		Middle part, apparently clean and not stained	+	—
54	Chestnut tail.	Tips, free and apparently clean and not stained	—	+
54 (a)		Middle part, some hairs caked together with dirt	—	—
55	Grey tail	Tips, rough to touch and some caked with dirt. Not obviously bloodstained.	++	—
55 (a)		Middle part, not caked or obviously stained	+	—
56	Black tail	Tips, free and clean. No obvious stains	—	—
56 (a)		Middle part free and clean	—	—
57	Black tail	Tips, some rough and harsh and slightly caked with dirt.	+	—
57 (a)		Middle part, stiff and slightly glued	—	—

The tail hair examined was usually very dirty. The butt or thick end of the tail always contained a white granular deposit and the hands became greasy and sticky after handling the hair. Only in rare instances were obvious stains observed on the butt. The flag end of the tail was usually free from the white deposit, but it was nearly always stained and harsh to the touch. In some instances it was definitely possible to say the flag end was bloodstained and in many cases it could be said that the staining was suspicious, though not perhaps sufficient to permit of a definite conclusion. In most tails the discolouration could only be observed after most careful examination. In no case was a definite blood clot found in tail hair, except possibly in one or two of the matted tails (but later in the inquiry definite and fairly large blood clots were observed). Hairs were in many instances glued together for short portions of their length, but usually blood was present simply as a stain on the surface of the hair.

SUMMARY.

Samples.	Total.	Infected.
Examined:—		
Mane Hair	32	—
Tail Hair	62	17
Certainly visibly bloodstained:—		
Mane Hair	4	—
Tail Hair	5	2
Not certainly visibly bloodstained, but giving the chemical re-action for blood:—		
Mane Hair	21	—
Tail Hair	23	5
Not bloodstained (including those marked doubtful):—		
Mane Hair	7	—
Tail Hair	34	10

The results of the examination of horsehair are contained in the above summary. It will be observed that 80 per cent. of the samples of mane hair were bloodstained, but no sample of this class of hair, whether bloodstained or not, proved to be infected. Of the samples of tail hair examined 45 per cent. were bloodstained, and of these 25 per cent. were infected, while 55 per cent. of the samples of tail hair showed no indication (in a few cases doubtful indications) of blood, and of these 29 per cent. proved to be infected.

The examination of hair showed that, as in the case of wool, freedom from visible bloodstains does not necessarily indicate absence of infection. Apart from this it was abundantly clear from the nature of the material and stains that attempts to sort out bloodstained hair would be of very small value. Although no sample of mane hair was found to be infected, while it was possible to cultivate anthrax from a good proportion of samples of tail-hair, the quantity of the former examined was too small relatively to the amount used in industry to permit the conclusion that it is free from infection. This would also be opposed to previous experience, which indicates that mane hair is at least as dangerous as tail hair. Coupling the results obtained with the evidence of manufacturers and workmen, however, a reasonable estimate of the state in which possibly infected hair is imported can be formed. This was, of course, necessary to enable us to prepare standard infected test material.

It was pointed out to us that a considerable trade in hair partly manufactured abroad (chiefly in China) has become established. This hair is imported in bundles, each hair lying perfectly straight and parallel with its neighbours, which are tied tightly every few inches by string. The length of these varies from three inches upwards. We are unanimously of opinion that satisfactory disinfection of such partly manufactured material is impracticable and that it is undesirable to permit any manufacture or any stage of manufacture to be carried out before disinfection. We have accordingly confined our investigation to the treatment of raw hair.

4. Preparation of Infected Test Material.

The preliminary laboratory examination having indicated the general conditions under which infection may be expected in horsehair, the preparation of standard infected test material was possible. Although a number of fairly heavily infected natural samples had been obtained it was decided to rely on artificially infected material for use as infected test material as in naturally infected samples the distribution and extent of infection and the power of resistance of the organism are too variable. Nevertheless some of these naturally infected samples were used in the experiments alongside standard artifically infected test material.

The method of making infected test material was, with the concurrence of Dr. Eastwood, arranged as follows :—

Anthrax spores (obtained as a first sub-culture from naturally infected horsehair, and proved to be capable of resisting a temperature of 80° C. for two hours) were suspended in serum from bullock's blood and the suspension was placed in a large round glass dish. Tails of white horsehair were divided into quantities about as thick at the butts as a pencil. Each "lock" was then tied tightly at the butts and the whole (except about two inches at the tie) was soaked in the suspension of anthrax spores, drained, and hung to dry on wires stretched across a draught cupboard.

Some of the naturally infected whole tails were also soaked in the suspension and dried in the same way. All were allowed to dry for four months before use in experiments. Cultures made from the suspension, and from the test samples after four months drying, gave a profuse growth of anthrax. Animals inoculated with material from the test samples at the time of use quickly developed anthrax and died.

5. Control of Solutions and of the Conditions of Experiment.

The solutions used in the preliminary treatment of the hair were freshly made up and brought to the required temperature for each experiment. The same formaldehyde solution was used throughout the investigation and was contained in a vessel heated by means of a copper coil through which passed water from a gas-heated boiler. The temperature of the solution could thus be closely controlled. Its strength was, in every test, determined by chemical analysis by the same method as in the wool experiments.

All the vessels were calibrated, so that when it was necessary to alter the strength of any of the solutions the quantities could easily be calculated. Careful observation was made of the temperature of the solutions throughout each experiment, but the variations never exceeded one or two degrees.

6. Damage Test Material and Methods of Experiment.

As in disinfection of wool so in disinfection of horsehair, two equally important considerations must be taken into account, viz.: (1) the certainty of disinfection; and (2) the effect on the material. Two tests had therefore to be applied at the same time, *i.e.*, (1) a bacteriological examination of the infected test material after treatment in order to ascertain the efficiency of the process measured by the destruction of anthrax spores; and (2) a commercial and manufacturing examination of damage test material, treated simultaneously with the infected test material, in order to indicate the effect on the hair from the manufacturing standpoint.

A further complication in the case of horsehair is that part is imported as mane hair and part in tails just as they are removed from the animals. Mane hair and tail hair are used for different purposes, and disturbance of the hair in the tails causes manufacturing difficulties. The condition in which mane hair is imported and the uses to which it is put allow it to be treated exactly in the same manner, and by the same machinery, as wool. Tail hair, however, cannot be treated by these methods. Indications of damage to hair are similar to those of injury to wool with the addition that tail hair must be considered to have suffered if the tails are broken up. It was, therefore, decided to use tail hair only as damage test material and to devise measures for preventing disturbance of the hair in the tails. It follows that if tail hair is undamaged mane hair will also be unaffected.

The investigation divided itself naturally into two parts: (1) experiments to test the disinfecting efficiency of the process as applied to hair and the effect of the process itself on the hair; and (2) experiments made for the purpose of testing the mechanical effect, in causing disturbance of the hair, of machinery it may be possible to use for disinfection. The former were, with the concurrence of the Conditioning House Committee of the Bradford City Council, carried out by means of plant set up by the Committee in the Bradford Conditioning House, and the latter in the works of Messrs. W. Atkinson and Son, Limited, Cleckheaton, and of Messrs. Thos. Burnley and Sons, Ltd., Gomersal, who were good enough to place machinery at the disposal of the Committee for this purpose.

7. Experiments to test the Disinfecting Efficiency, and the Effect on Hair, of the Process.

In the first stages of the inquiry it was suggested that passage of tails through rollers would cause disturbance of the hair, and that the experiments in disinfection ought to be conducted under conditions at least as difficult as those which might have to be faced in practice. Accordingly, in the purely disinfection part of the inquiry, no attempt was made in the preliminary process to cleanse the hair thoroughly, and rollers were not used. The object of this was to ascertain the possibilities of disinfection in these conditions, the argument being that if it be then efficient it will be quite certain under the easier conditions which would obtain should thorough cleansing of the hair and the use of rollers be found to be possible.

The prevention of disturbance of the hair was, of course, essential. Rectangular cages of perforated metal, measuring 30 ins. by 6 ins. by 6 ins. were therefore obtained, each capable of holding 10 to 12 tails stretched out at full length or with the flags only bent. These could be attached to the agitating mechanism of the small experimental plant used in the wool inquiry. When so attached, the cages with the hair inside were completely immersed in the liquids contained in the tanks which could penetrate freely among the hair though this was maintained by the form of the cages in such a position as to prevent breaking up of the tails.

In each experiment either a sample of the white infected test material (part of a tail, *see* section 4) was placed in the centre of a large black tail, which was placed in the middle of a cage and surrounded by 8 to 11 other tails, or the whole of an infected tail was placed in this position. The cage was then closed, attached to the mechanism, and moved backwards and forwards in the solutions for the requisite time.

The solution used in the preliminary process contained in some experiments 0·1 per cent. of soft soap and 0·25 per cent. of sodium carbonate. In others the soap was omitted. The disinfecting solution contained from 2·25 per cent. to 2·6 per cent. of formaldehyde. The temperature of both solutions was maintained at 105 degrees F. to 110 degrees F.

The hair in the cages attached to the agitating mechanism was submitted to the action of the solution of soap and sodium carbonate (or of the latter alone) for 30 minutes. The cages were then removed and, after allowing the hair to drain, were at once placed in the formaldehyde solution, in which they were moved backwards and forwards for 20 minutes. The hair was then removed, hydro-extracted, and dried at a temperature of 160 degrees F. to 180 degrees F. in the drying cylinders used at the Bradford Conditioning House for the testing of wool. These were very unsuitable for drying material of the length of horsehair, and great care had to be exercised to prevent scorching.

The results of the bacteriological examination of the infected test material by Dr. Eurich and Dr. Eastwood showed that practically complete sterilisation had been secured, and Dr. Eastwood reported that in his opinion the process is a satisfactory method of disinfection for horsehair.

The details and results of the experiments are given in the following table, and for convenience Dr. Eastwood's results are also included, though stated more fully in his report which follows the table.

Number of Experiment.	Infected Test Material used.	DETAILS OF EXPERIMENTS AND COMMITTEE'S RESULTS. Preliminary Treatment. Solution. Strength. Soap (Per cent. by weight)	Sodium Carbonate (Per cent. by weight).	Temperature.	Time of Immersion in.	Times Hair squeezed through Rollers.	Disinfecting Treatment. Formaldehyde Solution. Strength (Per cent. by weight of Formaldehyde).	Temperature.	Time of Immersion in.	Times Hair squeezed through Rollers.	Drying in current of Hot Air. Temperature of Air.	Time.	Time elapsing before Test Material put in Ammonia Solution.	Number of Colonies growing after 96–120 hours Incubation on Agar at 37° C. from one-tenth of Material from treated Infected Test Samples. ∞ = uncountable. Anthrax.	Other Organisms.	DR. EASTWOOD'S CONTROL TEST AND RESULTS. (See also Dr. Eastwood's Report.) Animals Inoculated with Material from Infected Test Samples. Guinea Pigs. Consecutive Number.	Mice. Consecutive Number.	Quantity of Material used for Inoculation.	Time Animals kept under observation.	Mode of Death.	Condition of Animal at Autopsy.	Culture Results. Colonies growing on Agar. ∞ = uncountable. Anthrax.	Other Organisms.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)
				° F.	Mins.			° F.	Mins.		° F.	Mins.	Hours.						Days.				
Control	Part of white tail artificially infected.	—	—	—	—	—	—	—	—	—	—	—	—	∞	∞	A	—	Sediment from a few bits of hair.	2	Died	Typical anthrax.	∞	See Dr. Eastwood's Report.
1	" "	0·1	0·25	107	30	—	2·67	109	20	—	184	30	27	0	9	1	—	See Dr. Eastwood's Report.	7	Killed	Normal	See Dr. Eastwood's Report.	"
																2	—	"	7	"	"	"	"
																3	—	"	7	"	"	"	"
																—	1	"	7	"	"	"	"
2	" "	0·1	0·25	107	30	—	2·67	109	20	—	184	30	27	0	6	4	—	"	7	"	"	"	"
																5	—	"	7	"	"	"	"
																6	—	"	7	"	"	"	"
																—	2	"	7	"	"	"	"
3	" "	0·1	0·25	107	30	—	2·67	109	20	—	184	30	27	0	6	7	—	"	7	"	"	"	"
																8	—	"	7	"	"	"	"
																9	—	"	7	"	"	"	"
																—	3	"	7	"	"	"	"
4	Whole of white tail both naturally and artificially infected.	0·1	0·25	107	30	—	2·67	109	20	—	184	30	27	0	3	10	—	"	7	"	"	"	"
																11	—	"	7	"	"	"	"
																12	—	"	7	"	"	"	"
																—	4	"	7	"	"	"	"
5	Part of white tail artificially infected.	Nil	0·25	110	30	—	2·57	110	20	—	176	30	24	0	10	13	—	"	7	"	"	"	"
																14	—	"	7	"	"	"	"
																15	—	"	7	"	"	"	"
																—	5	"	7	"	"	"	"

6	Part of white tail artificially infected.	Nil	0·25	110	30	—	2·57	110	20	—	176	30	24	0	11	16	—	*See* Dr. Eastwood's Report.	7	Killed	Normal	*See* Dr. Eastwood's Report.	*See* Dr. Eastwood's Report.
																17	—	"	7	"	"	"	"
																18	—	"	7	"	"	"	"
																—	6	"	7	"	"	"	"
7	" "	"	0·25	110	30	—	2·57	110	20	—	176	30	24	0	18	19	—	"	7	"	"	"	"
																20	—	"	7	"	"	"	"
																21	—	"	7	"	"	"	"
																—	7	"	7	"	"	"	"
8	Whole matted tail heavily infected both naturally and artificially.	"	0·25	110	30	—	2·57	110	20	—	176	30	24	0	3	22	—	"	7	"	"	"	"
																23	—	"	7	"	"	"	"
																24	—	"	7	"	"	"	"
																—	8	"	7	"	"	"	"
9	Part of white tail artificially infected.	"	0·33	110	30	—	2·48	109	20	—	184	25	48	0	1	25	—	"	7	"	"	"	"
																26	—	"	7	"	"	"	"
10	" "	"	0·33	110	30	—	2·48	109	20	—	184	25	48	0	5	27	—	"	7	"	"	"	"
																28	—	"	7	"	"	"	"
11	" "	"	0·33	110	30	—	2·48	109	20	—	184	25	48	0	1	29	—	"	7	"	"	"	"
																30	—	"	7	"	"	"	"
																—	9	"	4	Died	No anthrax.	"	"
12	Whole matted tail infected naturally and artificially.	"	0·33	110	30	—	2·48	109	20	—	184	25	48	-0	3	31	—	"	7	Killed	Normal	"	"
																32	—	"	7	"	"	"	"
																33	—	"	7	"	"	"	"
																—	10	"	7	"	"	"	"
13	Whole tail heavily bloodstained and naturally infected.	"	0·33	110	30	—	2·48	109	20	—	184	25	48	0	4	34	—	"	7	"	"	"	"
																35	—	"	7	"	"	"	"
																36	—	"	7	"	"	"	"
																—	11	"	3	Died	No anthrax.	"	"
13A	Few pieces of hair cut from 13 for control purposes.	—	—	—	—	—	—	—	—	—	—	—	—	70 on 4 plates after 18 hours.	∞	—	—	—	—	—	—	—	"
14	Part of white tail artificially infected (Control).	—	0·33	109	30	—	—	—	—	—	—	—	21	∞	∞	—	—	—	—	—	—	—	"

8. Report on the Control Tests.

Dr. Eastwood reported as follows on his control tests in connection with the investigation:—

Report on the Disinfection of Horsehair at Bradford.

By A. Eastwood, M.D.

I received from Mr. Duckering, for examination at the Pathological Laboratory of the Local Government Board, a portion of the artificially infected hair, prior to disinfection, and one half of each of the 13 samples which had been disinfected.

On 26th April a few bits of hair from the material prepared for the experiments were emulsified in normal saline, and the washings, after heating at 80° C. for one hour, were cultured and inoculated subcutaneously into a guinea pig. The culture gave a profuse growth of anthrax. The animal died in two days with typical anthrax. This shows that the test material contained abundant anthrax spores of high resistance.

The work on the Bradford experiments of 1st, 6th, and 13th May was commenced in the Board's laboratory on 5th, 12th, and 14th May respectively.

Material Used.

The whole of specimens 1–3, 5–7, 9–11 was used. Matted or tangled portions were selected from 4, 8, and 12, the bulk of material used in each case being about equal to the largest of the previous samples. About the same amount was taken from 13, bits being cut from different parts of the tail.

Method.

The hair was rubbed up in a mortar with 0·5 per cent. ammonia in normal saline, and the turbid liquid poured off; this process was repeated twice with fresh quantities of ammonia in saline. The three washings were put together, neutralised, distributed into four tubes, and centrifugalised. The clear supernatant liquid was poured off and a convenient quantity of normal saline was added to the deposit. One of the four tubes was shaken up and again centrifugalised; the clear fluid was removed and fresh saline was added to the deposit. After shaking up this tube, about a quarter of its contents was plated, three agar plates being used. The remaining contents of this tube and the whole of the three other tubes were inoculated subcutaneously into the animals specified in the protocol below.

Culture Results.

Many of the plates were sterile, and none showed more than a few colonies. There was no growth of anthrax. The colonies found were no doubt attributable to slight air-borne contamination subsequent to disinfection.

Results of Animal Experiments.

No. of Sample.	Animals Inoculated.	Duration of Experiment.	Condition of Animals at Autopsy.
1	*G.P. 1	†K., 7 days	Normal.
	G.P. 2	"	"
	G.P. 3	"	"
	Mouse 1	"	"
2	G.P. 4	"	"
	G.P. 5	"	"
	G.P. 6	"	"
	Mouse 2	"	"
3	G.P. 7	"	"
	G.P. 8	"	"
	G.P. 9	"	"
	Mouse 3	"	"
4	G.P. 10	"	"
	G.P. 11	"	"
	G.P. 12	"	"
	Mouse 4	"	"
5	G.P. 13	"	"
	G.P. 14	"	"
	G.P. 15	"	"
	Mouse 5	"	"
6	G.P. 16	"	"
	G.P. 17	"	"
	G.P. 18	"	"
	Mouse 6	"	"

* G.P. = Guinea Pig. † K. = Killed.

No. of Sample.	Animals inoculated.	Duration of Experiment.	Condition of Animals at Autopsy.
7	*G.P. 19 - - - - - -	†K., 7 Days - - - - -	Normal.
	G.P. 20 - - - - - -	" - - - - -	"
	G.P. 21 - - - - - -	" - - - - -	"
	Mouse 7 - - - - - -	" - - - - -	"
8	G.P. 22 - - - - - -	" - - - - -	"
	G.P. 23 - - - - - -	" - - - - -	"
	G.P. 24 - - - - - -	" - - - - -	"
	Mouse 8 - - - - - -	" - - - - -	"
9	G.P. 25 - - - - - -	" - - - - -	"
	G.P. 26 - - - - - -	" - - - - -	"
10	G.P. 27 - - - - - -	" - - - - -	"
	G.P. 28 - - - - - -	" - - - - -	"
11	G.P. 29 - - - - - -	" - - - - -	"
	G.P. 30 - - - - - -	" - - - - -	"
	Mouse 9 - - - - - -	‡D., 4 days - - - - -	No anthrax.
12	G.P. 31 - - - - - -	K., 7 days - - - - -	Normal.
	G.P. 32 - - - - - -	" - - - - -	"
	G.P. 33 - - - - - -	" - - - - -	"
	Mouse 10 - - - - - -	" - - - - -	"
13	G.P. 34 - - - - - -	" - - - - -	"
	G.P. 35 - - - - - -	" - - - - -	"
	G.P. 36 - - - - - -	" - - - - -	"
	Mouse 11 - - - - - -	D., 3 days - - - - -	No anthrax.

* G.P. = Guinea Pig. † K. = Killed. ‡ D. = Died.

In the case of each autopsy the findings were confirmed by microscopic examination.

Conclusion.

I am completely satisfied that the process of disinfection which was employed can be relied upon to kill all anthrax spores in material similar to that used.

22nd May 1919. (Signed) Arthur Eastwood.

9. Experiments made to Test the Effect of the Process of Disinfection on Horsehair.

In each disinfecting efficiency experiment the infected test material was surrounded by 10 to 12 tails of hair in each cage. These tails were used as a damage test material and were kept under observation at each stage of disinfection and manufacture. After bacteriological examination of the infected test material had proved the efficiency of disinfection they were examined and manufactured.

When the suitability of the process as a method of disinfection of horsehair had been demonstrated inquiries were instituted with a view to devising machinery by means of which the process of disinfection of tails of hair could be made continuous and mechanical without mixing or disturbance of the hair. Of the existing machinery available that used for scouring of yarn appeared to be suitable for our purpose and experiments were carried out with two entirely different types placed at our disposal by Messrs. W. Atkinson and Sons, Limited, St. Peg Mill, Cleckheaton (cylinder machine) and Messrs. Thomas Burnley and Sons, Limited, Gomersal (apron machine), respectively. The former type proved very successful the tails passing through the machine without any disturbance of the hair.

10. Results of the Manufacturing Tests.

The results of the manufacturing tests are described in the following report by Mr. Williams, managing director of Messrs. The Ripley Manufacturing Company, Limited, in whose factory they were carried out.

Report on Experiments made to ascertain the Effects of the Disinfection Process on Horsehair judged from a Manufacturing Standpoint.

In accordance with arrangements made at meetings of the Committee, I forwarded to Mr. Duckering several lots of Siberian tail horsehair, partly white and partly coloured, for treatment at Bradford by the disinfection process. Each lot was sufficiently large to enable me, after treatment, to manufacture it in the usual way at my firm's factories, and so permit me to test on a commercial scale the effect of the process on the hair from a manufacturing point of view. The hair was not in any respect specially selected, but Mr. Duckering informs me that the examination of it by Dr. Eurich and himself, before treatment, showed each lot to be extensively bloodstained, some of it badly, but the majority of it slightly.

The experiments were carried out partly by means of the small experimental plant set up by the Committee in the Bradford Conditioning House and partly by means of machinery placed at the disposal of the Committee by firms in the Bradford district. Mr. Webb of Worcester, myself, or the foreman of my hair-drawing department were present at many of them. They were of two kinds:—

(a) Experiments designed to test the effect of the process itself on the hair; and (b) Experiments designed to test the possibility of using certain types of machinery for disinfection of hair.

In (a) the hair for the manufacturing trial had placed among it samples of standard infected test material, which were bacteriologically examined after the treatment in order to make certain that disinfection had in fact been completed. In (b) the object was merely to ascertain the mechanical effect of passage of the hair through the machines. In each set of experiments the hair was returned to me after treatment, and careful observations were made in the factories as to its condition and characteristics. It was then manufactured, and its behaviour at each stage carefully noted.

(a) Experiments to Test the Effect of the Process on Horsehair.

The whole of these experiments were carried out by means of the small experimental plant originally devised for the treatment of wool. Mr. Duckering pointed out that, having regard to the necessity of keeping the tails intact, and preventing mixing or entangling of the hair, this apparatus possessed obvious defects, and that in particular it would, without special modifications, be difficult to secure efficient cleansing of the hair. After discussion it was decided (erroneously, as will be shown later) that, for the purpose of these experiments, cleansing of the hair was unimportant. Arrangements were therefore made to enclose the tails in perforated metal cages, each containing 8–12 tails, which could be attached to the agitating machanism and so be slowly moved backwards and forwards in the solutions. It was further agreed not to pass the hair through rollers, but merely to allow the cages of hair to drain for a few seconds in passage from one solution to the next. Mr. Duckering pointed out that, having regard to the experience gained in the experiments in disinfection of wool, this imposed a very severe test on the disinfection process, as it was then shown that freedom of material and use of rollers were very important factors in securing successful disinfection. The results showed that, while perfect disinfection could be secured by the method adopted, efficient cleansing was not obtained, and this is a vital factor from a manufacturing standpoint.

First Series of Experiments.

In the earlier experiments, the tails of hair were, in the preliminary process, exposed for 30 minutes to the action of a solution containing 0·25 per cent. of sodium carbonate, and 0·1 per cent. of soap, and, after draining a few seconds, they were in the second part of the process agitated for twenty minutes in a solution containing 2½ per cent. of formaldehyde. They were then hydro extracted and dried.

Examination of Treated Hair.—During drying a white deposit appeared on some of the tails, but other tails appeared brighter than before disinfection. The strength and elasticity of the hair appeared to be in no respect adversely affected. The tails were quite intact; the hair was free and straight, but handled cold and clammy. The conclusion drawn was that the hair was not affected by disinfection, but the limy appearance of some of it after treatment was objectionable.

Second Series of Experiments.

It was thought that the limy appearance of some of the hair after treatment in the first series of experiments might be due to the formation of an insoluble lime soap. Consequently, in the second series the hair was treated exactly as in the first, with the exception that no soap was used in the solution in the preliminary process.

Examination of Treated Hair.—The external hair of the tails treated in the second series of experiments was bright, and appeared to be improved by the process. Upon opening out the tails, however, it was palpably evident that very little of the natural dirt and grease had been removed. The strength and elasticity of the hair were unimpaired; it was perfectly free and straight, but it handled cold and clammy.

Manufacture.—After examination the hair was wet hackled, drawn and woven. Some of the tails hackled badly, and this operation was slower and more difficult than is customary.

Drawing was also slower and harder than usual and, what was worse, the hair showed an adhesive tendency when being worked in the cards. After being drawn, the hair had a soft and sticky handle.

The hair was then woven in a loom running at very high speed, and in this process its behaviour was normal.

The result of this test was distinctly unfavourable from a manufacturing standpoint. Although there was no apparent deterioration in the hair itself, and the weaving was satisfactory, the processes of wet hackling and drawing were adversely affected, rendering them comparatively slow and difficult, and the condition of the hair after drawing was unsatisfactory.

Examination of the Drawn Hair.—In order to find an explanation of the behaviour of the hair, some of the drafts were examined by Mr. Duckering and myself by means of a powerful magnifying glass, and compared with similar drafts of untreated hair. In the course of manufacture the latter had been steeped over-night in a solution of soap, carbonate of soda and disinfectant, wet hackled and drawn. It was immediately evident that the hair treated at Bradford was not as clean as that treated at Ripley. In the former, many hairs had small deposits on them, which took the form of cylinders completely surrounding the hair, and Mr. Duckering suggested that these were possibly remnants of blood stains on the hair, which had become hardened during the process of disinfection. In any event, they would account for the behaviour of the hair in drawing.

The conclusion drawn was that probably the observed manufacturing defects were due to inefficient cleansing of the hair, and it was decided to make efficient washing an integral part of the disinfection process.

Third Series of Experiments.

In the first and second series of experiments 8 to 12 tails had been placed in each metal cage, the whole forming a mass which could not be effectively washed, and squeezing through rollers had been omitted. After the second series of experiments, however, a demonstration on a commercial scale had shown the possibility of using continuous machinery by which each tail would be dealt with separately, and also that rollers could be safely used. In the third series, therefore, three tails only were placed in each cage, and these were agitated for 25 minutes in a solution containing 0·5 per cent. of soap and 0·25 per cent. of carbonate of soda. The tails were then passed through rollers and further agitated (in the cages) for 5 minutes in a 0·5 per cent. soap solution, passed through rollers, rinsed in clean water, and again passed through rollers. They were then agitated for 20 minutes in a 2·5 per cent. solution of formaldehyde, passed through rollers, hydro-extracted and dried.

Examination of Treated Hair.—The hair treated in the third series of experiments was immensely improved. Upon opening out the tails they were found to be quite free from dirt and grease. The hair was bright and glossy, free and open, handled crisp and dry, and was perfectly straight.

Manufacture.—The condition of the hair appeared to warrant dispensing with wet hackling and washing, and accordingly a portion was dry hackled exactly as received from Bradford. The result was very satisfactory, the hair passing through the hackles freely without breaking, and indicating that wet hackling was unnecessary.

A second portion was then wet hackled in the usual manner, with quite satisfactory results, but the wet hair did not pass so easily through the hackles as the dry.

A lot of untreated hair was then washed, and wet hackled in the usual way, and, after drying, the three lots, viz. :—

Lot "H" disinfected and dry hackled ;

Lot "G" disinfected and wet hackled ; and

Lot "F" untreated hair washed in my factory and wet hackled,

were compared. All were perfectly clean and glossy, and no difference could be detected in their appearance.

The three lots were then drawn. They behaved quite normally, and comparison of the drafts from the three lots showed no difference which could be detected. Each lot was clean, bright, and quite satisfactory.

It was quite clear from the results of the third series of experiments that the defective behaviour of the hair in the first and second series was due to the fact that no attempt was made to cleanse the hair in the disinfection process. I am quite satisfied that if hair can be treated in bulk and delivered to the manufacturer in the condition of the lot treated in the third series of experiments, wet hackling can be dispensed with.

Bleaching.—The white hair included in the lot treated in the third series of experiments was picked out and bleached. The hair behaved normally, and the result was satisfactory.

(b) Experiments to Test the Possibility of using Machinery for Disinfection.

In these experiments two types of machinery were the subject of experiment, arrangements being made with owners of existing machines to allow the Committee the use of the machines for a few hours. They consisted of automatic mechanism designed for carrying material through solutions, and subsequently drying it. The method followed was to pass hair in tails through a solution of soap and sodium carbonate. The tails of hair were collected as they emerged from the drying part af the machines, and examined.

Machine "A" (Cylinder Machine).—The hair, after treatment in this machine, was clean and greatly improved. The tails were not disturbed, and the hair was not entangled. On return to my factory it was dry hackled with very satisfactory results. It passed freely through the hackles without breaking, and in the drawing process behaved normally.

Machine "B" (Apron Machine).—The hair, after treatment in this machine, was beautifully clean and glossy, and greatly improved in appearance. There was a tendency, however, for the butts and tips to be reversed. Apart from this defect, which would involve re-arrangement of the tails by hand (unless by altering the mechanism it could be prevented), the hair was free. It was dry hackled with satisfactory results, although there was some degree of tangling, and in drawing it behaved quite normally.

Judging solely by the condition of the hair, machine "A" would be quite suitable for disinfection of horsehair. Machine "B" would require modification (if this be possible) before it could be so used.

Basing my opinion on the results of the tests of treated hair carried out in my factory, I have no hesitation in saying that the process of disinfection is quite practicable from a manufacturing point of view.

Ripley Manufacturing Company, Ltd.,
(Signed) J. Williams,
Managing Director.

11. Conclusions and Recommendations.

The investigation has clearly demonstrated that the process devised for disinfection of wool is efficient as a method of disinfection of horsehair, and can be satisfactorily applied to both mane and tail hair without causing manufacturing difficulties. Certain modifications are necessary in the case of tail hair, but these are simply due to manufacturing necessities and not to defects in the process. We are, therefore, unanimous in advising that this process is suitable for adoption as a method for the compulsory disinfection of horsehair.

We have considered whether we should make any further specific recommendations, but we see no reason for modifying the carefully considered proposals contained in Volume II. of the Report of the Departmental Committee on Anthrax which are equally applicable to wool and horsehair.* Questions of detail ought to be dealt with by the authority which the Report recommends should be set up with powers and facilities for enforcing disinfection of wool and hair.

The fact has, however, been brought to our notice that large quantities of drawn hair, *i.e.*, partly manufactured hair, are now imported from China, and further that consignments of shaving brushes made from infected hair are arriving in this country. The preparation of horsehair in China has now become established and the trade in hair partly manufactured in that country is likely to increase at the expense of the raw hair trade. The satisfactory disinfection of such prepared hair and of shaving brushes is impracticable, while the danger to consumers is very great. Two courses only are possible, viz.:—(1) Total prohibition of the import into this country of any manufactured or partly manufactured hair and of goods composed or partly composed of foreign horse or goat hair; or (2) the establishment, in the countries from which such goods are imported, of disinfecting stations under the control of a central authority invested with power to enforce disinfection of the raw hair before manufacture. This is a matter of international concern.

We have no official information of the incidence of anthrax in other countries from the manipulation or use of infected wool or hair or goods manufactured from them. There appear to be no official statistics of such incidence in most countries abroad nor any system of compulsory notification of cases of anthrax among human beings and animals. Materials similar to those which cause anthrax in this country are, however, used in other countries, and it is impossible to believe that the people of this country alone are susceptible to the disease. Indeed we have unofficial but necessarily incomplete information of outbreaks of anthrax among human beings in China, India, Constantinople and elsewhere.

* Report of the Departmental Committee appointed to inquire as to precautions to be taken for prevention of danger from anthrax in the manipulation of wool, goat hair and camel hair. Vol. I., Report of the Disinfection Sub-Committee [Cd. 9057], 1918, Price 1*s.* Vol. II., Report of the Committee [Cd. 9171], 1918, Price 6*d.* Vol. III., Summary of Evidence and Appendices [Cd. 9172], 1918, Price 1*s.* 6*d* Published by H.M. Stationery Office, Imperial House, Kingsway, London.

These are matters outside our reference, but we think it should be recognised that if in any country compulsory notification is not strictly enforced statements that anthrax does not there occur are of doubtful credibility.

We have not gone into the question of the varieties of horsehair which should be compulsorily disinfected or whether any variety should be exempted. These are questions which ought to be dealt with by a central authority. Russian, Chinese, Siberian and Asiatic horsehair generally are, however, certainly dangerous, and we recommend that the proposals contained in Volume II. of the Report of the Departmental Committee on Anthrax should be read as if these varieties of horsehair were included in the terms, "wool and hair" and "materials."

We have the honour to be,
Sir,
Your obedient Servants,

(Signed) WM. MIDDLEBROOK (*Chairman*).
EDWARD H. FOSTER.
WALTER BARBER.
F. W. EURICH.
W. M. JACKSON.
GEO. H. FEATHER.
WM. MACKINDER.
T. M. LEGGE.
J. WILLIAMS.
T. GRUNDY.
ALBERT WEBB.
SAMUEL WALKER.

G. ELMHIRST DUCKERING (*Secretary*).
2nd April, 1921.