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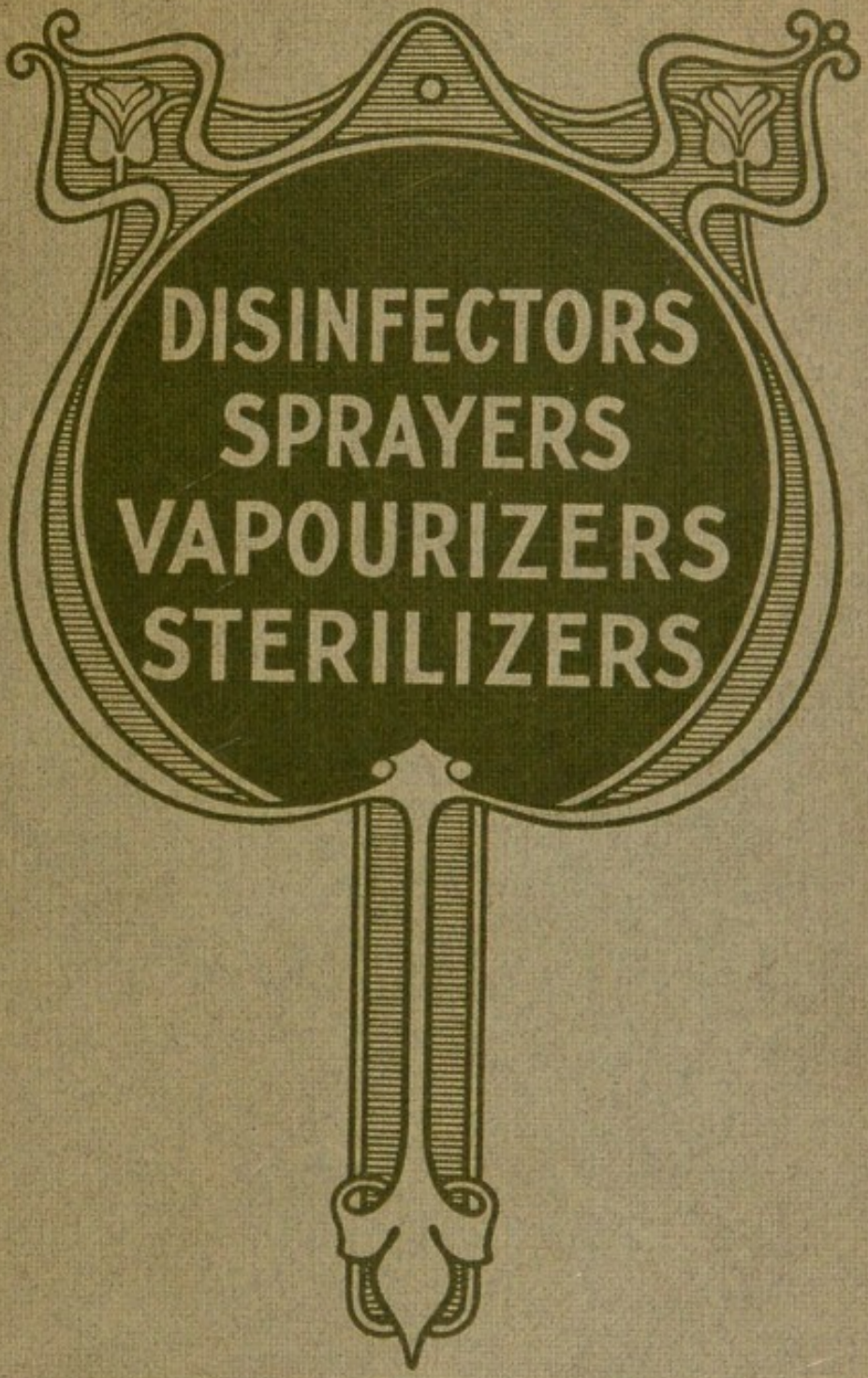
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DISINFECTORS

(Working at Atmospheric, Low, and High Pressures)

SPRAYERS

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The Essentials of Disinfection and Sterilization by Steam

By Professor Sheridan Delépine, M.Sc., M.B., etc.

ALSO

Reports on Disinfectors

By Professor G. Sims-Woodhead, M.A., M.D., etc.

The Thresh Disinfector Co., Ltd.

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AND

Sterilization by Steam

AT HIGH AND LOW PRESSURES

BY

S. Delépine, M.Sc., M.B., etc.

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Director of the Public Health Laboratory,
University of Manchester.

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The Essentials of Disinfection and Sterilization by Steam at High and Low Pressures

BY

S. DELÉPINE, M.Sc., M.B., &c.

INTRODUCTORY REMARKS.

In this article an attempt has been made to explain as simply and briefly as possible the most important facts bearing upon the practice of disinfection by steam. Although much has been written on the subject, there are several aspects of the question which are not generally understood. Detailed accounts of experiments and of the various types of steam disinfectors are not given in this paper. The results of many experiments carried out by the writer are given in the *Transactions of the 7th Congress of Hygiene and Demography* (1891), Vol. II., p. 328, London, 1892, and the *Journal of State Medicine*, 1897 and 1900. The first eleven paragraphs of this paper deal in an elementary fashion with physical facts, a general knowledge of which is needed to understand the following paragraphs. Some very interesting facts relating to heat of vaporisations cannot be dealt with in this statement.

1. Infection, Disinfection, and Sterilization.

An article is said to be INFECTED when it is contaminated with living germs capable of producing disease (pathogenic microbes). The object of DISINFECTION is to cause the death of pathogenic microbes. Articles in common use are almost invariably contaminated with microbes, but most of these are not capable of producing disease. Many of the *non-pathogenic* microbes have, however, the power of giving rise to putrefaction and other kinds of fermentations, and on that account it is frequently desirable to destroy them. Among these non-pathogenic microbes there are some which are much more difficult to kill than the most resistant pathogenic microbes known up to the present day.

The object of STERILIZATION is to cause the death of all kinds of microbes whether they are pathogenic or non-pathogenic.

2. Disinfection or Sterilization by Steam.

Steam, whenever applicable, is the most reliable disinfecting and sterilizing agent. Steam at a temperature not exceeding 126° C. is particularly suitable for the disinfection of bedding, clothing, woollen, cotton, or linen articles (such as blankets, sheets, curtains, carpets); utensils, instruments, morbid products, etc.

Leather, india-rubber, glue, wax, etc., are all more or less seriously damaged by the action of steam, so that articles into the composition of which these materials enter cannot be disinfected by steam without suffering some deterioration.

3. Saturated Steam.

Water heated in an open vessel, at the sea level, and under ordinary atmospheric pressure, boils at a temperature of 100° C. (212° Fah.), and is changed into vapour or steam, which on leaving the water, has also a temperature of 100° C. Under these conditions 1 cubic centimetre of water is changed into about 1,700 cubic centimetres of steam. Steam so generated condenses when it comes in contact with substances (solid, liquid, or gaseous) at any temperature below 100° C. A slight reduction of temperature is sufficient to cause condensation. Steam also condenses when the pressure is slightly increased. On returning to the liquid state steam contracts considerably, about 1,700 cubic centimetres of steam at 100° C. being changed into about 1 cubic centimetre of water at 100° C.

Steam at the temperature at which it has been generated (and which consequently condenses when the temperature is slightly reduced or the pressure slightly increased) is known as SATURATED STEAM.

4. The Effect of Pressure on the Temperature of Saturated Steam.

When water is boiled in a vessel, the outlet of which is guarded by a pressure valve, the steam escapes when it has reached a pressure slightly in excess of the resistance opposed by the valve. When this takes place it is found that the temperature of the boiling water, and of the steam arising from it, is higher than when the water boils at ordinary atmospheric pressure. *After all the air contained originally in the vessel has been expelled*, there is a definite and constant relation between the temperature of the steam and the pressure under which it is generated, as is shown by the following table :—

Boiling Point of Water at Various Pressures (after Regnault).

Above ordinary Atmospheric Pressure. *	Pressure Indicated by Manometer.	Temperature. †	
		Degrees C.	Degrees F.
0 Atmosphere	0.0-lbs. to the sq. in.	100	212
1 ,,	14.7-lbs. ,, ,,	120.6	249
2 Atmospheres	29.4-lbs. ,, ,,	133.9	273
3 ,,	44.1-lbs. ,, ,,	144.0	291
4 ,,	58.8-lbs. ,, ,,	152.2	306
5 ,,	73.6-lbs. ,, ,,	159.2	318
6 ,,	88.3-lbs. ,, ,,	165.3	329

* One atmosphere = 14.7-lbs. to the square inch = 29.9-in. or 760 mm. of mercury.
† The temperatures given in the Fahrenheit scale are approximate.

Saturated steam under pressure, like saturated steam at ordinary atmospheric pressure (sometimes, but incorrectly, called steam at no pressure), condenses when it is slightly cooled, or submitted to at a slight increase of pressure.

5. Boiling Point of Saline Solutions and Temperatures of the Steam generated from them at atmospheric pressure.

The addition of various salts to pure water causes a rise in the temperature at which boiling takes place. This is shown in the following table :—

Boiling Point of Saturated Solutions of some Salts at ordinary atmospheric pressure (after Legrand).

	Degrees C.	Degrees F.
Sodium carbonate	104.6 ..	220
Sodium chloride	108.4 ..	227
Sodium nitrate	121 ..	249.8
Potassium carbonate ..	135 ..	275
Calcium nitrate	151 ..	303.8
Calcium chloride	179.5 ..	355

By adding various salts to water it is therefore possible to cause the temperature of ebullition to rise without increasing the pressure. The steam generated in this way has the same temperature as that of the boiling solution, but on coming in contact with a cold insoluble substance it condenses and the temperature of the water of condensation does not rise above 100° C.* As soon as the temperature of the body upon which the steam has condensed reaches 100° C., the water of condensation is rapidly vaporised, and the vaporisation is accelerated owing to the high temperature of the surrounding steam.

6. Superheated Steam.

If dry steam (see paragraph 11) generated at ordinary atmospheric pressure (and therefore having a temperature of 100° C.) is made to pass sufficiently slowly through a long tube heated to a higher temperature, say 150° C., the temperature of the steam gradually rises, although the pressure remains the same. Wet steam cannot be superheated. When wet steam is heated the suspended water is vaporised, and so long as any water remains unchanged the temperature does not rise above the boiling point ; in other words, " superheated steam cannot endure in the presence of water."

In order to cause the condensation of superheated steam it is necessary to bring its temperature down to the boiling point corresponding to its pressure, or to submit it to a proportionate increase of pressure. On the supposition, for instance, that the temperature had reached 133.9° C., it would be necessary to reduce it by 33.9° C., or to submit the steam to a pressure of more than 29-lbs. 4-ozs. before condensation took place.

A reduction of 1° C. would not cause it to return to the liquid state, and would produce an almost inappreciable reduction of its volume. A similar lowering of temperature of saturated steam would cause it to condense, and at the same time its volume would be reduced to about $\frac{1}{1700}$-part of its original bulk. Superheated steam behaves as a gas, and is a bad conveyor and conductor of heat. Saturated steam is a good conveyor of heat owing to the readiness with which it condenses and gives off its latent heat.

* When the steam condenses upon the surface of a soluble body, some of the body enters into solution, and the temperature is determined by the nature of the solution produced.

7. Latent Heat or Heat of Vaporisation.

When water is heated its temperature increases gradually until the boiling point is reached ; after this the temperature of the boiling fluid remains constant so long as the pressure remains the same. The heat conveyed to the boiling water is used up in causing the water to become vapour. The heat which is thus absorbed is known as latent heat or heat of vaporisation. The amount of heat which becomes latent when water is vaporised may be estimated as follows :—

One part by weight of water heated from 0° C. to 100° C. requires as much heat as would raise 100 parts of water 1° C. ; one part by weight of water at 100° C. converted into steam at 100° C. requires as much heat as would raise 537 parts of water 1° C. (Regnault).

One great calorie is the amount of heat necessary to raise one kilogramme of water through 1° C., the 537 calories that are used in effecting the change of one kilogramme of water into steam become latent heat.

(In British Thermal Units the quantity is given as 965.7 B.T.U., the British Thermal Unit being smaller than the calorie).

When steam condenses again the latent heat of vaporisation is given off, and is communicated to the objects upon which condensation takes place.

8. Convection of Heat and Displacement of Air by Saturated Steam.

Air is a bad conductor and conveyor of heat. Porous objects, which for the present purpose may be said to include objects such as mattresses containing many spaces full of air, are heated very slowly when exposed to the action of hot air or of superheated steam. By means of saturated steam, however, it is easy to heat objects such as mattresses in a very short time.

When saturated steam comes in contact with the surface of a cold, " porous " object, it condenses and imparts its latent heat to the superficial parts of that object, and at the same time a considerable displacement of air is produced by the shrinking which takes place when the steam condenses ; this allows the steam to penetrate further and to condense upon deeper layers. This double process goes on until the central parts of the object have reached the temperature of the steam owing to the replacement of air by steam.

9. Current Steam and Confined Steam.

Whether steam is generated at high or low pressure, it may be produced so slowly that very little of it escapes from the boiler, or so rapidly that a more or less powerful current of steam is produced in the vessel. When such a current is produced the steam is called current steam. When steam is generated in a boiler, the outlet of which is guarded by a pressure valve through which very little steam is allowed to escape, the steam is said to be confined.

Displacement of air and penetration of heat are more rapid when an abundant supply of steam is available than when the supply is limited. When steam is confined in a chamber, from which the air has not been removed by special means, the air escapes very slowly, and the chamber remains filled with a mixture of air and steam for a considerable time.

10. Displacement of Air by Relaxation of Steam or by Production of a Partial Vacuum.

Those who advocate the use of confined steam rely upon auxiliary means to secure the removal of air and the penetration of steam. One of the simplest methods is to allow the steam to reach the desired pressure, and then to open an outlet valve so as to let the steam escape freely until the pressure has fallen to 0-lbs. The valve is then closed and the pressure allowed to rise again. This process is generally repeated three times when objects of a moderate bulk are disinfected, and more often when very bulky articles are dealt with.

Another way of removing the air is by producing a partial vacuum in the steam chamber by means of an air pump or an ejector. It is obviously impossible to remove all the air by this method. When the doors and valves of the disinfector are well made and carefully closed, a vacuum equal to 40 c/m. (15-in. or 16-in.) of mercury (sometimes more, but generally less) may be realised in a moderately short time.

11. Dry and Wet Steam.

When water boils briskly, the bursting of steam bubbles, and the general agitation of the surface of the fluid cause minute drops of water to rise above the surface and to mix with the steam. Steam mixed with unvaporised water is said to be wet or misty. The steam also becomes misty when suddenly cooled.

The droplets of water suspended in the steam may be removed by means of suitable baffles; they also disappear when the steam is passed over hot surfaces. Steam free from suspended water is called dry steam. Superheated steam is always dry (see paragraph 6); saturated steam may be dry or wet. Articles which have been exposed to wet steam are dried with more difficulty than those that have been exposed to dry steam.

12. Resistance of Bacteria to Heat.

The resistance of bacteria to heat is considerably influenced by several conditions, the most important of which are the following:—

1. The presence or absence of spores.
2. The amount of moisture.
3. The nature and amount of associated material, such as blood, sputum, fæces, soil, etc.
4. The nature and amount of material intervening between the bacteria and the source of heat.
5. The temperature.

13. Influence of the presence of Spores.

Sporeless bacteria, not protected by organic media, are, generally speaking, very rapidly killed by an exposure to any temperature exceeding 70° C. or 80° C. They are killed almost instantaneously by steam at 100° C.

Spores are not rapidly killed at temperatures below 100° C., and some spores may resist such a temperature for many hours (see paragraphs 14 and 17).

14. Influence of Moisture.

Some non-sporing bacteria (not killed by simple drying) may, when quite dry and exposed to hot dry air, resist a temperature of 100° C. for over one hour, but when moist and exposed to the action of steam at 100° C., they are almost instantaneously killed.

Spores when quite dry usually resist the effects of heating by hot air for many hours; dry spores of moulds generally resist heating to 110° C. to 115° C. for over one hour; the most resistant spores of bacteria are killed in three hours by hot, dry air at 140° C. The spores are much more rapidly affected when they are exposed to hot, moist air or to steam.

The following experiments made with dry spores of the bacillus anthracis, which offer only a moderate resistance to heat, indicate the influence of moisture:—

Unprotected dry spores exposed to hot, dry air at 100° C., were invariably killed only after eight hours' exposure.

Unprotected dry spores exposed to damp air at 100° C. were killed only after five hours' exposure.

Unprotected dry spores exposed to air, saturated with water vapour at 100° C., were killed after a half-hour's exposure.

Unprotected dry spores exposed to saturated current steam at 100° C. were killed after 35 seconds' exposure.

These experiments not only show the influence of moisture, but also the difference between saturated steam and mixtures of steam and air.

15. The Influence of the Associated Material.

In articles requiring disinfection, bacteria or their spores are almost invariably associated with some morbid products, dejecta, or other materials by which they are more or less completely surrounded. These products protect the bacteria against the access of heat, and thereby delay disinfection. A single example will suffice to indicate the delay which may be produced in this way. A sample of horse manure was found by the writer to require for sterilization from 5½ to 8 hours' exposure to current saturated steam at 100.5° C. This great resistance was found to be due to the presence of a sporing bacillus (*B. Mesentericus*). The spores of this bacillus, freed from the associated material (*i.e.*, bare), when exposed to current saturated steam at 100.5° C., under exactly the same conditions as the manure had been, were found to be invariably killed in 2½ hours, *i.e.*, in less than half the time necessary to sterilize the manure.

16. Influence of Material Intervening between the Bacteria and the Source of Heat—"Penetration of Heat."

Various articles liable to contamination by products containing bacteria interfere more or less (according to their bulk, structure, and composition) with the transmission of heat. Articles like blankets or mattresses, which have a felt-like structure and imprison in their meshes a considerable amount of air, are very bad conductors, and interfere considerably with the convection of heat. A layer a few inches thick of such materials may prevent the transmission of heat for a considerable time.

This is clearly shown by the following well-known experiment. A roll of blanket was placed in a hot-air oven in which the temperature of the dry air ranged between 118° C. (245° F.) and 124° C. (255° F.). After eight hours' exposure the following temperatures were observed at various depths of the blanket roll:—

Under 2 layers	110° C. (230° F.)
,, 4 ,, ...	105° C. (221° F.)
,, 6 ,, ...	101° C. (215° F.)
,, 12 ,, ...	91° C. (196° F.)

(After Whitelegge).

It is in connection with the convection of heat through bulky articles of this kind that the advantages of current saturated steam are so obvious. The central parts of a 16-layer roll of blanket exposed to current saturated steam at 100° C., or above, would be reached by the steam in less than six minutes. An explanation of this rapid penetration of steam has previously been given (see paragraph 8).

17. Influence of the Temperature (and Pressure) of Saturated Steam.

Of all the bacteria known at present those found in certain samples of soil and of manure are, when in the sporing stage, among the most resistant to heat. From a number of observations made by the writer, and by several other observers, it may be generally stated that these very highly-resistant spores when dry and quite unprotected by associated matter may be killed under the following conditions :—

By saturated steam at—		
100° C. (about 212° F.)	——	In from 2½ hrs. to 16 hrs.
115° C. (,, 240° F.)	10-lbs. pressure.	,, 15 min. to 30 min.
120° C. (,, 249° F.)	14-lbs. ,,	,, 10 min. to 20 min.
126° C. (,, 258° F.)	20-lbs. ,,	,, 5 min. to 15 min.

The figures given in this table are only approximate, the minimum times of exposure relate to the most resistant spores that have come under the notice of most observers. The maximum times include exceptional results recorded by two observers (Globig & Christen). It is possible that in those cases the spores were protected. In ordinary cases complete sterilization of bare spores would be obtained in less than the minimum times given in the table.

18. Practical Disinfection and Sterilization.

From the data given in the preceding paragraphs it is possible to deduce the conditions which have to be fulfilled in order to ensure the disinfection or sterilization of infected articles.

Firstly.—Dry saturated steam must be admitted to the disinfecting chamber.

Secondly.—Time must be allowed for the complete expulsion of air from the central parts of the most bulky objects.

Thirdly.—Time must then be allowed for the steam to act upon the microbes which have to be destroyed.

Fourthly.—The disinfected articles must be dried so as to be fit for use with as little delay as possible.

Fifthly.—The disinfection process must not produce a material deterioration or discolouration of the articles submitted to it.

In discussing these points, reference will be made to current steam disinfectors only. When confined steam is used, arrangements must be made for the complete expulsion of air, and time must be allowed for the working of various devices. It would be inconvenient to introduce details of this kind in a general statement (see paragraph 10).

1ST.—The time necessary to heat and fill the disinfector with dry saturated steam at the desired temperature depends on the method of heating and on the size and weight of the disinfector. On the supposition that the disinfector and its contents are cold at the beginning, and that the weight of the load is about 100-lbs., the time required to fill the disinfecting chamber with steam* at 100° C. will vary (according to the machine used) between 20 minutes and 1½ to 2 hours. Disinfectors of usual size would require at least 30 minutes.

2ND.—For the penetration of current saturated steam free from air through 8-in. to 10-in. of mattress or blanket, 10 to 15 minutes should be allowed; this time may be reduced when current steam under a pressure of 10-lbs. to 20-lbs. is used, provided always that some space is left between the articles.

When confined steam is used, penetration takes place very slowly, unless air has previously been expelled by means of current steam, or one of the auxiliary methods already described (paragraph 10) are employed. It is obvious that by using current steam only, the operations are simplified and quickened, and that chances of errors are avoided.

3RD.—*A*.—With current steam at ordinary atmospheric pressure, 5 to 15 minutes exposure is required to disinfect products containing pathogenic bacteria of a resistance not exceeding that of the spores of the bacillus anthracis (the variations in the time are due to variations in the amount and kind of associated material). But if it is desired to secure complete sterilization of products containing resistant spores of earth bacilli, at least 2½ hours' exposure should be allowed (and sometimes more than 8 hours would be required). The times necessary for ordinary disinfection and for complete sterilization, respectively, would therefore be as follows:—

Operation with Current Saturated Steam at 100° C.	Time taken for	
	Disinfection.	Sterilization.
For heating and filling disinfector with steam at 100° C.	30′ to 90′	30′ to 90′
For penetration of bulky articles such as large mattresses	10′ to 15′	10′ to 15′
For actual disinfection..	5′ to 15′	150′ to 480′
Total time required from the beginning to the end of the operations, *the disinfector being cold at the beginning*	45′ to 120′	190′ to 585′

Therefore the time necessary for ordinary disinfection would vary from three-quarters of an hour to two hours, and for sterilization from three hours to over nine hours.

The times given in the above Table include that necessary to heat the machine.

In actual practice, the time required for penetration and disinfection is about 15 to 30 minutes. With regard to sterilization, the times given in the above table would, in the great majority of cases, be excessive, as the most resistant spores are seldom present in articles which have to be disinfected.

* Steam free from air.

B.—With current steam at 10-lbs. pressure (115° C.) the time necessary for ordinary disinfection would be reduced by a few minutes only, but complete sterilization would be effected much more rapidly than with steam at 100° C. The earth bacilli spores would be killed in from 15 to 30 minutes by steam at 115° C., so that the duration of the whole process of sterilization would take from 55 to 145 minutes (or by deducting the preliminary period of heating, 25 to 55 minutes).

C.—With current steam at 20-lbs. pressure (126° C.) the time necessary to obtain complete sterilization would be from 45 minutes to 130 minutes (or by deducting the preliminary heating period, 15 minutes to 40 minutes). From this it is obvious, that, when complete sterilization is required, current steam under pressure offers considerable advantages. With a disinfector that can be rapidly heated, complete sterilization can be obtained at 20-lbs. pressure in the same time as simple disinfection (not securing complete sterilization) can be obtained with steam at atmospheric pressure. Even with current steam at 10-lbs. pressure only 10 minutes more is required to secure complete sterilization, instead of simple disinfection.

4TH.—With regard to drying, it is obtained rapidly in machines provided with an efficient vacuum apparatus, but when dry steam is used and undue condensation is prevented, equally good results can be obtained by causing a current of hot air to circulate through the disinfector chamber, at the end of the disinfection proper. Thin articles, such as clothing, sheets, and blankets, can be dried in less than half-an-hour by removing them from the disinfecting chamber immediately after disinfection whilst they are quite hot, and spreading them quickly in a dry shed. Articles that have been exposed to dry steam at a temperature above 100° C. dry quicker than those that have been treated by steam at 100° C.

5TH.—Articles can be exposed to dry saturated steam at a temperature not exceeding 126° C., and afterwards dried in air at a temperature under 120° C. without being materially damaged, provided they are not left in the hot, dry air longer than is absolutely necessary to remove the excess of moisture. (*Dry* woollen goods, such as blankets, flannels, etc., exposed to *dry*, hot air, the temperature of which exceeds 110° C., assume a yellowish colour after a time). A slight amount of shrinking and discolouration of woollen goods are produced by the action of the steam, and this effect is more marked with steam at high pressure than with steam at low pressure, but the quality of the goods is not materially affected by steam under pressures not exceeding 20-lbs. Flannel, and woollen blankets, are generally more altered by ordinary washing than by steam disinfection. Wetting during sterilization is a frequent source of damage, but this does not occur in well-constructed machines.

19. Advantages and Disadvantages of Low and High-Pressure Current Steam Disinfectors.

For the sake of convenience, disinfectors working at a pressure not exceeding 5-lbs. may be called *low-pressure disinfectors*, but it must be understood that the definition is quite arbitrary. *The advantages claimed for low-pressure disinfectors*, when they are properly designed, are that :—

1.—They are generally sufficient for practical purposes, and destroy all known pathogenic germs in from 15 to 30 minutes, according to the bulk of the material and the way in which it is packed.

2.—They supply steam, which, when wetting is successfully avoided, produces less alteration of the goods than steam at higher temperature.

3.—They allow a simpler construction to be adopted, may be made of lighter material, and, therefore, should be less costly.

4.—Their lightness makes them specially suitable when portable disinfectors are needed.

Their Disadvantages are that:—

1.—As all pathogenic microbes are not yet known, it may be argued that there is a possibility some dangerous microbes may escape disinfection by steam at low pressure; this is not possible when steam at 10-lbs. to 20-lbs. pressure is used.

2.—Disinfection by steam at low pressure is slower than disinfection by steam at high pressure.

3.—Steam at low pressure penetrates bulky articles somewhat more slowly than does steam at high pressure, when the quantity of steam used is the same.

4.—Articles which have been submitted to dry steam at a temperature above 100° C. dry more quickly than articles which have been treated by steam at 100° C.

The advantages and disadvantages of high-pressure disinfectors are sufficiently indicated by the above statements.

Finally, high-pressure current steam is certainly preferable to a high-pressure confined steam.

20. Advantages of Current Steam over Confined Steam.

It has been shown (paragraph 16) that the presence of air prevents the rapid penetration of steam and convection of heat to the centre of articles contained in disinfecting chamber.

Air escapes so slowly from a chamber in which steam is confined that the constructors of the older forms of disinfectors have been compelled to resort to various devices in order to secure the expulsion of air within a reasonable time (paragraph 10).

On the contrary, when a rapid current of steam is used, air is removed automatically, as the writer has shown by many experiments recorded in his previous papers.

In a properly constructed current steam disinfector large outlets are always provided to allow a free escape of steam at whatever pressure the steam is used.

The current steam disinfectors offer, therefore, several advantages over the confined steam disinfector:—

1.—They are simpler in construction.

2.—They are easier to work, the removal of air being automatic.

3.—They are free from the dangers associated with the confinement of steam.

General Conclusions.

It would appear therefore that, whenever both methods are available, it is sometimes preferable to use low pressure, though generally advantageous to use high-pressure current steam.

When cost or weight make the use of high-pressure disinfectors undesirable, a light low-pressure disinfector of simple construction is indicated.

When neither cost nor weight is prohibitive it is safer to use a high-pressure current steam disinfector.

APPENDIX.

I have previously described a number of experiments devised for the purpose of studying the rate of displacement of air by steam, but have not published any account of the methods adopted to observe the rate of penetration of steam, hot air, or mixtures of air and steam, into masses of hair, cotton, feathers, or other materials in common use, which always enclose air spaces of various sizes, interfering with the rapid transmission of heat.

In experiments upon disinfection the common practice has been to use mattresses, pillows, or rolls of blankets, for the purpose of estimating the rate of penetration. It is, however, impossible to obtain comparable results by these rough methods.

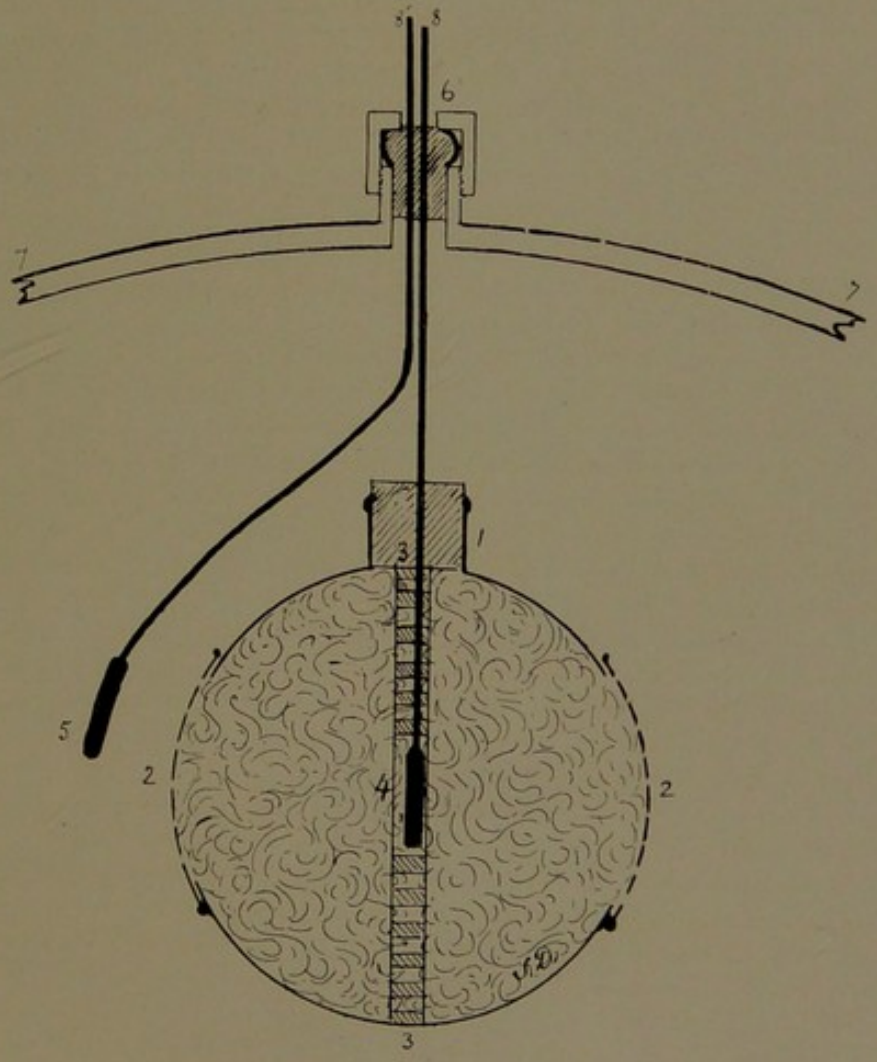


Fig. 1. Endothermometer.

To obtain comparable results an apparatus was constructed (Fig. 1), which I will call an Endothermometer or covered bulb thermometer. This apparatus consists of a copper sphere with three openings. One of these openings is provided with a short neck (1) through which the thermometer is introduced, the stem of the instrument being fixed

by a cork. The two other openings are large, symmetrical, and diametrically opposite to each other (2). These large openings are guarded by two perforated lids which, when closed, complete the sphere. The sphere is divided into two equal halves by a perforated wooden diaphragm (3), in which a channel is provided to allow the bulb (4) of the thermometer to be placed centrally in the sphere. The diagram (Fig. 1) shows how the thermometer is fixed. In the wall (7–7) of the steam chamber an opening is provided for the passage of the stem of the thermometer; the opening is closed by means of a suitable screw cap (6) and indiarubber plug. The stem of another thermometer passes through the same opening, and the bulb of that second thermometer penetrates into the steam chamber to the same depth as the bulb of the endothermometer; it is brought close to one of the perforated doors through which the steam penetrates into the sphere. This second bulb remains bare, and takes the temperature of the steam or air outside the sphere. The thermometer bulbs and stems represented in the diagram are parts of two Richard thermographs. By means of these well-constructed instruments it is possible to obtain fairly accurate continuous records of temperatures and to compare the temperature of the bare with that of the covered bulb at very short intervals. Certain errors are attached to these records, but they do not interfere very materially with the usefulness of the curves.

I will suppose now that one wishes to ascertain the time required for current saturated steam at 100° C. to penetrate to the centre of a flock mattress 10 inches thick exposed in a disinfecting chamber. The weight and volume of the mattress are ascertained, and the amount of flock which a sphere 10 inches in diameter should contain (in order that the density of the flock in the sphere should correspond to that of the flock in the mattress) is calculated. (In one instance I found that 1½-lbs. of flock had to be packed in the sphere in order to obtain this result.) One half of the material is packed carefully into one half of the sphere, and the remaining half of the material is then packed into the other half of the sphere. The material must be distributed as evenly as possible. The doors of the sphere are then fastened. The bulb of the endothermometer is now in the centre of a spherical mass of flock packed very much in the same way as it would be in the mattress. The steam chamber is then closed, steam is admitted to it, and the thermometers are watched. The curves reproduced on Fig. 2 show the results obtained in a large disinfecting chamber 6-ft. long and nearly 4-ft. in diameter. The chamber was in the first instance warmed by hot air, then an abundant current of saturated dry steam at ordinary atmospheric pressure, or slightly above it, was allowed to pass through the chamber until the temperature indicated by the bare bulb and the covered bulb were nearly the same; after this the pressure of the steam was caused to rise; finally the steam supply was cut off and a little later the steam in the chamber allowed to escape freely. These various stages are shown in the chart, a vertical line indicating the beginning of each stage (Fig. 2).

The continuous black line shows the temperature recorded by the thermometer freely exposed in the steam chamber, the dotted line gives the temperature in the centre of the 10 inches sphere of flock, as recorded by the endothermometer. The lower curve gives the steam pressure. The space between the lower curve and the abscissa is painted black. The space between the 100° C. line and the tempera-

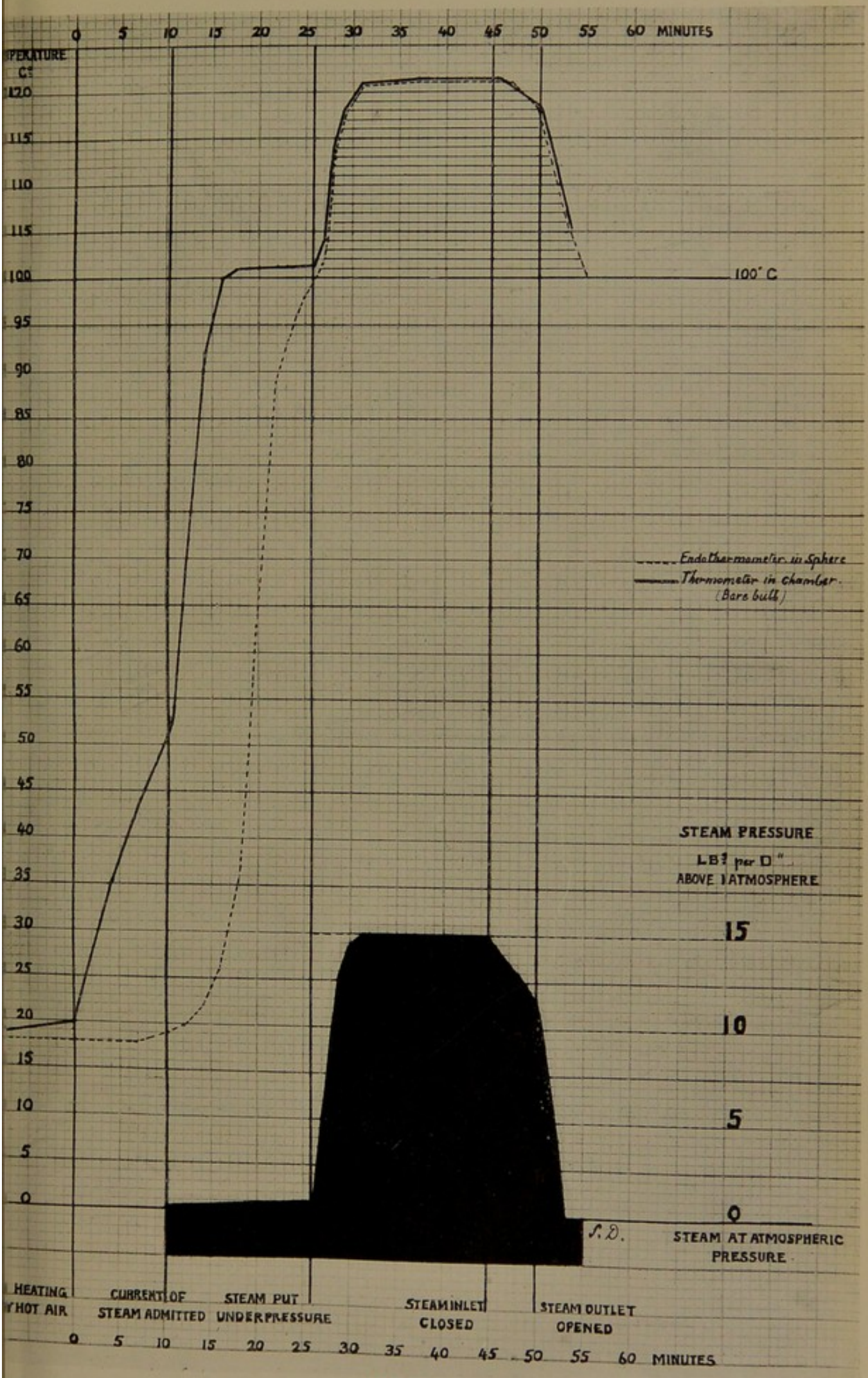

0 5 10 15 20 25 30 35 40 45 50 55 60 MINUTES
PERATURE
C°
120
115
110
115
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
100° C
Endothermometer in Sphere
Thermometer in chamber.
(Bare bulb)
STEAM PRESSURE
LB? per D"
ABOVE ATMOSPHERE
15
10
5
0
S. D.
STEAM AT ATMOSPHERIC
PRESSURE
HEATING
HOT AIR
CURRENT OF
STEAM ADMITTED
STEAM PUT
UNDER PRESSURE
STEAM INLET
CLOSED
STEAM OUTLET
OPENED
0 5 10 15 20 25 30 35 40 45 50 55 60 MINUTES

Fig. 2.

ture curves above it is also shaded to show at a glance the relations between the temperature and the pressure of steam in the course of the experiment. The curves show that:

1. When the chamber was heated by hot air the temperature outside the sphere rose from 20 to 53° C. in 11 minutes; during the same period the endothermometer recorded a rise of 1° C. only. In another experiment I continued heating by hot air for one hour and at the end of that time the bare bulb thermometer recorded a temperature of slightly under 90° C., the covered bulb thermometer indicated a temperature of 58° C. only.

2. As soon as current saturated steam was allowed to pass freely through the chamber, the temperature rose very rapidly; in five minutes the bare bulb showed a rise from 53° C. to 100° C. The covered bulb was not materially affected for about five or six minutes, but after that period the temperature rose very rapidly so that the centre of the flock in the sphere had reached 100° C. about eight minutes and a half after that temperature had been recorded by the bare bulb thermometer. By other experiments I have shown that when the endothermometer placed under the same conditions indicates a temperature of 100° C. practically all the air which was present originally in the fibrous material has been expelled.

3. When saturated steam has reached the centre of the material contained in the sphere, any change in the temperature of the steam outside the sphere is immediately followed by equal change of temperature in the centre of the sphere. This shows that the steam circulates as freely through the fibrous material deprived of air as in the chamber itself.

When instead of the chamber being filled with a current of saturated steam, it is occupied by a mixture of steam and air or by superheated steam, the penetration of steam and heat is much slower.

REPORT

UPON

The New Type "Thresh" Current Steam Disinfector.

(WORKING AT LOW PRESSURE)

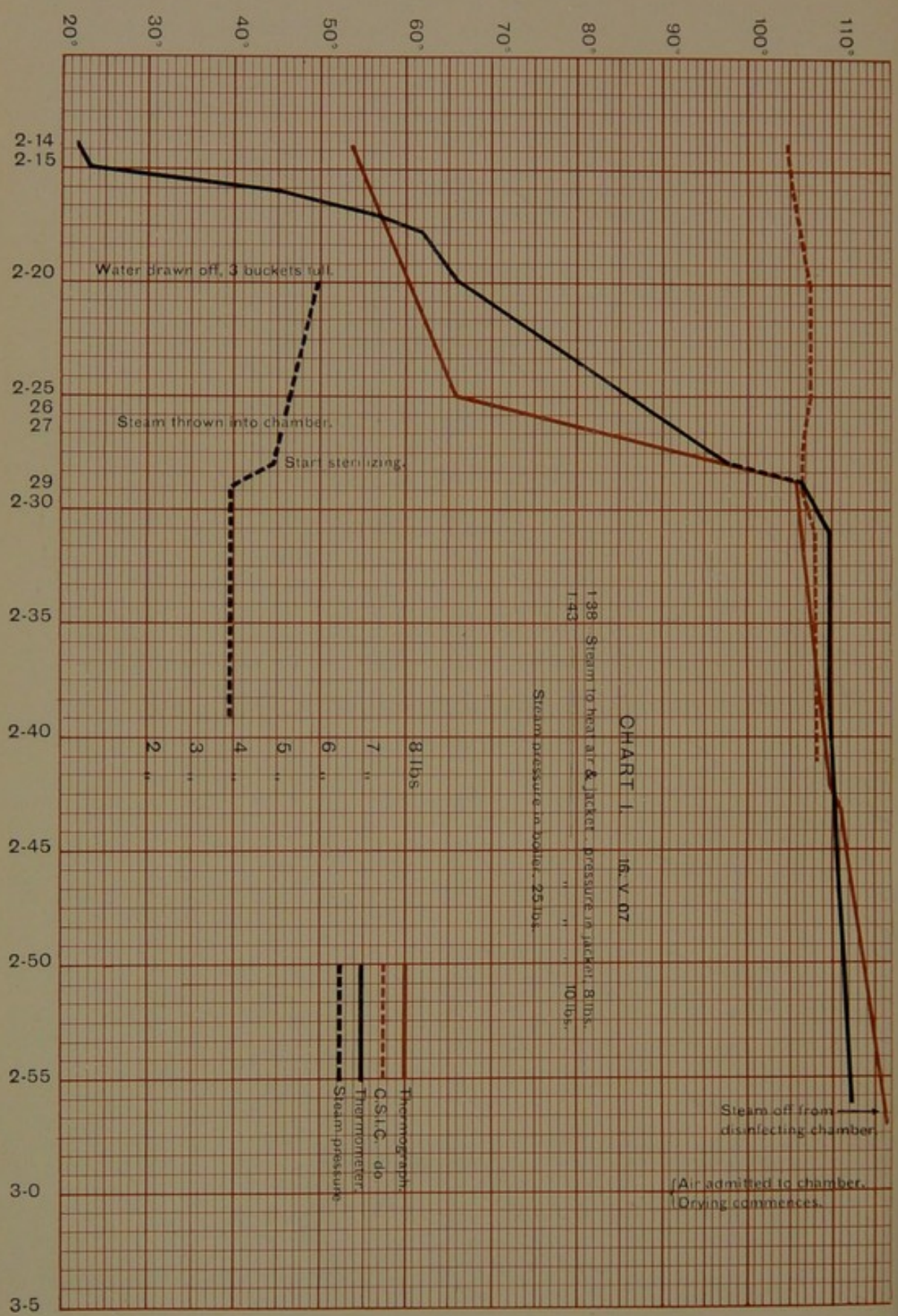
BY

Professor G. Sims-Woodhead, M.A., M.D., etc.

The Thresh Disinfector Co., Ltd.

BROOK HOUSE, 10–12, WALBROOK

LONDON, E. C.


20°
30°
40°
50°
60°
70°
80°
90°
100°
110°
2-14
2-15
2-20
2-25
26
27
29
2-30
2-35
2-40
2-45
2-50
2-55
3-0
3-5
Water drawn off, 3 buckets full.
Steam thrown into chamber.
Start sterilizing.
CHART I. 16. V. 07
1·38 Steam to heat air & jacket, pressure in jacket 8 lbs.
1·43 " " 10 lbs.
Steam pressure in boiler 25 lbs.
2 lbs.
3 "
4 "
5 "
6 "
7 "
8 lbs.
Thermograph.
C.S.I.C. do
Thermometer.
Steam pressure.
Steam off from disinfecting chamber.
Air admitted to chamber.
Drying commences.

Pathological Laboratory,
Cambridge.

Thresh's Disinfector.

I was asked to determine whether satisfactory results could be obtained with this Disinfector as now modified, to work with steam obtained from a high-pressure steam boiler (the pressure being lowered by a reducing valve), or where a boiler is not available, with low-pressure steam generated by a furnace.

Experiment No. 1.

Chart I. and Tables I. and II.

In carrying out these sterilization experiments the following method was adopted. Three organisms or sets of organisms were used :—(1) the spores of a series of active, vigorously-growing cultures of anthrax bacilli ; (2) a vigorous culture of a pus-producing micrococcus—the staphylococcus pyogenes aureus, and (3) a culture of a disease-producing bacillus—the bacillus diphtheriæ. In each case sterile silk threads were soaked in the emulsion and were then carefully dried in petri dishes and transferred singly to very small sterile test-tubes plugged with sterile cotton wadding. In order that no mistake might be made, a different coloured thread was used to receive each organism. Before these threads were placed in the middle of the flock bed, pillows, and blankets, each was placed in a separate bit of sterile paper and wrapped up as a chemist wraps up a powder. The papers containing the several kinds of organisms were then enclosed in an envelope, this envelope in turn being placed in the centre of the article to be sterilized. The threads could be easily "fished out," even from a flock bed, if around the envelope a piece of string—the other end of which was attached to the bed tick where the slit is made for the reception of the envelope—was tied. The organisms in these threads within the envelopes were, of course, exposed to heat during both the processes—that of steaming and that of drying.

The steam pressure in the boiler was 30-lbs. at the outset of the experiment and gradually fell to 25-lbs. It was reduced by means of a reducing valve first down to 12-lbs., and then to 8-lbs., the pressure in the "jacket" being regulated to 4-lbs. by a dead-weight safety valve. The heating of the machine was commenced at 1.40, and took about 40 minutes (the record on the Chart does not begin until 2.14) ; at the end of this process, three bucketfuls of condensed water were withdrawn (2.20 p.m.). At 2.27 p.m. the bedding, etc., with contained organisms and spores, was placed in the chamber and steam was admitted. Within two minutes the temperature had risen to 106° C., and in four minutes to 109° C. This, or a somewhat higher (see Chart I.) temperature was maintained for 26 minutes when the steam was turned off from the disinfecting chamber. Four minutes later air was turned through, and at the end of 48 minutes the bedding was taken out. For loss of weight see Table I.

Table I.

Loss of weight by articles sterilized in "Thresh's Disinfector."

Experiment 1.

	Minutes Steamed.	Minutes Dried	Before Experiment.	At the end of Experiment.	Loss of Weight.
			lbs. ozs.	lbs. ozs.	
Blankets ..	30	20	4 10	4 10	Neither loss nor gain.
Bolster	30	20	5 9	5 9	,, ,, ,,
Bed	30	20	32 14	32 12	2-ozs.
Pillow	30	20	3 3	3 3	Neither loss nor gain.
Total			46 4	46 2	2-ozs.

All the micro-organisms were killed. See Table II.

Table II.

Sterilization experiment with "Thresh's Disinfector."

Experiment 1.

	Minutes Steamed	Minutes Dried	Anthrax Spores.	Staphylo-coccus Pyogenes Aureus.	Bacillus Diph-theriæ.	
Blankets	30	20	0	0	0	No growth at end of 48 hours.
Pillow	30	20	0	0	0	,, ,,
Flock Bedding ..	30	20	0	0	0	,, ,,
Open Chamber ..	30	20	0	0	0	,, ,,
Control not Exposed	–	–	+	+	+	Growth at end of 24 hours.

+ = Growth. 0 = No Growth = Disinfection.

Experiment No. 2.

See Chart II. and Tables III. and IV.

In the next experiment the boiler pressure of 25-lbs. was reduced by the reducing valve to 12-lbs. before it went into the jacket; the outlet valve from the sterilizing chamber was set to lift at 4-lbs. The bedding, etc., was subjected to the action of the circulating steam for 14 minutes. The steam was then turned off and air was passed through the chamber for 30 minutes for the purpose of drying the bedding, etc. On taking the blankets out of the sterilizer and shaking them they were found to have lost 1-oz. in weight, the bedding to have lost 2-ozs., the bolster 5-ozs., and the pillow 2-ozs. See Table III.

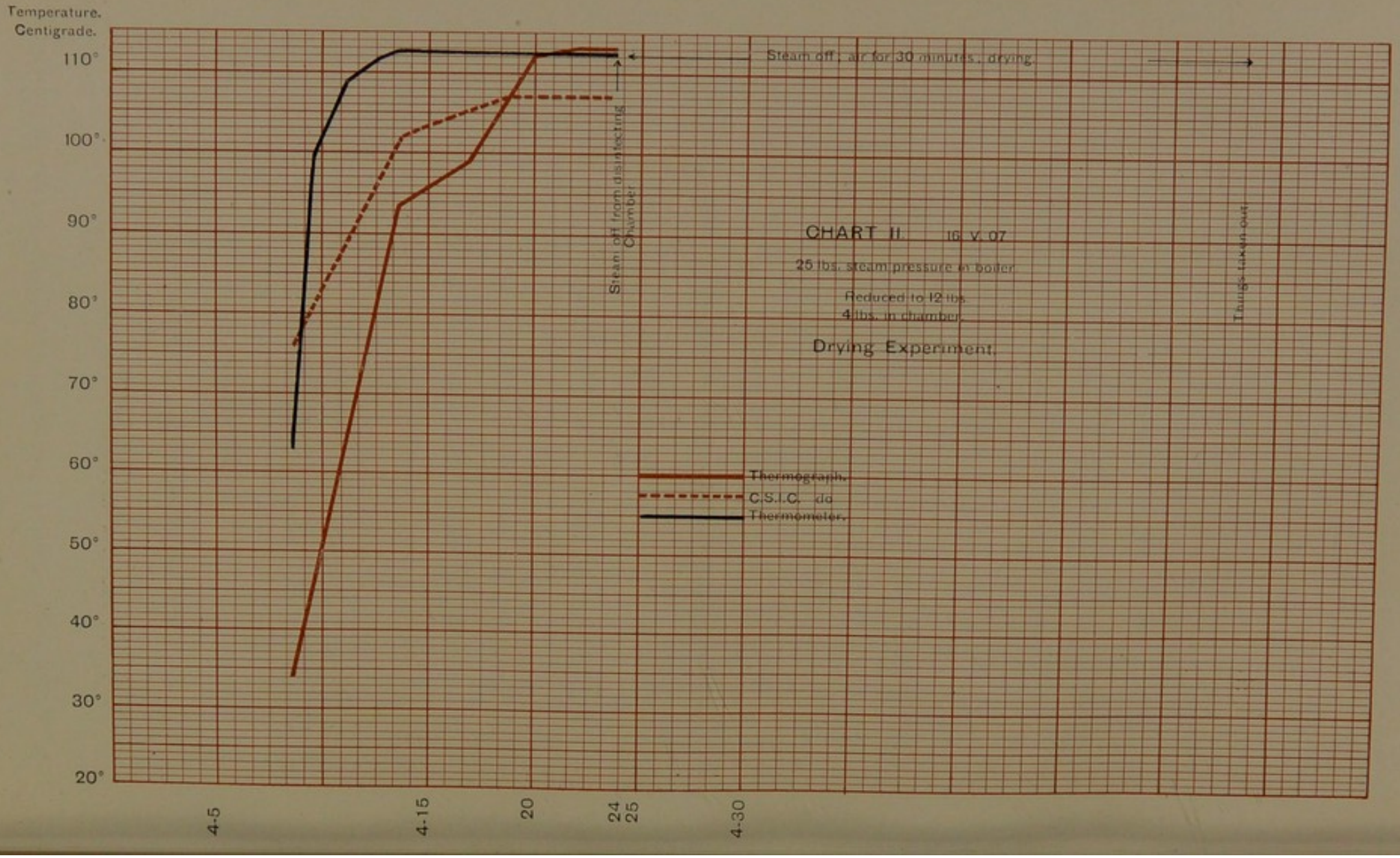

Temperature.
Centigrade.
110°
100°
90°
80°
70°
60°
50°
40°
30°
20°
Steam off; air for 30 minutes; drying.
Steam off from disinfecting Chamber.
Things taken out
CHART II 16. V. 07
25 lbs. steam pressure in boiler
Reduced to 12 lbs.
4 lbs. in chamber.
Drying Experiment.
Thermograph.
C.S.I.C. do
Thermometer.
4-5
4-15
20
24
25
4-30

Table III.

Loss of weight in "Thresh's Disinfector."

Experiment 2.

	Minutes Steamed.	Minutes Dried.	Before Experiment.	At end of Experiment.	Loss of Weight.
			lbs. ozs.	lbs. ozs.	ozs.
Blankets, 32 plies	14	30	4 8	4 7	1
Bolster	14	30	5 9	5 4	5
Pillow	14	30	3 2	3 0	2
Bedding	14	30	32 12	32 10	2
Total			45 15	45 5	10

All the organisms had succumbed. See Table IV.

Table IV.

Sterilization Experiments with "Thresh's Disinfector."

Experiment 2.

	Minutes Steamed.	Minutes Dried.	Anthrax Spores.	Staphylococcus Pyogenes Aureus.	Bacillus Diphtheriæ.	
Blankets	14	30	0	0	0	No growth at end of 48 hours.
Pillow	14	30	0	0	0	,, ,,
Flock Bed	14	30	0	0	0	, ,,
Open Chamber ..	14	30	0	0	0	,, ,,
Control not Exposed			+	+	+	Growth at end of 24 hours.

+ = Growth. 0 = No Growth = Disinfection.

The data concerning the results of treatment in the Disinfector is set out in the individual tables. As regards the drying, the loss of weight may safely be said to be the best indication of the loss of moisture. From the Tables in which the loss of weight of each individual article is given, and also the total loss of weight of the whole of the articles, it is evident that in spite of the fact that condensation must have taken place at the early part of the sterilizing process and also when air was admitted, we are, during the greater part of the experiment, working with saturated steam, and in the last part of the process with partially saturated hot air which carries off a large amount of moisture and in many cases leaves the bedding, etc., drier than when it was put into the Disinfector.

Experiment No. 3.

See Chart III. and Table V.

In the second experiment the live steam had been allowed to act for 14 minutes only, and an additional organism somewhat more resistant than any of those mentioned in the Chart—spores from organisms found in earth—were not killed, and as in an experiment carried out in another sterilizing apparatus, the spores of the anthrax bacilli used had resisted somewhat longer than this earth organism. I thought it well to repeat the first experiment, using the same resistant anthrax spores and certain other spores still more resistant. As the drying had been satisfactory, the drying experiment was not repeated. The organisms were introduced in the usual way into a 32-ply blanket weighing 4-lbs. 8½-ozs. and bedding weighing 46-lbs. 5-ozs., made into a roll about 5-ft. 7 in. in circumference. The steam pressure in the boiler was 27-lbs., when it was turned into the jacket, the temperature in the disinfecting chamber being 19.5° C. In five minutes the steam was turned into the chamber, and in a single minute the temperature had risen to 60° C., the pressure in the jacket had fallen to 4-lbs., the pressure in the chamber being at zero. In another minute the temperature had risen to 100° C., the pressure in the jacket had now fallen to zero and the pressure in the chamber had risen to 4¾-lbs.; the steam pressure in the boiler was also falling somewhat rapidly, though it never fell below 10-lbs. during the whole of the experiment. After this steam was passed through the chamber for half-an-hour, the pressure in the chamber being kept at about 3-lbs. and the temperature remaining during the experiment between 101° C. and 103° C. After partially drying by blowing out the steam and passing heated air through the disinfecting chamber for 10 minutes, the articles were removed and the organisms taken out for further examination. The results are given in Table V.

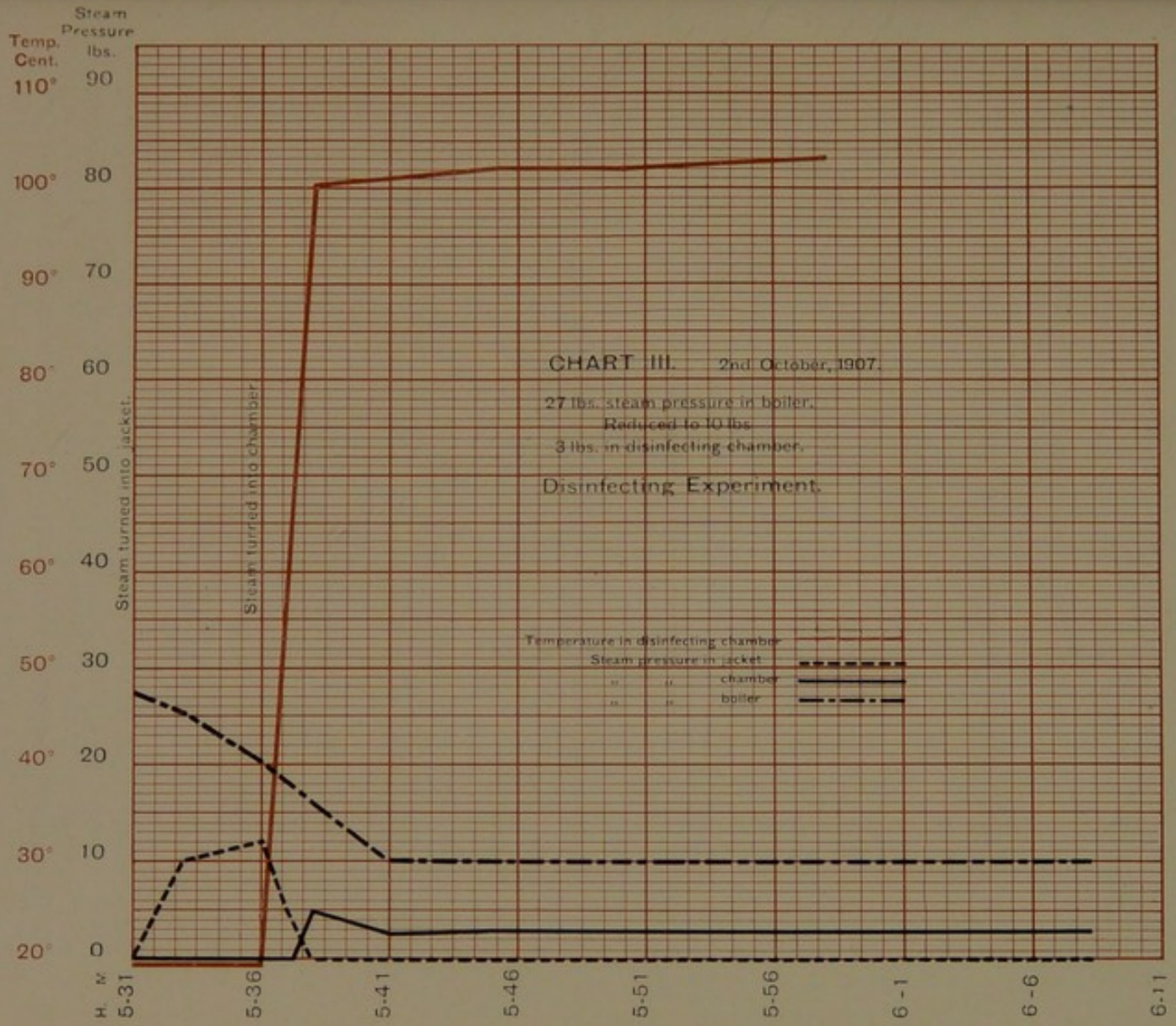
Table V.

Sterilization Experiment with "Thresh's Disinfector."

Experiment 3.

	Minutes Steamed.	Minutes Dried.	Anthrax Spores.	Staphylococcus Pyogenes Aureus.	Bacillus Diphtheriæ.	
Bedding	30	10	0	0	0	No growth at end of 48 hours.
Blankets	30	10	0	0	0	" "
Open Chamber ..	30	10	0	0	0	" "
Control not Exposed	–	–	+	+	+	Growth at end of 24 hours

+ = Growth. 0 = No Growth = Disinfection.


Temp. Cent.
Steam Pressure lbs.
110° 90
100° 80
90° 70
80° 60
70° 50
60° 40
50° 30
40° 20
30° 10
20° 0
Steam turned into jacket.
Steam turned into chamber
CHART III. 2nd October, 1907.
27 lbs. steam pressure in boiler.
Reduced to 10 lbs.
3 lbs. in disinfecting chamber.
Disinfecting Experiment.
Temperature in disinfecting chamber
Steam pressure in jacket
" " chamber
" " boiler
H. M.
5-31
5-36
5-41
5-46
5-51
5-56
6-1
6-6
6-11

In this case even the manure spores in one of the bundles were killed though they remained alive in the other. This is so extraordinary that I think the spores must have been somewhat enfeebled in the one case, though why they should be I could scarcely understand, as these spores had in other cases resisted boiling for several hours. However, the disease-producing organisms, non-sporing and spore-bearing alike, were all killed, the result must therefore be looked upon as very satisfactory.

From these experiments it is evident that the "Thresh" Disinfector can be utilised where a high-pressure steam supply is available, the pressure in the Disinfector being brought down to 3-lbs. beyond atmospheric pressure. That drying can be ensured is also evident, and disinfection can be at least as effectively carried out as when the apparatus is used in the ordinary way. The amount of "condense" is large, and only a small proportion of this can be re-evaporated on passing hot air through the chamber. It will, therefore, in most cases be necessary to draw off this condense before the drying process can be carried out effectively. This, however, can be done automatically by means of a condense outlet pipe connected to a steam trap.

(SIGNED) G. SIMS-WOODHEAD.

Cambridge.

REPORT

UPON

The Delépine-Jones Patent Current Pressure Steam Disinfector.

(WORKING AT ANY REQUIRED PRESSURE.)

BY

Professor G. Sims-Woodhead, M.A., M.D., etc.

The Thresh Disinfector Co., Ltd.
BROOK HOUSE, 10-12, WALBROOK
LONDON, E.C.

Pathological Laboratory,

Cambridge.

Delépine-Jones Patent Current Pressure Steam Disinfector.

I have made a careful examination of the Delépine Current Pressure Steam Disinfector, which is constructed as follows :—

The body or shell is of steel boiler plate with seams riveted by hydraulic machinery and caulked with pneumatic caulking tools.

The ends are strengthened by angle-steel rings, a groove or recess being formed for the packing by which the joints between the doors and the disinfector are made.

Immediately inside the shell is a continuous close coil connected by its inlet end to the steam boiler; through this coil the pressure steam from boiler passes before it is admitted into the Disinfecting Chamber. It thus heats up the Disinfector.

The outlet end of the coil is connected to a perforated steam pipe in the Disinfecting Chamber, and also to a pipe leading to a steam trap and steam jet used in the drying process (explained later). The perforated pipe and the steam jet are controlled by separate valves.

The perforated pipe to the Disinfecting Chamber lies along the bottom of the coil, the perforations being arranged over the coil pipes so that the steam, as it enters the Disinfecting Chamber, impinges on to the coil.

As the steam from the perforated pipe escapes into the Disinfecting Chamber it expands, and condenses; but as it comes at once into contact with the coil through which the pressure steam is passing, it is, almost immediately, re-evaporated. The continuous condensation of the incoming steam, taking place simultaneously, ensures that the steam in the Disinfecting Chamber is always saturated.

The actual Disinfecting Chamber is formed by a lining fitted inside the steam coil; this lining is open at both ends, and is secured at intervals to the body of the Machine by small double-angle brackets. At one end of this lining at its upper part a large opening is made for admission of the steam or air for disinfecting or drying as the case may be.

The primary object of this lining is to compel the air which passes through the Machine during the drying process to remain in close contact with the coil during its passage from the air inlet port to the clothes in the Disinfecting Chamber.

It also prevents any wetting of the clothes by the condensed water which may accumulate at the bottom of the Disinfecting Chamber.

The steam outlet from the Disinfecting Chamber is guarded by a loaded valve, and according to the weight on this, a continuous current of steam at that pressure is passed through the Disinfector. It is quite easy, therefore, to work the Machine as a Current Steam Disinfector at any pressure from O upwards.

This outlet valve has the additional function of a safety valve, but a dead-weight safety valve also is fixed on the Disinfector for further safety.

The steam outlet valve from the Disinfector is arranged to blow off outside the Disinfector House, and no steam escapes into the building to inconvenience the attendant.

When the Disinfection is complete, the steam is cut off from the perforated pipe and so excluded from the Disinfecting Chamber. The steam has then to pass to the steam trap by which it is held up. The water of condensation in the chamber is drawn off through a small pipe, the air inlet valve is opened (the air being drawn from the outside of the building), the steam jet valve and the outlet valve from the Disinfector are opened.

The air enters the Disinfector at one end at the bottom (the opposite end to the opening in the crown of the lining), and must pass over the steam coil between the shell and the lining, thus taking a diagonal direction, from end to end of the Machine, before it can enter the Disinfecting Chamber. The temperature of the air is thus raised above the condensing point of steam at atmospheric pressure.

The velocity of this air current is accelerated by a steam jet in the outlet pipe from the Disinfector.

The steam is supplied to the jet from the steam coil outlet already referred to on page XXVI.

The very rapid current of superheated air drawn through the Disinfector causes the "condense" in the clothing to be absorbed, and the articles are quickly dried, and after reasonable exposure to this drying process, the weight of the clothes is found to be much the same as when they were dry before they were put into the Disinfector.

Each of the doors of the Machine is constructed with a dished outer plate, carefully and accurately shaped, and with an inner dished plate. These plates are bolted to a circumferential casting or rim, turned in a lathe, and arranged with a lip or bead which is pressed into the rubber seating in each end of the Disinfector; steam-tight joints are thus made between the doors and the body of the Machine.

The space between the front and back plates of each door contains the mechanism for securing the doors. This consists of a system of radial locking bars, all operated from the centre by means of a wheel and screw, the levers working in sleeves, or guides, and through the circumferential door casting already named. By this means all the bolts are operated at one time, and are shot into a series of adjustable holdfasts arranged round the angle-iron rings at each end of the body of the Disinfector.

The door can thus be closed and made secure in a few seconds.

The spaces between the front and back plates of the doors are packed with non-conducting material to prevent radiation of the heat from inside, and to keep the outside of the door cool.

A guide wheel (with adjustment) is fixed at the bottom of the doors; this wheel, which takes the weight of the door, runs on a roller path fixed to the floor of the House.

No reducing valves are required, and whatever the initial steam pressure from the boiler may be, a continuous current of steam at any required pressure is assured by simply regulating the steam outlet valve.

Experiments.

On four occasions I have carried out disinfection experiments with this Machine—twice alone, and twice in conjunction with Professor Delépine.

In carrying out these tests I have deemed it advisable to follow as closely as possible former lines of experiment, and in obtaining records I have made use of thermometers, thermographs, and pressure gauges, in all cases comparing the records obtained from the various sets of instruments.

The tests to which the Machine has been submitted have been exceedingly severe, for not only have non-spore bearing organisms, such as staphylococcus and diphtheria bacillus, and the ordinary pathogenic spore-bearing organism—the anthrax bacillus with its spores, been used in the experiments, but the spore-bearing organisms found in earth and manure, some of the spores in these organisms withstanding action of boiling water at ordinary atmospheric pressure for from one to seven hours.

The test as far as the organisms are concerned is of course much more stringent than would be required for ordinary disinfection, and, in so far as the apparatus has borne the test, we have indication that it should meet the most severe experiments for disinfection. I mention this at once as otherwise some of the records may give a false impression, and I am so thoroughly satisfied with the success of the Disinfector in conforming to the requirements involved in these tests, that I should not like to discount, in anticipation, the results obtained.

FIRST SERIES.

The first two series of experiments were carried out in Professor Delépine's absence, but with the assistance of the skilled mechanics at the Thorncliffe Works.

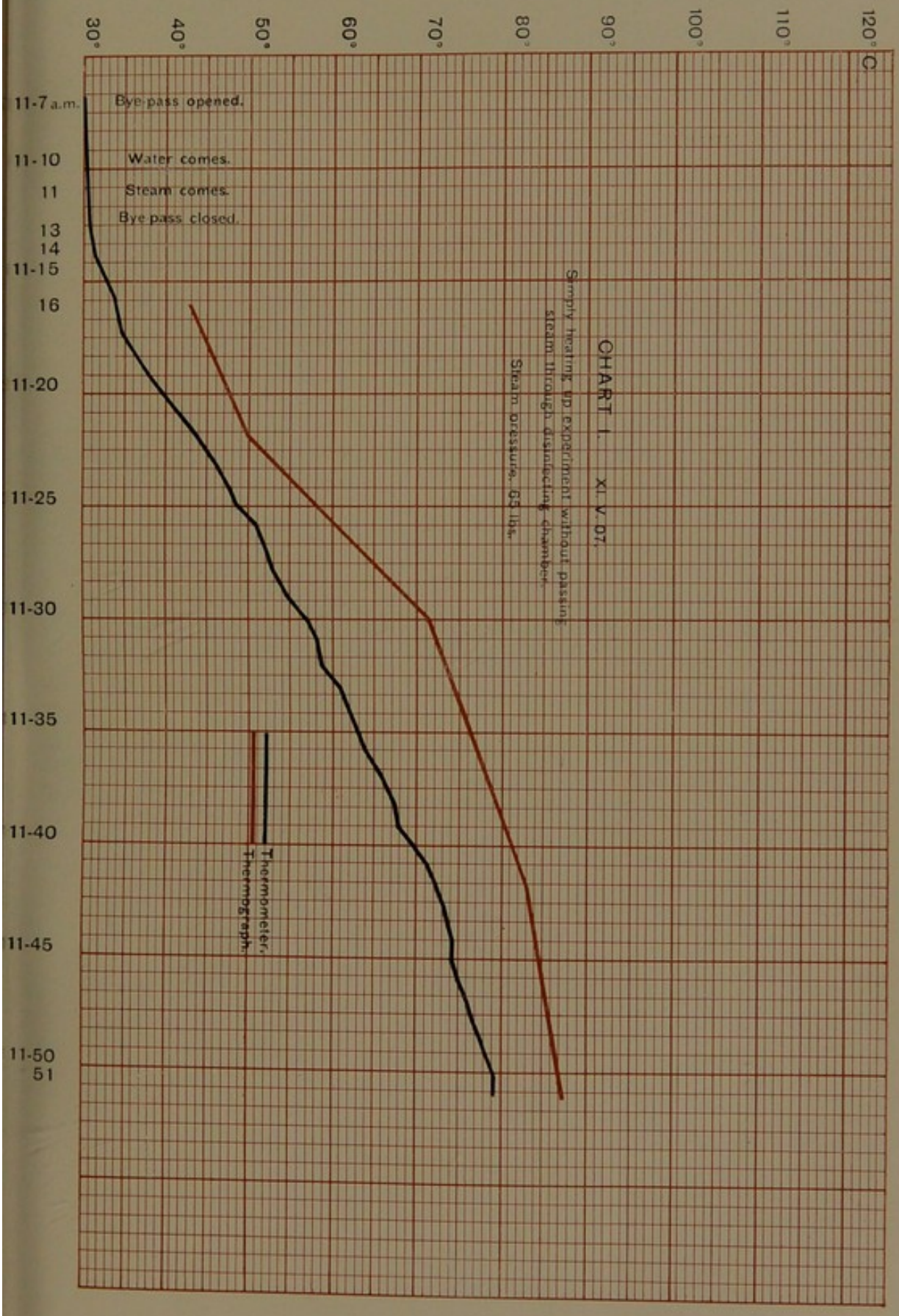
Experiment No. 1.

(See Chart I.)

In the first experiment the temperature of the air in the sterilizing chamber was raised simply by means of heat given off from the coil (Valve 1 open), no steam being allowed to pass into the Disinfecting Chamber. At the commencement of the experiment, when the initial pressure of the steam was 65-lbs., the by-pass (Valve A) was opened to allow the water condensed from the cooled steam to pass out of the coil. At the end of three minutes water was coming from the opening, but in another minute steam blowing out, the by-pass (Valve A) was closed. By-pass Valve A was at coil outlet.*

The thermograph record, it will be seen, rises steadily and regularly. Controlling this by the thermometer record which, however, is somewhat lower, it is found that in seven minutes from the closing of the by-pass (Valve A) the temperature had risen 9° C.; five minutes later 9° C. more; five minutes later another 8° C.; five minutes later 5° C.; and 7° C. at the end of another five minutes. Then in another five minutes only 4° C., and in the last few minutes of the experiment again only 4° C. The temperature had thus risen 49° C. in 38 minutes. It was not considered necessary to prolong this heating process as the machine was now warm enough to allow of the sterilizing process being begun.

* Valve "A" has since been found unnecessary.


30°
40°
50°
60°
70°
80°
90°
100°
110°
120° C.
11-7 a.m.
Bye pass opened.
11-10
Water comes.
11
Steam comes.
Bye pass closed.
13
14
11-15
16
11-20
11-25
11-30
11-35
11-40
11-45
11-50
51
CHART I. XI. V. 07.
Simply heating up experiment without passing steam through disinfecting chamber.
Steam pressure, 65 lbs.
Thermometer.
Thermograph.

In reading the following records of experiments it should be borne in mind that :—

VALVE 1. OPEN. Admits steam to the coil.
SHUT. Steam is shut off from the coil.
,, 2. OPEN. Air is allowed to escape from disinfecting chamber, and pressure valve is thrown out of work.
SHUT. Air outlet is closed.
,, 3. OPEN. Moist steam admitted to disinfecting chamber through perforated pipe, and directed against hot coil.
SHUT. Moist steam cut off from disinfecting chamber.
,, 4. OPEN. Admits escape of excess of "condense" and steam to reduce pressure and clear chamber and annular space.
SHUT. Closes above.
, 5. OPEN. Sets up steam jet ejector action, producing partial vacuum in chamber when Valve 2 is opened.
SHUT. Stops ejector action.
,, 6. OPEN. Admits pure air from outside for drying.
SHUT. Excludes air from disinfecting chamber.

Note by T. D. Co. See Diagrams pages 26 and 27 of Catalogue, Part I.

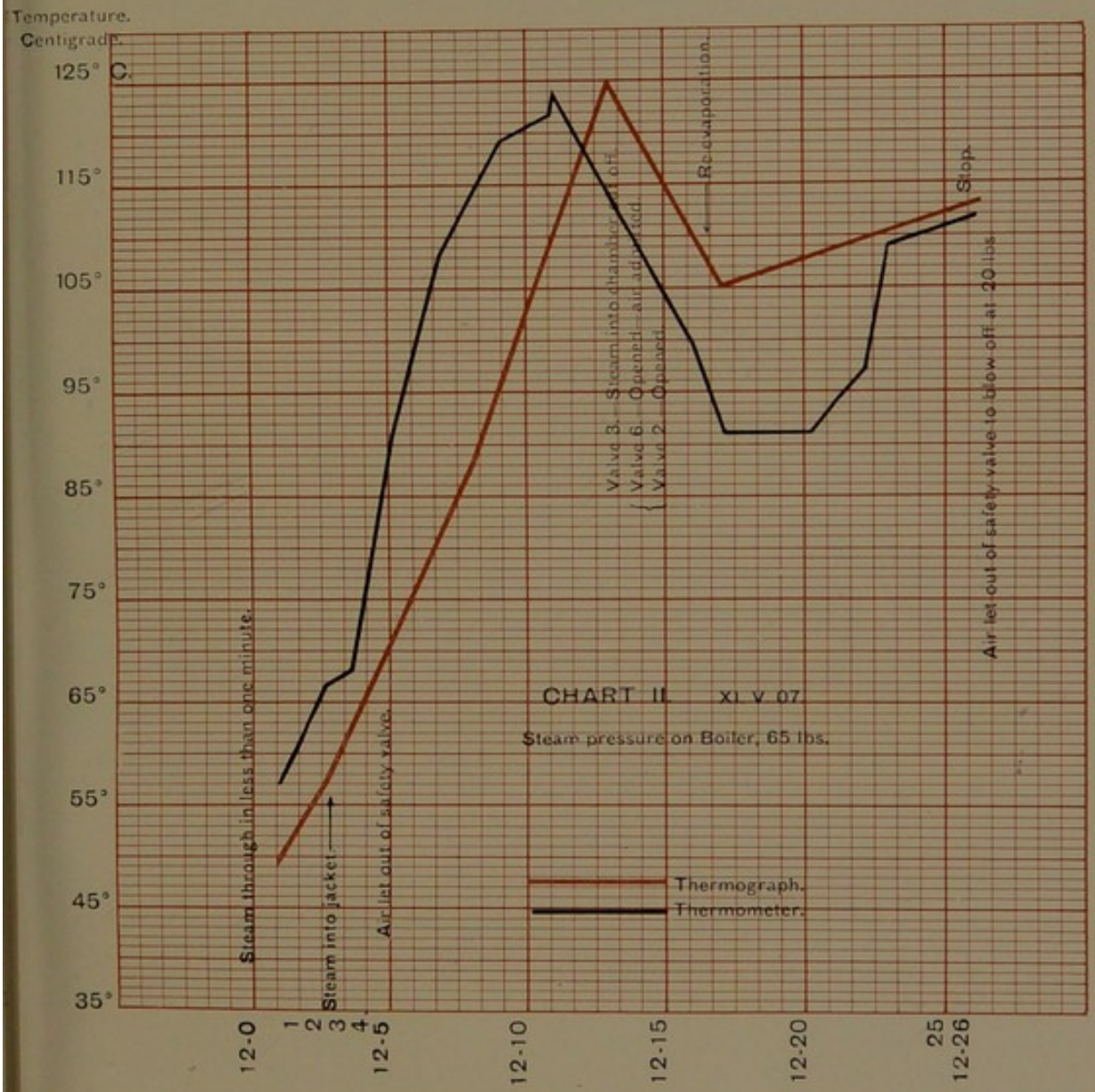
NOTE.—Since my first experiments, recorded herein, the Disinfector has been simplified, and special outlet Valve *A* of coil has been dispensed with, it being found sufficient to connect one of the branches from the steam coil with the steam trap.

Experiment No. 2.

(See Chart II.).

This was an entirely new experiment. At 12 noon, when the steam pressure in the boiler was 65-lbs., and the blow-off valve set to 20-lbs., the by-pass (Valve A) was opened, when a quantity of water escaped, steam then blowing through in less than a minute. At 12.3 p.m. Valve 3 was opened and steam was turned into the sterilizing chamber, and a couple of minutes later air was allowed to escape from the safety valve. Again using the thermograph record as giving the rather more reliable figures, though the dial thermometer, which was probably too near the hot coil, was used for purposes of control, it will be noted that a temperature of 125° C. was reached within eleven minutes. Steam was then cut off ; air was allowed to pass into the chamber, and four minutes later the temperature had fallen to 105° C. ; but nine minutes later it had risen to 113° C. The air valve (Valve 2) was then opened wide.

In carrying on the following sterilization experiments the following method was adopted :—Four organisms or sets of organisms were used : (1) the spores of several series of active, vigorously-growing cultures of anthrax bacilli ; (2) a vigorous culture of a pus-producing micrococcus—the staphylococcus pyogenes aureus ; (3) a culture of a disease-producing bacillus—the bacillus diphtheriæ ; and in later experiments (4) earth spores were used. In each case sterile silk threads were soaked in an emulsion of the culture, and were then carefully dried in petri dishes and transferred singly to very small sterile test-tubes plugged with sterile cotton wadding. In order that no mistake might be made, a different coloured thread was used to receive each organism. Before these threads were placed in the middle of the flock bed, pillows, and blankets to be disinfected, each was placed in a separate bit of sterile paper and wrapped up as a chemist


Temperature.
Centigrade.
125° C.
115°
105°
95°
85°
75°
65°
55°
45°
35°
Steam through in less than one minute.
Steam into jacket
Air let out of safety valve.
Valve 3. Steam into chamber shut off.
Valve 6. Opened—air admitted.
Valve 2. Opened.
Re-evaporation.
Stop.
Air let out of safety valve to blow off at 20 lbs.
CHART II XI V 07
Steam pressure on Boiler, 65 lbs.
Thermograph.
Thermometer.
12-0
1
2
3
4
12-5
12-10
12-15
12-20
25
12-26

wraps up a powder. The papers containing the several kinds of organisms were then enclosed in an envelope, this envelope in turn being placed in the centre of the article to be sterilized. The threads could be easily "fished out" even from a flock bed if around the envelope a piece of string, the other end of which was attached to the bed tick where the slit is made for the reception of the envelope, was tied. The organisms in these threads within the envelope were, of course, exposed to heat during both the processes—that of steaming and that of drying. They were then transferred to tubes containing sterile nutrient broth, and it was noted whether any growth took place or not. When no growth occurred we had the best possible evidence that complete sterilization had taken place. I used also Professor Delépine's method with exactly the same results.

SECOND SERIES.

Experiment No. 3.

(See Chart III.).

Steam pressure in boiler 70-lbs. per square inch, and at blow-off valve 22-lbs. A number of micro-organisms—diphtheriæ bacilli, staphylococci, anthrax spores and earth spores—each in a little paper packet—were then placed in an envelope, to which a piece of string was attached, this string serving as a recovery line for the envelope. One of these envelopes with its four packets of micro-organisms was then inserted in the middle of a flock bed, another in a flock pillow, and another in a pile of blankets, sixteen fold; a fourth was exposed in the open chamber. The bed, pillow, and blankets were all rolled and tied into firm bundles. The conditions were thus made to be fully as exacting as, or even more exacting than, they would be in an ordinary "sterilization" on a practical scale.

Steam came through the by-pass from the coil in one minute, and a minute later steam was passed into the chamber. Three minutes later the temperature in the bundle of blankets was 55° C. and in the open chamber 103° C. After another minute the temperature in the blankets was 55° C., in the chamber 119° C.; eleven minutes later the temperature had risen to 125° C. in the blankets and 126° C. in the open chamber. Steam was shut off at the end of seventeen minutes, then evaporation was commenced, and in seventeen minutes the temperature in the blankets had fallen to 96° C. It was evident that at this point the cool air had been allowed to enter too rapidly and too much condensation took place, the cooling being very marked. The disinfector door was then opened and air was allowed to pass into the disinfecting chamber for nine minutes. The flocks, then examined, were found to be somewhat damp. The door was again closed and the heated air jet put on for fifteen minutes more. The various articles were now found to be thoroughly well dried and to have lost weight. See Table I.

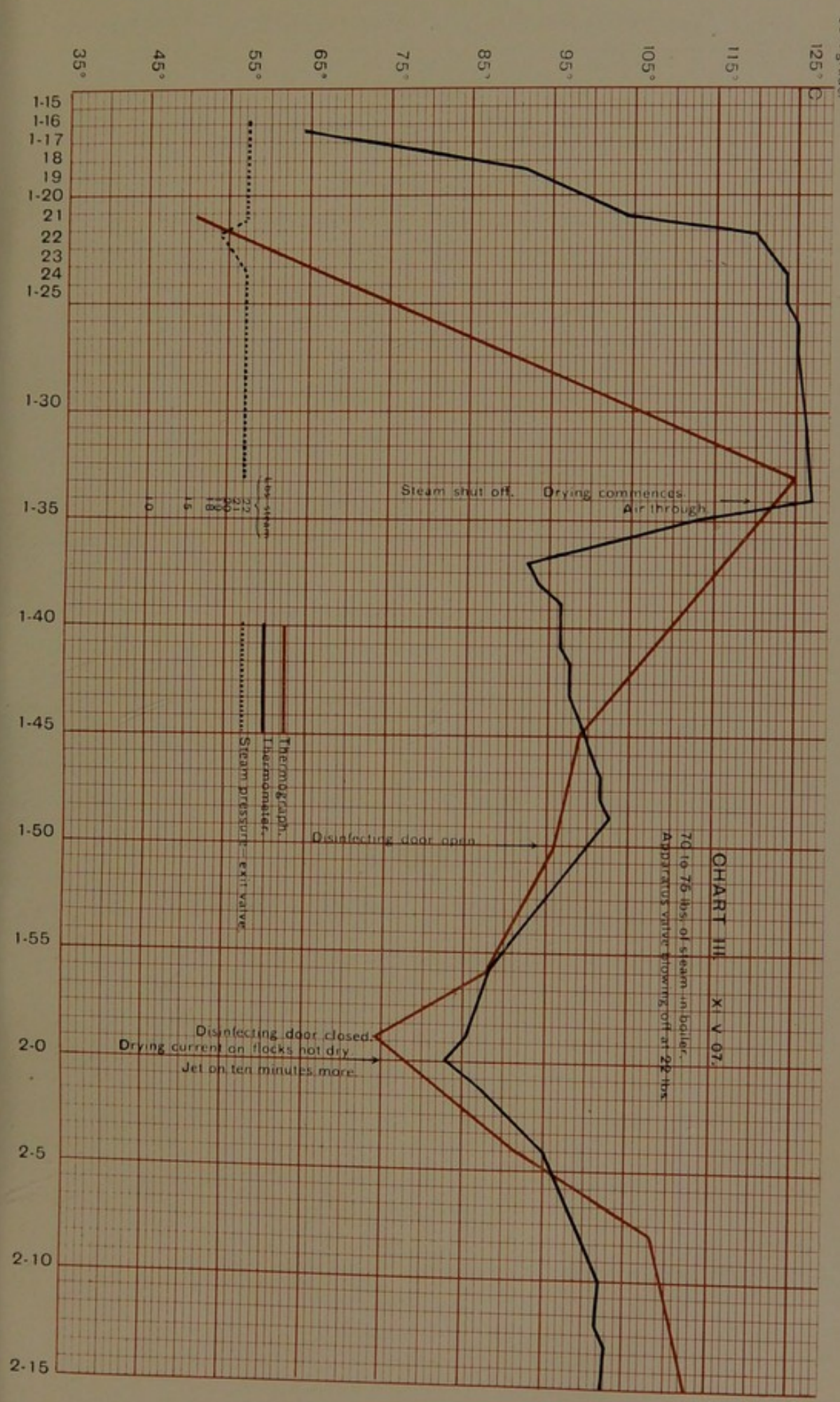

Temperature, Centigrade.
35°
45°
55°
65°
75°
85°
95°
105°
115°
125° C.
1-15
1-16
1-17
18
19
1-20
21
22
23
24
1-25
1-30
1-35
1-40
1-45
1-50
1-55
2-0
2-5
2-10
2-15
Steam shut off.
Drying commences.
Air through.
Disinfecting door opens.
Disinfecting door closed.
Drying current on, flocks not dry.
Jet on ten minutes more.
Thermograph.
Thermometer.
Steam pressure—exit valve.
CHART III. XI V 07.
70 to 75 lbs. of steam in boiler.
Apparatus valve blowing off at 22 lbs.

Table I.

Loss of weight in "Delépine's Disinfector."

Experiment 3.

	Minutes Steamed.	Minutes Dried.	Before Experiment.	At end of Experiment.	Loss of Weight.
			lbs. ozs.	lbs. ozs.	lbs. ozs.
Blankets—					
Bundle 1	14	35	5 0	4 12	0 4
,, 2	14	35	5 14	5 11	0 3
Bolster	14	35	5 12	5 8	0 4
Pillow, No. 1	14	35	3 3	3 2	0 1
,, No. 2	14	35	3 4	3 2	0 2
Flock Bed	14	35	33 4	32 0	1 4
Total			56 5	54 3	2 2

The threads containing the organisms removed from the paper packets were placed in broth. In one case only, *i.e.*, that in which the thread had been in the centre of the flock bed and that contained anthrax spores, could any growth be observed. Here a pure culture of the bacillus anthracis was obtained. All the other threads exposed during this experiment gave no growths. Control (unexposed) threads gave luxuriant growths. See Table II.

Table II.

Sterilising experiments in "Delépine's Disinfector."

Experiment 3.

	Minutes Steamed	Minutes Dried.	Anthrax Spores.	Earth Spores.	Staphylo-coccus pyogenes aureus.	Bacillus Diph-theriæ.	
Blankets, 16 plies ..	14	35	–	–	–	–	No growth at end of 24 hours.
Pillows	14	35	–	–	–	–	,, ,,
Flock Bed ..	14	35	+	–	–	–	Growth of anthrax spores only at end of 24 hours.
Open Chamber	14	35	–	–	–	–	No growth at end of 24 hours
Control, not Exposed ..			+	+	+	+	Growth in all within 24 hours.

+ = Growth. – = No Growth = Disinfection.

Experiment No. 4.

(See Chart IV.)

A second test was started at 3.51 on the same day, the boiler pressure now being only 38-lbs., and during the experiment falling to 36-lbs. The blow-off pressure rose gradually from 1-lb. to 13-lbs. in eight minutes, and was maintained between 13 and 12-lbs. for seventeen minutes. The bed, pillows, and blankets, in which were placed the test micro-organisms, were enclosed as in the previous experiment (No. 3).

The temperature within the blankets rose to 119° C. within six minutes; this temperature was maintained for twelve minutes, when the steam supply to the disinfecting chamber through the open perforated pipe was cut off. This set up re-evaporation, which was continued for fifteen minutes, but at the end of that period the blankets were not subjected to drying, and were found to have gained two ounces in weight. See Table III.

Table III.

Gain of weight in "Delépine's Disinfector" without drying in or out of the machine.

Experiment 4.

	Minutes Steamed.	Minutes Dried.	Before Experiment.	At end of Experiment.	Gain in Weight.
			lbs. ozs.	lbs. ozs.	lbs. ozs.
Blankets—					
Bundle 1	35	0	4 12	4 14	0 2
,, 2	35	0	5 11	5 14	0 3
Bolster	35	0	5 8	5 12¼	0 4¼
Flock Bed	35	0	32 0	34 1	2 1
Total Weight			47 15	50 9¼	2 10¼

All the organisms and spores that had been enclosed in the envelope, however, were killed. The anthrax spores had, along with the others, succumbed to this treatment. From a consideration of these two experiments it is evident that although all the spores were not killed in fourteen minutes, even the most resistant had succumbed in thirty-five minutes. See Table IV.


Temperature.
Centigrade.
120° C.
110°
100°
90°
80°
70°
60°
50°
40°
Steam.
14 lbs.
13 "
12 "
11 "
10 "
9 "
8 "
7 "
6 "
5 "
4 "
3 "
2 "
1 "
Evaporation of water.
Steam supply to disinfecting chamber through open perforated pipe is cut off.
CHART IV. XI V 07
Steam pressure in boiler before valve is turned on, 38 lbs.
" " " " during experiment ... 36 "
Thermograph.
Thermometer.
Steam pressure—exit valve.
3-50
3-55
4-0
4-5
4-10
4-15
4-20
4-25
4-26

Table IV.

Sterilizing experiment in "Delépine's Disinfector."

Experiment 4.

	Minutes Steamed	Minutes Dried.	Anthrax Spores.	Earth Spores.	Staphylo-coccus pyogenes aureus.	Bacillus Diph-theriæ.	
Blanket, 32 plies ..	35	0	–	–	–	–	No growth at end of 24 hours.
Pillow	35	0	–	–	–	–	" "
Flock Bed ..	35	0	–	–	–	–	" "
Open Chamber	35	0	–	–	–	–	" "
Control, not Exposed ..			+	+	+	+	Growth in all within 24 hours.

+ = Growth. – = No Growth = Disinfection.

Experiment No. 5.

(See Chart V.)

On May 16th, 1907, another series of experiments was carried out. In these an additional accurately-regulated thermograph was used to check the thermometer which we had used in the first experiment. The thermograph used on the first occasion was, in this experiment, used for the purpose of obtaining the temperature record within the blankets. At the commencement of the experiment the boiler-pressure gauge recorded 80-lbs., and the exit valve from the sterilizer was set for 20-lbs. pressure. One minute after steam was turned into the apparatus, at 11.9 a.m., water came through the by-pass; three minutes later, 11.12 a.m., steam came through, and in five minutes, 11.14 a.m., the steam was turned into the sterilizing chamber.

The temperature recorded by the thermograph had risen to 96° C. at the end of ten minutes, 11.19 a.m., and in seventeen-and-a-half minutes, 11.26½ a.m., to 126° C. At this time the steam pressure in the Disinfector was 22-lbs. The valve was adjusted to 20-lbs., but the temperature fell a single degree only—to 125° C. This temperature and pressure were maintained for twenty-two minutes, 11.54 a.m. The steam was now shut off from the chamber and passed through the coil alone for drying purposes and the condense in the Disinfecting Chamber drawn; only a cupful came out. At the end of the experiment the bedding remained the same weight, but on shaking it in the air it lost two ounces in a couple of minutes. Table VI.

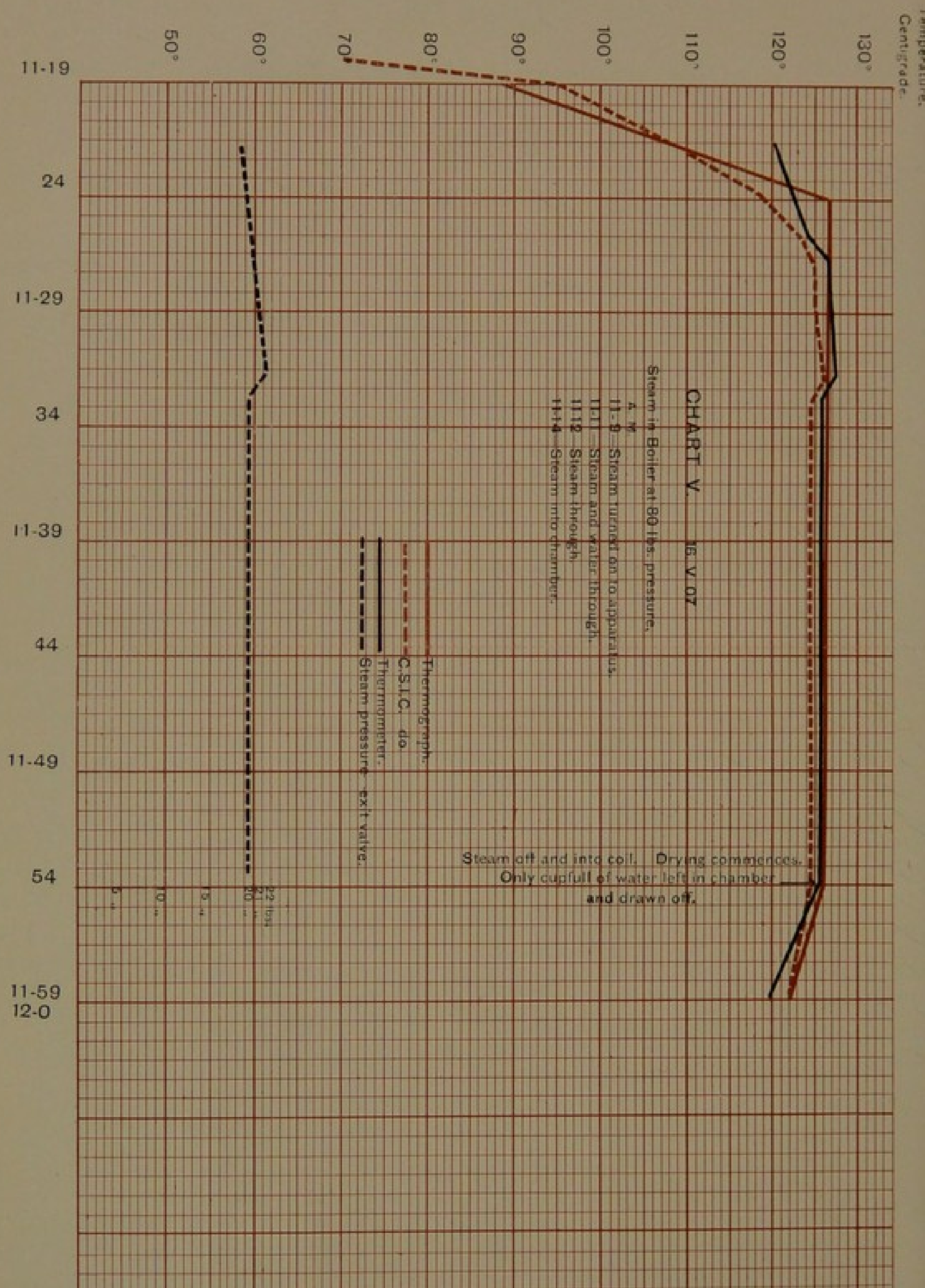

Temperature, Centigrade.
130°
120°
110°
100°
90°
80°
70°
60°
50°
11-19
24
11-29
34
11-39
44
11-49
54
11-59
12-0
CHART V. 16. V. 07
Steam in Boiler at 80 lbs. pressure.
A. M.
11-9 Steam turned on to apparatus.
11-11 Steam and water through.
11-12 Steam through.
11-14 Steam into chamber.
Thermograph.
C.S.I.C. do.
Thermometer.
Steam pressure exit valve.
Steam off and into coil. Drying commences.
Only cupfull of water left in chamber and drawn off.

Table V.

Sterilizing results of experiment in "Delépine's Disinfector."

Experiment 5.

	Minutes Steamed	Minutes Dried.	Anthrax Spores.	Earth Spores.	Staphylococcus pyogenes aureus.	Bacillus Diphtheriæ.	
Bedding ..	30	48	–	–	–	–	No growth at end of 48 hours
Open Chamber	30	48	–	–	–	–	,, ,,
Control, not Exposed ..			+	+	+	+	Growth within 24 hours

+ = Growth. – = No Growth = Disinfection.

The most resistant (all as above) organisms that had been placed in this bedding were killed.

Table VI.

Loss of weight by bedding sterilized in "Delépine's Disinfector."

Experiment 5.

	Minutes Steamed.	Minutes Dried.	Before Experiment.	At end of Experiment.	Loss of Weight.	
			lbs.	lbs. ozs.	ozs.	
Bedding	30	48	33	32 14	2	This loss was noticed when shaken in air for two minutes.

THIRD SERIES.

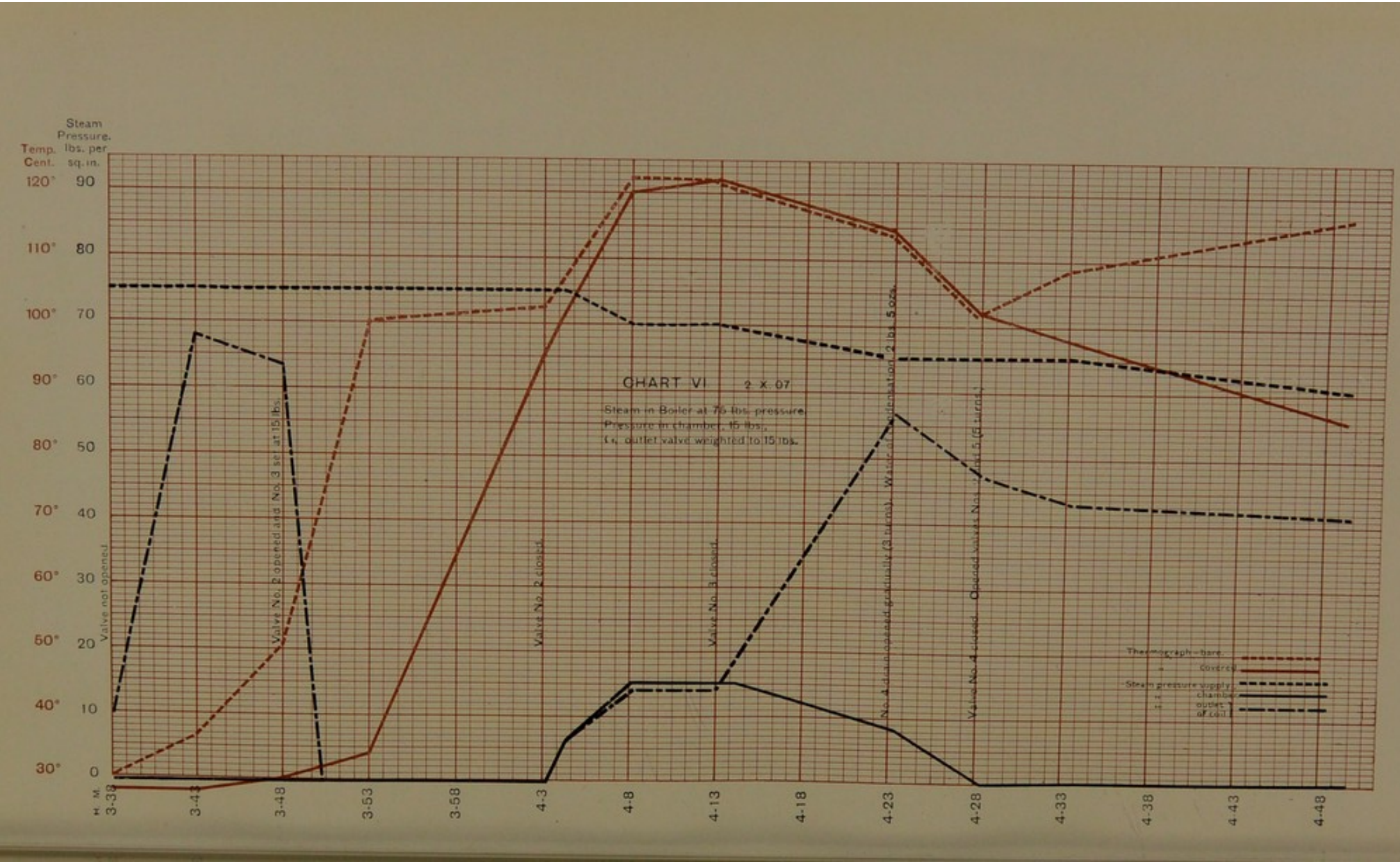
The experiments of this Series were carried out in co-operation with Professor Delépine in a Disinfector as simplified, but with the outlet valve as before. Valve 4 is now the valve on the outlet for water of condensation in the annular space. All test organisms were placed in duplicate in the Disinfector, Professor Delépine taking one sample, I the other. Exit valve set at 15-lbs. pressure.

Experiment No. 6.

(See Chart VI.).

Time. p.m.	Minutes after Starting.	Thermograph (Centigrade).		Steam Pressure.			Remarks.
		Bare.	Covered.	Supply.	Chamber.	Outlet of Coil.	
3.38	0	30	28	75	0	10	Valve No. 1 opened. Door closed.
3.43	5	36	28	75	0	67.5	
3.48	10	50	29.5	75	0	63	Valve No. 2 opened and No. 3 set at 15-lbs.
3.50	12	Record	missed	75	0	0	
3.53	15	100	34	75	0	0	
4.3	25	102	95	75	0	0	Valve No. 2 closed.
4.4	26	107	100	75	6	6	
4.8	30	122	120	70	15	14.5	
4.13	35	122	122	70	15	14.5	Valve No. 3 closed.
4.23	45	114	114	65	8	56	No. 4 opened gradually (3 turns), water of condensation 2-lbs. 5-ozs.
4.28	50	102	102	65	0	46	No. 4 closed, No. 5 opened, No. 2 opened (5 turns).
							Weight at 4.54 p.m. lbs. ozs.
4.33	55	108	98	65	0	43	Bedding 46 12½ Blankets 4 12
							Weight at 5.0 p.m. lbs. ozs.
4.49	71	116.5	86	60	0	—	Bedding 46 6 Blankets 4 8½

Into a blanket weighing 4-lbs. 10-ozs., and in 32 folds, were placed a sample of manure and three samples of sporulating anthrax bacillus supplied by Professor Delépine, and one of anthrax bacillus supplied by myself. These organisms would be some 2 or 3-in. only from the surface. A bed weighing 45-lbs. 12-ozs. was made into a bundle with a circumference of 3-ft. 7-in., and in the middle of this bundle were placed two samples of sporulating anthrax bacillus (Delépine) and one sample of sporulating anthrax bacillus (Woodhead). The organisms in this case would be some 8 or 9-in. from the surface of the bundle. A copper sphere measuring 10-in. in diameter and containing 1½-lbs. of flock packed tightly around samples of the above organisms, which were thus about 5-in. from the surface was also used. At each side of this sphere was a perforated door through which steam could pass


Steam Pressure. lbs. per sq. in.
Temp. Cent.
120° 90
110° 80
100° 70
90° 60
80° 50
70° 40
60° 30
50° 20
40° 10
30° 0
CHART VI 2 x 07
Steam in Boiler at 75 lbs. pressure.
Pressure in chamber, 15 lbs.,
i.e. outlet valve weighted to 15 lbs.
Valve not opened
Valve No. 2 opened and No. 3 set at 15 lbs.
Valve No. 2 closed.
Valve No. 3 closed.
No. 4 drum opened gradually (3 turns). Weighted with 2 lbs. 5 ozs.
Valve No. 4 closed. Opened valve Nos. 1 and 5 (5 turns).
Thermograph-bare.
Covered.
Steam pressure supply.
chamber.
outlet weighted to 15 lbs.
H. M.
3-38
3-43
3-48
3-53
3-58
4-3
4-8
4-13
4-18
4-23
4-28
4-33
4-38
4-43
4-48

XLI.

rapidly. The bulb of one of the thermographs was usually placed in the middle of the flock contained in this sphere. This is spoken of as the covered bulb.

At 3.38 p.m. the door of the Machine was closed, No. 1 valve was opened and steam was passed through the coil, the steam pressure in the boiler being 75-lbs. ; the temperature recorded by the thermograph, the bulb of which was exposed free in the chamber, was 30° C. ; that by the thermograph bulb within the flock was 28° C. ; the pressure in the Disinfecting Chamber was zero ; and the pressure at the outlet of coil, 10-lbs.

In five minutes, 3.43 p.m., the temperature recorded from the exposed bulb had risen to 36° C., that of the covered bulb remaining at 28° C. The pressure in the chamber was still zero, and in the coil, 76½-lbs. In ten minutes, 3.48 p.m., the temperature of the exposed bulb was 50° C. ; in the protected bulb 29½° C. ; the pressure at the outlet of the coil, 63-lbs.

Valves Nos. 2 and 3 were now opened and the outlet valve was set at 15-lbs., the pressure at the outlet of coil of course falling to zero. In fifteen minutes, 3.53 p.m., the temperature recorded from the exposed bulb was 100° C., from the covered bulb 34° C., the pressure in the chamber and at the outlet being zero. In twenty-five minutes, 4.3 p.m., the temperature of the exposed bulb had risen to 102° C., and of the covered bulb to 95° C., and Valve No. 2 was closed. In another minute the temperature of the exposed bulb had risen to 107° C., and of the protected bulb to 100° C. The pressure in the chamber being now 6-lbs., and at the outlet of coil 6-lbs. In four more minutes, 4.8 p.m., that is thirty minutes from the start, the temperature recorded from the exposed bulb was 122° C., and from the protected bulb 120° C., the steam boiler pressure had now fallen to 70-lbs., the pressure in the chamber being 15-lbs., and at the outlet of the coil 14½-lbs. Five minutes later, 4.13 p.m., the exposed bulb thermograph still recorded 122° C., the protected bulb 122° C., the pressure at the various points remaining as above. No. 3 Valve was now closed, and at the end of ten minutes more, 4.23 p.m., or forty-five minutes from the commencement of the experiment, the temperature recorded from both exposed and protected bulbs was 114° C. The steam supply pressure had fallen to 65-lbs., the pressure in the Disinfecting Chamber being 8-lbs., and at outlet of the coil, 56-lbs.

Valve No. 4, or draining valve, was now opened gradually, when 2-lbs. 5-ozs. of condensation water was drawn off. Five minutes later, 4.28 p.m., the temperature had fallen to 102° C., as recorded by both thermographs ; the pressure in the Disinfecting Chamber had fallen to zero, the pressure at the outlet of coil remaining at 56-lbs. Valve No. 4 was now closed and the air inlet opened (Valve No. 6) ; No. 5 opened ; No. 2 was also opened gradually, five turns, and the drying process was commenced. In five minutes, 4.33 p.m., or fifty-five minutes from the start, the temperature recorded from the exposed bulb had risen to 108° C., but that from the covered bulb had fallen to 98° C. ; the pressure at the outlet of coil now being 43-lbs. Sixteen minutes later, 4.49 p.m., or seventy-one minutes from the start of the experiment, the temperature given by the exposed bulb was 116.5° C. ; by the covered bulb, 86° C. ; the steam pressure in the boiler now being 60-lbs. ; and the pressure at the outlet of coil 41-lbs.

Valve No. 5 was closed and the Disinfector was opened as quickly as possible, and the mattress removed at 4.54 p.m., when it was found to weigh 46-lbs. 12-ozs., the blankets 4-lbs. 12-ozs. On exposing to the air for six minutes the bedding lost 6½-ozs. in weight and the blankets 3½-ozs.

As pointed out by Professor Delépine, the outlet valve was not quite so sensitive as he would have wished it, and he suggested that before any further experiments were performed, some slight alterations should be made in this outlet valve. It was agreed that a further test should be carried out as soon as these alterations had been made. Table VII. gives loss of weight.

Table VII.

Loss of weight in "Delépine's Disinfector."

Experiment 6.

	Minutes Steamed.	Minutes Dried.	Weight before Experiment.		Weight after Experiment.		After drying six minutes.		Loss of Weight during six minutes' drying.
			lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	ozs.
Blankets	20	26	4	10	4	12	4	8½	3½
Bedding	20	26	45	12	46	12½	46	6	6½

Table VIII. shows results of our experiments as regards the effect of exposure of the various micro-organisms in the Disinfector during the above operations. Sterilization was complete.

Table VIII.

Sterilizing experiments with "Delépine's Disinfector."

Experiment 6.

	Minutes Steamed.	Minutes Dried.	Spores from Manure.	Anthrax Spores.				
				1	2	3	4	5
Blankets	20	26	0	0	0	0	0	–
Bedding	20	26	–	0	–	–	0	0
Copper Sphere ..	20	26	–	0	0	0	0	0
Controls			+	+	+	+	+	+

+ = Growth. 0 = No Growth = Disinfection. – = No Experiment.

In this case a few spores contained in earth and in manure remained alive in the bedding at the end of the experiment, but as they were embedded in earth or manure, they are not included in this Table. It will be noted that the manure spores on threads are all killed.

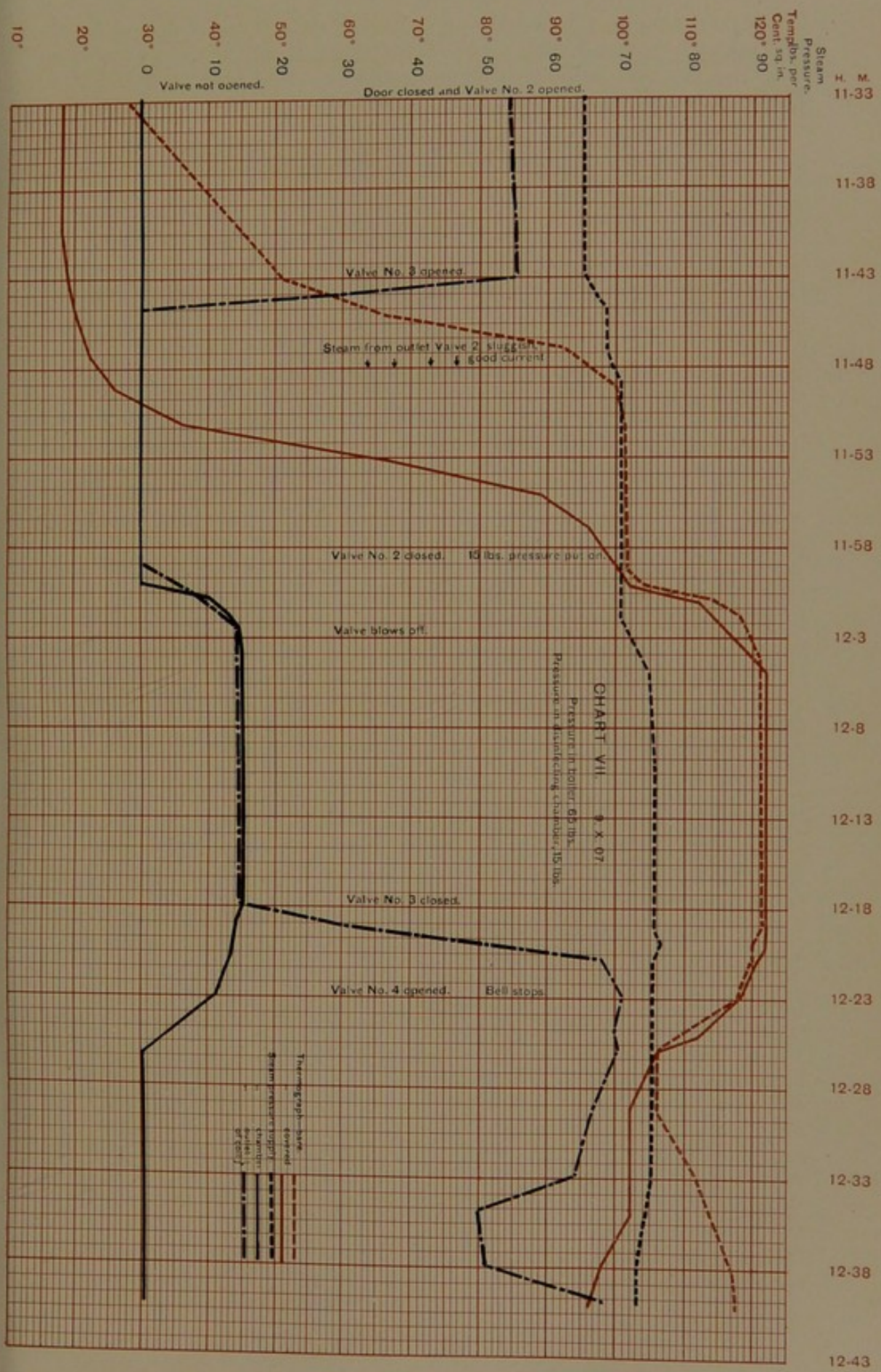
FOURTH SERIES.

With outlet valve made more sensitive.

The fourth series of experiments was made on the 9th October, 1907. A preliminary experiment was carried out with the pressure valve set at 15-lbs., the steam supply being at 65-lbs. pressure. From the exposed thermograph bulb there was a record of 16° C., and from the covered bulb of 18° C.

Experiment No. 7 (See Chart VII.)

Time.	Minutes after Starting.	Thermograph (Centigrade).		Steam Pressure.			Remarks.
		Pare.	Covered.	Supply.	Chamber.	Outlet of Coil.	
11.21	—	16	18	—	—	0	Machine loaded and Valve 1 opened.
11.33	0	28	18	65	0	54	Door closed. Valve 2 opened.
11.40	7	44	18	65	0	55	
11.43	10	51	19	65	0	55	Valve 3 opened.
11.45	12	66	20	68	0	0	
11.47	14	92	22	68	0	0	Steam from outlet Valve 2 sluggish.
11.48	15	—	—	—	—	—	Steam from outlet Valve 2, good
11.49	16	100	26	70	0	0	current.
11.51	18	101	36	70	0	0	
11.53	20	101	65	70	0	0	
11.55	22	101.5	89	70	0	0	
11.56	23	101.5	93	70	0	0	
11.57	24	101.5	96	70	0	0	
11.58	25	101.5	98	70	0	0	
11.59	26	101.5	99.5	70	0	0	Close Valve 2. 15-lbs. pressure put on.
12.0	27	104	102	70	0	5	Bell rings.
12.1	28	114	112	70	10	9.5	
12.2	29	118	118	70	13	12.5	
12.2½	29½	—	—	—	14.5	14.5	Exit Valve blows off.
12.4	31	121	121	72.5	15	14.5	
12.5	32	121	122	74	15	14.5	
12.10	37	121.75	122.25	75	15	14.5	
12.15	42	121.75	122.25	75	15	14.5	
12.18	45	121.75	122.25	75	15	14.5	Close Valve 3.
12.19	46	121.75	122.25	75	14	30	
12.20	47	120.25	122	76	13.5	50	
12.21	48	120	121	75	13	67	
12.22	49	—	—	—	—	—	
12.23	50	118	118	75	11	70	Bell stops. Open Valve 4. 2½-lbs. condense drawn off.
12.25	52	110	112	75	4	69	
12.26	53	106	106	75	0	69	
12.29	56	106	102	75	0	66	
12.33	60	112	102	75	0	63	Open air inlet and Valves 2 and 5 (5 turns).
12.35	62	114	101.75	74	0	49	Close Valve 4.
12.38	65	117	98	73	0	50	Close Valve 5. Leave all other valves open.
12.40	67	117.5	96	73	0	67	Door opened.


Steam Pressure. Temps. Cent. Lbs. per sq. in.
10° 20° 30° 0 40° 10 50° 20 60° 30 70° 40 80° 50 90° 60 100° 70 110° 80 120° 90
H. M.
11-33
11-38
11-43
11-48
11-53
11-58
12-3
12-8
12-13
12-18
12-23
12-28
12-33
12-38
12-43
Valve not opened.
Door closed and Valve No. 2 opened.
Valve No. 3 opened.
Steam from outlet Valve 2 sluggish, good current
Valve No. 2 closed. 10 lbs. pressure put on
Valve blows off.
CHART VII. 9 X 07.
Pressure in boiler 65 lbs.
Pressure in disinfecting chamber, 15 lbs.
Valve No. 3 closed.
Valve No. 4 opened. Bell stops.
Thermograph bare covered
Steam pressure gauge
chamber
boiler

At 11.21 a.m. the Machine was loaded as before and Valve No. 1 was opened, but the door was not closed until 11.33 a.m., at which time the exposed bulb thermograph recorded 28° C., the covered one 18° C. The pressure at the outlet of coil had risen from zero to 54-lbs.

At this point Valve No. 2 was opened. In seven minutes, 11.40 a.m., the temperature from the exposed bulb thermograph had risen to 44° C., that from the covered bulb remaining at 18° C., the pressure at outlet now being 55-lbs. In ten minutes, when the temperature from the exposed bulb was 51° C., and from the covered bulb 19° C., Valve No. 3 was opened. Four minutes later, 11.47 a.m., the steam from the outlet Valve No. 2 was coming somewhat sluggishly, the temperature recorded from the exposed bulb was 92° C., and from the covered bulb, 22° C. In another minute there was a good current of steam, and at the end of another minute, sixteen minutes from the start, 11.49 a.m., the temperature recorded from the exposed bulb was 100° C., and from the covered bulb, 26° C., the supply steam now being at 70-lbs. pressure. In twenty-six minutes from the commencement of the experiment, 11.59 a.m., the exposed bulb thermograph recorded 101.5° C., the covered bulb 99.5° C. Valve No. 2 was now closed, and the outlet valve set at 15-lbs. A minute later the temperature recorded from the exposed bulb had risen to 104° C., that of the covered bulb to 102° C.; the pressure at the outlet valve was 5-lbs., and the bell contact-thermometer, set to 100° C., and placed in the middle of the bedding, sounded. In twenty-nine minutes, 12.2 p.m., the temperature recorded from both bulbs had risen to 118° C., the pressure in the chamber being 13-lbs., and at the outlet valve 12½-lbs. A minute later 14½-lbs. was recorded in both chamber and at the outlet of coil, and steam was escaping from outlet valve. At the end of thirty-two minutes the temperature was 121° C., as recorded from the exposed bulb, and 122° C. from the covered bulb thermograph, the steam supply pressure being 74-lbs., in the chamber 15-lbs., and at the outlet 14½-lbs. At the end of forty-five minutes, 12.18 p.m., the conditions remaining much the same, Valve No. 3 was closed, and at the end of fifty minutes, 12.23 p.m., the temperature recorded by both thermographs was 118° C., the pressure in the chamber was 11-lbs., of the steam supply 75-lbs., and at the outlet of coil 70-lbs. Valve 4 was opened, and 2½-lbs. of water of condensation drawn off. At 12.33 p.m., sixty minutes, Valve No. 5 was opened and five turns given to Valve No. 2. The temperature, as recorded from thermograph with the exposed bulb, immediately began to rise (see Chart VII.) Two minutes later Valve No. 4 was closed, and three minutes later the temperature recorded from the exposed bulb thermograph still rising, but that from the protected bulb falling, Valve No. 5 was closed, all the other valves remaining open. At 12.40 p.m., or sixty-seven minutes from the start of the experiment, the temperature recorded by the exposed bulb thermograph was 117.5° C., by the covered bulb thermograph, 96° C., the steam supply being 76-lbs., the pressure in the sterilizing chamber zero, and at the outlet of coil, 67-lbs. The door was opened as quickly as possible, and the clothing, etc., removed.

Table IX.

Sterilizing Experiments with "Delépine's Disinfector."

Experiment 7.

	Minutes Steamed.	Minutes Dried.	Spores from Manure.	Anthrax Spores.					
				1	2	3	4	5	6
Blankets	20+15	7	0	0	0	0	0	–	–
Bedding	20+15	7	–	0	–	–	0	0	+
Copper sphere packed tightly with flock ..	20+15	7	–	0	0	0	0	0	0
Controls. No Exposure ..			+	+	+	+	+	+	+

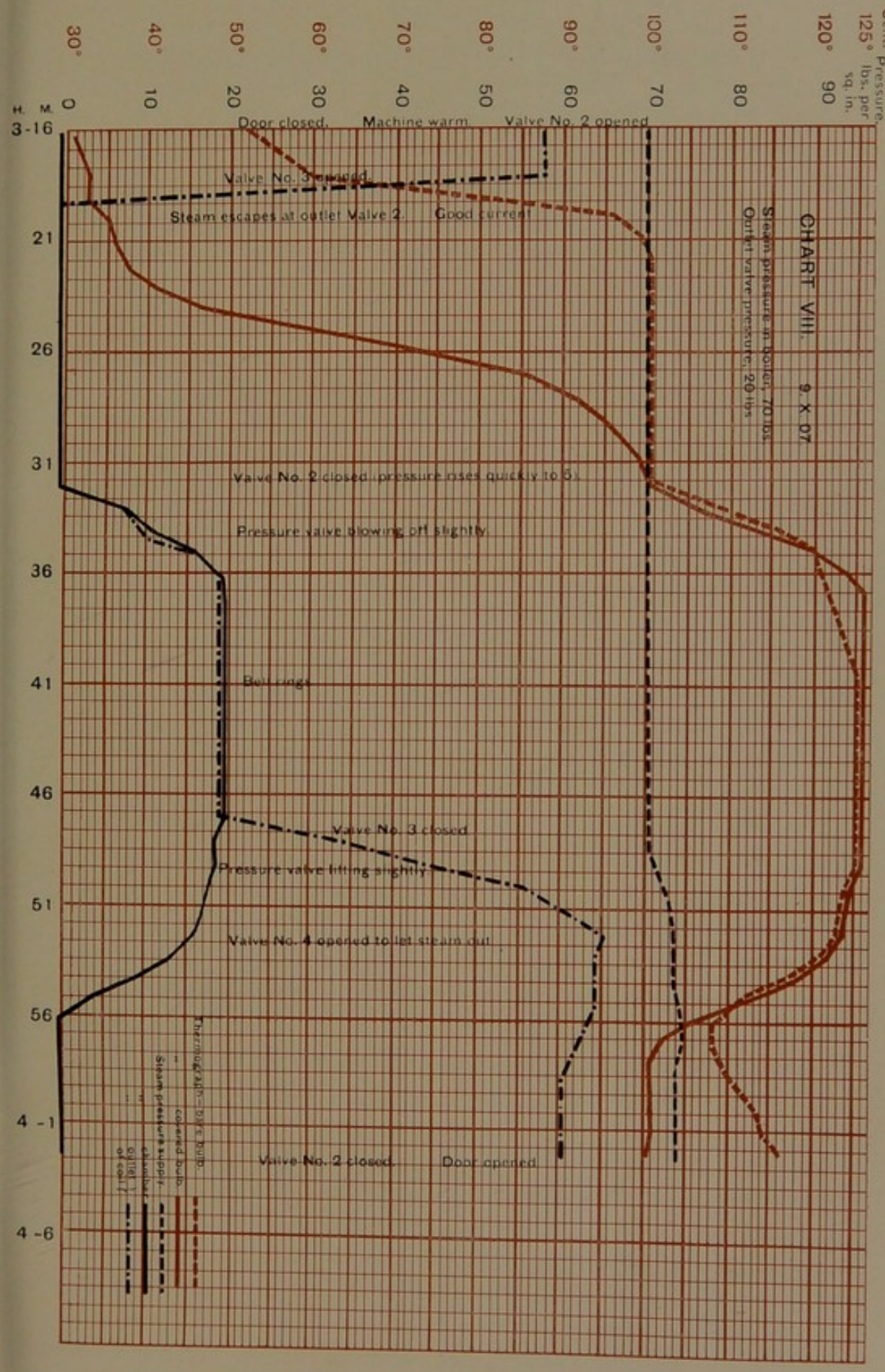
\+ = Growth of organism in broth.
0 = No Growth after 48 hours in broth.
– = No Experiment.

Here again earth and manure containing spores were used, some of the spores in each remained alive at the end of the experiment, although the manure spores on threads had all succumbed.

Experiment No. 8.

(See Chart VIII.)

Time.	Minutes after Starting.	Thermograph (Centigrade).		Steam Pressure.			Remarks.
		Bare.	Covered.	Supply.	Chamber.	Outlet of Coil.	
3.16	0	52	31	70	0	58.5	Door closed. Machine warm. Valve 2 opened.
3.18	2	60	33	70	0	58.5	Valve 3 opened.
3.19	3	82	33	70	0	0	
3.20	4	96	35	70	0	0	Steam escapes outlet Valve 2, good current.
3.21	5	99.5	36	70	0	0	
3.22	6	100	38	70	0	0	
3.23	7	100	41	70	0	0	
3.24	8	100 +	47	70	0	0	
3.25	9	100.2	59	70	0	0	
3.26	10	100.25	74	70	0	0	
3.27	11	100.25	86	70	0	0	
3.28	12	100.25	92	70	0	0	
3.29	13	100.25	95	70	0	0	
3.30	14	100.25	97	70	0	0	
3.31	15	100.25	99	70	0	0	
3.32	16	100.25	100	70	0	0	Valve 2 closed. Pressure rises to 5-lbs. quickly.
3.33	17	108	107	70	8	8	
3.34	18	116	114	70	11.5	11	Pressure valve blowing off slightly.
3.35	19	120	120	70	17	17	
3.36	20	124	124	70	19.75	19.75	
3.37	21	126	126 −	70	20	19.50	
3.38	22	126	126	70	20	19.75	
3.39	23	126	126	70	20	19.75	
3.40	24	126 +	126 +	70	20	19.75	
3.41	25	126	126	70	20	19.75	
3.47	31	126	126.25	70	20	19.75	Valve 3 closed.
3.48	32	126	126	70	19	35	
3.49	33	126 −	126 −	71	19	46	Pressure valve lifting slightly.
3.50	34	125	125	72	18.5	56	
3.52	36	124	124 +	73	17	65	Open Valve 4 to let steam out.
3.53	37	122	122	73	14	64	
3.54	38	118	118	73	9.5	64	
3.55	39	112	112	73.5	4	64	
3.56	40	108	106	74	0	63	
3.57	41	108	102	74	0	62	
3.58	42	109	101 +	73.5	0	61	
3.59	43	111	101 +	73.5	0	60	
4.0	44	113	101	73.5	0	60	
4.1	45	114	101 −	73.5	0	60	
4.2	46	116	100.75	73.5	0	60	Open Valve 2. Door opened.


Temp. Cent.
Steam Pressure 125° lbs. per sq. in.
30° 40° 50° 60° 70° 80° 90° 100° 110° 120°
0 10 20 30 40 50 60 70 80 90
H. M.
3-16
21
26
31
36
41
46
51
56
4 -1
4 -6
CHART VIII. 9. X. 07
Steam pressure in boiler, 70 lbs.
Outlet valve pressure, 20 lbs.
Door closed. Machine warm. Valve No. 2 opened.
Valve No. 3 opened.
Steam escapes at outlet Valve 2. Good current.
Valve No. 2 closed: pressure rises quickly to 5.
Pressure valve blowing off slightly.
Bell rings.
Valve No. 3 closed.
Pressure valve lifting slightly.
Valve No. 4 opened to let steam out.
Valve No. 2 closed. Door opened.
Thermograph—bare bulb.
Steam pressure supply chamber.
covered bulb.
Outlet of coil.

This was regarded as being the crucial experiment, the times for the different stages of the process being calculated from data obtained from a consideration of the construction of the Machine and from a number of actual experiments. The outlet valve was weighted to 20-lbs. ; the steam supply was at 70-lbs.

At 3.16 p.m., the Machine still being warm, the door was closed and Valve No. 2 was opened, the temperature recorded from the exposed thermometer bulb being 52° C., that from the protected bulb 31° C., the pressure in the sterilization chamber was at zero, and that at the coil outlet 58.5-lbs. In a couple of minutes the exposed bulb temperature had risen to 60° C., that of the covered bulb to 33° C. ; Valve No. 3 was then opened. In four minutes, 3.20 p.m., steam was escaping freely at the outlet controlled by Valve No. 2, the exposed bulb temperature had risen to 96° C., and that of the covered bulb to 35° C. At the end of sixteen minutes, 3.32 p.m., Valve No. 2 was closed, the exposed bulb now recording 100.25° C., and the protected one 100° C. The steam supply was at 70-lbs., the pressure at the outlet valve rising quickly to 5-lbs. In eighteen minutes, 3.34 p.m., the exposed bulb temperature was 116° C., of the covered bulb 114° C. The pressure within the chamber was 11½-lbs., and at the outlet 11-lbs., the pressure valve blowing off slightly. In nineteen minutes both thermographs recorded 120° C., the pressure both in the chamber and at the outlet being 17-lbs. In twenty-one minutes the temperature recorded by both thermographs was 126° C. ; steam pressure 70-lbs., the pressure within the chamber 20-lbs., and at the outlet 19½-lbs. In thirty-one minutes, 3.47 p.m., the conditions remaining much the same, Valve No. 3 was closed. In thirty-three minutes the pressure valve was lifting slightly, at thirty-six minutes, 3.52 p.m., the temperature recorded by both thermographs was 124° C., the steam supply being 73-lbs., the pressure within the sterilizing chamber fell to 17-lbs as the steam was let out, the pressure at the coil outlet rising to 65-lbs. In thirty-nine minutes the temperature recorded by both thermographs had fallen to 112° C., the pressure in the chamber to 4-lbs., the external pressure to 64-lbs., the steam pressure in the boiler now being 73.5-lbs. From this point the temperature recorded by the exposed bulb thermograph gradually rose to the end of forty-six minutes, 4.2 p.m., when it was 116° C., the temperature recorded from the covered bulb falling steadily during the same period. Valve No. 2 was now opened, the door thrown open, and the bedding, etc., removed. All the organisms had succumbed. See Table X.

Table X.

Sterilizing experiments with the "Delépine Disinfector."

Experiment 8.

	Minutes Steamed.	Minutes Dried.	Spores from Manure.	Anthrax Spores.					
				1	2	3	4	5	6
Blankets	30	0	–	0	–	0	0	0	0
Bedding	30	0	0	0	0	–	–	0	0
Copper sphere packed tightly with Flock	30	0	0	0	0	–	0	0	0
Controls. No Exposure ..			+	+	+	+	+	+	+

+ = Growth. 0 = No Growth = Disinfection. – = No Experiment.

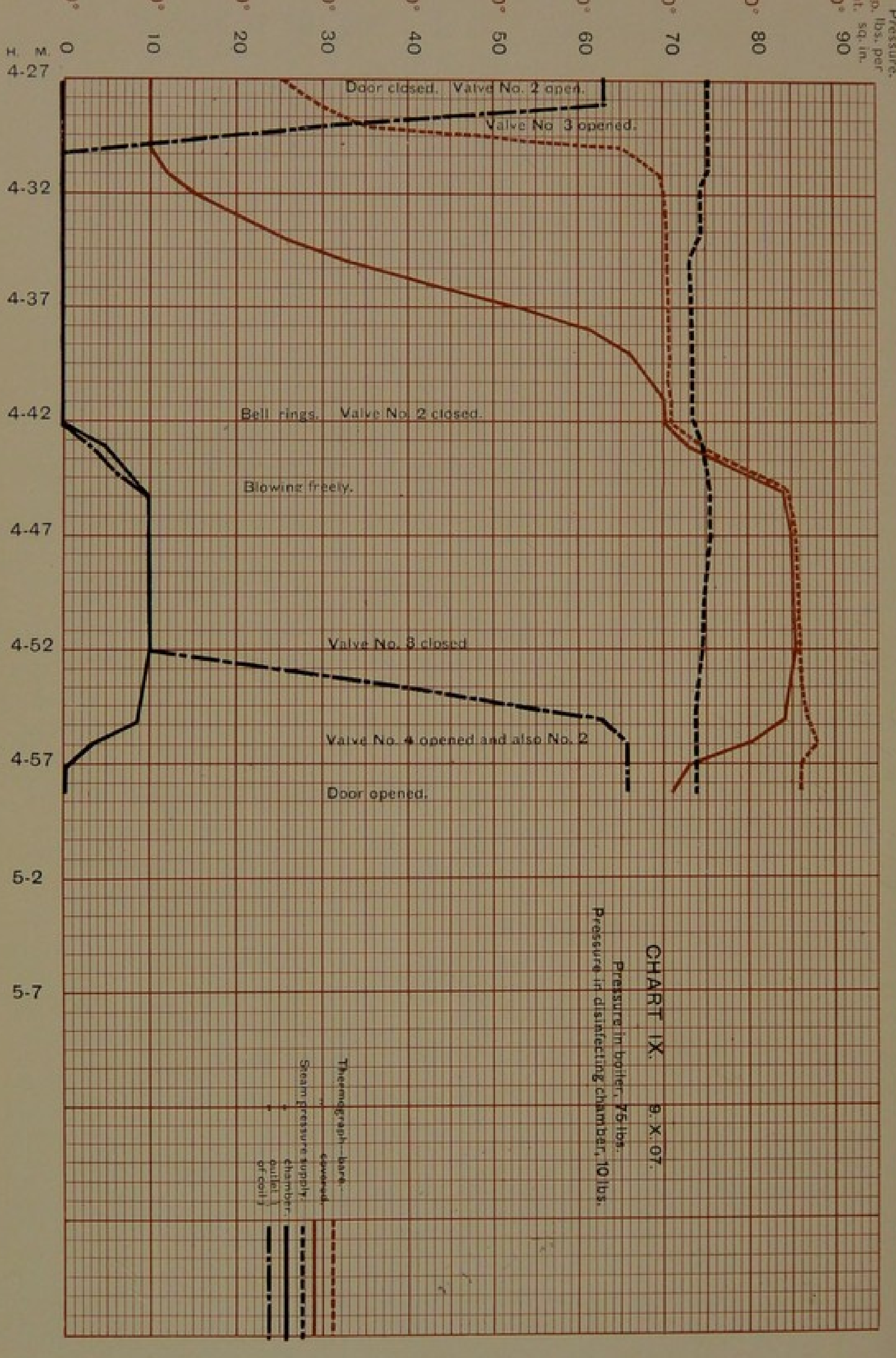
Here again spores contained in manure and earth were placed in the various positions along with the spores on threads, and so thorough was the disinfection that not a single organism remained capable of growing when placed in a nutrient broth.

This was looked upon as being the critical experiment, and the result is, therefore, most satisfactory.

Experiment No. 9.

(See Chart IX.)

Time.	Minutes after Starting.	Thermograph (Centigrade).		Steam Pressure.			Remarks.
		Bare.	Covered.	Supply.	Chamber.	Outlet of Coil.	
4.27	0	56	40	75	0	63	Door closed. Valve 2 open.
4.28	1	60	40	75	0	63	
4.29	2	66	40	75	0	11	Valve 3 open. Steam from pressure valve.
4.30	3	95	40 +	75	0	0	
4.31	4	99.75	42	75	0	0	
4.32	5	100	45	74	0	0	
4.33	6	100	49	74	0	0	
4.34	7	100.25	56	74	0	0	
4.35	8	100.25	63	73	0	0	
4.36	9	100.25	72	73	0	0	
4.37	10	100.25	83	73	0	0	
4.38	11	100.25	91	73	0	0	
4.39	12	100.25	96	73	0	0	
4.40	13	100.25	98	73	0	0	
4.41	14	101	100	73	0	0	Bell rings. Close Valve 2.
4.42	15	101	100.5	73	0	0	
4.43	16	104	103	74	5	4	
4.45	18	114	114	75	10	10	Blowing freely.
4.47	20	115	115	75	10	10	
4.52	25	115.5	115.5	74	10	10	Close Valve 3.
4.55	28	117	114	73	8.5	62	
4.56	29	118	110	73	3.5	65	Open Valve 4. Open Valve 2.
4.57	30	116	102	73	0	65	
4.58	31	116	101	73	0	65	Open door.



Steam-Pressure. lbs. per sq. in.
Temp. Cent.
120° 90
110° 80
100° 70
90° 60
80° 50
70° 40
60° 30
50° 20
40° 10
30° 0
H. M.
4-27
4-32
4-37
4-42
4-47
4-52
4-57
5-2
5-7
Door closed. Valve No. 2 open.
Valve No. 3 opened.
Bell rings. Valve No. 2 closed.
Blowing freely.
Valve No. 3 closed.
Valve No. 4 opened and also No. 2
Door opened.
CHART IX. 9. X. 07.
Pressure in boiler, 75 lbs.
Pressure in disinfecting chamber, 10 lbs.
Thermograph—bare.
" covered.
Steam pressure supply.
" " chamber.
" " outlet (of coil.)

A third Experiment (No. 9) with the outlet-pressure valve set for a pressure of 10-lbs., was carried out the same day, the machine remaining warm from Experiment No. 8. The bedding, etc., with organisms as in the last experiment, was loaded into the sterilizing chamber at 4.27 p.m. with the exposed bulb thermograph recording 56° C., the covered bulb 40° C., the steam supply at a pressure of 75-lbs. ; the pressure in the chamber being at zero, and at the outlet of coil 63-lbs. At the end of two minutes, 4.29 p.m., the temperature recorded from the exposed bulb having risen to 60° C., Valve No. 3 was opened. The temperature rose steadily for fifteen minutes, 4.42 p.m., when the exposed bulb recorded 101° C., and the covered bulb 100.5° C., the contact thermometer bell ringing at this point. A single minute later, sixteen minutes from the start, the temperature still rising slightly, the pressure in the chamber was 5-lbs., at the outlet valve 4-lbs., and at eighteen minutes the temperature recorded by both thermographs had risen to 114° C., the pressure in the sterilization chamber was 10-lbs., and at the outlet, 10-lbs., steam blowing freely from the pressure valve. In twenty-five minutes, 4.52 p.m., the temperature recorded by both thermographs now being 115.5° C., the other conditions remaining stationary, Valve No. 3 was closed. In twenty-nine minutes, 4.56 p.m., Valve No. 4 was opened ; Valve No. 2 was also opened. At this time the temperature recorded from the exposed bulb was 118° C.; from the covered bulb, 110° C. ; steam pressure, 73-lbs. ; pressure in the chamber, 3.5-lbs., and pressure at the outlet, 55-lbs. In thirty-one minutes, 4.58 p.m., the exposed thermograph bulb gave 116° C., the covered bulb 101° C. ; steam supply 73-lbs. ; the pressure in the chamber was at zero, and the outlet pressure 65-lbs. In this case we had no " Manure " spores in the bedding and sphere, and of the spores placed in the blankets all the anthrax spores were killed.

Table XI.

Sterilizing experiment with the " Delépine Disinfector."

	Minutes Steamed.	Minutes Dried.	Spores from Manure.	Anthrax Spores.					
				1	2	3	4	5	6
Blankets	15	0	–	0	–	0	0	0	0
Bedding	15	0		0	0	–	–	0	0
Copper sphere packed tightly with flock	15	0		0	0	–	0	0	0
Control. No Exposure ..	0	0	+	+	+	+	+	+	+

+ = Growth. 0 = No Growth = Disinfection. – = No Experiment.

As we had previously been so thoroughly satisfied with the drying experiments, we thought it unnecessary to make any further observations on this point.

As regards the actual working of the Disinfector it is not necessary that I should lay down any hard and fast rules. The disinfection of various materials will require different treatment, small articles and articles easily penetrated being, of course, much more easily disinfected than heavy and dense articles, but, in both cases, it is evidently merely a question of time. These differences are well shown in the preliminary Experiments 1 to 7 inclusive. In Experiment 8 the time necessary to ensure complete disinfection is demonstrated.

This applies also to the drying process. Large dense objects must have hot air driven through them for a much longer period than small open objects.

As already pointed out, non-spore-bearing test organisms are very easily killed in this apparatus. The spore-bearing organisms obtained from earth and manure and the spores of anthrax bacilli required a greater degree of, or a longer exposure to, heat to kill them off, whilst spore-bearing organisms left in the manure and in the earth required an even greater degree of, or longer exposure to, heat to render them inert. For example, the anthrax spores derived from various sources when exposed on silk threads to steam at 100° C., were killed within a minute, and even when these silk threads were enclosed in the small tubes in which the threads were used throughout this experiment, they were killed within five minutes. The spores of the bacillus isolated from horse manure by Dr. Delépine, dried on silk threads, required a temperature of 100.5° C., continued for from two to two-and-a-half hours to kill them. The same spores imbedded in a quarter gramme of horse manure, and placed in small glass tubes exposed to steam at the same temperature, require from five-and-a-half to eight hours for their complete sterilization, or exposure to saturated steam at 121° C. for fifteen minutes. The earth, which was used in quantities of three grammes, in some cases resisted the temperature of 121° C. for from fifteen to thirty minutes. These two latter substances can scarcely be looked upon as offering a constant and therefore fair test, but in the experiments in which spores contained in the manure and earth were killed, we have a very important indication of the great efficacy of this Disinfecting Apparatus.

Although the accompanying charts give, relatively, fairly accurate record tracings, these must not be accepted as in any way absolute records. They serve, however, to control one another and give a very fair working indication of what takes place.

It is evident, of course, in all these experiments that when steam is turned into the chamber a considerable amount of condensation water is formed as the steam comes in contact with the cool objects, and that whilst saturated steam is passing through the disinfecting chamber, this water of condensation which accumulates in the annular outside the disinfecting chamber cannot be entirely evaporated. As soon, however, as the steam is cut off from the disinfecting chamber, but is still allowed to pass through the coil, the water of condensation must be re-evaporated, and, in time, the whole of it might be taken up again. As this, however, involves very considerable delay, though it prolongs the period of actual sterilization, it is found well in practice to draw off the excess of condensation water, as when that is done drying commences when heated air is passed through the chamber.

Bearing all these facts in mind, and having worked this Disinfector on four separate occasions, I am satisfied that Professor Delépine has devised an apparatus simple to work, highly efficient in its sterilizing capacity, and effective in driving off moisture from the sterilized articles.

Its high efficiency as a sterilizing apparatus is seen from the readiness with which it kills not only the Bacillus Diphtheriæ, the Staphylococcus Pyogenes Aureus, but the resistant spores of the disease-producing Anthrax Bacillus, and the still more highly-resistant spores obtained from stable manure, and even spores embedded in the actual manure and in earth, these latter being very difficult to kill, a fact to which reference has already been made.

7TH MARCH, 1908. (SIGNED) G. SIMS-WOODHEAD.

REPORT

UPON

The Current Saturated Pressure Steam Disinfector.

BY

Professor S. Delépine, M.Sc., M.D., etc.

The Thresh Disinfector Co., Ltd.

BROOK HOUSE, 10–12, WALBROOK

LONDON, E.C.

1. Short Description of the Disinfector.

The photographs and plans give accurate representation of this Disinfector, the essential parts of which are further shown schematically in Diagrams I. and II.

Diagram A is a diagrammatic vertical projection.

Diagram B. is a diagrammatic horizontal projection in which the relation of the various pipes to the disinfecting chamber *X* are shown.

In both diagrams the pipes *a b c d e f* connected with the boiler in which steam is generated are tinted; it is in these pipes that the steam reaches its highest pressure.

The pipes shaded with black line *g h* are outlet pipes through which air and steam escape at various times from the disinfecting chamber.

The Disinfector consists of an external and of an internal cylinder; between the two cylinders is an annular space *Y* communicating by a large opening *S*, with the cavity of the internal cylinder *X*, which is the disinfecting chamber.

When the doors *m* and *n* are closed, the internal cylinder *X*, and annular space *Y*, are closed at the same time, but still communicate freely through the opening *S*, which is close to the door *n*, through which disinfected articles are removed at the end of a disinfection operation.

In the annular space *Y*, and quite close to the outer cylinder, is fixed a spiral tube *b b* extending from one end to the other of the Machine. For brevity the spiral tube is called the coil. Close to door *m*, through which articles to be disinfected are introduced into the disinfecting chamber, one end of the coil is connected by the pipe *a a* with the boiler.

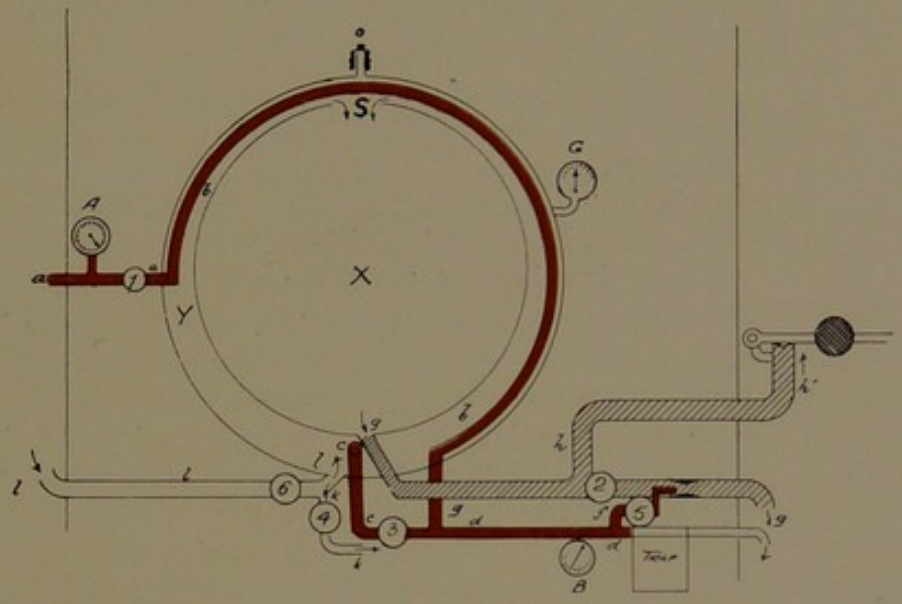
Near door *n*, the other end of the coil passes out of the outer cylinder and divides into two branches, *c* and *d*.

Branch *c* re-enters the outer cylinder, and extends longitudinally to the other end of the annular space, resting upon the lowermost part of the coil. This pipe has a series of perforations arranged so as to direct steam escaping from pipe *c* against the various turns of the coil. When pipe *c* is closed, the steam, instead of passing into the Disinfector, is carried by pipes *d* and *c* to a steam trap. Pipe *d* is also connected with steam jet *f* of the steam injector.

At the lower part of the outer cylinder, near door *m* (infected end), is situated the opening of pipe *l l*, through which air may be admitted to the annular space *Y*. A branch *k k* issues from this pipe *l l* quite close to the body of the Machine, this pipe serves for drawing off any water of condensation which may have accumulated in the annular space during the disinfecting operation.

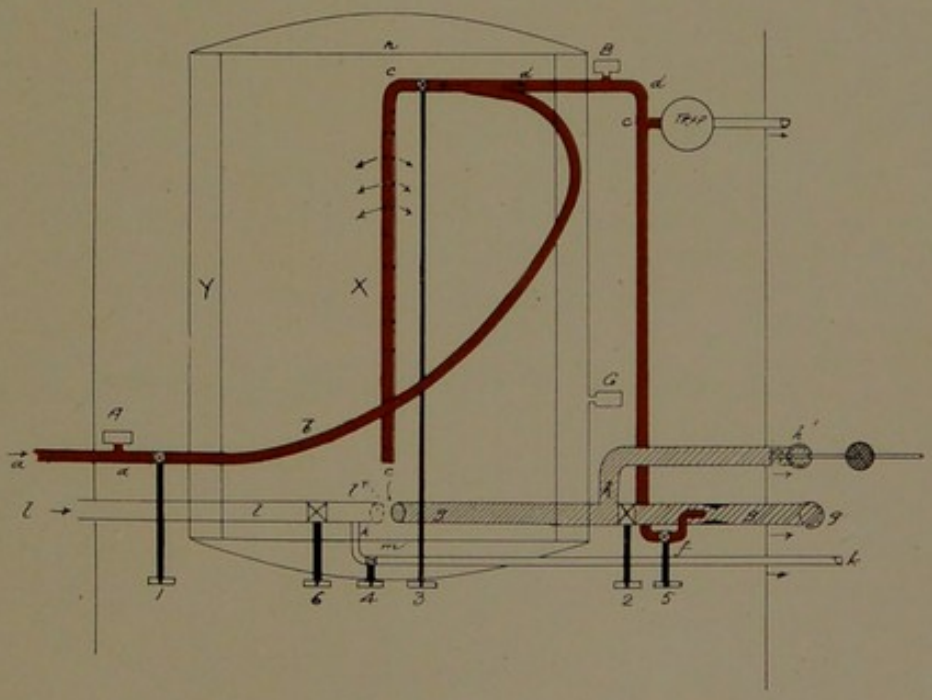
At the lower part of the inner cylinder, and also close to door *m*, is the opening of the outlet pipe *g g*, already mentioned. A large pipe *h h* branches out of pipe *g g*, and the outer end of this branch is guarded by a lever pressure valve *h'*, by which the pressure of the steam in chamber *X* can be regulated. At the upper part of the external cylinder is an additional safety valve *O*.

A



Sectional Elevation.

B



Sectional Plan.

These various pipes are controlled by six valves which act, as described below :—

VALVE 1 (on pipe *a a*).—When opened, admits steam from boiler to coil *b b*.

VALVE 2 (on pipe *g g*).—When opened, allows air, steam, or both to escape from chamber *X*.

When closed the steam is forced into pipe *h h*, and has to overcome the resistance of the pressure valve *h'* before escaping.

VALVE 3 (on pipe *C C*).—When opened, allows steam to pass into the annular space *Y* through the perforations in pipes *C C*. (When this valve is opened, Valves 5 and 6 are always closed.)

When Valve 3 is closed, the steam is forced into pipe *d*, and is held up by the trap unless allowed to escape through pipe *f* supplying the steam ejector.

VALVE 4 (on pipe *k k*).—When opened (Valve 6 being closed), allows any water of condensation to escape from the annular space *Y* after disinfection, and before drying.

VALVE 5 (on pipe *f*).—When opened, sets the steam ejector working, and when Valves 2 and 6 are opened, a current of air passes through the annular space *Y*, and then through chamber *X* by way of the opening *S*.

VALVE 6 (on pipe *l l*).—When opened, allows air to enter the annular space *Y*, where it is heated by passing over coil *b b*, before entering the chamber *X* at *S*.

The manometers *A B G*, shown in the diagrams, were used for experimental purposes ; manometer *G*, indicating the pressure of steam in the Disinfector, is the only one which is useful in practice. A recording thermometer with covered bulb would, however, be of greater use and sufficient to control the operations.

The theoretical considerations and experimental data, which have led to the designing of this type of Disinfector, are fully explained in the introduction.

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2. Method of Working the Disinfector.

Boilers in which steam is generated under pressures of, say, 30-lbs. to 100-lbs., may safely be connected with the coil through pipe *a a*. An abundant supply of steam is desirable. By setting the pressure valve *h'*, for any pressure between 0-lbs. and 20-lbs., the desired pressure of steam is obtained in the disinfecting chamber *X*. It will be noted that no reducing valve is needed.

A disinfecting operation is conducted as follows :—

ALL THE VALVES BEING CLOSED, the pressure valve *h'* is set for the required pressure (generally 15-lbs.). Valve 1 is opened to admit steam to the coil. In less than ten minutes the coil is full of steam at a pressure a few pounds lower than that of the steam in the boiler. The steam and condense at this stage pass into the steam trap. (By opening Valve 5 and driving the water of condensation out of the coil direct, instead of through the trap, the coil is charged with steam much more rapidly, but this is unnecessary in ordinary practice.)

Whilst this is going on the Machine is loaded, care being taken to leave spaces between bulky articles such as mattresses.

The doors are closed.

Valve 2 is opened to let air out, and Valve 3 is opened to admit steam to the disinfecting chamber. This steam in pipe *C* is under pressure, and in passing out of this pipe into space *Y*, which is at ordinary atmospheric pressure, it condenses in the form of a spray of steam and hot water; this spray is directed through the holes in pipe *C*, against the hot coil, on which the water of condensation (which is at a temperature of nearly 100° C.) is immediately and almost entirely re-evaporated. The steam is at first mixed with air, and after passing from space *Y* into chamber *X*, it escapes through tube *g g*. The steam being generated rapidly, displaces the air very speedily.

When the disinfecting chamber is full of saturated steam, free from air, the temperature indicated by the thermometer remains fixed between 100° C. and 101° C., if Valve 2 is fully opened. When the steam has remained for ten minutes at that temperature, it can be safely assumed that it has penetrated to the centre of the thickest mattress.

Valve 2 is now closed, and the steam confined until it reaches a pressure sufficient to overcome the resistance of Valve *h'*; after this, the temperature becomes practically constant again, and corresponds to the pressure fixed by Valve *h'*. After allowing steam at the desired pressure to act for a sufficient time (say twenty minutes to twenty-five minutes) Valve 3 is closed again, and the water of condensation which has accumulated in annular space *Y*, and which is always nearly at boiling point, is now for the most part re-evaporated, owing to its being heated by the coil; ten minutes after Valve 3 has been closed, very little water of condensation remains, and to remove what may be left, Valve 4 is opened. This allows the water of condensation referred to, and at the same time steam in chamber *X*, to escape, and the pressure falls rapidly to O in the disinfecting chamber. At this stage the door may be opened, and thin articles, such as clothes, sheets, blankets, etc., may be removed from the Disinfector; these, if shaken at once and hung in a dry, well-ventilated place, will be quite dry a few minutes after removal. Mattresses, pillows, etc., treated in the same way take a few hours to dry completely. It is for the purpose of more rapidly drying such bulky articles that arrangements have been made for the induction of a current of hot air through the disinfecting chamber. For this purpose Valves 2, 5, and 6 are opened; Valve 5 starts the ejector causing the steam contained in the chamber to pass into the outlet pipe *g g*. The steam is replaced by air admitted through pipe *l l*. This air is heated by the coil during its passage through the annular space. Mattresses may be dried by leaving them in the hot Disinfector, with one door slightly opened. The pipes are arranged so that all the steam, as well as the water of condensation, is taken out of the rooms where operations are conducted, so that no inconvenience may be caused to the operator.

All the valves, clearly numbered, are at one end of the Disinfector.

The attendant before passing to the "disinfected" side should remove his overall, and wash, and disinfect himself. He afterwards removes the articles disinfected through door *n*, and quickly spreads or hangs them until they are quite cold. The room in which this is done

should be quite clean, dry, and well ventilated. When convenient, it is advantageous to cause the pipe supplying steam to the coil to pass through this room. If a special boiler is needed, it may be placed in such a way as to heat this drying chamber.

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3. Experimental Testing of the Working of the Disinfector.

The Tables and the eight sets of curves reproduced here (pages LX. to LXXIX.) show that with supplies of steam at various pressures it is easy to fill the disinfecting chamber with saturated steam at any pressure between 0-lbs. and 20-lbs.

XII.—With supply at 30-lbs. pressure, steam at pressure of 0-lbs. to 5-lbs. was obtained.

XXVI.—With supply at 73-lbs. to 75-lbs. pressure, steam at pressure of 0-lbs. to 10-lbs. was obtained.

XXIII.—With supply at 60-lbs. to 75-lbs. pressure, steam at pressure of 0-lbs. to 15-lbs. was obtained.

XXIV.—With supply at 65-lbs. to 75-lbs. pressure, steam at pressure of 0-lbs. to 15-lbs. was obtained.

XXV.—With supply at 70-lbs. to 74-lbs. pressure, steam at pressure of 0-lbs. to 20-lbs. was obtained.

XVIII.—With supply at 28-lbs. to 32-lbs. pressure, steam at pressure of 0-lbs. to 20-lbs. was obtained.

XXI.—With supply at 75-lbs. pressure, steam at pressure of 0-lbs. to 20.5-lbs. was obtained.

XX.—With supply at 70-lbs. to 75-lbs. pressure, steam at pressure of 0-lbs. to 22-lbs. was obtained.

These diagrams have been carefully made from observations taken at short intervals (generally of one minute). The black line shows the temperature indicated by a thermometer, the bare bulb of which was exposed in the disinfecting chamber at a distance of about 1-ft. from the walls of same.

The brown line shows the temperature indicated by a thermometer, the bulb of which was covered by sixteen layers of blanket, tightly rolled, or by a layer of 5-in. of flock, tightly packed. The bulb of the thermometer was in the centre of a copper sphere, 10-ins. in diameter, containing 1½-lbs. of flock; two lateral openings with wire gauze doors allowed the sphere to be packed with flock, and the steam to penetrate it. I have devised this sphere for the purpose of making penetration experiments more accurately comparable than when mattresses or blankets are used.

The pressure of steam in the supply pipe from the boiler; the pressure in pipe *d* at the outlet of the coil; and the pressure in the disinfecting chamber, are also indicated.

To make easy the comparison of the pressure of steam, and of the temperature in the disinfecting chamber, the space between the horizontal line corresponding to 100° C. and the temperature curve is shaded, and in similar fashion the space between the horizontal line corresponding to 0-lbs. pressure and the line indicating the pressure of steam in the disinfecting chamber is also shaded.

The curves show clearly :—

(1) that the pressure of steam in the disinfecting chamber is quite independent of the pressure in the supply pipe (except that it is always lower).

(2) that the temperature in the chamber corresponds to that which saturated steam should have at the pressures reached in the chamber. (Slight irregularities in some of the curves are due to the difficulty of making at short intervals, a number of readings of temperatures and pressures, and also to slight imperfections in the recording instruments, which lead to errors, and cannot be accurately corrected in all cases).

(3) that the temperature indicated by the covered bulb is exactly the same as that of the bare bulb, after a short preliminary period during which air is being expelled from the blanket, or flock, surrounding the covered bulb. After the temperature in the chamber has reached 100° C. penetration to the centre of 10-in. of flock requires not more than ten minutes. I have previously shown, by direct experiments, that when the temperature of the central parts of a roll of blanket, surrounded by current saturated steam at 100° C. has reached the same temperature, no material amount of air remains in the blanket.

(4) that the air admitted to the Machine at the end of disinfection is sufficiently heated, by passing over coil, to maintain in the chamber a temperature ranging between 115° C. and 120° C. (Experiments XX., XXI., and XXIV.).

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4. Bacterial Tests.

These tests were conducted as follows :—Bacteria of known resistance, and prepared as explained below, were placed (1) in the centre of a heavy mattress rolled upon itself and tied firmly ; (2) in the centre of rolls of blanket tied tightly ; (3) in the centre of bundles of workmen's clothing ; (4) in the centre of the copper sphere filled with flock, used also to test the penetration of steam (see above). These articles were then placed in the disinfecting chamber, and submitted to disinfection.

A number of experiments were made on a practical scale to test the efficiency of the Disinfector, and to determine the duration of the exposures which were required to secure :—

A.—Disinfection under ordinary circumstances.

B.—Sterilization of objects contaminated with bacteria of a resistance exceeding that of all known disease-producing bacteria. It will not be necessary to refer to experiments made with non-sporing pathogenic microbes, which were invariably killed in a much shorter time than the following sporing bacteria :—

1. Spores of anthrax bacilli dried on silk threads. The threads were placed in small glass tubes closed at one end and plugged with cotton wool at the other end. When contained in such tubes, and quite dry, these anthrax threads required for disinfection an exposure of three to five minutes to saturated steam at 100.5° C.

2. Spores of bacilli found in horse manure. These spores, treated in the same way as the anthrax spores, required an exposure to steam at 100.5° C. of not less than two to two-and-a-half hours before they were killed.

3. Manure containing the above spores. A quarter gramme of this manure contained in small tubes as described could not be sterilized by an exposure of less than five-and-a-half hours to steam at 100.5° C., and sometimes resisted for eight hours.

4. Earth containing highly-resistant spores of earth bacilli. Fairly large quantities of this earth, two grammes to 3 grammes were used, the results were variable, and when this material was tested in the same way as the manure, it generally proved more resistant than the manure. This was due to the fact that when steam reached the soil some gas was generated, owing to the composition of the soil, and it is not a factor that has to be usually allowed for in practical disinfection.

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5. Tabulated and Graphic Records of Eight Typical Experiments.

As observations were generally taken at one minute intervals, full tabulated records would occupy much space, and be difficult to read. I have therefore given only one full record (Experiment XVIII.); in the other Tables I have given only the temperatures and pressures which were of special interest.

The curves, constructed on the basis of the actual records, supply all the information which would be found in long tables. The thermographic records are also reproduced in regard to Experiment XXIII., because the direct observations made during such Experiment were not sufficiently numerous to allow of a satisfactory curve being constructed. Record XXV. is given for comparison with the constructed curve.

The thermographic tracings were taken on two different drums. In tracing XXIII. the original tracing of covered bulb thermometer has been accurately transferred to the sheet on which is the original tracing of the bare bulb thermometer; in tracing XXV. the reverse has been done. As the motions of the drums were not absolutely constant, the time cannot be reckoned with great accuracy by the examination of these curves; but the error due to this cause is slight. A more serious source of error is due to the unequal friction of the pens; it is almost impossible to make this friction absolutely equal in two instruments, or at each position of the lever in a single instrument. Another difficulty is due to the fact that the error of both instruments is not the same at all temperatures. None of these sources of error are, however, sufficiently great to obscure the remarkable correspondence between the various parts of the curves, or between the automatically-traced curves and those constructed on the basis of direct observation.

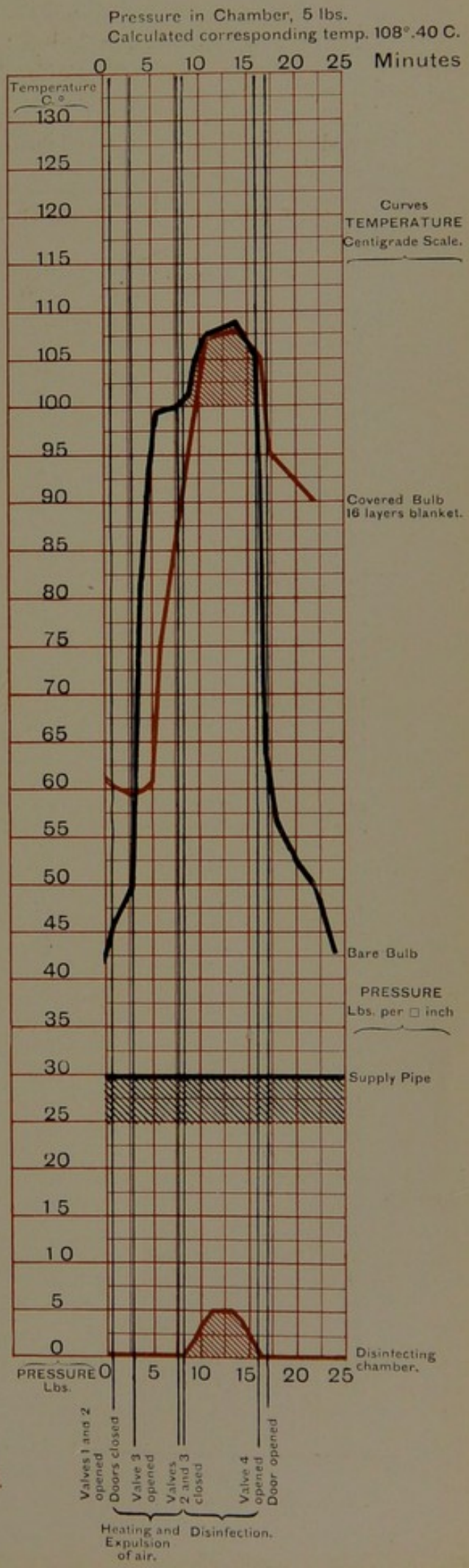
Experiment XII.

Steam supply, 28-lbs. to 32-lbs.; maximum pressure in chamber, 5-lbs.

July 11th, 1907, THORNCLIFFE.

The Machine was not completely finished. The object of this experiment was to ascertain whether the Disinfector could easily be used as a low-pressure disinfector without the steam being superheated by the coil.

The experiment showed that the Disinfector could be used safely as a low-pressure disinfector—subsequent experiments confirmed this; it will be noticed on comparing the various curves that during the first period of the operations the steam in the disinfecting chamber remains at the ordinary atmospheric pressure (or very slightly above it) and at the corresponding temperature, as long as Valve 3 is not made to act. In this experiment the pressure valve was made to act before the air was completely expelled from the Disinfector; this accounts for the time taken by the covered bulb to reach the temperature of the bare bulb. (Compare with Curves XXIII., XXIV., XXV., and XXVI., which show the results obtained when air is completely expelled).



Experiment XVIII.

Steam supply, 28-lbs. to 32-lbs. ; maximum pressure in chamber, 20-lbs.

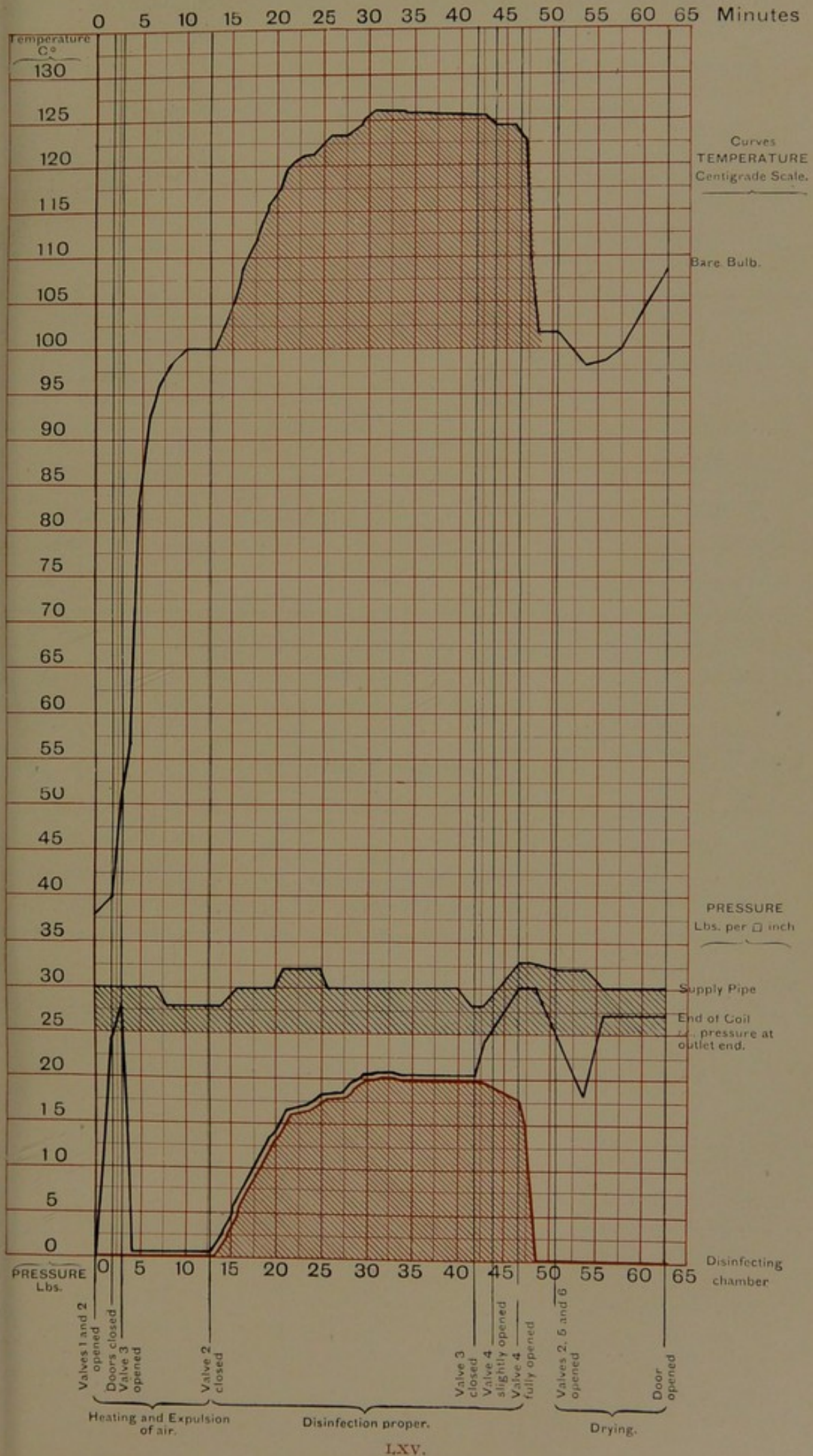
July 23rd, 1907.—THORNCLIFFE.

Pressure valve unfinished and difficult to adjust. This experiment had chiefly for object to determine whether a steady pressure of 20-lbs. could be obtained in the disinfecting chamber, with a steam supply at about 30-lbs.

Time in Minutes.	Temperature.		Pressure, lbs.			OPERATIONS.		REMARKS.
	F°	C° Approximate.	Supply at Coil Inlet.	Disinfecting Chamb'r	Outlet of Coil.			
0	100	37.7	28	0	0	Valves 1 and 2 opened. Machine loaded.	Heating and Driving Air Out.	Machine still warm on account of previous experiment.
2	104	39.9	30	0	24	Doors closed.		A " Richard " recording thermometer with a Fahrenheit graduation used in this experiment. The temperature in Centigrade scale was calculated approximately.
3	122	50.02	30	0	28	Valve 3 opened.		
4	134	56.74	30	0	0			
5	178	82.78	30	0	0			
6	198	92.58	30	0	0			
7	204	95.94	—	0	0			
8	208	98.18	28	0	0			
9	211	99.28	28	0	0			
10	212	100	28	0	0			
11	212.5	100.28	28	0	0			
13	212.5	100.28	28	0	0	Valve 2 closed.		Unfinished valve adjusted approximately for a pressure of 20-lbs.
14	216	102.24	28	1	1 –		Disinfection Period.	
15	220	104.44	29	3	3			
16	226	108.04	36	5	4+			
17	230	110.28	30	7	7			
18	234	112.52	30	9	9			
19	239	115.28	30	11	11			
20	242	116.7	30	12.5	12.5			
21	246	119.46	32	14	14			
22	249	120.7	32	16	16			
23	250	121.2	32	—	—			
24	250	121.2	32	16.5	16			
25	252	122.32	32	17	17			
26	254	123.34	30	17.7	17.7			
27	254.5	123.6	30	17.7	17.7			Valve blows off too easily, and is slightly weighted.
28	254.5	123.6	30	18	18			
29	256	124.46	30	19	19			
30	257.5	125.5	30	19.7	19.7			
31	258.5	126	30	19.7	19.7			
32	259.1	126.3	30	20	20			
34	259.1	126.3	30	19.8	19.8			
42	258	126	28	19.7	19.7	Valve 3 closed.		
43	258	126	28	19.5	24			
44	256	124.44	—	—	—	Valve 4 opened gradually.		
46	256	124.44	—	—	—		Drying.	
47	254	123.34	33	18	30			
48	230	110.28	33	14	30			
49	216	102.24	—	0	—	Valve 2 opened.		Valves not yet regulated.
51	216	102.24	32	0	—	Valve 5 opened.		Current of air too rapid.
54	208	98.18	32	0	18	Valves 2 and 5 closed.		
56	210	98.8	—	0	—			
58	212	100	30	0	27			
63	226	108.4	—	0	—	Doors opened ; articles taken out.		

EXPERIMENT XVIII.

Pressure in Chamber, 20 lbs.
Calculated corresponding temperature, 126°C.



Experiment XVIII.—*Continued*

Bacterial Tests.

After disinfection, threads loaded with spores incubated in bouillon at 37° C. for 14 days.

Evidence of growth indicated in Table as follows :—

Spores used for Testing.	Positions of Infected Threads during Disinfection.			Controls.
	Mattress, 46-lbs. 6½-ozs. Threads at depth of 9-in. from surface.	Blankets rolled 24 to 48 folds—7-lbs. 5½-ozs. Tests from 3 to 6-in. from surface.	Blanket rolled 16 folds. Tests 2-in. from surface.	Not exposed to steam.
Spores of bacillus from horse manure dried on threads :—				
A.—Old spores	o	o	o	+++
B.—Young spores ..	o	o	o	+++

+++ = Abundant Growth. o = Sterilization.

Drying Tests.

One mattress, two pillows, three blankets, bundle of clothes, placed in disinfecting chamber :—

Total weight before disinfection .. .. .. 69-lbs. 3-ozs.
„ „ immediately after .. .. .. 71-lbs. 0½-ozs.
„ „ 30 minutes after removal .. 69-lbs. 0½-ozs.

Two Typical Drying Experiments.

		Experiment XVII. Saturated Dry Steam.	Experiment XVIII. Saturated Dry Steam
DRYING.	Duration of drying after Valve 4 opened and pressure fallen to 0-lbs.	39 minutes.	14 minutes.
	Temperature when pressure fallen to 0-lbs.	109°	102°
	Temperature when doors opened	119°	108.4°
	Pressure in coil during drying	75-lbs.	30–33-lbs.
ARTICLES CONTAINED IN THE DISINFECTING CHAMBER.	FLOCK MATTRESS.		
	Weight when artificially dried by heat for a whole night	45-lbs. 12½-ozs.	45-lbs. 12½-ozs.
	Weight before operation *	46-lbs. 7-ozs.	46-lbs. 6½-ozs.
	,, immediately after operation	47-lbs. 0-ozs.	47-lbs. 10½-ozs.
	,, 20 to 30 minutes after operation	46-lbs. 6½-ozs.	—
	,, 1 hour to 1 hour 30 minutes after operation	—	46-lbs. 5½-ozs.
	PILLOWS.		
	Weight before operation	9-lbs. 7-ozs.	9-lbs. 6½-ozs.
	,, immediately after operation	9-lbs. 7-ozs.	9-lbs. 9½-ozs.
	,, 10 minutes after operation	9-lbs. 6½-ozs.	—
	,, 30 minutes after operation	—	9-lbs. 5½-ozs.
	BLANKETS & QUILTS.		
	Weight before operation	7-lbs. 6½-ozs.	7-lbs. 5½-ozs.
	,, immediately after operation	7-lbs. 8-ozs.	7-lbs. 10-ozs.
	,, 15 minutes after operation	7-lbs. 5½-ozs.	—
	,, 30 minutes after operation	—	7-lbs. 4½-ozs.
	CLOTHES.		
	Weight before operation	6-lbs. 2-ozs.	6-lbs. 0½-oz.
	,, immediately after operation	6-lbs. 1½-ozs.	6-lbs. 2½-ozs.
	,, 10 minutes after operation	6-lbs. 0½-oz.	—
	,, 30 minutes after operation	—	6-lbs. 1-oz.

	Expt. XVII. lbs.	ozs.	Gain or Loss. %	Expt. XVIII. lbs.	ozs.	Gain or Loss. %
A. Total weight of charge before operation	69	6½	—	69	3	—
B. Total weight of charge immediately after operation	70	0¼	+0.9	71	0½	+2.7
C. Total weight of charge half to two hours after operation	69	3	−0.3	69	0½	−0.23

Gain + or loss − % shown after the actual weights.

* The mattress, after being thoroughly dried, gained 10½-ozs. when exposed to ordinary air. The mattress was therefore at the beginning of the operation in the state in which it would have been when in use. The weight of a mattress is materially affected by the amount of moisture in the air.

Experiment XX.

Steam supply, 70-lbs.; pressure in chamber, 20-lbs.

September 27th, 1907.—THORNCLIFFE.

The pressure valve was not quite finished, and was difficult to adjust. The pressure rose to 22-lbs. for a short time, while the weight was being adjusted.

Time. Mins.	Temperature. II. Bare Bulb. C°	Temperature. I. Covered Bulb C°	Pressure. Inlet of Coil, lbs. 10-in. Sphere.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil, lbs.	OPERATIONS.	REMARKS.
0	21	22.5	70	0	0	Valves 1 and 2 opened. Doors closed.	In this experiment the bare bulb of thermometer II. was accidentally forced out of place when the machine was loaded and was within 3-in., (probably not more than 2-in.) from the inner cylinder, *i.e.*, in a region where slight superheating of steam occurs.
15	48	23.5	74	0	62.5	Valve 3 opened.	
20	101	27	72	0	0		
25	102.5	80	70	0	0	Valve 2 closed.	The records given by Thermometer II. are also liable to be 2° too high at 125° to 130 C.
26	111	103	70	6	6		Contact Thermometer in centre of mattress rings.
28	121	115	70	14	13.5	Disinfection.	
33	131	126	70	22	21		Weight on valve reduced.
42	130	128	70	20.75	19.75	Valve 3 closed.	
52	124	123	74	14	68	Valve 4 opened gradually.	Condensation water 2-lbs. 5-ozs.
60	108	102	75	0	54	Valve 5 opened; Valve 2 five turns.	
69	117	94.5	75	0	47	Valve 5 closed. Doors opened.	Complete drying not attempted.

Bacterial Tests.

Evidence of growth after three weeks' incubation (of disinfected threads) in broth.

TEST OBJECTS.	Mattress 60-in. circ. 46-lbs. Tests 9-in. from surface	Sphere, 4-lbs. Tests 5-in. from surface	Blanket, 16 folds, 4-lbs. 10-ozs. Tests 2-in. from surface	Controls. 48 hours.
Manure 177	0	0	0	+++
Spores from Manure 177	0	0	0	+++
,, of Bacillus Anthracis .. 175	0	0	0	+++
,, ,, ,, ,, .. 120	0	0	0	+++
,, ,, ,, ,, .. 4	0	0	0	+++
,, ,, ,, ,, .. 2	0	0	0	+++
,, ,, ,, ,, .. 1	0	0	0	+++

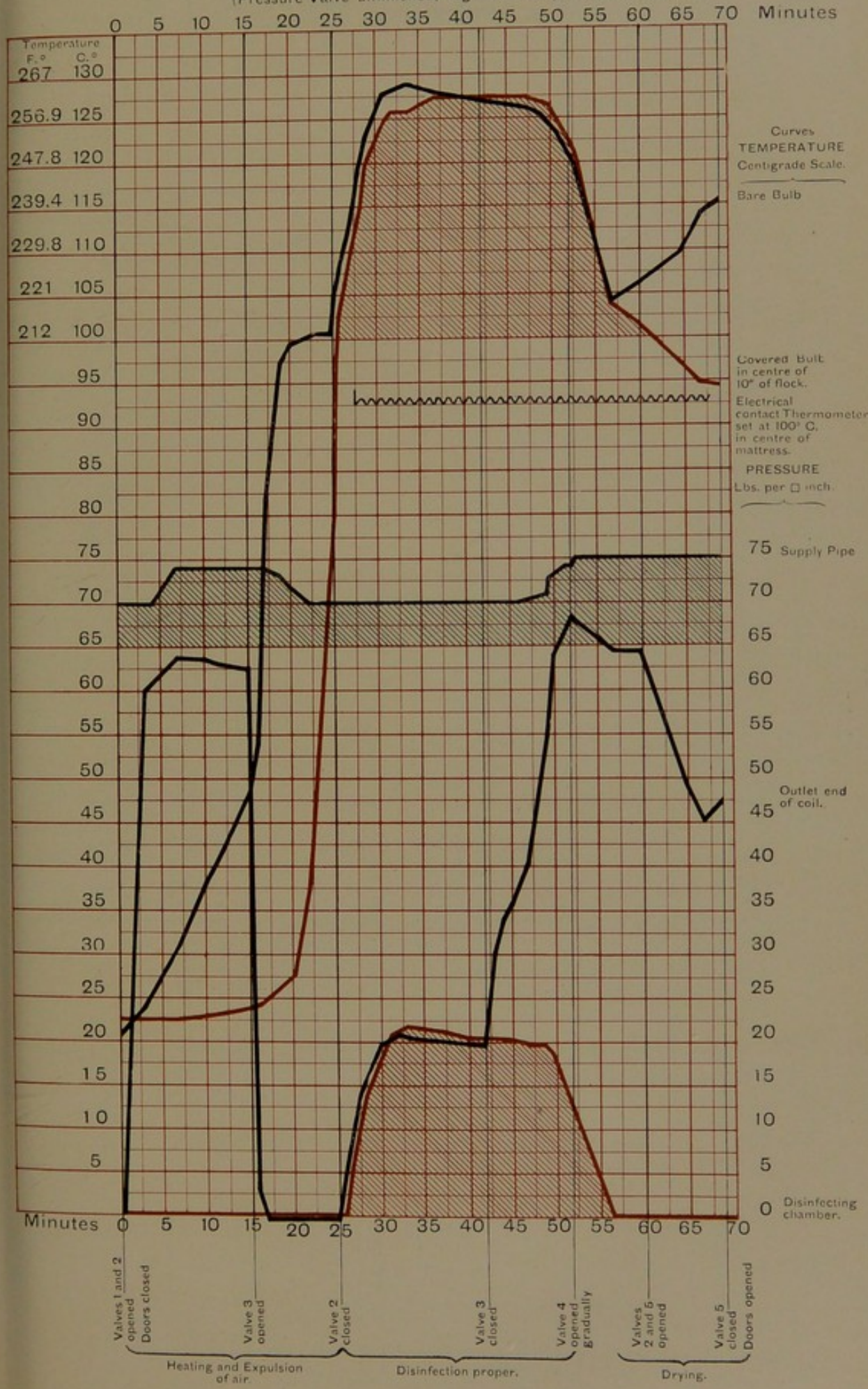
+++=Abundant Growth. 0= Sterilization.

Disinfection complete to a depth of 9-in. of flock.

EXPERIMENT XX.

Maximum Pressure in Chamber, 22 lbs.
Calculated corresponding temperature, 127°.8 C.

(Pressure Valve unfinished, regulation of pressure imperfect.)



Experiment XXI.

Steam supply, 75-lbs. ; pressure in chamber, 20-lbs.

September 27th, 1907.—THORNCLIFFE.

Disinfector warm from previous experiments; two or three minutes to be added to times recorded below.

Time. Mins.	I. Temperature. Bare Bulb. C°	II. Temperature. Covered Bulb C° 10-in. Sphere.	Pressure. Inlet of Coil. lbs.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil. lbs.	OPERATIONS.	REMARKS.
0	33	33	75	0	0	Valve 1 opened. Doors closed.	
11	54	34	75	0	64.5	Valves 2 and 3 opened.	
14	100	39	75	0	0	Valve 2 closed.	
21	102	97	75	0	0		
22	104	102	75	3	3		Contact Thermometer in centre of mattress rings.
28	128	129	75	20.5	20		
35	128	129	75	20.25	20	Valve 3 closed.	
41	125.5	126	75	17.5	67	Valve 4 opened.	Condensation water 2-lbs. 7-ozs.
54	111.5	103.2	75	0	57	Valve 5 opened ; Valve 2 five turns ; large air inlet after two minutes.	
89	121	89	75	0	58	Valve 5 closed. Doors opened.	

Bacterial Tests.

(Evidence of growth after three weeks' incubation).

TEST OBJECTS.	Mattress 46-lbs. Tests 9-in. from surface.	10-in. Sphere 4-lbs. Tests 5-in. from surface.	Blanket, 16-folds, Tests 2-in. from surface.	Controls.
Manure .. .. No. 177	0	0	0	+++
Spores from Manure .. ,, 177	0	0	0	+++
,, of Bacillus Anthracis ,, 175	0	0	0	+++
,, ,, ,, ,, ,, 120	0	–	0	+++
,, ,, ,, ,, ,, 4	0	0	0	+++
,, ,, ,, ,, ,, 2	0	–	0	+++
,, ,, ,, ,, ,, 1	0	0	0	+++

+++ = Abundant Growth. 0 = No Growth = Disinfection. – = No Experiment.

Disinfection complete to a depth of 9-in. of flock.


EXPERIMENT XXI
Pressure in Chamber, 20.5 lbs.
Calculated corresponding temperature, 126°.4 C.
Pressure Valve unfinished.
Minutes
Temperature F.° C.°
267 130
256.9 125
247.8 120
239.4 115
229.8 110
221 105
212 100
Curves
TEMPERATURE
Centigrade Scale.
Bare Bulb.
(Black)
Electrical contact Thermometer set at 100° C. in centre of mattress.
Covered Bulb in centre of 10" flock.
(Brown)
PRESSURE
Lbs. per □ inch
Supply Pipe
Outlet end of coil.
Disinfecting chamber.
Valve 1 opened
Doors closed
Valves 2 and 3 opened
Valve 2 closed
Valve 3 closed
Valve 4 opened gradually
Valves 2 and 5 opened
5 closed
6 opened
Valve 5 closed
Doors opened
Heating and Expulsion of air.
Disinfection proper.
Drying.

Experiment XXIII.

Steam supply, 75-lbs.; pressure in chamber, 15-lbs.

October 2nd, 1907—(Experiment 1).—THORNCLIFFE (Professor G. S. Woodhead present).

Disinfector still warm, two hours forty minutes after the end of a previous experiment.

A few minutes (two to five) should be added to the times recorded below in order to allow for the rise from 20% to 30% C.

Time. Mins.	I. Temperature. Bare Bulb. C°	II. Temperature. Covered Bulb C° 10-in. Sphere.	Pressure. Inlet of Coil. lbs.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil. lbs.	OPERATIONS.	REMARKS.
0	30	28	75	0	0	Valve 1 opened. Doors closed.	
10	50	29	75	0	63	Valve 3 opened.	
15	100	34	75	0	0		
25	102	95	75	0	0	Valve 2 closed.	
26	107	100	75	6	6		
30	122	120	70	15	14½		
35	122	122	70	15	14½	Valve 3 closed.	
45	114	114	70	8	56	Valve 4 opened gradually.	Water of condensation, 2-lbs. 5-ozs.
50	102	102	65	0	46	Valve 5 opened; Valve 2 five turns, also air inlet.	
71	116.5	86	60	0	41	Valve 5 closed. Doors opened.	

Exposure of bulb protected by 5-in. of flock before Valve 4 was opened:—To steam 100° C. .. .. .. 19 minutes.
,, 120° C. .. .. .. 6 ,,

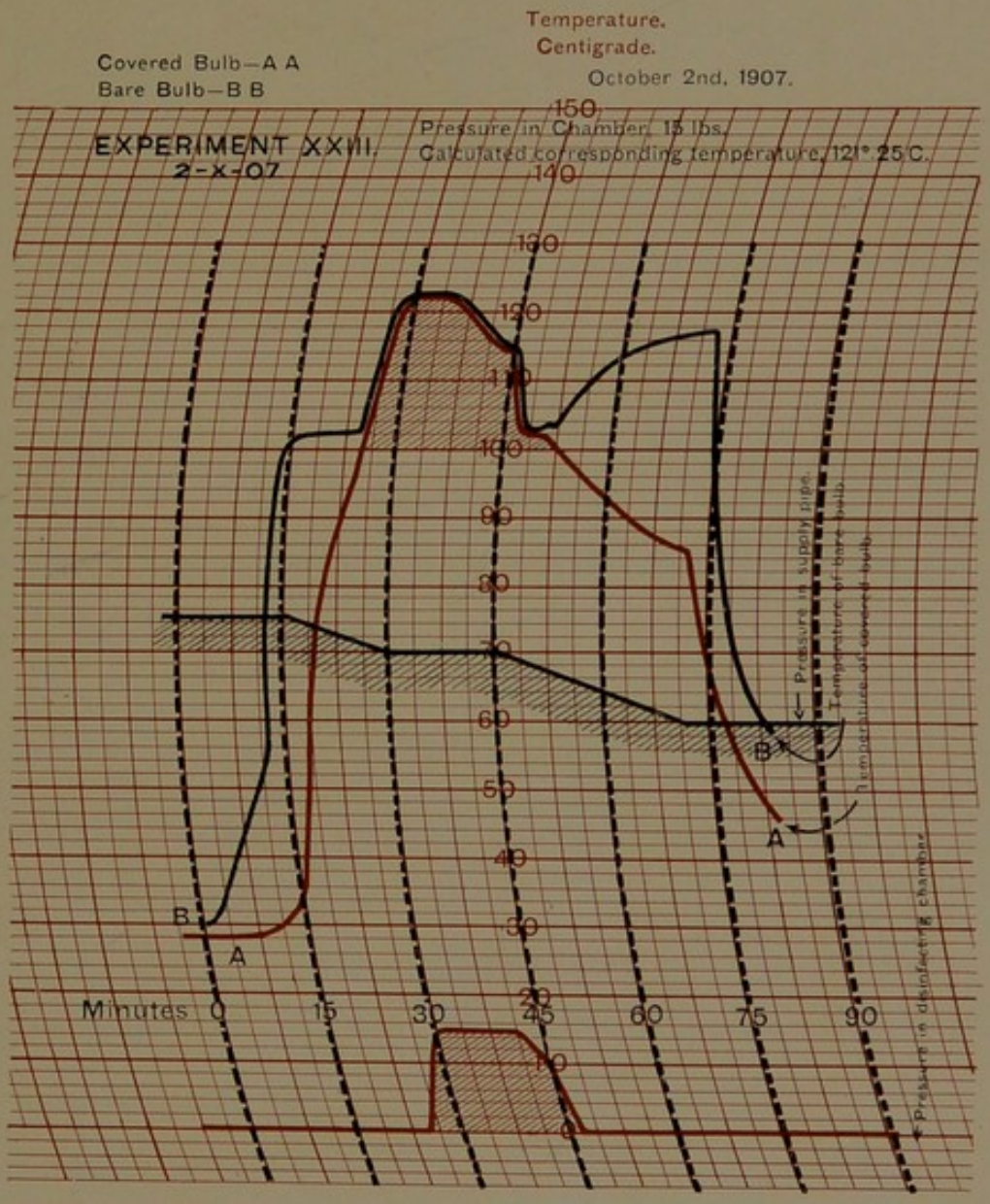
Bacterial Tests.

(Evidence of growth after three weeks).

TEST OBJECTS.	Mattress 46-lbs. Tests 8-in. from surface.	10-in. Sphere, 4-lbs. Tests 5-in. from surface.	Blanket, 16 folds, 4-lbs. 10-ozs. Tests 2-in. from surface.	Controls. 48 hours.
G.S.W. { Earth	++	0?	0?	+++
G.S.W. { Spores of Bacillus Anthracis	0	0	–	–
Manure .. .. No. 177	++	0	0	+++
Spores of Manure Bacilli .. ,, 177	0	0	0	+++
,, ,, Bacillus Anthracis ,, 175	0	0	0	+++
,, ,, Bacillus Anthracis ,, 120	0	0	0	+++
,, ,, Bacillus Anthracis ,, 4	0	0	0	+++
,, ,, Bacillus Anthracis ,, 2	0	0	–	+++
Agar plates made with ½ C.C. of earth bouillon :—				
After 48 hours' incub. at 37° C. ..	A few colonies.	1 colony (contamination?)	0	Colonies.
After 8 days' incub. at 37° C.	Ditto	0	0	Innumerable

++ = Moderate Growth. +++ = Abundant Growth.
0 = No Growth = Disinfection. – = No Experiment.

Disinfection complete to a depth of 5-in. of flock.
,, incomplete at a depth of 8-in. of flock, but bacillus anthracis spores killed.


Temperature.
Centigrade.
Covered Bulb—A A
Bare Bulb—B B
October 2nd, 1907.
EXPERIMENT XXIII.
2-X-07
Pressure in Chamber, 15 lbs.
Calculated corresponding temperature, 121° 25 C.
150
140
130
120
110
100
90
80
70
60
55
40
30
20
10
0
Pressure in supply pipe.
Temperature of bare bulb.
Temperature of covered bulb.
B
A
B
A
Minutes 0 15 30 45 60 75 90
Pressure in disinfecting chamber

Experiment XXIV.

Steam supply, 75-lbs.; pressure in chamber, 15-lbs.

October 9th, 1907—(Experiment 1).—THORNCLIFFE (Professor G. S. Woodhead present).

Steam admitted to coil eight or ten minutes before closure of doors, *i.e.*, while loading and arrangements of apparatus were going on. (During that time the bare bulb rose 4° C., covered 2° C.).

Time. Mins.	I. Temperature. Bare Bulb C°	II. Temperature. Covered Bulb C° 10-in. Sphere.	Pressure. Inlet of Coil. lbs.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil. lbs.	OPERATIONS.	REMARKS.
—	16	18	65	0	0	Valve 1 opened, loading.	
0	20	18	65	0	54	Doors closed, Valve 2 opened	
10	51	19	65	0	55	Valve 3 opened.	
16	100	26	68	0	0		
26	101.5	99.5	70	0	0	Valve 2 closed.	
27	104	102	70	5	5		Control Thermometer in mattress rings.
31	121	121	72	15	14.5		
45	121.75	122.25	75	15	14.5	Valve 3 closed.	
50	118	118	75	11	70	Valve 4 opened.	About 2½-lbs. water of condensation.
60	114	101.75	74	0	49	Valve 5 opened; Valve 2 (five turns) open.	Contact thermometer stops ringing.
67	117.5	96	73	0	67	Valve 5 closed. Doors opened.	Drying in chamber not attempted.

Exposure of bulb protected by 5-in. of flock before Valve 4 was opened:—To steam 100° C. .. .. .. 24 minutes.
,, 120° C. .. .. .. 17 ,,

Bacterial Tests.

(Evidence of growth after 10 days.)

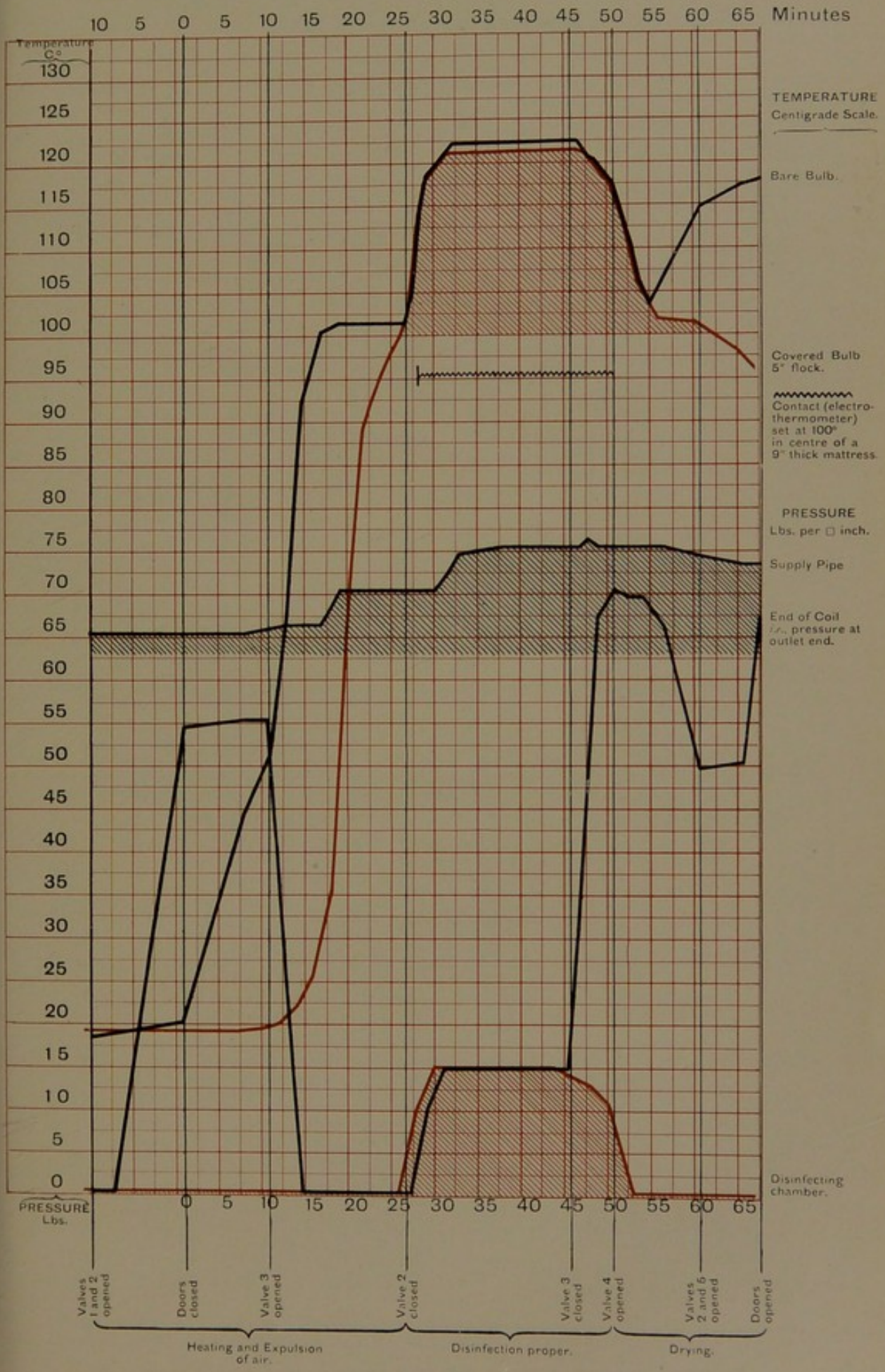
TEST OBJECTS.		Mattress. Tests 8-in. from surface.	10-in. Sphere. Tests 5-in. from surface.	Blanket, 16 folds. Tests 2-in. from surface.	Controls. 48 hours.
G.S.W.	Earth	++	0	0	+++
	Spores of Earth Bacilli No. 1	0	0	–	–
	,, ,, Earth Bacilli No. 2	0	0	–	–
	,, ,, Bacillus Anthracis	0	0	–	–
S.D.	Manure .. .. .. No. 177	++	0	0	+++
	Spores of Manure Bacilli ,, 177	0	0	0	+++
	,, Bacillus Anthracis ,, 2	0	–	–	+++
	,, Bacillus Anthracis ,, 4	0	0	–	+++
Agar plates made with ½ C.C. of earth bouillon :—					
After 48 hours' incub. at 37° C... ..		++	—	0	Colonies innumerable
After 8 days' incub. at 37° C.		++	—	0	do.

++ = Moderate Growth. +++ = Abundant Growth.
0 = No Growth = Disinfection. – = No Experiment.

Disinfection complete to a depth of 5-in. of flock.
,, incomplete at a depth of 8-in. of flock, but anthrax spores killed.

EXPERIMENT XXIV.

Pressure in Chamber, 15 lbs.
Calculated corresponding temperature, 121°.25.



Experiment XXV.

Steam supply, 70-lbs.; pressure in chamber, 20-lbs.

October 9th, 1907—(Experiment 2).—THORNCLIFFE. (Professor G. S. Woodhead present.)

Disinfector warm on account of previous experiment. Time necessary to heat Machine from 20° C. to 100° C., 16 minutes (Experiment XXIV.). Time taken in this experiment to reach 100° C. was six minutes only, therefore ten minutes should be added to the six minutes in order to make Experiments XXIV. and XXV. comparable.

Time. Mins.	I. Temperature. Bare Bulb C°	II. Temperature. Covered Bulb C° 10-in. Sphere.	Pressure. Inlet of Coil, lbs.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil, lbs.	OPERATIONS.	REMARKS.
0	52	33	70	0	58.5	Valve 1 opened. Doors closed. Valve 2 opened.	Coil was hot before the doors were closed.
2	60	32	70	0	58.5	Valve 3 opened.	
6	100	37	70	0	0		
16	100.25	100	70	0	0	Valve 2 closed.	
21	126	126	70	20	19.75		
31	126	126.2	70	20	19.75	Valve 3 closed.	
36	124	124	73	17	65	Valve 4 opened.	About 2½-lbs. water of condensation.
46	116	100.75	73.5	0	60	Valve 2 opened. Doors opened.	Drying not attempted.

Exposure of bulb protected by 5-in. of flock before Valve 4 was opened:—To steam 100° C. .. .. .. 20 minutes about.
,, 120° C. .. .. .. 17 ,, ,,
,, 126° C. .. .. .. 12 ,, ,,

Bacterial Tests.

(Evidence of growth after fourteen days).

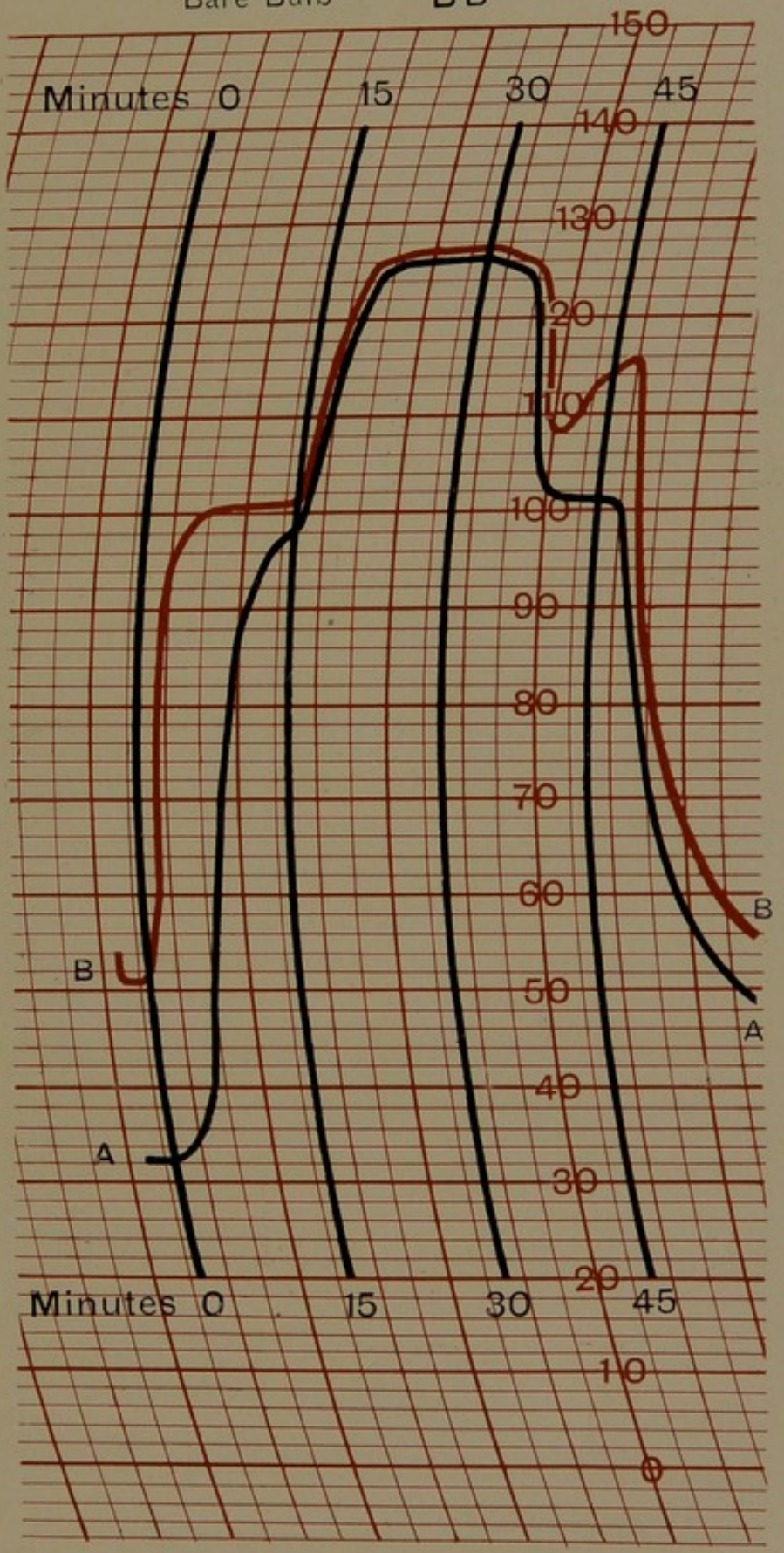
TEST OBJECTS.		Mattress 46-lbs. Tests 8-in. from surface	10-in Sphere, 4-lbs. Tests 5-in. from surface	Blanket, 16 folds. 4-lbs. 10-ozs. Tests 2-in from surface	Controls. 48 hours.
G.S.W.	Earth	0	0	0	+++
	Spores of Earth Bacilli, No. 1	0	0	0	–
	,, ,, Earth Bacilli, No. 2	0	0	–	–
	,, ,, Bacillus Anthracis	0	0	0	–
S. D.	Manure 177	0	0	0	+++
	Spores of Manure Bacilli 177	0	0	0	+++
	,, ,, Bacillus Anthracis 2	0	0	–	+++
	,, ,, Bacillus Anthracis 4	0	–	0	+++
Agar plates made with ½ C.C. of earth bouillon :—					
After 48 hours' incub. at 37° C. ..		0	0	0	Colonies innumerable
After 8 days' incub. at 37° C.		0	0	0	do.

+++ = Abundant Growth. 0 = No Growth = Disinfection. – = No Experiment.

Disinfection complete to a depth of 8-in. to 9-in. of flock.

EXPERIMENT XXV.

II.—20 lbs
Covered Bulb– AA
Bare Bulb– BB
October 9th, 1907.



Experiment XXVI.

Steam supply, 75-lbs.; pressure in chamber, 10-lbs.

October, 1907—(Experiment 3).—THORNCLIFFE (Professor G. S. Woodhead present).

Disinfector warm on account of previous experiment. The time taken to reach 100° C. was five minutes. In Experiment XXIV. the time taken for the temperature to rise from 20° C. to 100° C. was sixteen minutes. It is therefore necessary to add eleven minutes to the times recorded below to make experiments comparable.

Time. Mins	I. Temperature. Bare Bulb, C°	II. Temperature. Covered Bulb, C° 10-in. Sphere.	Pressure. Inlet of Coil. lbs.	Pressure. Chamber. lbs.	Pressure. Outlet of Coil. lbs.	OPERATIONS.	REMARKS.
0	56	38	75	0	63	Valves 1 and 2 opened. Doors closed.	
2	66	38	75	0	63	Valve 3 opened.	
5	100	43	74	0	0		
15	102	98.5	73	0	0	Valve 2 closed.	Contact Thermometer rings in centre of mattress.
18	114	113	75	10	10		
25	115.5	115.5	74	10	10	Valve 3 closed.	
28	117	114	73	8½	62	Valve 4 opened.	
31	116	101	73	0	65	Doors opened.	No drying attempted.

Exposure of bulb protected by 5-in. of flock before Valve 4 was opened:—To steam 100° C. .. .. .. 14 minutes.
,, 114° C. .. .. .. 10 ,,

Bacterial Tests.

TEST OBJECTS.	Mattress 46-lbs. Tests 8-in. from surface.	10-in. Sphere, 4-lbs. Tests 5-in. from surface.	Blanket, 16 folds. Tests 2-in. from surface.	Controls, 48 hours.
G.S.W. Earth	–	–	+?	+++
G.S.W. Spores of Earth Bacilli, No. 1	0	0	0	–
G.S.W. ,, ,, Earth Bacilli, No. 2	0	0	0	–
G.S.W. ,, ,, Bacillus Anthracis	0	0	0	–
S.D. Manure .. .. .. No. 177	++	0	0	+++
S.D. Spores of Manure Bacilli ,,177	0	0	0	+++
S.D. ,, ,, Bacillus Anthracis,, 2	–	0	–	+++
S.D. ,, ,, Bacillus Anthracis,, 4	0	–	0	+++
Agar plates made with ½ C.C. of earth bouillon :—				
After 48 hours' incub. at 37° C. ..	–	–	4 colonies (*)	Colonies innumerable.
After 8 days' incub. at 37° C.	–	–		Ditto.

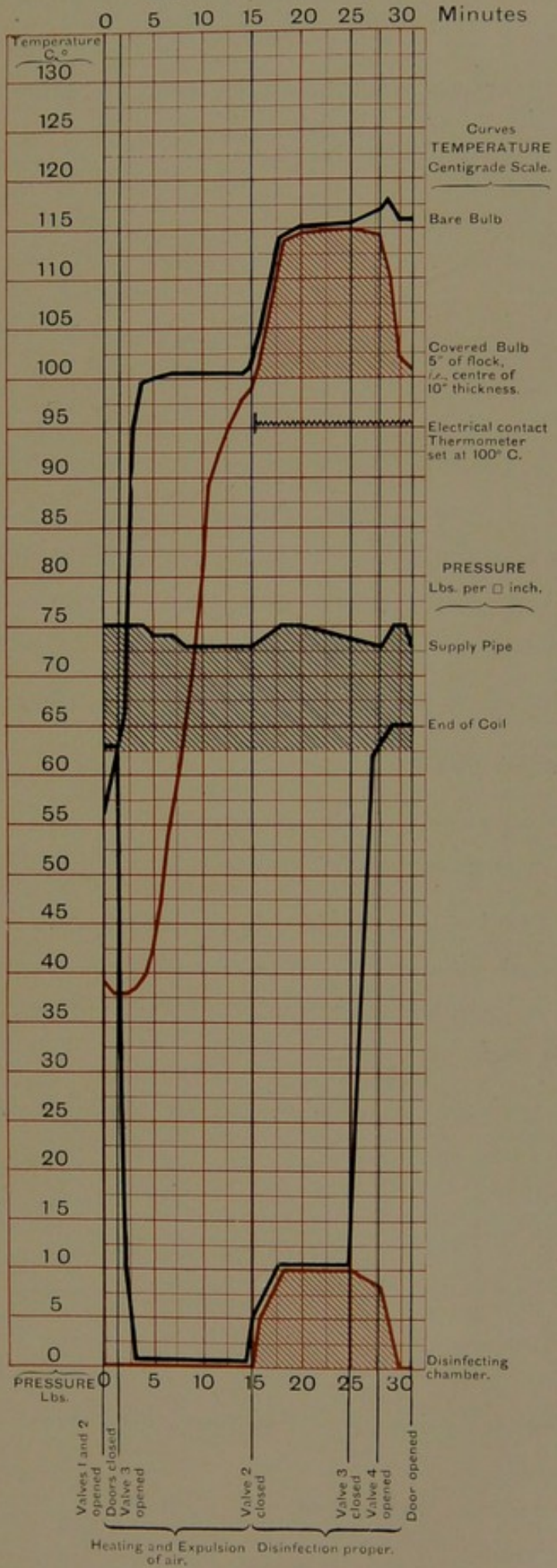
(*) The 4 colonies were colonies of cocci, and must have been due to accidental contamination.

+ = Growth. ++ = Moderate Growth. +++ = Abundant Growth.
0 = No Growth = Disinfection. – = No Experiment.

Disinfection complete at a depth of 5-in. of flock.
,, incomplete at a depth of 8-in. of flock, but anthrax spores killed.

EXPERIMENT XXVI.

Pressure in Chamber, 10 lbs.
Calculated corresponding temperature, 115° C.



IMPORTANT.

These experiments show that when using the new Disinfector, if one wishes to destroy pathogenic bacteria of a resistance not exceeding that of the spores of anthrax bacilli, it is possible to disinfect thick mattresses in thirty-five minutes with steam at pressures from 10-lbs. to 12-lbs., and in thirty minutes with steam at 14-lbs. to 15-lbs.

These times are from starting with the Machine cold.

Higher pressures are unnecessary in such cases.

Good results could be obtained in a shorter time, but a certain margin must be allowed for all contingencies.

When one desires to sterilize thick mattresses, *i.e.*, not only to kill known pathogenic germs, but also the more resisting spores found in soil and manure, forty-five minutes should be allowed when steam at 20-lbs. is used.

Steam at 15-lbs. would generally, but not invariably, produce sterilization in the same time.

Appendix II.

Temperature of Saturated Steam at Various Pressures.

(Calculated Approximately.)

Steam Gauge Pressure in lbs.	Temperature. Degrees F.	Temperature. Degrees C.	Interpolation Curve.
0	212	100	100
1	215.4	101.8	101.8
2	218.7	103.7	103.5
3	221.6	105.3	105.2
4	224.6	107	106.8
5	227.1	108.4	108.4
6	229.8	110	109.8
7	232.3	111.2	111.2
8	235.2	112.9	112.5
9	237.2	114	113.8
10	239.4	115.4	115.1
11	241.5	116.6	116.4
12	243.6	117.7	117.6
13	245.9	118.8	118.7
14	247.8	120	119.8
15	249.9	121	120.9
16	251.4	122.1	121.9
17	253.4	122.7	122.9
18	255.1	124.1	123.9
19	256.9	125	124.9
20	258.7	126.1	125.9
21	260.1	127.2	126.9
22	262.1	127.8	127.8
23	—	—	128.7
24	—	—	129.6
25	267	130.5	130.5

$$t^\circ = \frac{1060 + 367 \log \frac{p}{14.7}}{5 - \log \frac{p}{14.7}}$$

p = pressure in lbs. per square inch.

t = temperature in degrees Fah.

Directions for Working Disinfector.

A.—Sterilization (*i.e.*, Absolute Disinfection).

Minutes from beginning.	Valve 1 opened, doors opened, Machine loaded	
0	Doors closed, Valve 2 opened	Heating and expulsion of air.
10	Valve 3 opened	
25	Valve 2 closed	Disinfection.
45	Valve 3 closed	
50	Valve 4 opened	
60	Valves 2, 5, and 6 opened	Drying.
90	Doors opened	
	Articles removed and spread rapidly.	

The time necessary for each operation is based on the supposition that the Machine is cold and in a room at 16° C. to 20° C. (60° F. to 68° F.).

When the Disinfector is still warm, on account of previous operations, Valve 3 may be opened immediately after the doors are closed, and Valve 2 opened ten minutes after Valve 3 has been opened. In this way the duration of the disinfection is reduced to forty-five minutes (time for drying is not included).

When the articles to be disinfected do not include heavy mattresses, they may be removed immediately after the pressure has been reduced to 0-lbs., by opening of the Valve 4 (see drying). When this is done, the time taken for disinfection is reduced to fifty minutes, the Machine being cold to begin with.

B.—Practical Disinfection (sometimes Incomplete Sterilization).

The times given above are in excess of what is actually necessary when steam at 20-lbs. is used, and are sufficient for all practical purposes when steam at 15-lbs., or even 10-lbs., pressure is used.

With Steam at 10-lbs.—Spores of anthrax bacilli are killed even when protected by 9-in. of flock, but earth and manure bacilli spores may resist if embedded in the original material (earth or manure).

With Steam at 15-lbs.—Only fairly large masses of earth do resist when protected by 8-in. or 9-in. of flock, but are sterilized when the layer of flock is not more than 5-in. thick. All other organisms, sporing or not, are killed even when protected by 8-in. or 9-in. of flock, whether steam at 10-lbs. or 15-lbs. pressure is used.

All these results may be obtained whether the original steam supply is at 30-lbs. or 75-lbs. pressure, or any intermediate pressure.

Drying.

To obtain complete drying of a heavy mattress before removal from the Disinfector, it is necessary to allow the current of hot air, induced by the steam ejector, to pass through the chamber for at least one hour, at the end of that time the mattress will frequently weigh less than it did at the beginning of the operations.

Equally good results can be obtained by removing the mattress after half-an-hour, and spreading on trestles (or exposing it in any other way to the free access of air) in a dry, well-ventilated room for one or two hours. The mattress may also be left in the hot Machine after the doors have been slightly opened.

Blankets, clothing, sheets, etc., may be removed immediately after disinfecting operations, and if well shaken and suspended in a well-ventilated room, will be found perfectly dry in from ten minutes to half-an-hour.

JUNE, 1909. ALL PREVIOUS LISTS CANCELLED

Telegrams:
"ACCOLADE, LONDON."

Telephone:
London Wall, 5496

Code: A B C, Fifth Edition

DISINFECTORS

(Working at Atmospheric, Low, and High Pressures)

SPRAYERS

VAPORIZERS

STERILIZERS

The Thresh Disinfector Co., Ltd.

BROOK HOUSE, 10-12, WALBROOK

LONDON, E.C.

PRICES SUBJECT TO ALTERATION WITHOUT NOTICE

Entered at Stationers' Hall.]

CATALOGUE AND PRICE LIST

INDEX

OUR DISINFECTORS

are in use at the following Institutions

England

Isolation and Smallpox Hospitals

Abingdon
Ashton-under-Lyne
Bagnall
Barnard Castle
Barnoldswick
Barnsley (Kendray Hospital)
Beckenham
Belper
Blandford
Braintree
Brentwood
Bridge
Brighouse
Broadstairs
Bromsgrove, Droitwich, and Redditch
Burnham-on-Crouch
Bury (2)
Calne
Cannock
Catherington
Chailey
Cheadle
Chester-le-Street
Chiddingstone Joint
Clevedon
Colchester
Cromer
Cuckfield
Curborough (Lichfield)
Devizes
Dislingbury
Dorking
Dronfield
Dudley
Dunstable
Ealing
Easington
East Grinstead
East Ham
Elwell
Ely
Enfield
Epping
Fareham
Farnham
Foleshill
Folkestone
Gainsborough (2)
Gosport and Alverstoke
Gt. Clacton
Gravesend
Hailsham
Halesowen
Halifax
Halstead
Harrogate and Knaresborough Joint
Harrow
Haughton (Hove)
Havant
Hebburn-on-Tyne
Huntingdon
Ilfracombe
Jarrow
Keighley
Kidderminster
King's Norton and Northfield
Lanchester
Langport
Langwith
Lewes
Lewis Home, Hebden Bridge
Leyton
Linslade
Liversedge and Mirfield Joint
Lydd
Macclesfield
Maldon
Malton and Norton
Malvern
Marlborough
Middleton
Minehead
Morton
Newburn-on-Tyne
Newcastle-under-Lyme
Newmarket
Newton Abbott
Normans Ridding, Whickham, R.S.O.
Northfleet
Ormskirk
Orsett Joint
Oundle
Oxford
Oxted
Penzance
Petersfield
Redruth
Repton
Richmond (Yorks)
Rochester (St. William's)
Runcorn
St. Albans
Sedgefield
Sevenoaks
Southall-Norwood
South Shields (2)
South Staffordshire Joint
Staveley
Stoke-on-Trent
Stone
Sunderland Rural
Sutton Ford
Tamworth
Tanfield
Ticehurst
Tiverton
Todmordon (2)

OUR DISINFECTORS
are in use at the following Institutions

England (*Continued*)

Isolation and Smallpox Hospitals (*Continued*)

Torquay
Tring
Trowbridge
Tunbridge Wells Joint
Undercliffe (Ventnor)
Upton-on-Severn
Walsall and District
Waltham
Wanstead
Warrington
Welbeck
Wells
Weston-super-Mare
Wetherby
Windy Nook
Wolverhampton
Worcester
Workington
Worksop, Blyth and Cuckney
Yeovil

Asylums, General Hospitals, &c.

Banstead (L.C.C.)
Barnsley Hall
Berkshire
Bicton (Shrewsbury)
Bristol
Burntwood (Lichfield)
Chartham, near Canterbury
Chatham
City of London Lying-in
Delancey Hospital, Cheltenham
Derwent Valley Water Board
East Sussex Asylum, Hellingly
Gravesend Hospital
Hill End, St. Albans
Holloway Sanatorium
Isle of Wight County Hospital
Kesteven Asylum
Manor Asylum, Epsom (L.C.C.)
Netherne Asylum, Coulsdon
Plymouth Borough
Radcliffe-on-Trent
Rochester (St. Bartholomew's)
Somerset and Bath Lunatic
Stafford County
Suffolk County (2)
University College Hospital
West Sussex County
Worcester County

Garrison Hospitals, &c.

Aldershot, Cambridge Hospital
Bodmin
Caterham, Guards' Depôt
Chatham, Fort Pitt
Gravesend, R.E. Depôt
Haslar Hospital
Lichfield
Oxford

Garrison Hospitals, &c. (*Continued*)

Parkhurst
Pembroke Dock
Preston
Ryde, R.E. Eastern Forts
Sheerness
Shorncliffe
Shoeburyness
Warwick
Windsor, R.E. Barracks
York

Workhouses, Infirmaries, Casual Wards, Laundries, &c., &c.

Bermondsey Workhouse, Ladywell
Billericay Union
Birkenhead Union
Bishop Auckland Union
Blean Union
Braintree Union
Camberwell Union Cottage Homes
Dorking Union
Exeter City Workhouse
Grenoside Union
Hertford Union
Holborn Casual Wards
Holborn Union
Holborn Union Infirmary
King's Norton
Maidstone Union
Mitcham Workhouse
Northern Rowton House, Newcastle (Laundries)
Ormskirk Union
Oxford Union
Poplar Union
Rotherham Union
Rowton House, London (Laundry)
Scarborough Union
Stepney Union
Stourbridge Workhouse
Tavistock Workhouse
Thorne Union
Tiverton Workhouse
Yarmouth Union

Schools

Ackworth School, Pontefract
Chase Farm Schools, Enfield
Christ's Hospital, Hertford
Denstone College Infirmary
Felstead
Haileybury College
Hemel Hempstead
Holborn Union Schools, Mitcham
Infant Orphan Asylum, Wanstead
Kensington and Chelsea (Banstead)
Marlborough College
North Eastern County School
Rugby School Sanatorium
Sedbergh

OUR DISINFECTORS
are in use at the following Institutions

Wales

Isolation Hospitals

Abertillery
Barry
Blackmill
Bridgend
Caernarvon
Maesteg
Mountain Ash
Penarth
Pembroke Dock
Pontardawe

Scotland

Isolation Hospitals

Alford
Badenoch
Brechin
Campbeltown and Kintyre
Deeside
Dufftown
Elgin
Ellon-Gordon
Fraserburgh
Glendale
Huntly
Inverurie
Portsoy
St. Andrews
Summerhill, Aberdeen
Turriff Epidemic

Asylums

Banff

General Hospitals

Stirling Combination
Perthshire County Council

Ireland

Garrison Stations

Ballincollig
Charles Fort, Kinsale
Cork (2)
Dundalk
Fermoy
Fort Elizabeth
Holywood
Limerick
Queenstown
Spike Island
Tipperary

Hospitals

Dublin Fever
Meath Hospital and County Dublin Infirmary

Unions, Infirmaries, &c.

Ballinasloe Union
Dublin City Disinfecting Station
Lord Iveagh's Lodging House, Dublin
Loughrea Union
Naas Union
Skibbereen Infirmary

Colonies, &c.

Channel Islands
Calcutta
Cape of Good Hope (7)
Capetown Corporation
Ceylon (5)
Egypt (8)
India (26)
Kimberley
Natal (4)
St. Helena
South Australia
Straits Settlements
Transvaal (14)
South Africa (War Office) 68

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

This is a " current steam Disinfector," the steam passing through the chamber at atmospheric pressure.

The steam is generated in the jacket of Disinfector from a solution of carbonate of potash of such a density as will give a boiling point of 215 degrees Fahr. at sea level.

The form generally adopted is the " furnace-heated " type, the Disinfector being set in brickwork with a furnace under. The provision of a separate high-pressure steam boiler is thus dispensed with and the cost of installation consequently much reduced.

When, however, a supply of high-pressure steam is available, (in the Hospital, Asylum, or Union where the Disinfector is to be fixed), the pressure steam can be used as the heating medium, and the carbonate of potash solution in jacket of Disinfector brought to boiling point, partly by passing the pressure steam through a battery of copper coils in jacket of Disinfector, and partly by means of an injection pipe, the pressure steam being passed into the solution after the latter has been heated almost to boiling point by conduction through the coils.

The objects attained by using the carbonate of potash solution in the jacket are threefold :—

(*a*) Preventing excessive wetting of the clothing during disinfection, by heating the chamber slightly above the condensing point of steam at atmospheric pressure.

(*b*) Raising temperature of air, used for drying after disinfection.

(*c*) Preventing incrustation in jacket of Disinfector.

A solution of chloride of calcium was originally employed (vide *Lancet Commision Reports*), but was discontinued, as a solution of carbonate of potash was found preferable.

The steam in the machine must remain saturated so long as it is in contact with the moisture condensed in the machine and on the clothing ; until all this is re-evaporated the steam, though slightly above its normal temperature, must be saturated.

This Disinfector has been thoroughly tested many times by independent experts, and the results of such tests have been published, *e.g.*—

Dr. Barwise, County M.O.H. for Derbyshire in *Public Health*, March, 1896.

Lancet Special Commission Report, 1896.
(*Copy furnished upon application.*)

Dr. Mearns Fraser, M.O.H. Portsmouth, 1896.

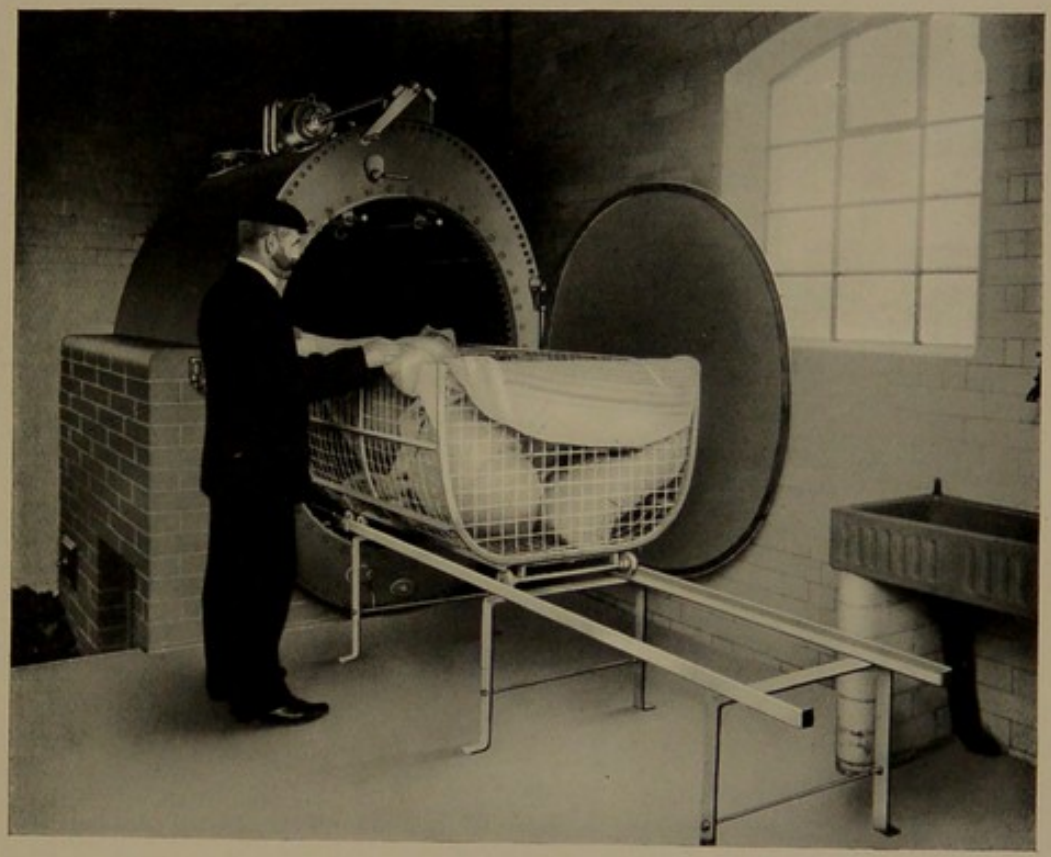
In addition a great number of Medical Officers of Health, at home and abroad, have satisfied themselves (by personally conducted tests) of the efficiency of the Machine to sterilize clothing and bedding, infected by organisms of disease which affect mankind.

A list of places to which this type of Disinfector has been supplied will be found on pages 3–5.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

FURNACE-HEATED DISINFECTOR



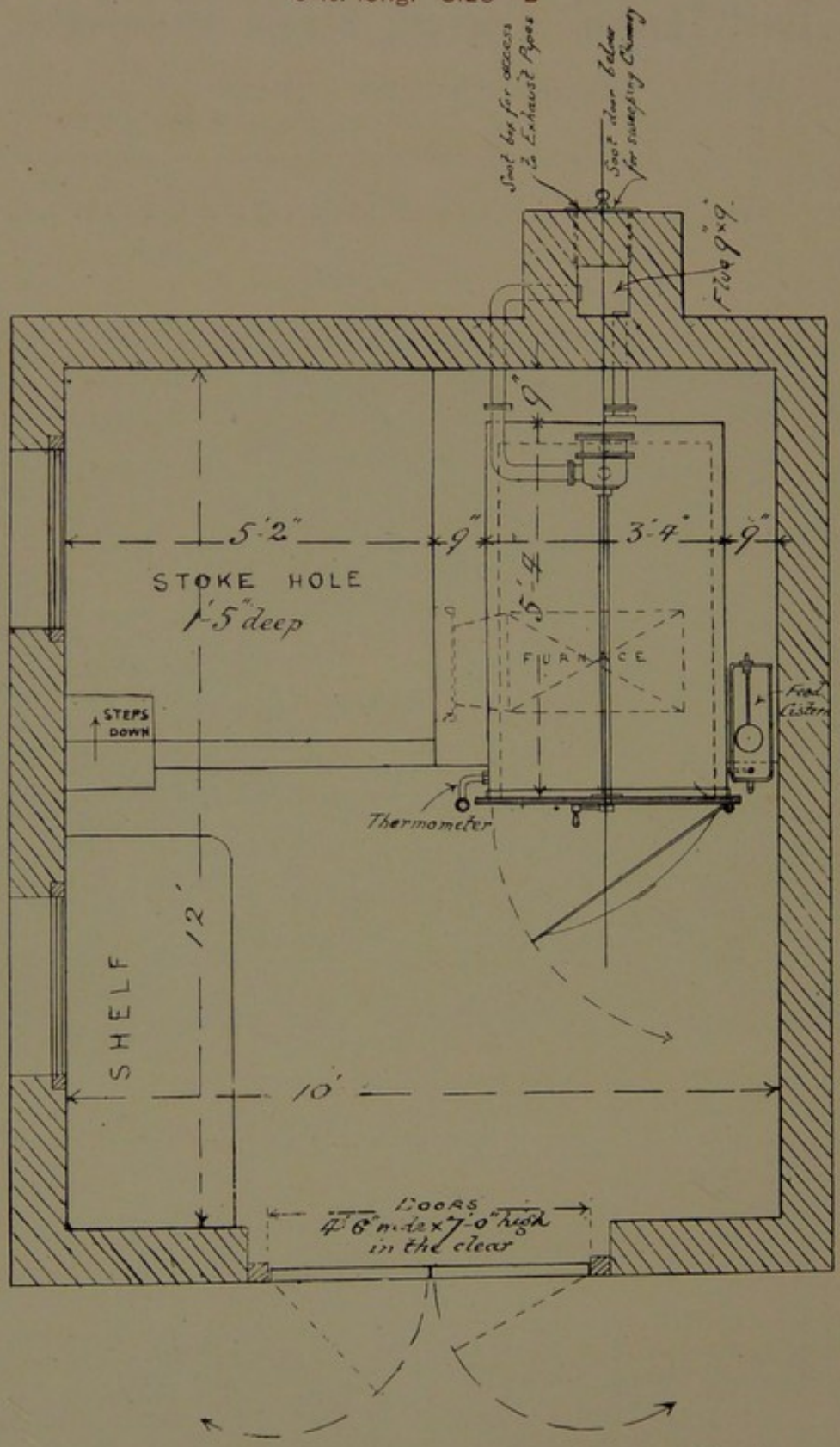
7-ft. size "C" Furnace-heated Double-door Disinfector, showing brickwork setting, etc.

For description, see page 6.

Particulars of different sizes, etc., given on page 11.

PLAN OF HOUSE

Suitable for a Furnace-heated Single-door "Thresh" Disinfector,
5-ft. long. Size "B"

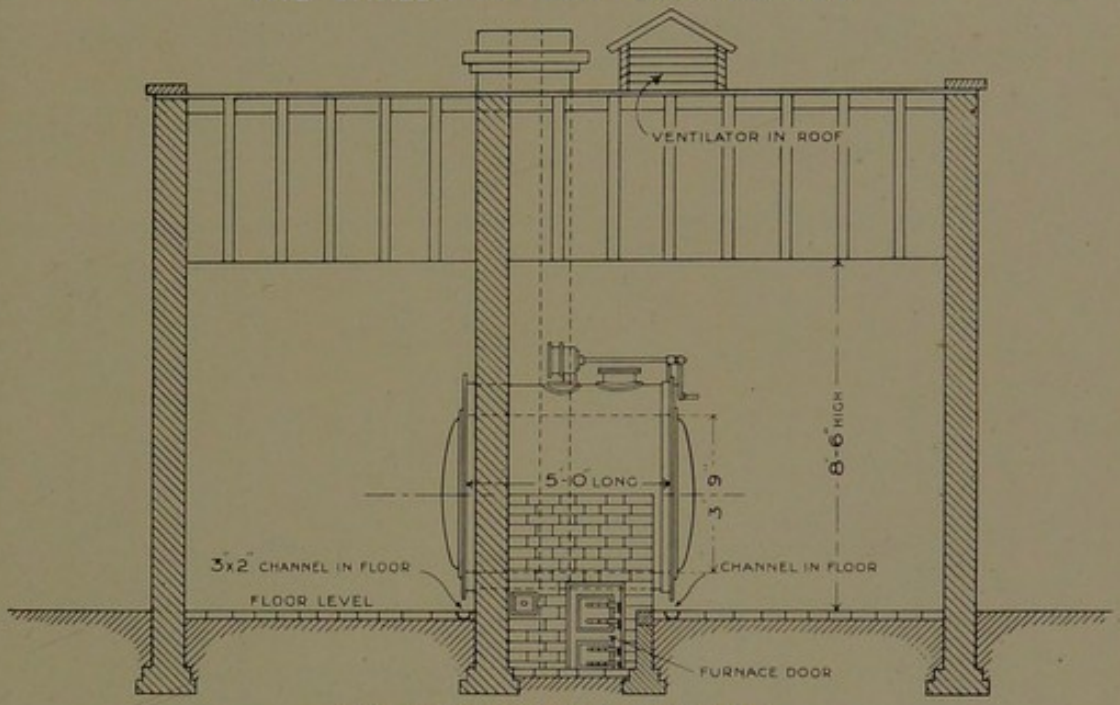


NOTE.—A similar House, but 7-ft. in width, would suit a 5-ft. Steam-heated Machine. *See pages* 14–18.

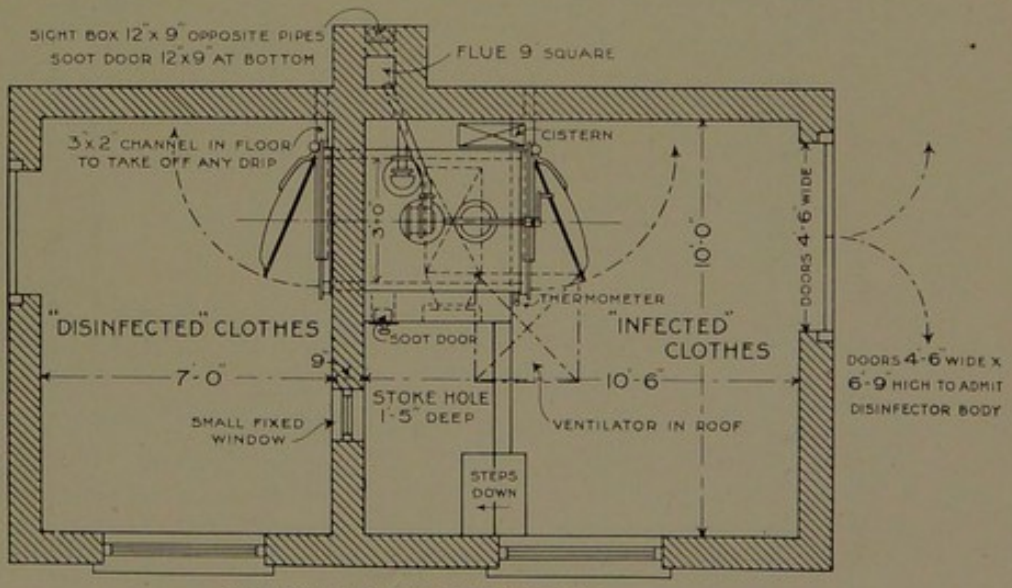
PLAN OF BUILDING

Suitable for a Furnace-heated Double-door "Thresh" Disinfector,
5-ft. long. Size "H"

THE "THRESH" PATENT DISINFECTOR



SKETCH SECTION OF BUILDING
SUITABLE FOR A 5FT "H" SIZE FURNACE-HEATED DISINFECTOR

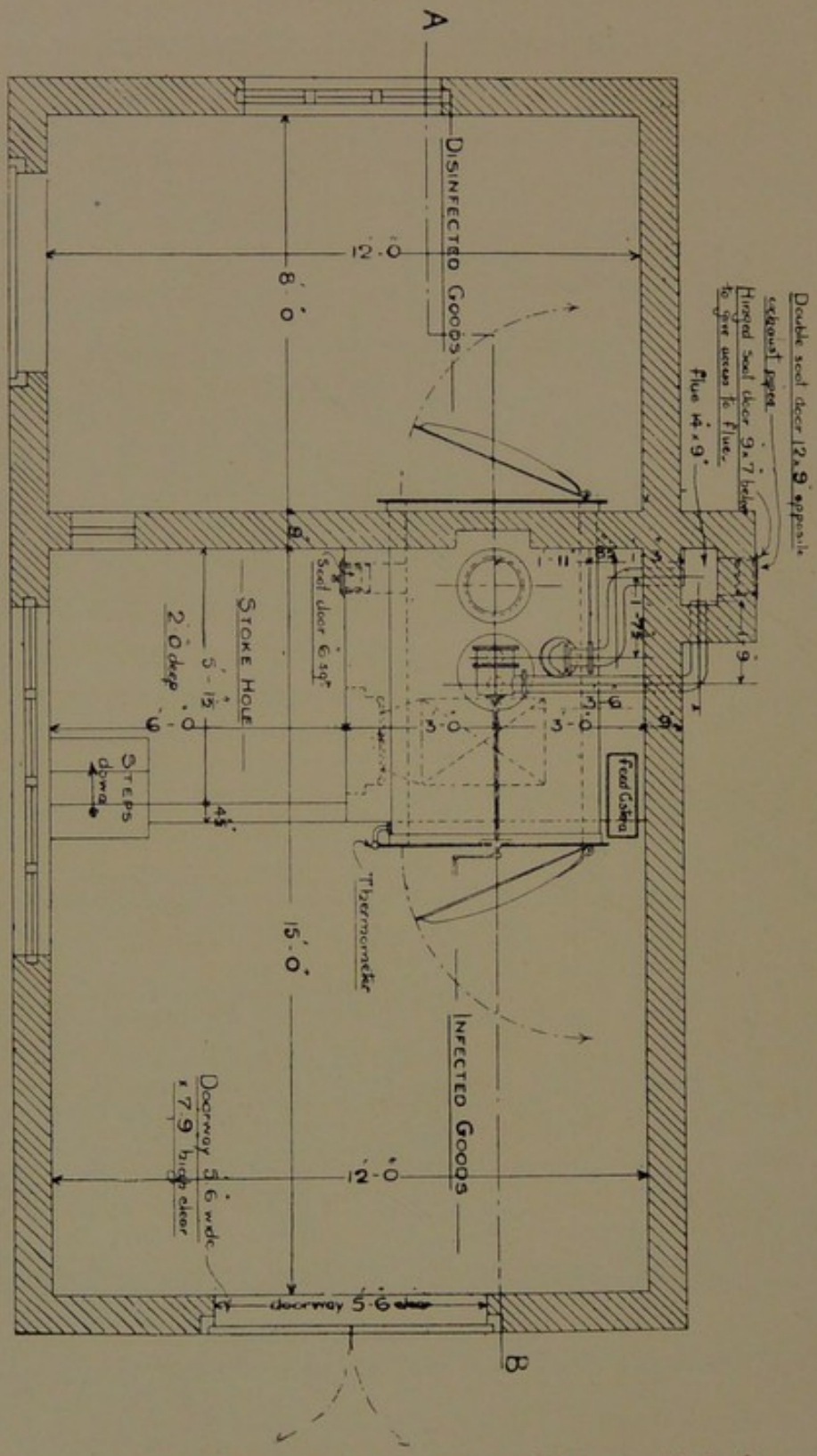


SKETCH PLAN OF BUILDING
SUITABLE FOR A 5FT "H" SIZE FURNACE-HEATED DISINFECTOR

NOTE.—A similar House, but 7-ft. in width, would suit a 5-ft. Steam-heated Machine. *See pages* 14–18.

PLAN OF BUILDING

Suitable for a Furnace-heated Double-door "Thresh" Disinfector, 7-ft. long. Size "C"



For an 8-ft. Furnace-heated Disinfector the "infected" side should be 16-ft. long—all other dimensions as shown above.

NOTE.—A similar House, but 3-ft. less in width, would do for a 7-ft. Steam-heated Machine. *See pages* 14–18.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

Furnace-heated.—Brickwork setting — no separate steam boiler required.

Single-door Machines. — Suitable for Workhouses, Casual Wards, Laundries, Schools, Small Hospitals, Lodging Houses, etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber			Capacity Cubic Feet.	Overall Dimensions.		
	Long.	High.	Wide.		Long.	High.	Wide.
	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.
A (Astray)	3 9	3 9	3 0	33	4 7	5 9	3 9
B (Broach)	5 0	3 9	3 0	45	5 10	5 9	3 9

Double-door Machines. — Suitable for Isolation Hospitals, Smallpox Hospitals, General Hospitals, Local Disinfecting Stations, Asylums, Sanatoria, Infirmaries, etc., etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.			Capacity Cubic Feet.	Overall Dimensions.		
	Long.	High.	Wide.		Long.	High.	Wide.
	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.
H (Hoax)	5 0	3 9	3 0	45	5 9	5 9	3 9
J (Jester)	6 0	3 9	3 0	54	6 9	5 9	3 9
C (Canary)	7 0	4 6	3 6	88	7 10	7 0	4 7
D (Despot)	8 0	4 6	3 6	100	8 10	7 0	4 7

Special sizes made if required.

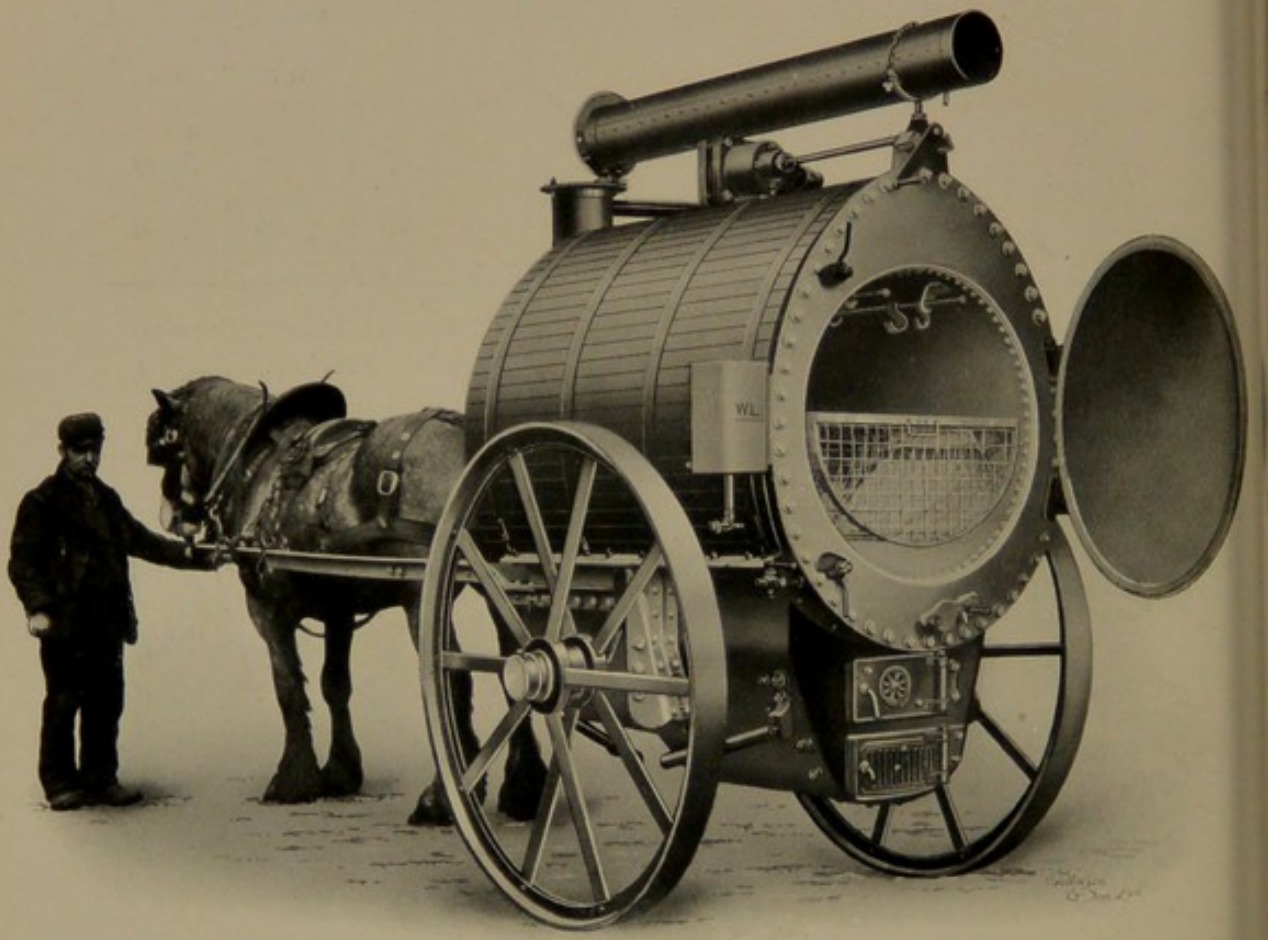
With the Disinfector is supplied Galvanized Water Cistern, Ball Valve, Thermometer, Galvanized Iron Clothes Basket, Hanging Rails and Hooks, Galvanized Extension Rails (upon which to run clothes basket in and out of machine), Furnace Ironwork, Soot Doors for chimney, and Potash Solution for jacket.

For prices, cost of packing, delivery, etc., see page 52.
Approximate shipping particulars are given on page 59.
Plans for setting furnished to purchasers, on application.
Estimates given for complete erection, including brickwork, etc.
Dimensions of suitable buildings shown on pages 8–10.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

Portable Type. **Furnace-heated**



2-Wheel Portable Disinfector. Sizes "E" and "F"

(For ORDINARY Districts).

For sizes, capacities, etc., see next page.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

Portable Type. **Furnace-heated**

4-Wheel Portable Disinfector. Size "G"

(For HILLY districts).

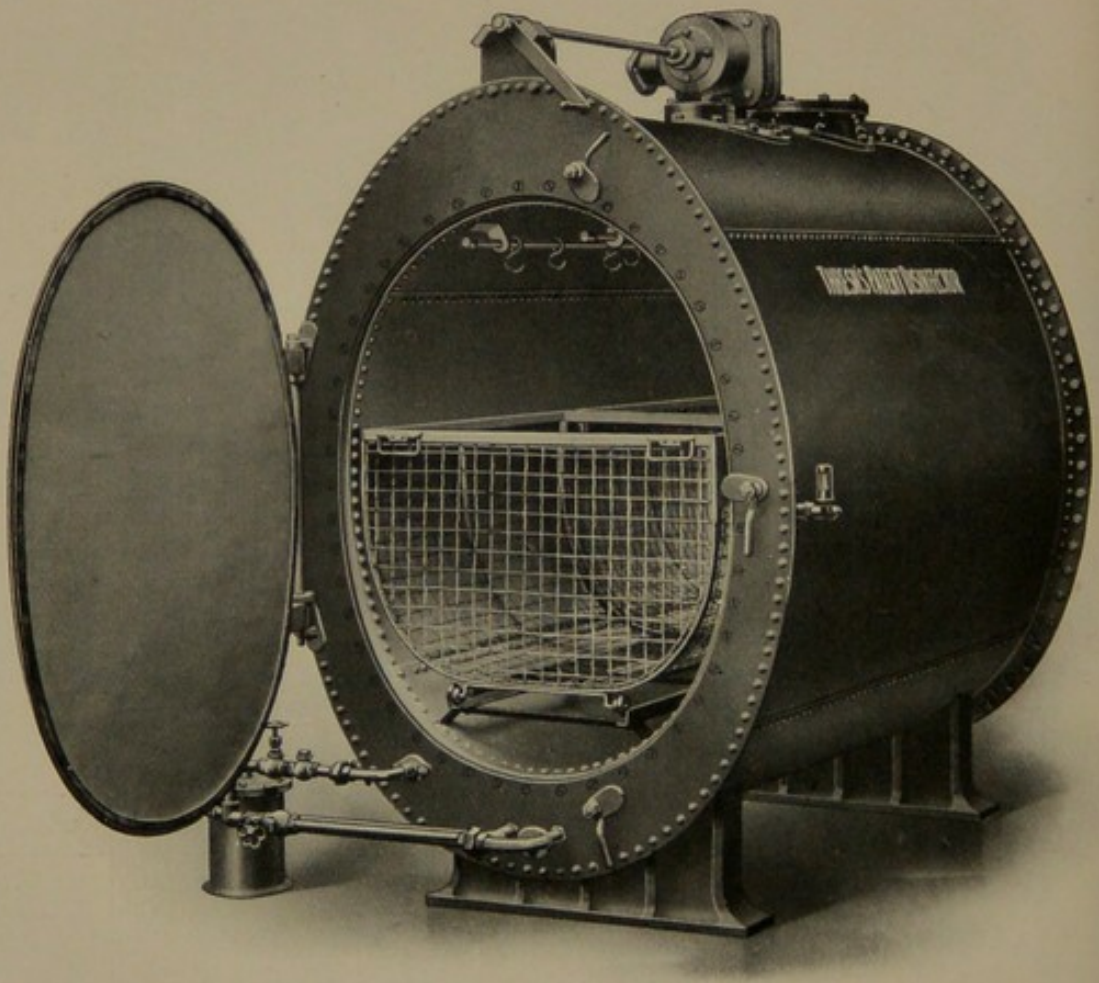
SIZE AND CODE DESIGNATION.	Number of Wheels.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.		
		Long.	Diam.		Long.	High.	Wide.
		ft. in.	ft. in.		ft. in.	ft. in.	ft. in.
E (Eagle)	2	3 9	3 0	26½	5 6	8 9	5 10
F (Fairy)	2	5 0	3 0	35½	6 9	8 9	5 10
G (Grouse)	4	5 0	3 0	35½	9 6	8 9	5 10

For prices, cost of packing, delivery, etc., see page 52.
Approximate shipping particulars are given on page 59.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure with Steam from Independent Boiler or existing Installation

STEAM-HEATED DISINFECTOR



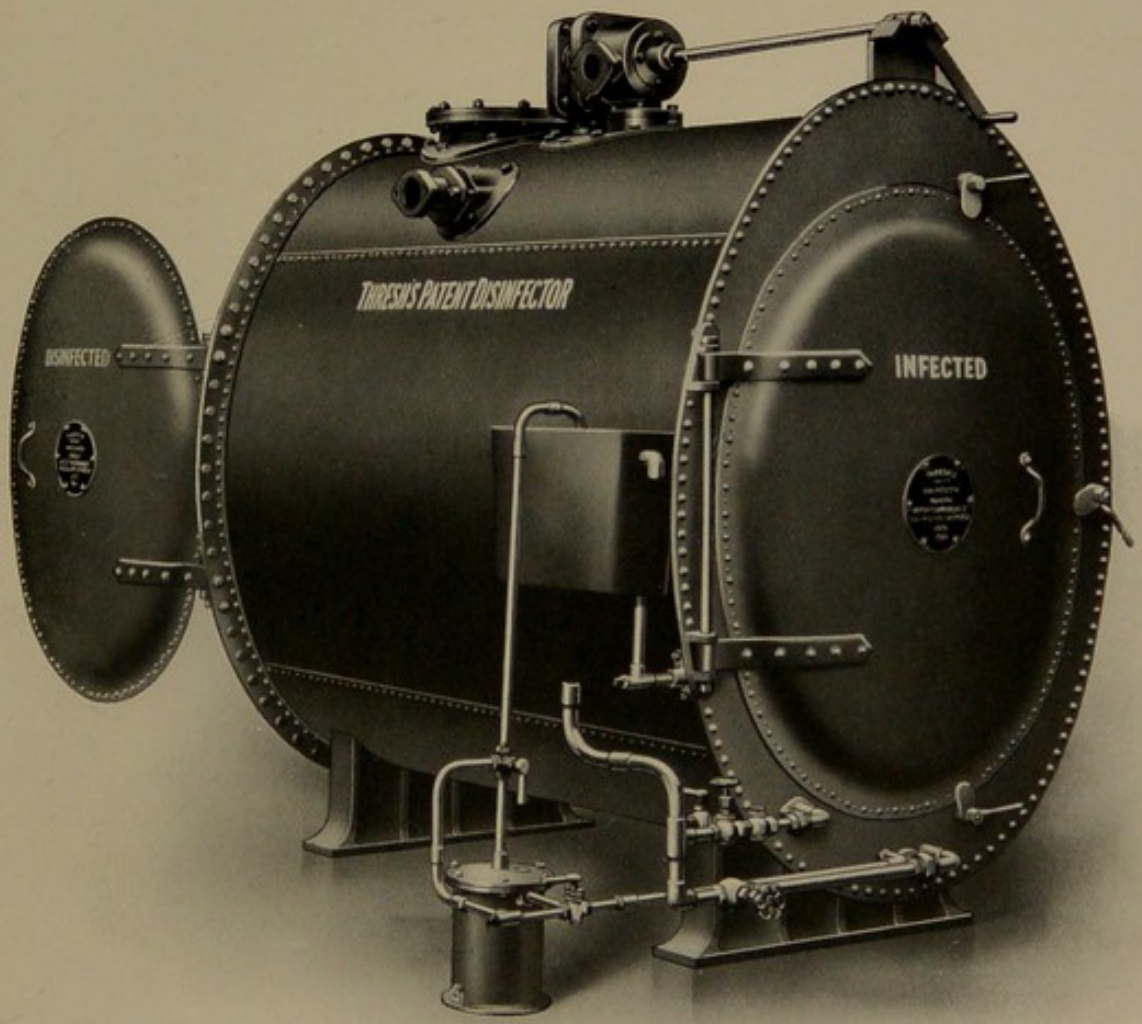
Showing Interior of Machine.

Particulars of different sizes, &c., given on page 18.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure with Steam from Independent Boiler or Existing Installation

STEAM - HEATED DISINFECTOR

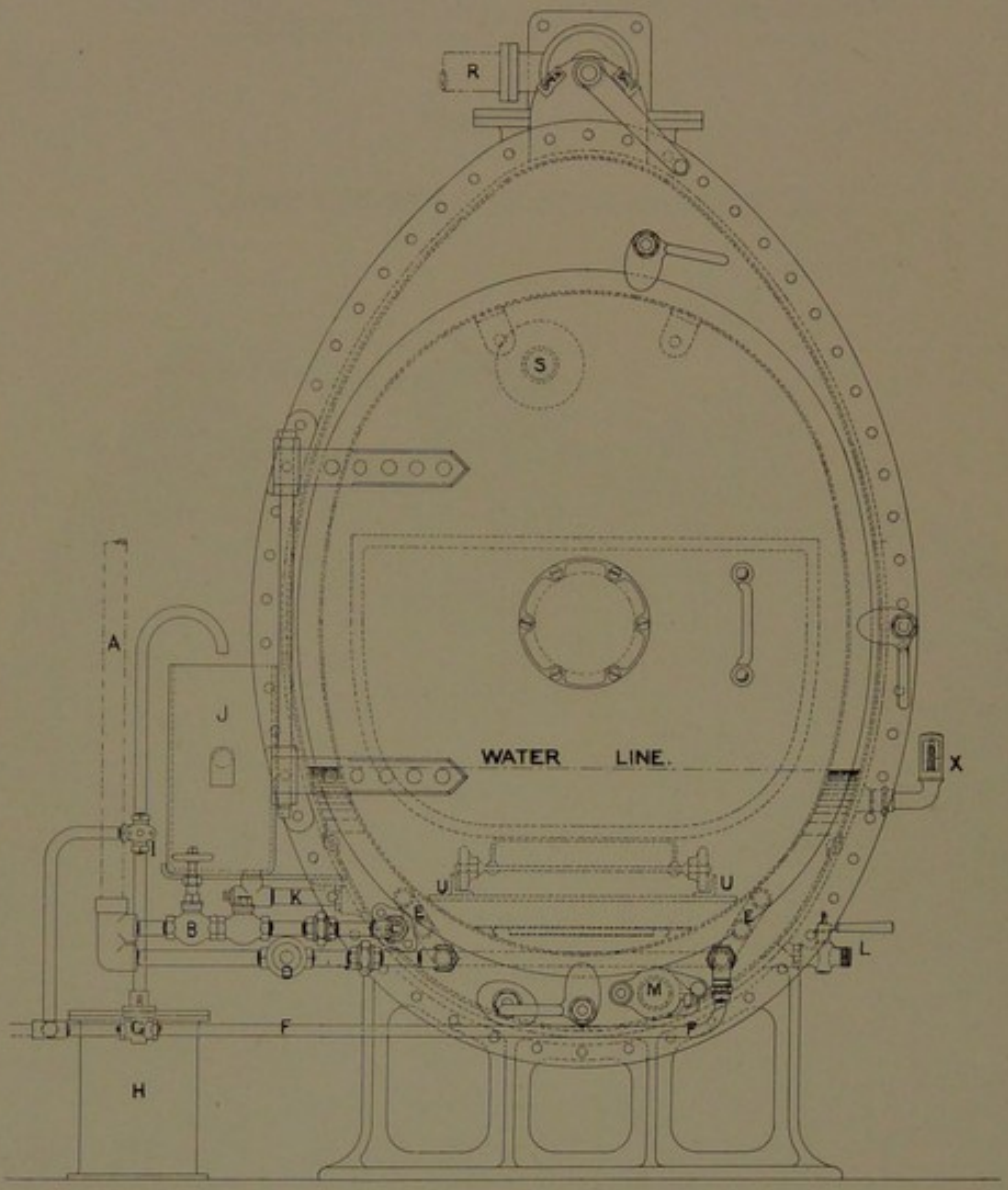


Showing Connections to Steam Supply, Steam Trap, &c.
Particulars of different sizes, &c., given on page 18.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

STEAM-HEATED MACHINE



FRONT ELEVATION

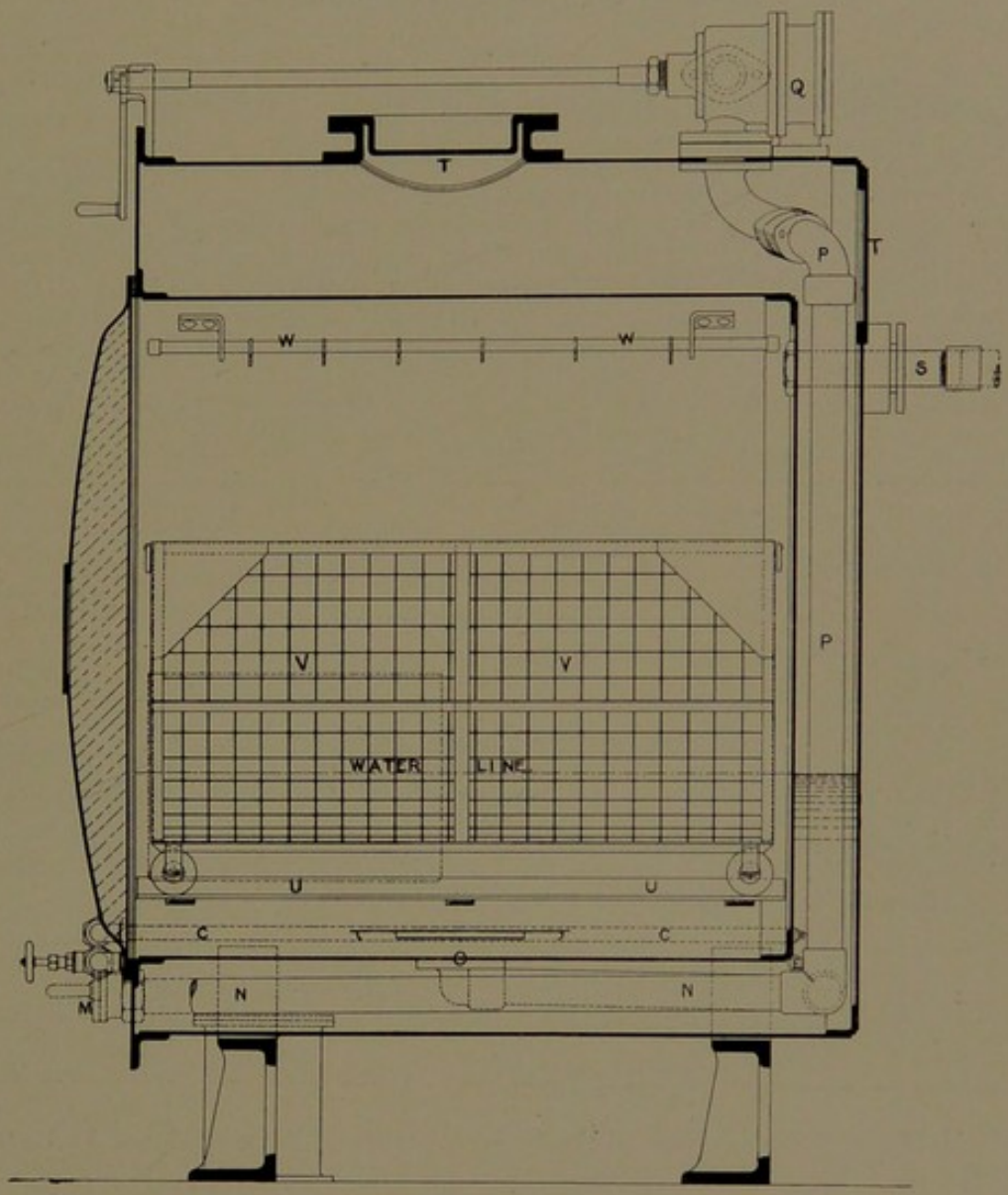
Elevation showing Arrangement of Fittings, &c.

INDEX

A Steam Pipe from Boiler.
B Inlet Valve to Live Steam Injection Tube C.
C Live Steam Injection Tube.
D Inlet Valve to Heating Coil E.
E Copper Heating Coil.
F Condense Pipe from Heating Coil.
G Three way Cock to Bye-pass Steam Trap H when required.
H Steam Trap.
I Three-way Cock to Bye-pass Feed Cistern J when required.
J Feed Cistern with Overflow and Feed Connection.
K Supply Pipe between Cistern and Jacket.
L Draw-off Tap to empty Jacket when required.
M Air Inlet Valve to large Coil N (in Double-door Machine at disinfected end).

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure



LONGITUDINAL SECTION

Section showing Arrangement of Fittings, &c.

INDEX—*continued*

N Large Coil for passing Steam or Hot Air to Inner Chamber.
O Inlet Port for Steam and Hot Air into Inner Chamber.
P Connection between large Coil and Steam Valve Q.
Q Valve to pass steam from Jacket to Inner Chamber, or from Jacket to Exhaust Pipe R.
R Exhaust Steam Pipe from Valve Q.
S Exhaust Pipe for either Steam or Hot Air from Inner Chamber.
T Manhole to give access to Jacket.
U Moveable Rails to support Wire Basket V.
V Wire Basket to receive articles for disinfection.
W Rods and Hooks to receive articles for disinfection.
X Thermometer.

NOTE.—Doors can be handed and exhaust pipes arranged to suit the building.

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure

Steam - heated Machine.—Worked with steam from an independent boiler or from an existing Installation; the steam being utilised as the heating medium by passing it from the boiler through a coil fitted in the jacket of Disinfector in which is the solution to be heated. The Disinfector is fixed on iron stands, and brickwork setting dispensed with. This is illustrated on the previous pages.

It will be seen at once that this arrangement is very convenient in large establishments where steam boilers are in use for other purposes, and that the cost of heating the Disinfector is practically *nil*.

Single-door Machines.—Suitable for Workhouses, Casual Wards, Laundries, Schools, small Hospitals, Lodging Houses, etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.			Capacity Cubic Feet.	Overall Dimensions.		
	Long.	High.	Wide.		Long.	High.	Wide.
	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.
A A (Acorn)	3 9	3 9	3 0	33	4 7	5 9	3 9
B B (Basin)	5 0	3 9	3 0	45	5 10	5 9	3 9

Double-door Machines.—Suitable for Isolation Hospitals, Smallpox Hospitals, General Hospitals, Local Disinfecting Stations, Asylums, Sanatoria, Infirmaries, Large Laundries, etc., etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.			Capacity Cubic Feet.	Overall Dimensions.		
	Long.	High.	Wide.		Long.	High.	Wide.
	ft. in.	ft. in.	ft. in.		ft. in.	ft. in.	ft. in.
H H (Hulk)	5 0	3 9	3 0	45	5 9	5 9	3 9
J J (Jingo)	6 0	3 9	3 0	54	6 9	5 9	3 9
C C (Cuckoo)	7 0	4 6	3 6	88	7 10	7 0	4 7
D D (Digit)	8 0	4 6	3 6	100	8 10	7 0	4 7

Special sizes made if required.

With the Disinfector is supplied Galvanized Water Cistern, Stop Valve, Thermometer, Galvanized Iron Clothes Basket, Hanging Rails and Hooks, Galvanized Extension Rails (upon which to run clothes basket in and out of machine), Potash Solution for Jacket, Steam Trap, Steam Stop Valves, and Back-pressure Valve.

For prices, cost of packing, delivery, etc., see page 52.
Approximate shipping particulars are given on page 59.
Plans for setting furnished to purchasers, on application.
Estimates given for complete erection.
Dimensions of suitable buildings shown on pages 8–10.

The New Type

"Thresh" Current Steam Disinfector

Working at Low Pressure

A modified type of the Current Steam Disinfector has been designed and patented.

In this Machine a temperature exceeding 212° Fah. is obtained, by using steam at a pressure a little above that of the atmosphere. The volume of steam passed through the disinfecting chamber in a given time is thus increased. Afterwards, a steam jet is utilised for producing a rapid current of air for drying purposes

The steam is introduced into the Disinfecting Chamber at the top, and readily displaces the heavier air, assuring rapid penetration and disinfection.

For drying after disinfection, the hot air is introduced at the bottom as in the original "Thresh" Machine; the volume admitted can be exactly regulated to give the best results.

This Machine is as simple in its construction and manipulation as the original atmospheric pressure machine.

The Doors can be fitted with Jones' Patent Combined Disc and Radial Bolts—as illustrated on pages 20 and 22—or with the simple fastenings as shown on pages 12, 14, 15, etc.

A series of experiments have been carried out by Professor G. Sims-Woodhead, of Cambridge University, the results of which abundantly demonstrate the reliable character of the Machine.

A copy of this Report will be supplied on application.

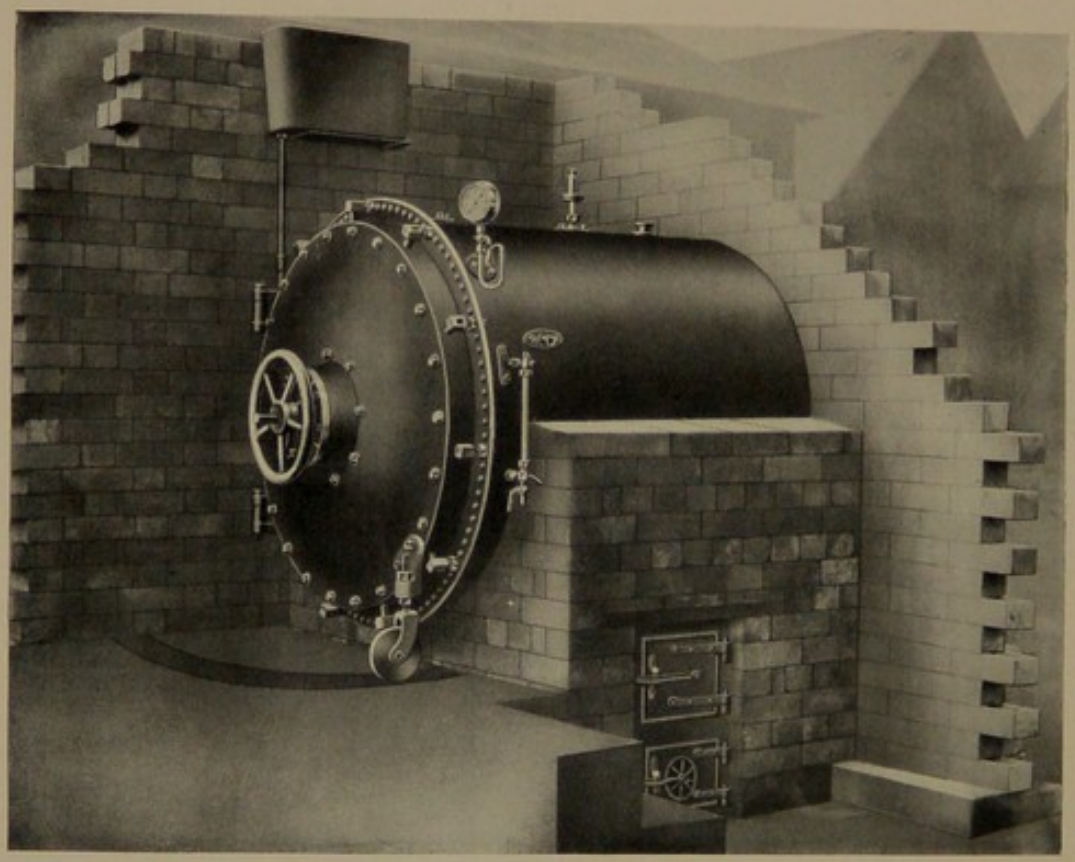
The New Type

"Thresh" Current Steam Disinfector

Working at Low Pressure

Furnace-heated.—Brickwork setting.

NO SEPARATE STEAM BOILER REQUIRED.



For description, see page 19.

Plans, sections, etc., of suitable buildings for these Disinfectors are shown on pages 8, 9, and 10.

Particulars of various sizes, etc., on page 21.

NOTE.—Doors can be handed and exhaust pipes arranged to suit the building.

The New Type
"Thresh" Current Steam Disinfector
Working at Low Pressure

Furnace-heated.—Brickwork setting — NO SEPARATE STEAM BOILER REQUIRED.

Single-door Machines

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diameter.		Long.	Diameter.
	ft. in.	ft. in.		ft. in.	ft. in.
K (Kayak)	3 0	3 7	30	4 6	4 5
L (Lectern)	4 0	3 7	40	5 6	4 5
M (Medlar)	5 0	3 7	50	6 6	4 5

Double-door Machines

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diameter.		Long.	Diameter.
	ft. in.	ft. in.		ft. in.	ft. in.
N (Nopal)	3 0	3 7	30	5 0	4 5
O (Oakum)	4 0	3 7	40	6 0	4 5
P (Pancake)	5 0	3 7	50	7 0	4 5
Q (Quarry)	6 0	3 7	60	8 0	4 5
R (Ratch)	7 0	3 7	70	9 0	4 5
S (Sarcoid)	8 0	3 7	80	10 0	4 5

Portable Machines (Single-Door)

SIZE AND CODE DESIGNATION.	Number of Wheels.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
		Long.	Diameter.		Long.	Diameter.
		ft. in.	ft. in.		ft. in.	ft. in.
T (Talon)	2	3 9	3 0	26¼	5 3	3 10
TT (Tebeth)	2	5 0	3 0	35	6 6	3 10
X (Tipula)	4	5 0	3 0	35	6 6	3 10

Special sizes made if required.

With the Disinfector is supplied Galvanized Water Cistern, Thermometer, Galvanized Iron Clothes Basket, Hanging Rails and Hooks, Galvanized Extension Rails (upon which to run clothes basket in and out of machine), Pressure Gauge, Water Gauge, Gauge Cocks, Emptying Cock, Furnace Ironwork, and Soot Doors for chimney.

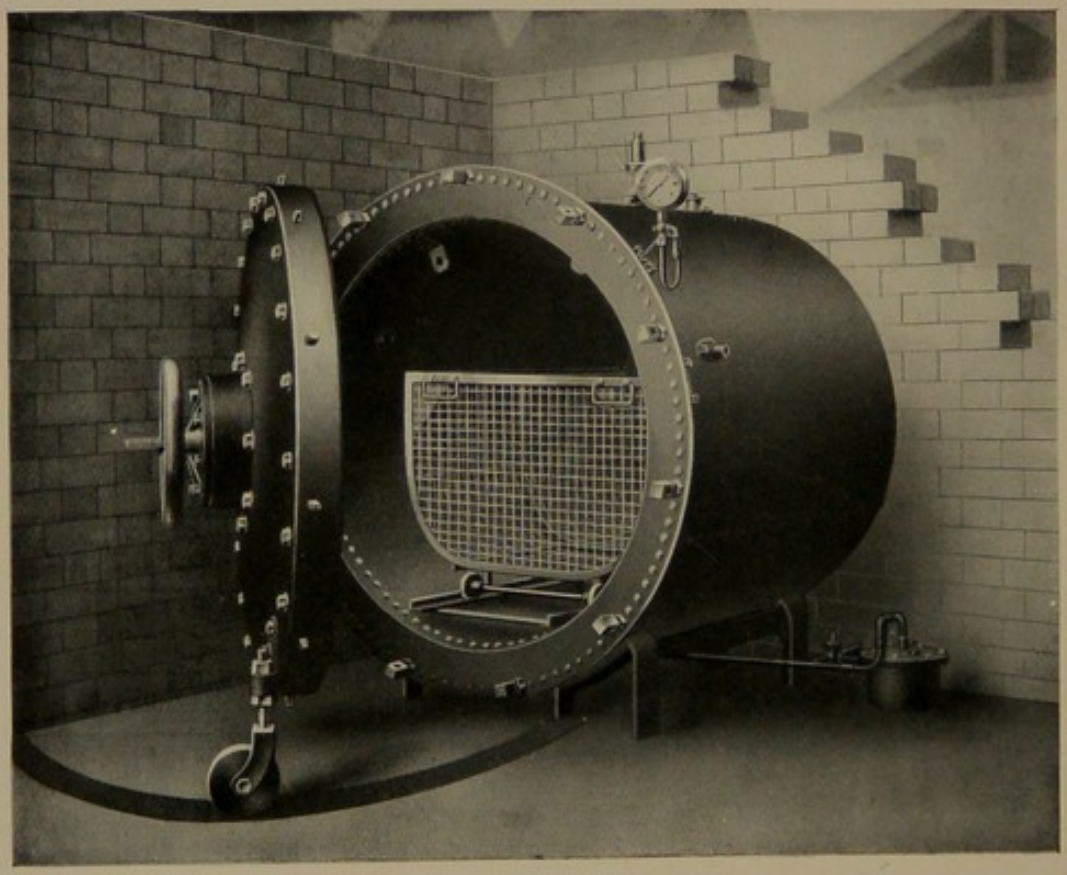
For prices, cost of packing, delivery, etc., see page 53.
Approximate shipping particulars are given on page 60.
Plans for setting furnished to purchasers, on application.
Estimates free for complete erection, including brickwork, etc.
Dimensions of suitable buildings shown on pages 8-10.

The New Type

"Thresh" Current Steam Disinfector

Working at Low Pressure

Steam-heated.—Worked with steam from an independent boiler or from an existing Installation; the steam being utilised as the disinfecting medium.



For description, see page 19.

Plans, sections, etc., of suitable buildings for these Disinfectors are shown on pages 8–10.

Particulars of different sizes, etc., on page 23.

Note.—Doors can be handed and Exhaust Pipes arranged to suit the building.

The New Type

"Thresh" Current Steam Disinfector

Working at Low Pressure

Steam-heated.—Worked with steam from an independent boiler or from an existing Installation; the steam being utilised as the disinfecting medium.

Single-door Machines.—Suitable for Workhouses, Casual Wards, Laundries, Schools, Small Hospitals, Lodging Houses, etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diameter.		Long.	Diameter.
	ft. in.	ft. in.		ft. in.	ft. in.
K K (Ketchup)	3 0	3 7	30	4 6	4 5
L L (Leopard)	4 0	3 7	40	5 6	4 5
M M (Mesole)	5 0	3 7	50	6 6	4 5

Double-door Machines.—Suitable for Isolation Hospitals, Smallpox Hospitals, General Hospitals, Local Disinfecting Stations, Asylums, Sanatoria, Infirmaries, Large Laundries, Steamships, etc., etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diameter.		Long.	Diameter.
	ft. in.	ft. in.		ft. in.	ft. in.
N N (Nutria)	3 0	3 7	30	5 0	4 5
O O (Odontor)	4 0	3 7	40	6 0	4 5
P P (Pibroch)	5 0	3 7	50	7 0	4 5
Q Q (Quest)	6 0	3 7	60	8 0	4 5
R R (Rotary)	7 0	3 7	70	9 0	4 5
S S (Spume)	8 0	3 7	80	10 0	4 5

Special sizes made if required.

With the Disinfector is supplied Steam Stop Valves, Thermometer, Galvanized Iron Clothes Basket, Hanging Rails and Hooks, Galvanized Extension Rails (upon which to run clothes basket in and out of machine), Steam Trap, Pressure Gauge, Exhaust Outlet Valves, and Cast-iron Cradles to carry Disinfector.

For prices, cost of packing, delivery, etc., see page 53.
Approximate shipping particulars are given on page 60.
Plans for setting furnished to purchasers, on application.
Estimates given for complete erection.
Dimensions of suitable buildings shown on pages 8–10.

The Delépine-Jones Patent

Current Pressure Steam Disinfector

Working at any required Pressure

As the use of steam under pressure for disinfecting purposes is often preferred, we have produced a Disinfector which ensures absolute sterilization of the most resistant spore-bearing organisms, and dispenses with all reducing valves, vacuum-producing arrangements, and other complicated appliances usually fitted to high-pressure Disinfectors.

Although this machine is very simple in manipulation, there is no possibility of the failures in sterilization, which have occurred with complex high-pressure Disinfectors when not skilfully handled.

The Machine consists of an outer shell of steel, lined with a continuous close coil of steam tubing. The pressure steam (from the boiler) passes through this coil, and is admitted into the disinfecting chamber by a perforated pipe which lies on the bottom of the coil. The perforations are so arranged that the steam entering the chamber impinges on the coil. Superheating is impossible, as the steam, condensed upon entering the disinfecting chamber, is rapidly re-evaporated, and remains saturated.

For drying purposes an inner lining is provided, causing the air which is admitted at one end of the machine to travel over the coil containing the pressure steam, before it obtains access (at the opposite end) to the disinfecting chamber proper.

The steam in the disinfecting chamber is retained at any required pressure by a loaded valve on the outlet, and so long as steam is issuing freely from this valve the operator knows that disinfection is proceeding satisfactorily. An Automatic Recording Gauge can be attached to the Machine if desired.

A continuous current of steam *at any desired pressure up to* 20-*lbs.* can be maintained by regulating the load on the outlet valve.

The pressure of the steam at the inlet is immaterial, so long as it exceeds that at which it is desired to conduct the disinfecting process.

At the conclusion of the disinfection the air inlet valve is opened, and—by means of a steam jet in connection with the steam coil—a rapid current of (hot) air is drawn through the disinfecting chamber, and the articles contained therein are quickly dried.

The doors of the Machine are of special design, and are opened or closed by merely turning a central hand-wheel, dispensing with the use of a series of screw clamps each of which has to be operated independently. This simple method of opening or closing saves considerable time, and the particular arrangement adopted renders it very difficult for the door to be opened whilst the steam in the disinfecting chamber is under pressure. The holdfasts into which the bolts are shot are adjustable.

This important improvement in the construction of the doors is patented, and can only be applied to Machines made by this Company.

In addition to the long series of experiments conducted by Professor Delépine, the Machine has been tested independently by Professor G. Sims-Woodhead, M.A., D.Sc., etc., of Cambridge University, and the results obtained clearly show that the most resistant organisms known to science, however well protected in the folds of blankets or mattresses, are invariably killed by short exposures in this Disinfector.

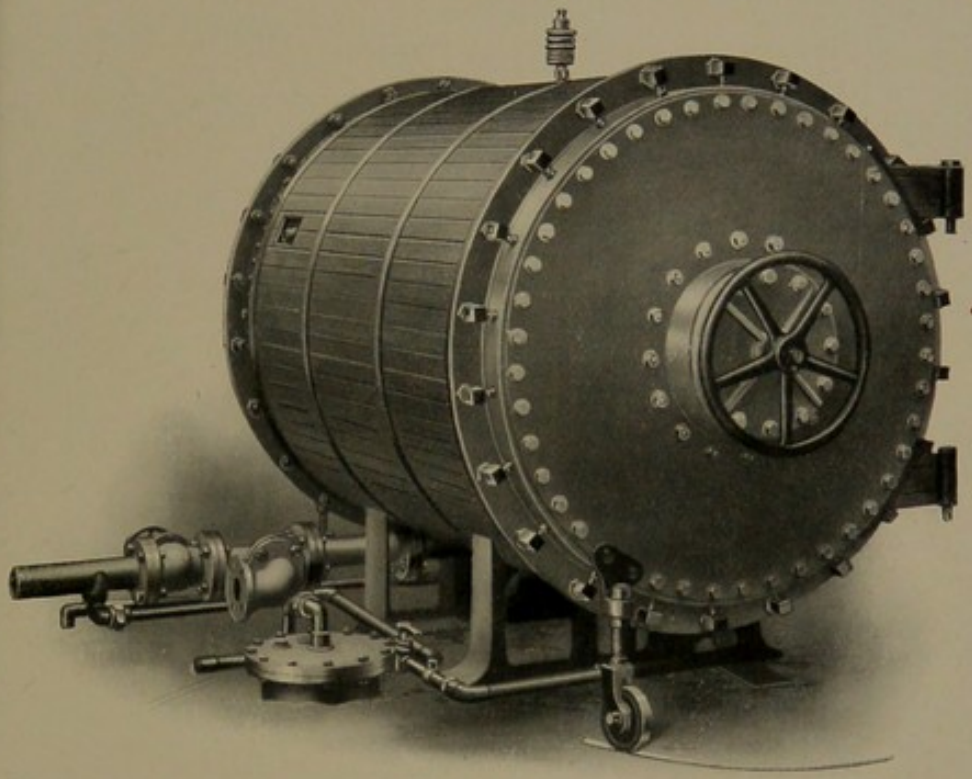
PROFESSOR SIMS-WOODHEAD summarizes his conclusions in the following paragraphs:—

> "Having worked this Disinfector on four separate occasions, I am satisfied that Professor Delépine has devised an apparatus simple to work, highly efficient in its sterilizing capacity, and effective in driving off moisture from the sterilized articles.
>
> "Its high efficiency as a sterilizing apparatus is seen from the readiness with which it kills not only the Bacillus Diphtheriæ and the Staphylococcus Pyogenes Aureus, but the resistant spores of the disease-producing Anthrax Bacillus, and the still more highly-resistant spores obtained from stable manure, and even spores embedded in the actual manure and in earth—these latter being very difficult to kill."

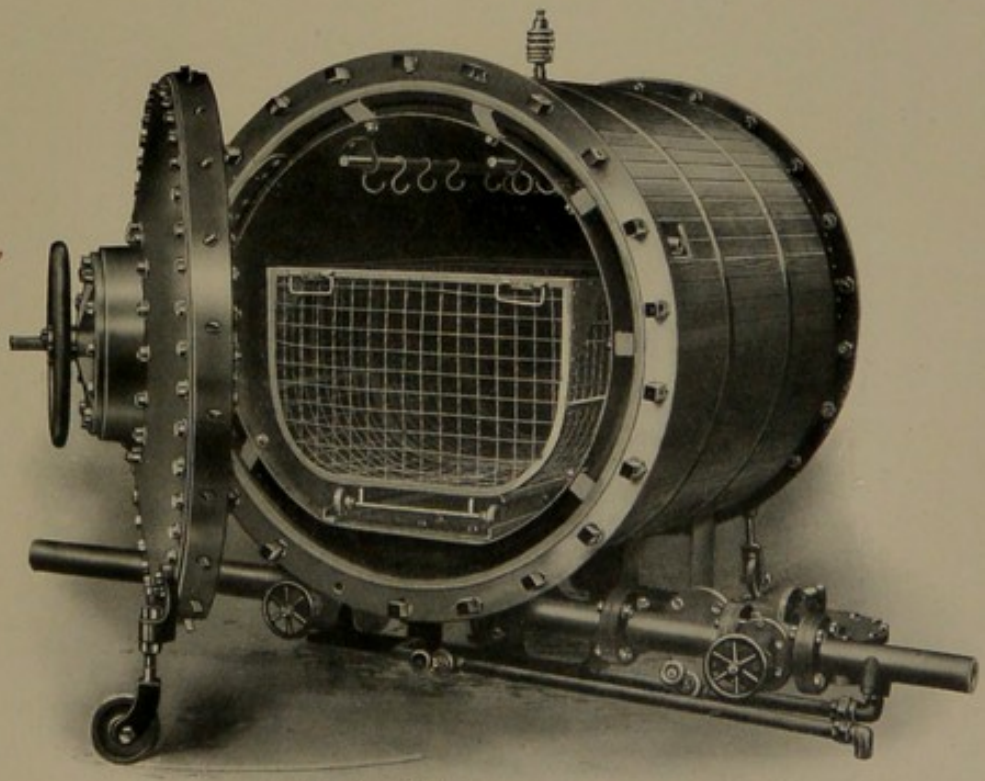
The Delépine-Jones Patent

Current Pressure Steam Disinfector

Working at any required pressure



"Disinfected" End



"Infected" End

For description see page 24.

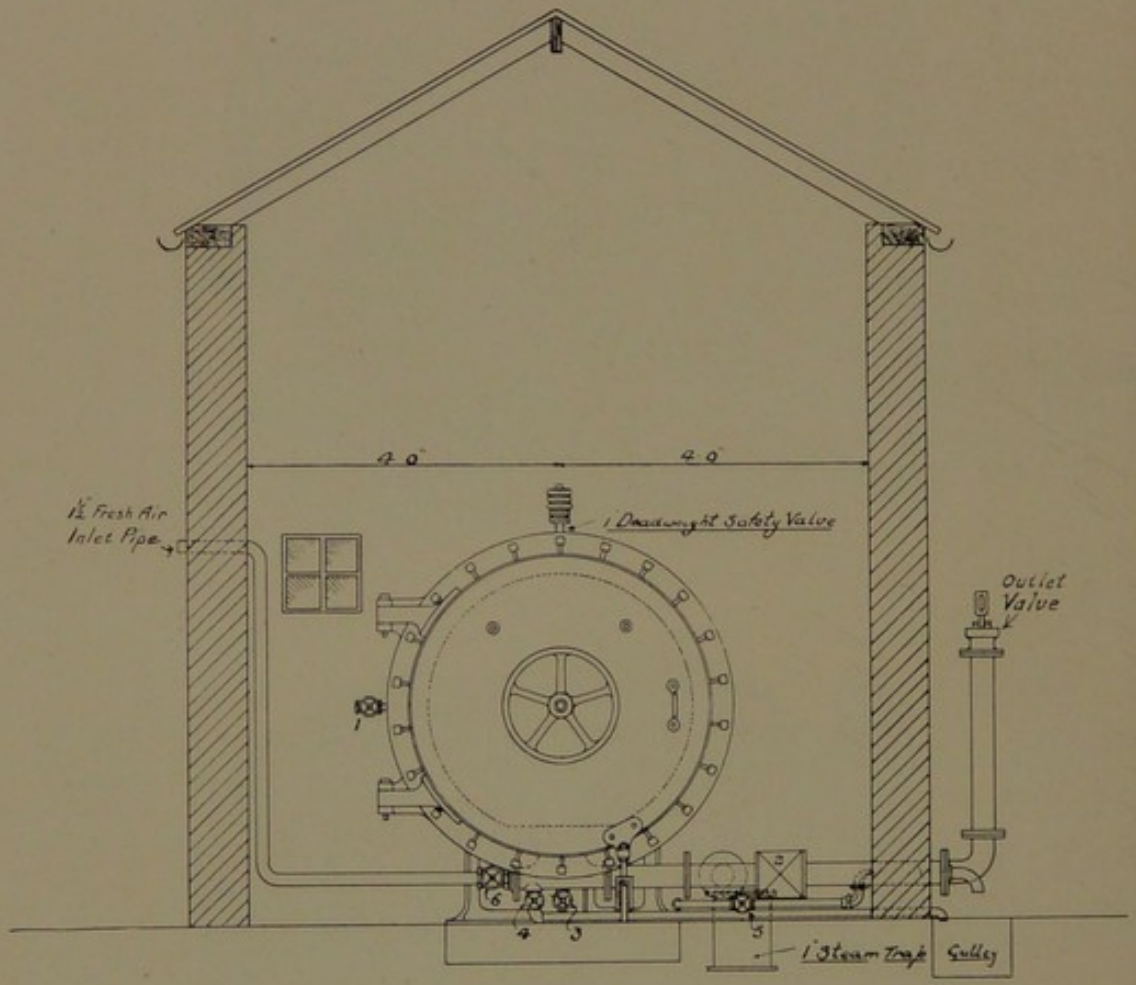
Doors may be hung, and connections arranged, to suit the building.

The Delépine-Jones Patent

Current Pressure Steam Disinfector

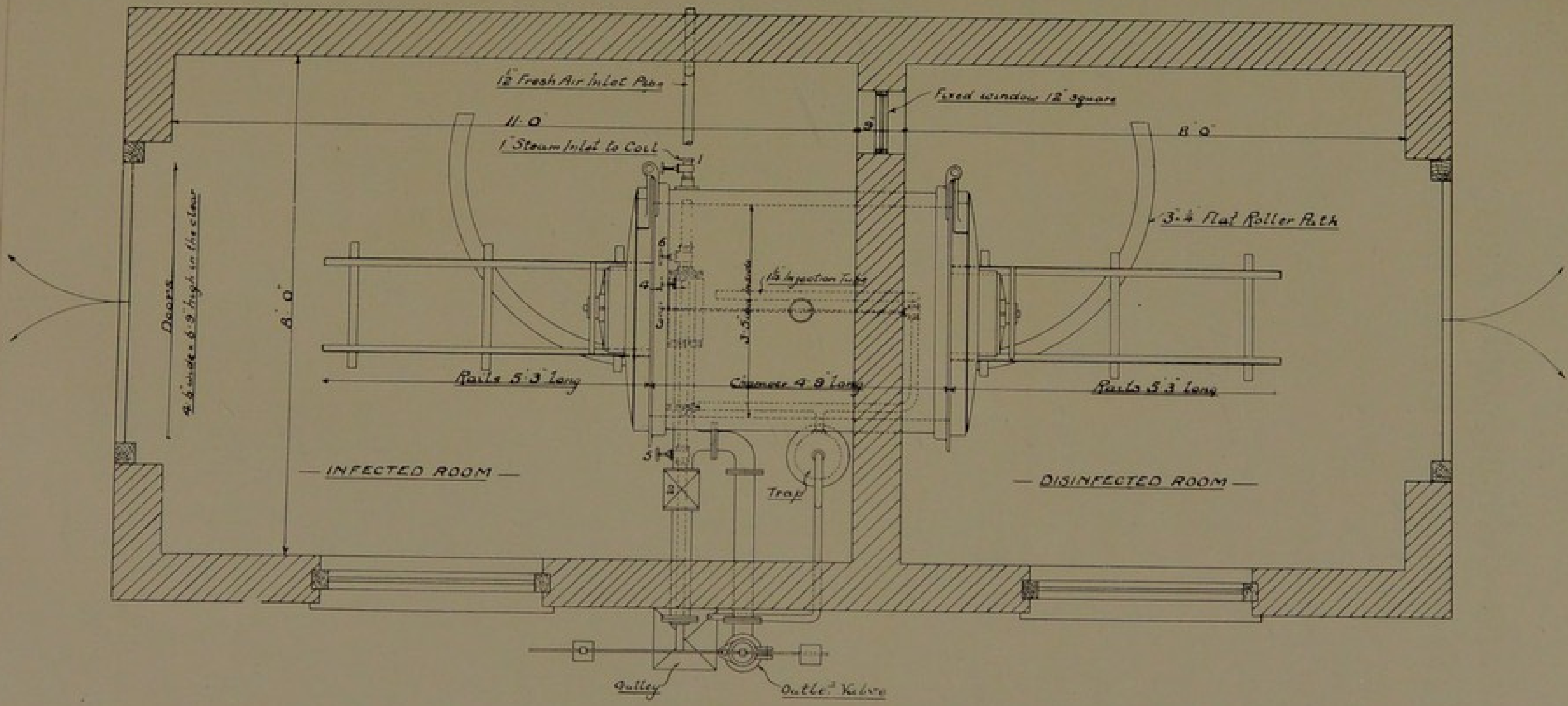
SECTION OF BUILDING

Suitable for a Double-door Disinfector. 5-ft. long. Size "H."



Mark	Index to Valves
N°1	Steam Inlet to Coil in Jacket
2	Steam & Air Outlet Pipe
3	Steam Inlet to Chamber
4	Drain from Jacket
5	Steam Jet to Steam & Air Outlet Pipe
6	Fresh Air Inlet

NOTE.—A similar House, but 4-ft. longer on "Infected" side and 2-ft. longer on "Disinfected" side, would suit a 7-ft. Disinfector.



PLAN OF BUILDING

Suitable for a Double-door Disinfector. 5-ft. long. Size "H."

NOTE.—A similar House, but 4-ft. longer on "Infected" side, and 2-ft. longer on "Disinfected" side, would suit a 7-ft. Disinfector.

The Delépine-Jones Patent
Current Pressure Steam Disinfector

Working at any required Pressure

The steam supply may be at *any pressure* provided it exceeds that at which it is proposed to disinfect. It may be taken from a boiler specially provided, or from an existing steam installation. **No reducing valves are required.**

Single-door Machines.—Suitable for Operating Theatres, Small General Hospitals, Workhouses, Casual Wards, Laundries, Schools, and Lodging Houses; also for Steamships, Quarantine Stations, etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diam.		Long.	Diam.
	ft. in.	ft. in.		ft. in.	ft. in.
A (Affix)	2 0	2 0	6⅓	3 0	3 0
B (Belt)	3 0	2 0	9½	4 0	3 0
C (Celery)	3 0	3 5	27½	4 0	4 6
D (Dance)	4 0	3 5	36¾	5 0	4 6
E (Ember)	5 0	3 5	46	6 0	4 6

Automatic Recording Gauges can be fitted if required.

All Machines fitted with Patent Quick-acting Radial Locking-Bar Doors, as illustration.

Special sizes made if required.

With the Disinfector is supplied Galvanized Extension Rails (upon which to run basket in and out of machine), Pressure Gauge, Steam Trap, Stop Valves, Outlet Valve, Safety Valve, Hanging Rails and Hooks, and Clothes Basket, but no piping beyond the various valves.

All Machines are covered with non-conducting material, lagged with varnished pitch-pine laths, V-jointed, and secured by brass or steel bands.

For prices, cost of packing, etc., see page 54.
Approximate shipping particulars are given on page 61.
Plans for setting furnished to purchasers, on application.
Estimates given for complete erection.

The Delépine-Jones Patent

Current Pressure Steam Disinfector

Working at any required Pressure

The steam supply may be at *any pressure*, provided it exceeds that at which it is proposed to disinfect. It may be taken from a boiler specially provided, or from an existing steam installation. **No reducing valves are required.**

Double-door Machines.—Suitable for Isolation Hospitals, Smallpox Hospitals, General Hospitals, Local Disinfecting Stations, Asylums, Sanatoria, Infirmaries, Port Sanitary Stations, and Large Laundries; also for Steamships, Quarantine Stations, etc.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diam.		Long.	Diam.
	ft. in.	ft. in.		ft. in.	ft. in.
F (Fame)	3 0	3 5	27½	5 0	4 6
G (Grippe)	4 0	3 5	36¾	6 0	4 6
H (Halo)	5 0	3 5	46	7 0	4 6
J (Jowl)	6 0	3 5	55	8 0	4 6
K (Knob)	7 0	3 5	64½	9 0	4 6
L (Larch)	8 0	3 5	73½	10 0	4 6

Automatic Recording Gauges can be fitted if required.

All Machines fitted with Patent Quick-acting Radial Locking-Bar Doors, as illustration.

Special sizes made if required.

With Disinfector is supplied Galvanized Extension Rails (upon which to run basket in and out of machine), Pressure Gauge, Steam Trap, Stop Valves, Outlet Valve, Safety Valve, Hanging Rails and Hooks, and Clothes Basket, but no piping beyond the various valves.

All Machines are covered with non-conducting material, lagged with varnished pitch-pine laths, V-jointed, and secured by brass or steel bands.

For prices, cost of packing, delivery, etc., see page 54.

Approximate shipping particulars are given on page 61.

Plans for setting furnished to purchasers, on application.

Estimates given for complete erection.

Delépine-Thresh Patent
Current Steam Disinfector
Working at Low Pressure

This is a Machine designed for lightness and portability, and to be heated by either a gas or petroleum furnace. It can be made in any size.

To prevent condensation, the walls of the disinfecting chamber are heated by compelling the gases from the furnace to travel round the chamber on their way to the chimney exit. The passage of these gases of combustion is exactly regulated by carefully-constructed baffles, to ensure uniformity in heating.

The steam is generated from a thin layer of water in the bottom of the disinfecting chamber. The water is supplied from a vessel outside, connected to the chamber by a feed pipe controlled by a valve.

The steam is kept at the required pressure by means of a loaded valve on the outlet. There is no danger of an excessive pressure being reached accidentally.

When sufficient water has been evaporated for disinfecting properly, the surplus is drawn off, and a current of hot air passed through the machine for drying purposes.

The weight of the machine has been reduced to the minimum compatible with strength and rigidity, rendering the Disinfector extremely portable.

This reduction in weight enables one quickly to obtain the necessary temperature, thus cheapening the cost of working. Also, to obtain a rapid generation of steam, the smallest quantity of water compatible with safety is used. With *portable* Machines the heat is obtained from a powerful petroleum furnace, with *fixed* machines from either a petroleum furnace or Bunsen gas burners. Size "A" Machine, 4-ft. long × 3-ft. 6-in. in diameter, requires less than four pints of petroleum at a cost of about 4d. to heat, disinfect, and dry one charge of bedding.

The time occupied for the whole operation does not exceed 60 minutes; in the case of light articles (blankets, sheets, clothing, etc.) it is less.

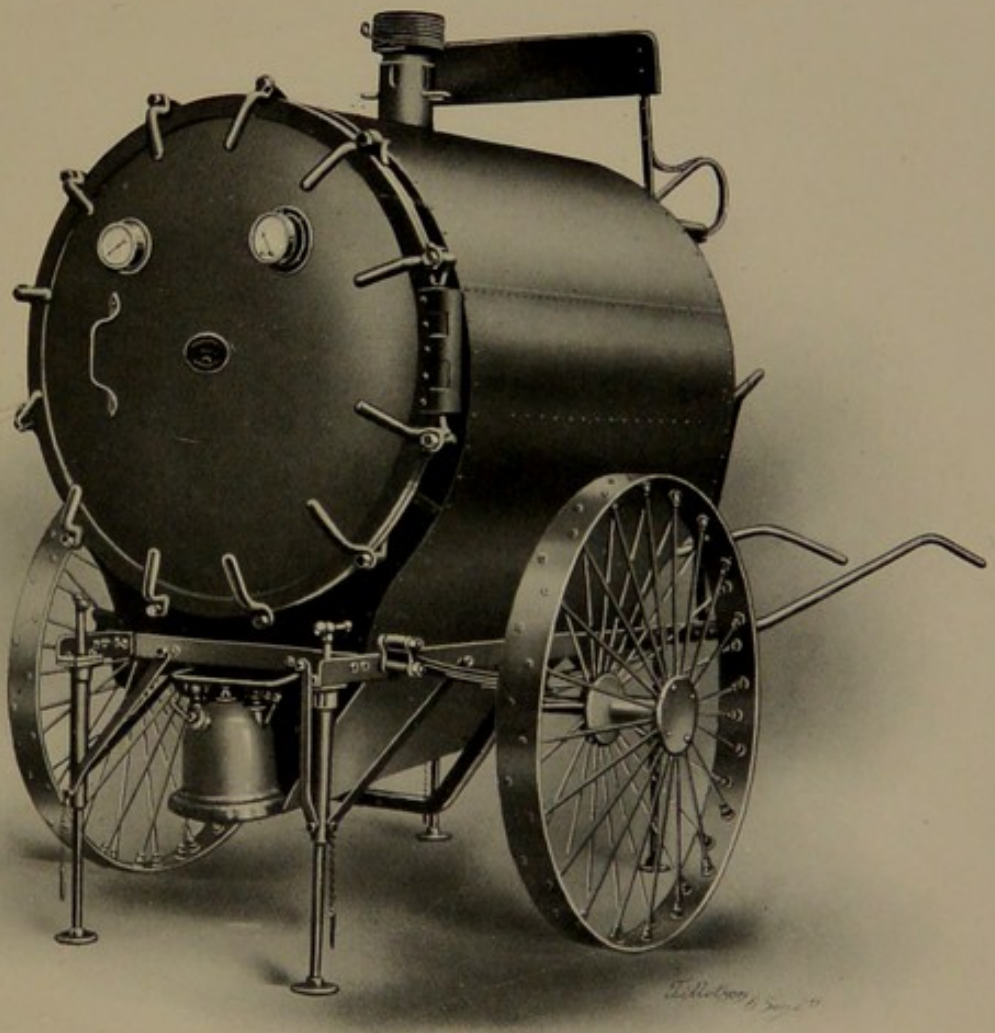
The Machine is so simple in construction that any person of ordinary intelligence can manipulate it perfectly.

The results of various tests made by Professor Delépine are recorded fully in the *Journal of State Medicine* for April, 1900, a copy of which will be furnished on application.

Delépine-Thresh Patent

Current Steam Disinfector

Working at Low Pressure



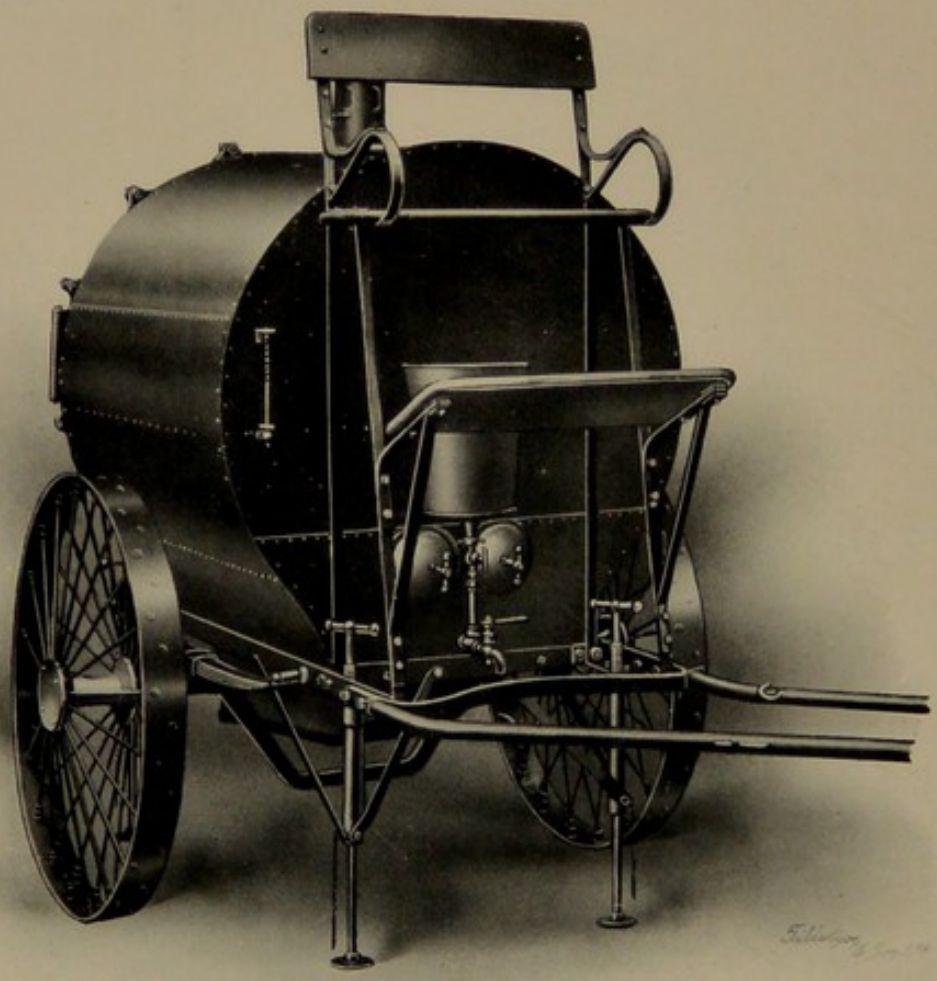
Portable Disinfector, size "A A," as supplied to the Indian Government

For description, see page 30.

Delépine-Thresh Patent

Current Steam Disinfector

Working at Low Pressure



Portable Disinfector, size "A A," as supplied to the Indian Government

For description, see page 30.

Delépine-Thresh Patent
Current Steam Disinfectors

Working at Low Pressure (0 to 10 lbs.)

Suitable for Rural Districts, Small Urban Areas, Hospitals, Sanatoria, Public Schools, Unions, Laundries, Steam Ships, etc., etc.

Single-door Machines.

Fixed Type.—On Wrought-iron Stands.

SIZE AND CODE DESIGNATION.	Dimensions of Inner or Disinfecting Chamber.		Capacity Cubic Feet.	Overall Dimensions.	
	Long.	Diam.		Long.	Diam.
	ft. in.	ft. in.		ft. in.	ft. in.
A (Apple)	4 0	3 6	38½	5 3	4 0
B (Bomb)	5 6	3 6	52⅓	6 9	4 0

Portable Type.—On specially-built Underframes and Tangentially-spoked Wheels.

				Minus Shafts.	Over Wheelboxes.
A A (Aspic)	4 0	3 6	38½	6 0	4 3
B B (Bantam)	5 6	3 6	52⅓	7 6	4 3

Double-door Machines.

Fixed Type only.—On Wrought-iron Stands.

C (Chess)	7 0	3 6	67⅓	8 0	4 0

Special sizes made if required.

Automatic Recording Gauges fitted if desired.

With the Disinfector is supplied Water Cistern, Petroleum Furnace with Pressure Pump (including connecting tube, wrench, pricker for burners, and measure for spirit), or Gas Furnace complete, also *Stand* in case of *Fixed* Machines, or *Under Carriage* complete with springs, wheels, shafts, supports, etc., in case of *Portable* Machines.

For prices, cost of packing, delivery, etc., see page 55.

Approximate shipping particulars are given on page 62.

Estimates given for complete erection.

Thresh's Patent
"Emergency" Disinfector

This Machine has been largely adopted by Smallpox Hospital Authorities and by Rural Councils; also by Schools, Nursing Homes, etc., as an efficient, portable, and inexpensive Disinfector.

The apparatus has an oblong chamber sufficiently large to take an ordinary bed when properly folded.

The bottom of the chamber is perforated for the admission of steam or hot air.

The steam is generated in a pan, which slides under the bottom of body of machine, and which is charged with the proper quantity of water and formal solution.

The necessary heat is furnished by an oil furnace of special design.

The steam and formaldehyde vapour traversing the machine disinfect the contents without rendering them unduly wet.

At the end of the disinfecting process the pan is withdrawn and a baffle plate inserted in its place. Heated air then enters the chamber, displaces the steam, and dries the articles.

In about half an hour a bed can be withdrawn practically dry, and after being unfolded and allowed to cool in the open air for a few minutes it is ready for immediate use.

The Machine thus possesses the advantage of drying as well as disinfecting.

Articles, such as leather goods, furs, etc. (which are damaged by steam), can be disinfected by formalin gas.

The apparatus can be moved quite easily on a hand cart.

The cost of each disinfection is about 2d. for petroleum and 5d. for formalin.

The Machine is equally useful for destroying vermin, moths, etc., in clothing and other articles.

Ordinarily, the body of this Disinfector is cased with *wood*, but where a stronger machine is desired, or when wanted for use in hot climates, it is made with a casing of *steel*.

It is supplied in three sizes to suit the requirements of Nursing Homes, Small or Large Hospitals, Unions, Schools, &c.

In May, 1902, the Machine was tested by an eminent bacteriologist at the request of the Editor of the *British Medical Journal*, and his Report was printed in the Journal of June that year. *Copies may be had on application.*

The Report dealt with:—

(*a*) Low initial cost.
(*b*) Small working expenses.
(*c*) Extreme portability.
(*d*) Simplicity of construction.
(*e*) Ease of manipulation, efficiency, and rapidity of disinfection.

For the bacteriological tests twelve different organisms were used, including tubercle bacilli embedded in dry sputum; spore-bearing anthrax; and spore-bearing bacillus mesentericus.

Even in the centre of flock beds the spores of the anthrax bacillus were killed in 30 minutes, and 45 minutes exposure was sufficient to destroy the spores of the bacillus mesentericus.

The conclusion arrived at was:—

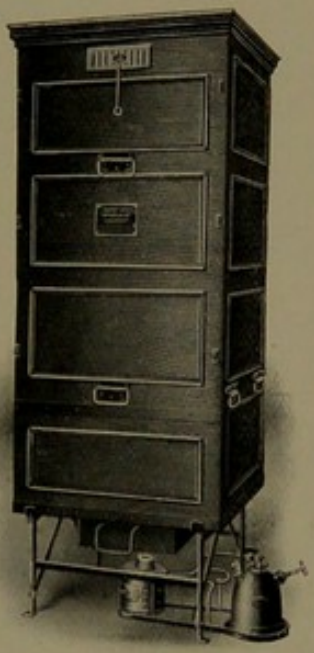
"That the addition of formalin greatly aids the process of disinfection, and that if the machine is used as directed even the spores of the most resistant organisms, folded in blankets or enclosed in a rolled flock bed, are invariably destroyed."

The drying of the clothing was found to be quite satisfactory.

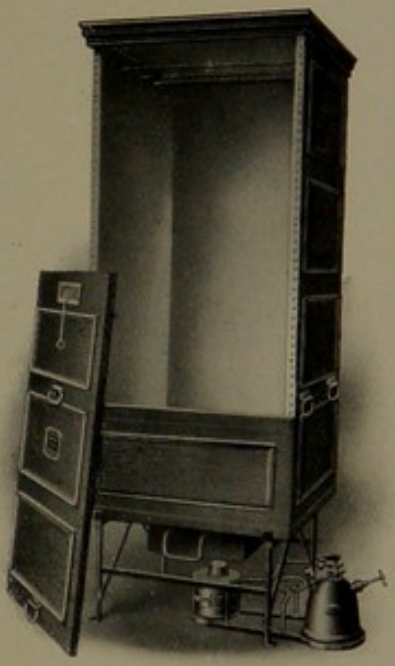
Particulars of different sizes, etc., given on page 36.

Thresh's Patent
"Emergency" Disinfector

Disinfection by Current Steam saturated with the vapour of Formic Aldehyde



With Wood Body



With Steel Body

Thresh's Patent
"Emergency" Disinfector

Disinfection by Current Steam saturated with the Vapour of Formic Aldehyde

Suitable for Private use, Nursing Homes, Rural Authorities, Schools, Small Hospitals, Sanatoria, Smallpox Hospitals, Temporary Hospitals, etc., etc.

Sizes usually made

SIZE AND CODE DESIGNATION.	Dimensions of Disinfecting Chamber.			Capacity Cubic Feet.	Approximate Weight Complete.
	High.	Wide.	Deep.		
	ft. in.	ft. in.	ft. in.		cwt.
No. 0 (Orb)	2 3	2 3	2 3	9	1
No. 1 (Alpha)	5 6	2 3	2 3	23	2¼
No. 2 (Beta)	6 6	2 9	2 9	40	3¼

No. 0 Size for Private use, Nursing Homes, etc.

No. 1 Size for disinfecting articles other than a full-sized bed or mattress.

No. 2 Size to receive a full-sized bed or mattress.

The above made with **wooden** bodies for **ordinary** use, and cased with **sheet steel for hot climates, or when a stronger machine is required.** In latter case, add Code Word "FORTIS" when cabling.

These Disinfectors can be constructed of any size to suit special requirements.

With the Disinfector is supplied Hanging Rails and Hooks, Iron Pan for Solution, Baffle Plate, Petroleum Furnace with pressure pump, connecting tube, wrench, pricker for burner, and measure for spirit, also Stand complete.

For prices, cost of packing, delivery, etc., see page 55.

Approximate shipping particulars are given on page 63.

The Delépine Sterilizer

This is a small Machine designed by Professor Delépine for use in Laboratories, Operating Rooms, Small Hospitals, Schools, etc. It can be employed advantageously by private practitioners, and for disinfecting the clothing of Nurses after exposure to infection.

The Disinfector consists of a strong jacketed copper cylinder with slightly conical bottom, the upper end closed by a lid, which in use is firmly clamped to the body.

The inner chamber and the jacket are provided with outlets guarded by weighted valves.

The upper part of inner chamber (used for disinfecting purposes) is separated from the lower part (used as a boiler) by a diaphragm, so constructed that it acts as a steam baffle and anti-primer.

The heat is obtained from either an oil or gas furnace.

The Machine is operated quite easily and is certain and rapid in action.

A full description, with results of tests made which prove its reliability, was published in the *Journal of State Medicine. Copy can be obtained on application.*

The Delépine Sterilizer

Fixed Type—on Stand. **Portable Type**—on Wheels.

With Petroleum Furnace or Bunsen Gas Furnace.

Suitable for:—

LABORATORIES, OPERATING ROOMS, SMALL HOSPITALS, SCHOOLS, PRIVATE PRACTITIONERS, etc., etc.

The Delépine Sterilizer

SIZE AND CODE DESIGNATION.	Dimensions.		Description.
	High.	Diam.	
	in.	in.	
X (Xylol)	24	22	**ON WHEELS**— Made of copper, double cased, with copper box for instruments, dressings, etc., with inside tinned copper wire basket.
X X (Xystos)	24	22	**ON STAND**— As described above.
Y (Yeast)	18	16	**ON WHEELS**— As described above.
Y Y (Youth)	18	16	**ON STAND**— As described above.
Z (Zany)	14	10	**ON STAND**— Copper inner body, iron outer casing, fitted with tinned copper box.

Special sizes made to order.

The " Fixed " Type is provided with a strong Iron Stand and a Swedish Petroleum Furnace with all accessories complete, or with a Bunsen Gas Furnace complete with union for attachment to rubber tubing.

The " Portable " Type has Rubber-tyred Wheels fitted to axle, as illustrated, and Iron Handles, properly braced.

It is usual to fit the " Portable " Sterilizers with Petroleum Furnaces unless specially ordered otherwise.

No Thermometer included.

For prices, cost of packing, delivery, etc., see page 56.

Approximate shipping particulars are given on page 63.

Room Disinfection

The foregoing portion of this Catalogue deals with various Machines used for disinfecting the bedding and clothing of persons who have suffered from infectious disease, or who have come into contact with infectious cases.

It is necessary, however, to disinfect every apartment (and its contents) where infection may have been carried.

To this end the walls, ceiling, furniture, and floor should be sprayed with liquid disinfectant, or steam and formalin vapour driven into the room from outside.

The Sprayers, and Vaporizer, hereafter described, are superior to most appliances of like character on the market.

Hundreds of our "Mackenzie" Sprays have been supplied to Sanitary Authorities, Schools, Boards of Guardians, etc., etc.

The "Demuth" Vaporizer is a recent introduction, and has been thoroughly tested by a well-known bacteriologist (Dr. Eyre, of Guy's Hospital).

The "Mackenzie" Spray

This apparatus was devised by Dr. Leslie Mackenzie, Inspector of the Local Government Board, Scotland, to meet the want which existed for an ABSOLUTELY RELIABLE PORTABLE SPRAY.

By means of this apparatus every portion of the surface within a room (the walls, ceiling, furniture, and floor) can be sprayed with a solution of a powerful disinfectant.

As the air becomes impregnated, the germs fall to the ground and are rapidly destroyed.

The whole operation in a room of ordinary size can be completed in ten minutes.

The room is then closed for three or four hours, after which it may be cleaned, and is ready for re-occupation.

If the spraying is conducted with reasonable care, and according to the directions furnished, no injury results to the wall paper or furniture.

The great advantage of this Spray is that it completely and uniformly moistens every portion of the surface to which it is applied; many sprays fail to do this, and consequently cause the process to be in a measure discredited.

Drs. Thresh and Sowden contributed a paper at the Congress of the Sanitary Institute held at Manchester in 1902, in which they showed:—

1. That for spraying to be efficient, every portion of the surface to be disinfected must be thoroughly moistened with the disinfecting solution.
2. That white-washed surfaces require particular attention, being far more difficult to disinfect than surfaces of wood and paper.
3. That an efficient spray properly used effects room disinfection in the minimum of time at the minimum of expense, and is more reliable than disinfection by sulphur dioxide or formalin vapour.

A 2% formalin solution was recommended by them, one ounce of 40% Formaldehyde to each pint of water, but solutions of Izal, Cyllin, or other well-known disinfectants may be employed.

The *Lancet*, in referring to this Spray, said:—

"The apparatus, therefore, is not a toy like many of the Portable Sprays, and can be thoroughly relied upon."

The Spray complete is only a few pounds in weight, and can be carried in the hand, or on a bicycle, without any inconvenience.

It is made in different sizes and with one, two, or three nozzles, according to the size of room for which it is required.

Its use is not confined to room disinfection, it is equally valuable for spraying yards, passages, outbuildings, etc.

Code designation: **Mace**

Size "A" for ordinary work consists of Spray, Crosspiece with two nozzles, additional Rods for reaching ceiling, and Rubber Tubing.

Rubber Bucket for containing the disinfecting fluid, and for carrying the spraying apparatus when not in use.

Code designation: **Magi**

Size "B" for large and lofty chambers, Schools, Offices, etc., consists of Spray, Crosspiece with three nozzles, lengthening Rods for reaching ceiling, and Rubber Tubing. Special Iron Vessel for containing the disinfecting fluid and to receive spray when not in use.

For HOT CLIMATES Flexible Metallic Tubing is recommended in place of rubber tubing.

For prices and cost of packing, see page 56.

Approximate shipping particulars are given on page 64.

The "Mackenzie" Spray

For Disinfecting Walls, Floors, Ceilings, Desks, &c.

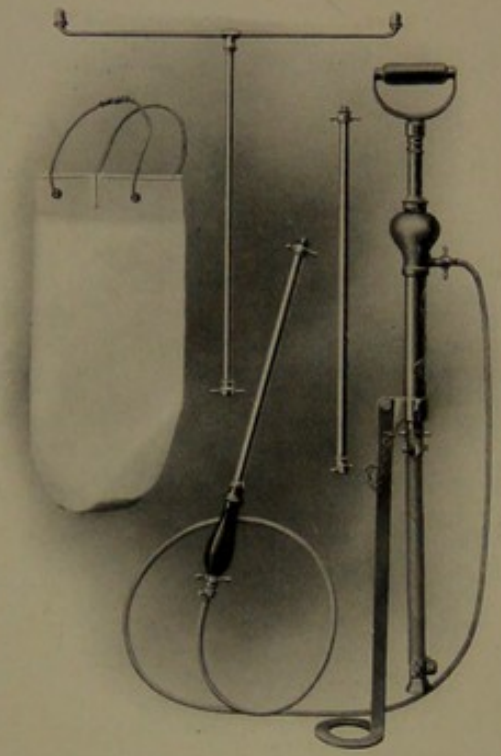


Illustration of Size "A"—for ordinary work

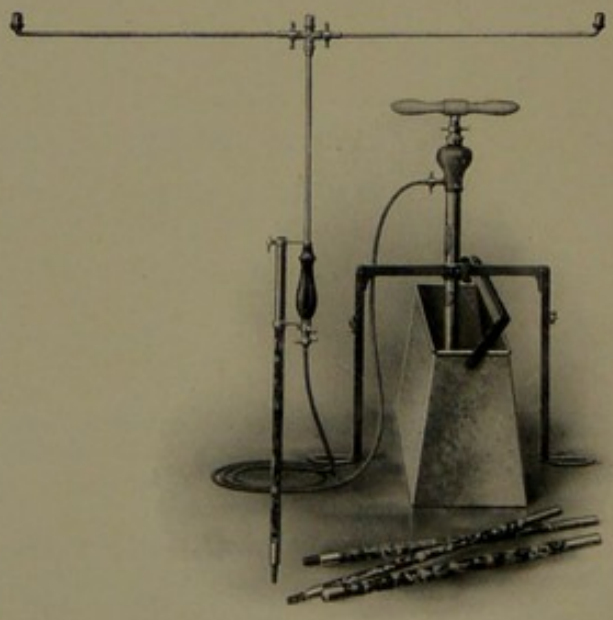
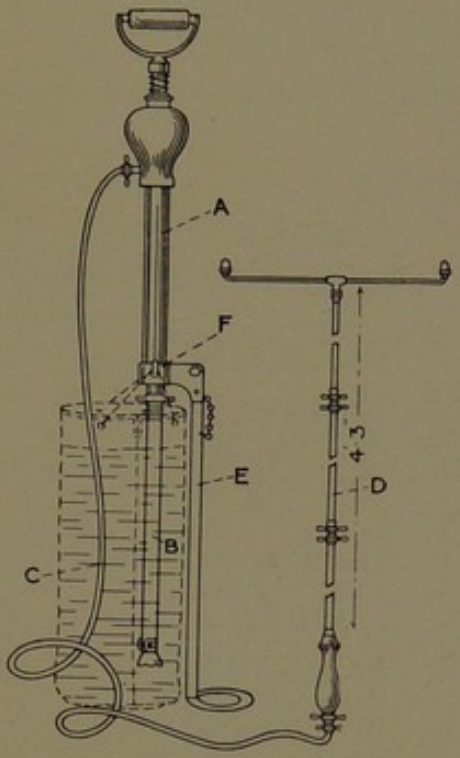


Illustration of Size "B"—for large and lofty chambers

The "Mackenzie" Spray



Size "A"

A—Pump.

B—Suction Tube (detachable) for immersing in vessel containing disinfecting fluid.

C—6-ft. Rubber Tube.

D—Brass Tube, in three lengths, with Wood Handle at one end, and Spraying Nozzle at other end.

E—Pump support, pivoted for folding up.

Bucket is shown in dotted lines, and hangs on F.

Spray can be taken to pieces promptly and packed in bucket.

A—Pump.

C—6-ft. Rubber Tubing.

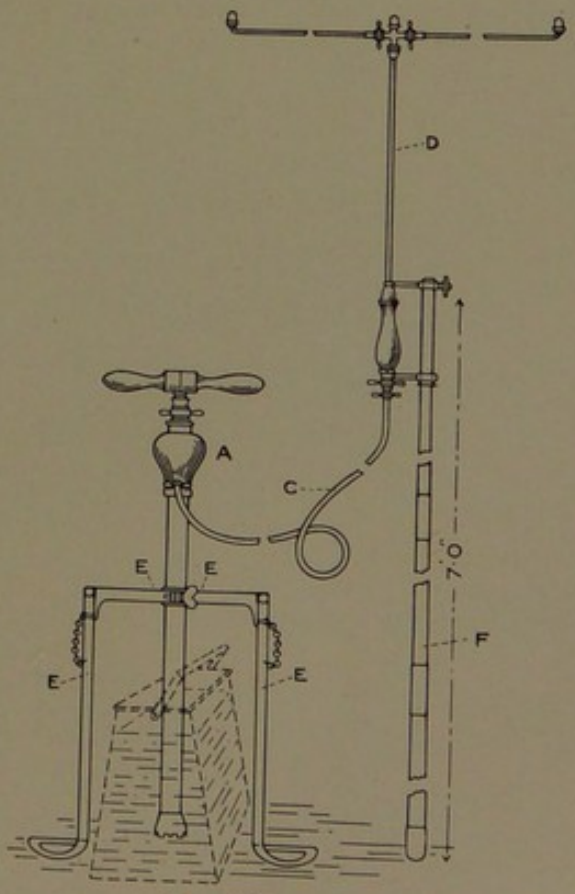
D—Brass Tube, with Wood Handle at one end, and Spraying Nozzle at other end.

E—Pump supports, pivoted for folding up.

F—Extension Rods of Bamboo.

Iron Vessel for Disinfecting Fluid shown in dotted lines.

Spray can be taken to pieces promptly and packed in vessel.



Size "B"

Demuth's Rapid
Formaldehyde Vaporizer

Instead of applying Formalin solution in the form of a spray, it may be vaporized with steam under pressure and driven into a room properly sealed, so that the mixture of steam and Formalin which condenses may thoroughly moisten every portion of the exposed surfaces. This is a favourite method of disinfecting on the Continent.

A great advantage is that the operator is not exposed to the irritating vapour of Formalin, the Vaporizer being worked outside, and the vapour passed into the room through a nozzle inserted in the keyhole.

The furnace can be lighted, and the machine left unattended for the time required for disinfection.

The "Demuth" apparatus is strongly made, simple in construction, easily handled, and, when once started, requires very little attention.

Dr. Eyre, of Guy's Hospital, tested this Vaporizer, and found it to be quite efficient, but it is necessary to keep the room closed for 20 hours after disinfection. With this period of exposure pathogenic germs of typhoid, cholera, diphtheria, etc., placed in closed tubes and sealed in envelopes, were killed.

The Disinfector is capable of effectually treating a room of 9,000 cubic feet contents at one filling.

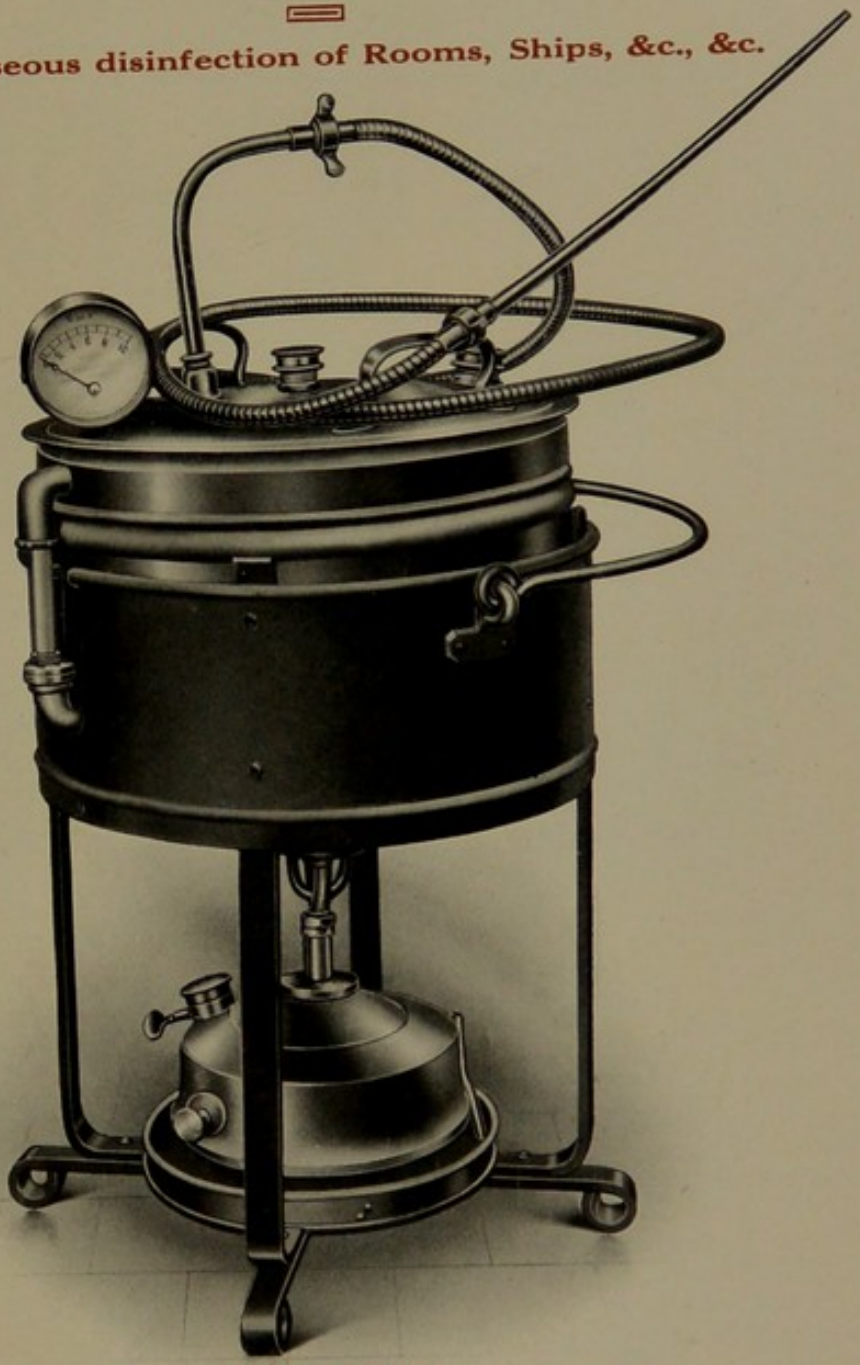
Code Designation: Demure.						
For	9,000	cubic feet	use	5-lbs.	Formalin; 1½ gallons	water.
,,	7,500	,,	,,	4¼-lbs.	,, 12½-lbs.	,,
,,	6,000	,,	,,	3½-lbs.	,, 10-lbs.	,,
,,	4,500	,,	,,	2½-lbs.	,, 7½-lbs.	,,
,,	3,000	,,	,,	1¾-lbs.	,, 5-lbs.	,,
,,	1,500	,,	,,	1-lb.	,, 2½-lbs.	,,

For price, cost of packing, etc., see page 57.

Approximate shipping particulars are given on page 64.

Demuth's Rapid
Formaldehyde Vaporizer

For gaseous disinfection of Rooms, Ships, &c., &c.



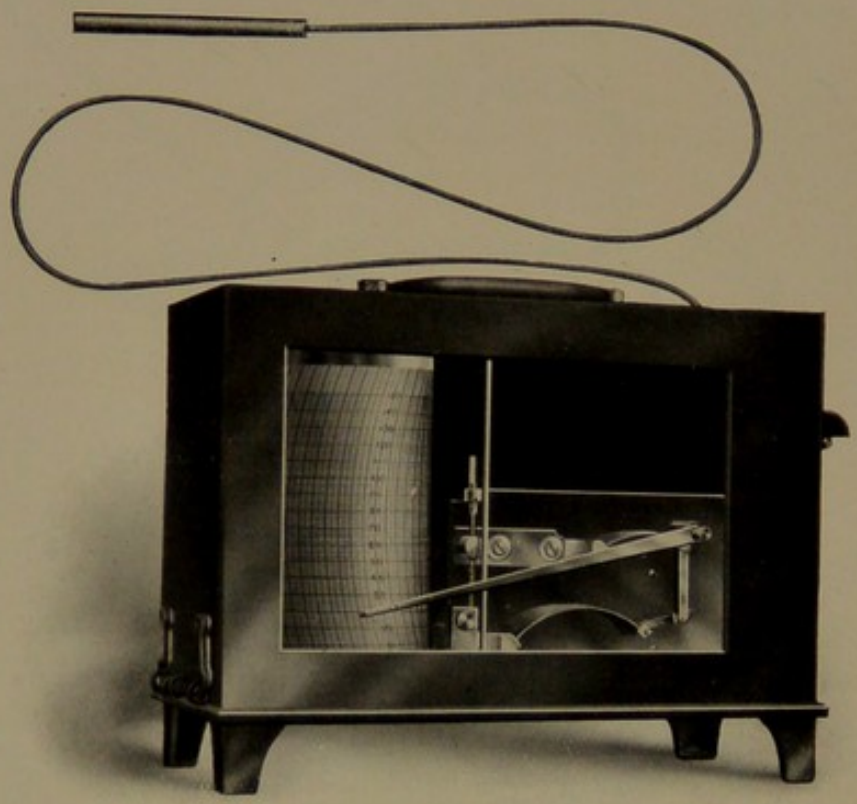
Description

The Generator, made of stout copper, is divided into two compartments, the smaller for Formalin, the larger for Water.

When the water boils the steam generated under pressure passes into the compartment containing Formalin, causing the latter to become vaporized and to mix with the steam ; the mixture passes through the pipe, the nozzle of which is inserted in the keyhole of the door of room to be disinfected.

A Swedish Furnace is used for vaporization. A Water Gauge is fitted to the apparatus, also a pressure gauge.

Automatic Recording Thermograph



Code Designation—**Autocrat.**

Many Medical Officers of Health require an accurate self-recording instrument fitted to the Disinfector, as a check upon the attendant, and to indicate whether the required steam temperature has been obtained, and maintained, for a sufficient period to ensure complete disinfection of the articles introduced into the apparatus.

The instrument illustrated above is extremely sensitive; it is constructed by the celebrated firm of Richards, of Paris, and is the best made.

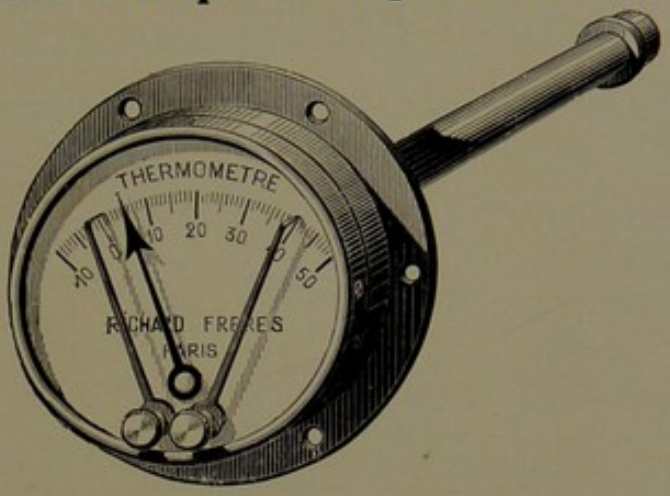
It has a pliable Temperature Receiver, which is convenient, as it enables records to be taken of the temperatures obtained in different parts of the Disinfector.

NOTE.—If a Disinfector is to be made to receive a Self-Recording Thermometer, it must be so stated at time of ordering, that a ferrule may be fitted to the Disinfector to allow the temperature receiver of the thermograph to be passed from outside into the disinfecting chamber proper.

For prices, etc., see page 57.

Approximate shipping particulars are given on page 64.

Patent Compensating Thermometers



Code Designation—**Compare.**

The working of these Thermometers is based upon the principle of the expansion of liquids through heat, the expansion being constant and always comparable to itself. In this respect they are superior to those thermometers whose construction is based upon the expansion of a metallic rod, or the elasticity of bi-metallic springs, as the expansion in such case acts upon the molecular state of the spring or rod, and so prevents them remaining constantly comparable to themselves.

Another improvement in these Thermometers is in the use of a compensator which nullifies the effect of the variation of temperature of the surroundings upon the parts of the instrument giving the indications.

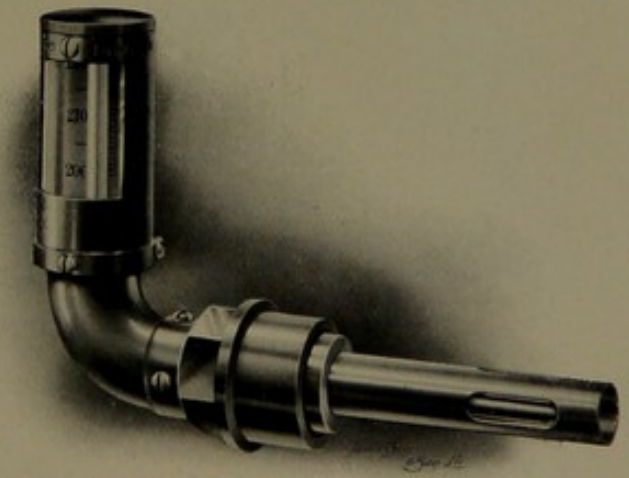
Adjusted to work up to 300° Fah.

For prices, etc., see page 57.

Approximate shipping particulars are given on page 64.

"Thresh" Disinfector Thermometer

as illustrated below, kept in stock



Code Designation—**Ledge**—Left-hand Thermometer.
" " **—Rigid**—Right-hand Thermometer.

When ordering state whether "*right*" or "*left*" *hand*, *i.e.*, on which side of Disinfector they are fixed, **as one faces the door of Machine.**

Other Thermometers, Electric Alarum Metallic Thermometers, etc., etc., supplied as required.

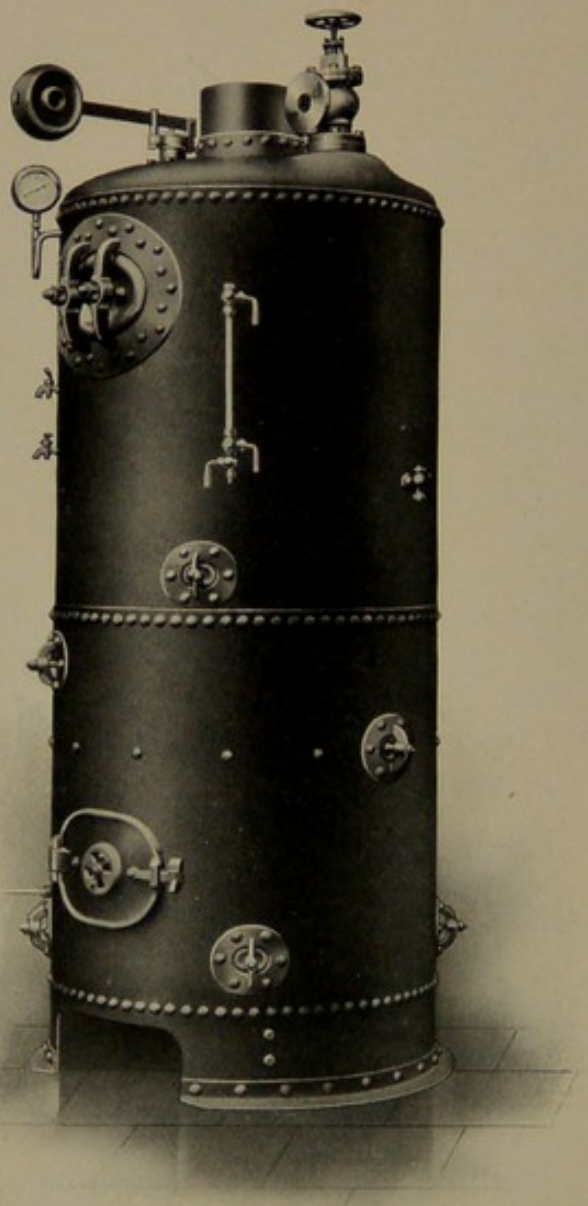
For prices, etc., see page 57.

Approximate shipping particulars are given on page 65.

Vertical Steam Boilers

With Cross Tubes. Made from Siemens' Mild-Steel Plates

80-lbs. Working Pressure



Specification

The plates are of steel " boiler quality " tested to Lloyd's requirements at Works, and have a tensile strength of 26 to 30 tons per square inch with an elongation of not less than 20% in 10-in. Rivets are of special quality steel.

All the vertical seams of the shells are double riveted, and all manholes and mudholes have strengthening rings riveted round them to compensate for the material cut out, and to prevent wasting and thinning of the boiler shell through imperfectly-made joints when in use.

Specification of Vertical Steam Boilers—(*Continued*)

The firebox is flanged to the shell at the bottom and connected at the fire-hole by a solid wrought blocking ring. Tubes are flanged and riveted (or welded if preferred) to the sides of the firebox. All flanging, dishing, and riveting, wherever possible, is done by hydraulic machinery.

Every boiler is tested by hydraulic pressure to 160-lbs. per square inch, and by steam to 80-lbs. per square inch.

Fittings:—Included in price of Boiler are Firebars, Firebar Ring and Fire-door, with Air Regulator and Baffle Plate.

Mountings are **not** included in the price of Boiler, but are quoted separately.

They include Safety Valve, Steam Valve, Feed Valve, Water Gauge (with glass and rings), Test Taps, Steam Gauge, and Blow-off Cock.

Nominal Horse Power	5	6	8	10
Height	7′ 0″	7′ 6″	8′ 6″	9′ 0″
Diameter	3′ 0″	3′ 3″	3′ 6″	4′ 0″
Cross Tubes	2	3	3	4
Uptake, diameter	8″	9″	9″	10″
Plates of Shell	$\frac{5}{16}$″	$\frac{3}{8}$″	$\frac{3}{8}$″	$\frac{3}{8}$″
,, Firebox	$\frac{3}{8}$″	$\frac{3}{8}$″	$\frac{7}{16}$″	$\frac{7}{16}$″
,, Crown	$\frac{3}{8}$″	$\frac{3}{8}$″	$\frac{7}{16}$″	$\frac{1}{2}$″
Approximate Heating Surface, square feet	49	66	79	95
Approximate Grate Area, square feet	5	6	7	9½
Code Designation	Fivos	Sixor	Eider	Tender

If Mountings required with Boiler add "Mo" to Boiler Code Word.

The 5 and 6 N.H.P. Boilers are suitable for Disinfectors 5-ft. long and under.

The 8 N.H.P. Boilers for 6-ft. and 7-ft. Disinfectors.

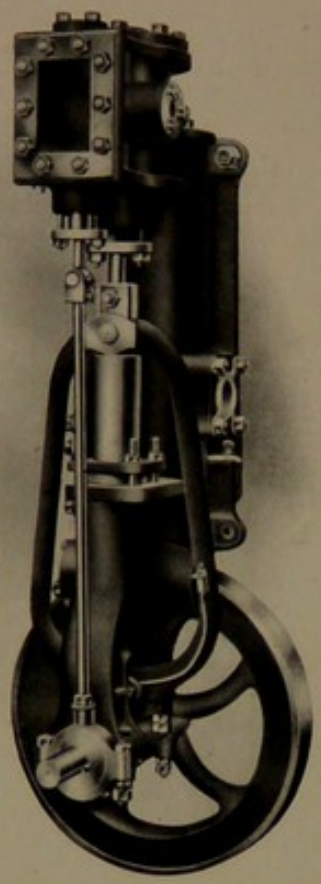
The 10 N.H.P. Boilers for 8-ft. Disinfectors and over.

For prices, cost of packing, delivery, etc., see page 58.

Approximate shipping particulars are given on page 65.

Other sizes and types of Boilers supplied.

Estimates given for complete erection.



Boiler-Feed Donkey Pumps

Single action, arranged for steam and exhaust connections to be made on either side of the cylinder. Suction and Delivery Flanges are made interchangeable, so that they may be used as either one or the other, on whichever side of pump is convenient.

The Rams, Glands, Valves, Seatings, and Bearings are of gun-metal.

Starting Valve, Grease Cup, Pet Cock, and Loose Flanges included in price of pump.

Sizes	No. 1	No. 2
Diameter of Ram	$1\frac{5}{16}''$	$1\frac{9}{16}''$
,, Cylinder	$2\frac{1}{2}''$	$3''$
Length of Stroke	$2\frac{1}{2}''$	$3''$
Gallons per Hour	130	210
Diameter of Steam Pipe	$\frac{3}{8}''$	$\frac{3}{8}''$
,, Exhaust Pipe	$\frac{1}{2}''$	$\frac{1}{2}''$
,, Suction and Delivery Pipes	$\frac{3}{4}''$	$1''$
Code Designation	Pompous	Pomposity

No. 1 size Pump suitable for Boilers up to 6 N.H.P.

No. 2 size Pump suitable for Boilers up to 10 N.H.P

For prices, cost of packing, delivery, etc., see page 58.

Approximate shipping particulars are given on page 65.

Injectors for Boilers

These are often fitted in place of Boiler-Feed Pumps. They are cheaper but not so reliable in working, and we recommend the use of a Feed Pump as preferable in all ways.

SIZE.	Code Designation.	Size of Boiler.
S	Inmi	Suitable for 5 and 6 N.H.P. Boilers
L	Inmax	Suitable for 8 and 10 N.H.P. Boilers

For prices, cost of packing, delivery, etc., see page 58.

NOTE.—For shipment the Injector would be packed in a case and securely fastened inside the firebox of the boiler.

Price List

The "Thresh" Current Steam Disinfector

Working at Atmospheric Pressure.

Furnace-heated Fixed Machines. *(See page 11 of Catalogue).*

SIZE.	Code Designation.	Price delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
A	Astray	69 6 0	7 10 0
B	Broach	98 3 6	8 0 0
H	Hoax	109 14 6	8 0 0
J	Jester	132 16 6	9 0 0
C	Canary	138 12 0	9 10 0
D	Despot	161 14 0	10 0 0

Furnace-heated Portable Machine. *(See page 13 of Catalogue).*

E	Eagle	115 10 0	8 0 0
F	Fairy	138 12 0	9 0 0
G	Grouse	159 12 0	10 0 0

Steam-heated Fixed Machines. *(See page 18 of Catalogue).*

A A	Acorn	83 4 3	7 10 0
B B	Basin	113 8 0	8 0 0
H H	Hulk	124 19 0	8 0 0
J J	Jingo	148 1 0	9 0 0
C C	Cuckoo	156 19 6	9 10 0
D D	Digit	182 14 0	10 0 0

The New Type

"Thresh" Current Steam Disinfector

Working at Low Pressure

Furnace-heated Fixed Machines. (*See page 21 of Catalogue*).

SIZE.	Code Designation.	Price Delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
K	Kayak	85 0 0	7 0 0
L	Lectern	95 0 0	8 0 0
M	Medlar	105 0 0	9 0 0
N	Nopal	100 0 0	7 0 0
O	Oakum	110 0 0	8 0 0
P	Pancake	120 0 0	9 0 0
Q	Quarry	135 0 0	10 0 0
R	Ratch	150 0 0	11 5 0
S	Sarcoid	175 0 0	12 10 0

Furnace-heated Portable Machines. (*See page 21 of Catalogue*).

T	Talon	135 0 0	9 10 0
T T	Tebeth	165 0 0	9 10 0
X	Tipula	200 0 0	10 10 0

Steam-heated Fixed Machines. (*See page 23 of Catalogue*).

K K	Ketchup	95 0 0	7 0 0
L L	Leopard	105 0 0	8 0 0
M M	Mesole	115 0 0	9 0 0
N N	Nutria	105 0 0	7 0 0
O O	Odontor	115 0 0	8 0 0
P P	Pibroch	125 0 0	9 0 0
Q Q	Quest	140 0 0	10 0 0
R R	Rotary	155 0 0	11 5 0
S S	Spume	180 0 0	12 10 0

NOTE.—The prices quoted above include doors fitted with the Patent Quick-Fastening Central Screw Arrangement, as illustrated on pages 20 and 22.

If Doors with ordinary fastenings fitted, as shown on pages 14 and 15, prices will be reduced £4 per door.

Delépine - Jones Patent

Current Pressure Steam Disinfector

Working at any required Pressure

Single-door Machines. (*See page 28 of Catalogue*).

SIZE.	Code Designation.	Price Delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
A	Affix	85 0 0	3 10 0
B	Belt	95 0 0	4 0 0
C	Celery	135 0 0	6 0 0
D	Dance	146 10 0	7 0 0
E	Ember	157 10 0	8 0 0

Double-door Machines. (*See page 29 of Catalogue*).

F	Fame	145 0 0	6 10 0
G	Grippe	156 10 0	7 10 0
H	Halo	169 0 0	8 10 0
J	Jowl	193 0 0	9 10 0
K	Knob	217 0 0	10 10 0
L	Larch	241 0 0	11 10 0

Delépine-Thresh Patent
Current Steam Disinfector

(*See page 33 of Catalogue*).

Single-door Machines

Fixed Type—On Wrought-iron Stands.

SIZE.	Code Designation.	Price Delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
A	Apple..	97 0 0	5 0 0
B	Bomb..	124 0 0	6 10 0

Portable Type—On Underframe and Wheels.

A A	Aspic..	125 0 0	6 0 0
B B	Bantam	160 0 0	7 10 0

Double-door Machine

Fixed Type only—On Wrought-iron Stands.

C	Chess	180 0 0	8 10 0

Thresh's "Emergency" Disinfector

(*See page 36 of Catalogue*).

No. 0	Orb	12 10 0	2 0 0
No. 1	Alpha..	25 0 0	3 0 0
No. 2	Beta	35 0 0	3 10 0

If Bodies made with *sheet steel casing* instead of wood, price increased 40% for each size respectively. Add Code Word "Fortis" when cabling.

The Delépine Sterilizer

(*See page 39 of Catalogue*).

SIZE.	Code Designation.	Price Delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
X	Xylol	22 0 0	2 10 0
X X	Xystos	20 0 0	2 10 0
Y	Yeast..	15 10 0	2 0 0
Y Y	Youth	14 0 0	2 0 0
Z	Zany	7 10 0	1 10 0

The Mackenzie Spray

(*See page 41 of Catalogue*).

Code Designation.	Description.	Price Delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
Mace	**Size "A" Spray**	2 2 0	0 3 6
	* Rubber Bucket for Disinfecting Liquid.	0 5 6	—
Magi	**Size "B" Spray**	3 3 0	0 5 0
	* Iron Vessel for Disinfecting Fluid	0 7 0	—

Flexible Metallic Tubing for use in place of Rubber Tubing (for hot climates)—6-ft. length, 15/- extra; 12-ft. length, 30/- extra.

For 6-ft. length add "**os**" to Code Word=Maceos or Magios.
For 12-ft. length add "**bo**" to Code Word=Macebo or Magibo.

* These are not recommended for shipment so much as for home use.

Demuth's
Rapid Formaldehyde Vaporizer

(*See page 44 of Catalogue*).

Code Designation.	Price delivered to Railway Station in United Kingdom or F.O.B English Port.	Packing for Shipment extra.
	£ s. d.	£ s. d.
Demure	7 7 0	0 10 6

Automatic Recording Thermograph

(*See page 46 of Catalogue*).

Autocrat	11 0 0	0 15 0

Patent Compensating Thermometer

(*See page 47 of Catalogue*).

Compare	5 5 0	0 7 6

Thresh's Disinfector Thermometers

(*See page 47 of Catalogue*).

HAND.	Code Designation.	Price to Railway Station or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
Left	Ledge	1 10 0	0 5 0
Right	Rigid	1 10 0	0 5 0

Vertical Steam Boilers

(*See page 49 of Catalogue*).

Nominal Horse-power.	Code Designation.	Price to Railway Station or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
5	Fivos	40 0 0	—
With Mountings	*Fivosmo	48 0 0	0 15 0
6	Sixor	50 10 0	—
With Mountings	*Sixormo	59 0 0	0 15 0
	Eider	59 0 0	—
With Mountings	*Eidermo	68 0 0	1 0 0
10	Tender	75 0 0	—
With Mountings	*Tendermo	85 5 0	1 0 0

* The Code Words starred indicate that Mountings are to be sent with the Boiler.

Boiler-Feed Donkey Pumps

(*See page 50 of Catalogue*).

SIZE.	Code Designation.	Price delivered to Railway Station in United Kingdom or F.O.B. English Port.	Packing for Shipment extra.
		£ s. d.	£ s. d.
1	Pompous	9 0 0	0 10 0
2	Pomposity	13 0 0	0 15 0

Injectors for Boilers

(in place of **Feed Donkey Pumps**)

(*See page 51 of Catalogue*).

S	Inmi	5 15 0	0 5 0
L	Inmax	7 10 0	0 5 0

Approximate Shipping Lists

"Thresh" Current Steam Disinfector

Furnace-heated Machines

(*See page 11 of Catalogue*).

Fixed Type

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Cwts.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Astray	1	4 7	6 6	7 6	25	10¾	35¾
Broach	1	4 8	7 1	7 6	30¼	10½	40¾
Hoax	1	4 8	7 1	7 6	30¼	10½	40¾
Jester	1	4 8	7 1	8 6	36¼	12¾	49
Canary	1	9 0	5 6	8 4	45½	15¾	61¼
Despot	1	10 0	5 3	8 6	49¼	21¼	70½

Portable Type

(*See page 13 of Catalogue*).

Eagle	1	4 6½	6 7½	8 3	27½	8½	36
	1	5 5½	5 5½	2 5	6¼	3¼	9½
	1	11 6	1 1	1 0	1¾	1¼	3
Fairy	1	4 6½	7 10½	8 3	35¾	11¾	47½
	1	5 5½	5 5½	2 5	6¼	3¼	9½
	1	11 6	1 1	1 0	1¾	1¼	3
Grouse	1	4 7½	7 10	11 9	46½	11¼	57¾
	1	5 5½	5 5½	2 5	8¾	3¼	12
	1	11 0	4 6	1 0	1¼	2	3¼

Steam-heated Fixed Machines

(*See page 18 of Catalogue*).

Acorn	1	4 7	5 8	7 4	23½	11	34½
Basin	1	4 8	7 1	7 6	29	11½	40½
Hulk	1	4 8	7 1	7 6	29	11½	40½
Jingo	1	4 8	8 1	7 6	32	12½	44½
Cuckoo	1	5 6	9 0	8 4	45¼	16	61¼
Digit	1	5 6	10 0	8 6	49¼	20¾	70

The New Type
"Thresh" Current Steam Disinfector

Furnace-heated Fixed Machines

(*See page 21 of Catalogue*).

Size.	Code Designation.	Number of Cases.	Dimensions in Feet and Inches. Length.		Breadth.		Depth.		Measurement Cubic Feet.	Weight in Cwts. Nett.	Tare.	Gross
			ft.	in.	ft.	in.	ft.	in.				
K	Kayak ..	1	5	6	5	6	6	0	182	23	6	29
L	Lectern ...	1	6	6	5	6	6	0	215	25	7	32
M	Medlar ...	1	7	6	5	6	6	0	248	27	8	35
N	Nopal ..	1	6	0	5	6	6	0	198	26	7	33
O	Oakum ...	1	7	0	5	6	6	0	231	28	8	36
P	Pancake ..	1	8	0	5	6	6	0	264	30	9	39
Q	Quarry ...	1	9	0	5	6	6	0	297	32	10	42
R	Ratch ...	1	10	0	5	6	6	0	330	34	11	45
S	Sarcoid ...	1	11	0	5	6	6	0	363	36	12	48

Furnace-heated Portable Machines

(*See page 21 of Catalogue*).

T	Talon ...	1	6	8	4	8	8	6½		30	11	41
		1	5	4	5	4	2	5	345	8	3	11
		1	11	4½	1	7½	0	10		1½	1½	3
T T	Tebeth	1	7	10	4	8	8	6½		36	11	47
		1	5	4	5	4	2	5	391	8	3	11
		1	11	4½	1	7½	0	10		1½	1½	3
X	Tipula ...	1	7	10	4	8	8	6½		54	13	67
		1	5	4	5	4	4	0	458	12	4	16
		1	10	6	4	0	1	0		2	2	4

Steam-heated Fixed Machines

(*See page 23 of Catalogue*).

K K	Ketchup ...	1	5	6	5	6	6	0	182	19	6	25
L L	Leopard ..	1	6	6	5	6	6	0	215	21	7	28
M M	Mesole ...	1	7	6	5	6	6	0	248	23	8	31
N N	Nutria ...	1	6	0	5	6	6	0	198	22	7	29
O O	Odontor ...	1	7	0	5	6	6	0	231	24	8	32
P P	Pibroch ...	1	8	0	5	6	6	0	264	26	9	35
Q Q	Quest .	1	9	0	5	6	6	0	297	28	10	38
R R	Rotary ..	1	10	0	5	6	6	0	330	30	11	41
S S	Spume ...	1	11	0	5	6	6	0	363	32	12	44

Delépine-Jones Patent
Current Pressure Steam Disinfectors

(*See pages 28 and 29 of Catalogue*).

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Cwts.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Affix	1	4 0	4 6	4 0	18	3	21
Belt	1	5 0	4 6	4 0	20	4	24
Celery	1	5 3	6 0	5 6	34	8	42
Dance	1	6 3	6 0	5 6	38	9	47
Ember	1	7 3	6 0	5 6	42	10	52
Fame	1	5 6	6 0	5 6	37	8	45
Grippe	1	6 6	6 0	5 6	41	9	50
Halo	1	7 6	6 0	5 6	45	10	55
Jowl	1	8 6	6 0	5 6	49	11	60
Knob	1	9 6	6 0	5 6	53	12	65
Larch	1	10 6	6 0	5 6	57	13	70

Delépine-Thresh Patent
Current Steam Disinfectors

(*See page 33 of Catalogue*).

Fixed Type—Single-door.

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Cwts.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Apple	1	5 8	5 6	7 2	6¼	7¼	13½
Bomb	1	7 2	5 6	7 2	7¾	9	16¾

Portable Type—Single door.

Aspic	1	6 7	5 8½	7 3	6	8	14
	1	8 6	1 2	0 8	7½	1	8½
Bantam	1	8 0	5 8½	7 3	7½	10	17½
	1	10 0	1 2	0 8	9	1¼	10¼

Fixed Type—Double-door.

Chess	1	8 8	5 6	7 2	11½	10¾	22¼

Thresh's "Emergency" Disinfector

(*See page 36 of Catalogue*).

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Cwts.		
		Length.	Width.	Depth.	Nett.	Tare	Gross.
		ft. in.	ft. in.	ft. in.			
Orb	1	3 9	3 0	3 0	1	2	3
Alpha	1	7 0	3 0	3 0	2¼	2½	4¾
Beta	1	8 0	3 7	3 7	3¼	3	6¼

If bodies are made with *Sheet steel casing*, add about 10% to gross weight. Add Code Word "**Fortis**" when cabling.

Delépine Sterilizer

(*See page 39 of Catalogue*).

Xylol	1	2 7	2 7	3 6	1¾	⅝	2⅜
Xystos	1	2 3	2 3	3 6	1½	⅝	2⅛
Yeast	1	2 1	2 1	3 0	1¼	½	1¾
Youth	1	1 9	1 9	3 0	1	½	1½
Zany	1	1 2	1 2	2 6	⅝	¼	⅞

Mackenzie Sprays

(*See page 41 of Catalogue*).

(Exclusive of Iron Vessel—Size B).

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Lbs.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Mace	1	1 10	0 7	0 6	9	5	14
Magi	1	2 7	1 1	1 0	20	23	43

Demuth's Rapid Formaldehyde Vaporizer

(*See page 44 of Catalogue*).

Demure	1	2 0	1 6	1 6	20	56	76

Automatic Recording Thermograph

(*See page 46 of Catalogue*).

Autocrat	1	1 6	0 7	0 9½	12½	15½	28

Patent Compensating Thermometer

(*See page 47 of Catalogue*).

Compare	1	1 3	0 9	0 9	10	10	20

Thresh's Disinfector Thermometers

(*See page 47 of Catalogue*).

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Lbs.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Ledge	1	1 4	0 11	0 9	1¾	16¼	18
Rigid	1	1 4	0 11	0 9	1¾	16¼	18

Vertical Steam Boilers

(*See page 49 of Catalogue*).

Code Designation	Number of Cases.	Dimensions in Feet and Inches.			Weight in		
		Length.	Width.	Depth.	Cwts.	Qrs.	Lbs.
		ft. in.	ft. in.	ft. in.			
Fivos	1 Boiler	7 11	3 5	3 5	21	3	0
*Fivosmo	1 Chimney	6 0	0 9	0 9	—	2	0
Sixor	1 Boiler	8 5	3 8	3 8	27	2	0
*Sixormo	1 Chimney	6 0	0 10	0 10	—	2	7
Eider	1 Boiler	9 6	3 11	3 11	34	2	—
*Eidermo	1 Chimney	6 0	0 10	0 10	—	2	7
Tender	1 Boiler	9 11	4 5	4 5	45	—	—
*Tendermo	1 Chimney	6 0	0 11	0 11	—	2	7

* The Code Words starred indicate that Mountings are to be sent with the Boiler. When so sent the box containing them will be packed inside firebox of boiler.

Boiler-Feed Donkey Pumps

(*See page 50 of Catalogue*).

Code Designation.	Number of Cases.	Dimensions in Feet and Inches.			Weight in Lbs.		
		Length.	Width.	Depth.	Nett.	Tare.	Gross.
		ft. in.	ft. in.	ft. in.			
Pompous	1	2 8	1 3	1 3	116	40	156
Pomposity	1	3 3	1 6	1 5	212	60	272