HYGIENE

SCHOOL HYGIENE.

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PREFACE.

THE importance of Hygiene to the community at large, and more particularly to the younger members of the race, is now at last becoming generally recognised. Moreover, medical inspection of some kind has now become compulsory in schools. No excuse, therefore, is necessary for the appearance of this book, dealing especially with the hygiene of children and of school life: the experience of the author in lecturing to large bodies of teachers throughout the West Riding of Yorkshire and also in the Midlands has shown him that there is need for such a text-book.

The subject-matter in this book largely consists of the material of the various courses of lectures to teachers referred to above. It is believed that it provides a thorough course in the practical hygiene of child and school life. Efforts have been made to make it self-contained, and to assume no previous knowledge of the subject, but at the same time care has been taken to avoid the introduction of an unnecessary proportion of theoretical information, and to explain the more difficult portions of the subject in the simplest language available. While fully recognising the value and importance of a sound knowledge of physiology to a teacher, yet the author has been careful to eliminate all unnecessary physiological facts from the book, and to include only such physiological details as are necessary for the clear explanation and appreciation of hygienic rules. One of his chief objects has been to demonstrate as simply as possible such facts with regard to the growth, constitution, and nurture of the child as will not only enable the teacher to take a new and much more interesting view of his work, but also to act as an intelligent assistant under the direction of the school doctor. It is obvious that if medical inspection is to have its full beneficial effects all teachers must be sufficiently trained in practical hygiene to be able to co-operate with the medical officer: the school teacher must in fact stand in the same relation to the medical officer as the hospital nurse to the doctor.

There is no doubt that a large amount of theoretical instruction in hygiene and physiology has been given in all grades of schools for many years, but such instruction appears to have produced little or no result. In the author's opinion this is the effect of too much theory and too little practice in the kind of instruction given. The lessons have been directed to explaining reasons for, instead of laying down the rules of a healthy life. Moreover, few of the teachers have had instruction in the subject from experts. Another great force that has neutralised all such efforts is the lack of ventilation and general dirtiness of the schools.

Indebtedness to the authors of numerous books and papers dealing with this subject has been acknowledged in many places throughout the text, but the author wishes to express the fact that his sense of obligation is far greater than would appear from the number of such quotations. Thanks are also due to Mr. G. E. Slim for nearly all the photographic illustrations, and to many friends for valuable help and suggestions.

ROBERT ARTHUR LYSTER.

HANDSWORTH,
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ON

MEDICAL INSPECTION OF CHILDREN

UNDER SECTION 13 OF THE EDUCATION (ADMINISTRATIVE PROVISIONS) ACT, 1907.

[*Issued by the Board of Education, November* 1907.]

The Board are convinced that the work of medical inspection cannot be properly accomplished by medical men without assistance. The teacher, the school nurse (where such exists), and the parents or guardians of the child must heartily co-operate with the school medical officer. In whatever way the system be organised, its success will depend, immediately and ultimately, upon the cordial sympathy and assistance of the teachers. . . . .

From what has been said it will be clear that the fundamental principle of Section 13 of the new Act is the medical examination and supervision not only of children known, or suspected, to be weakly or ailing, but of all children in the elementary schools, with a view to adapting and modifying the system of education to the needs and capacities of the child, securing the early detection of unsuspected defects, checking incipient maladies at their onset, and furnishing the facts which will guide Education Authorities in relation to physical and mental development during school life. . . . .

It cannot be doubted that a large proportion of the common diseases and physical unfitness in this country can be substantially diminished by effective public health administration, combined with the teaching of hygiene and a realisation by teachers, parents, and children of its vital importance. . . . .

PART I.

THE SCHOOL BUILDING.

CHAPTER I.

INTRODUCTORY.

Health at School.

The Hygiene of School Life is of paramount importance in connection with the subjects of Political Economy and the prosperity of the nation. It must be taken into consideration by all those who are in any way connected with the education of the young, and especially by the teacher, if real success is to be achieved. Its importance is equal to that of the hygiene of the nursery, and its responsibilities are even greater. Undoubtedly, both subjects have been very much neglected in the past by all classes of the community, but recent events show clearly that an increased amount of official and public attention is being directed to the improvement of the health of the children.

Vast amounts of public money are being wasted in education because the children are not in the necessary physical condition to assimilate the instruction they are given. Sir John Gorst says: "The children are underfed, stunted, and suffering from a large percentage of preventable diseases. To make these poor little creatures learn multiplication tables and do sums is as cruel as forcing an underfed horse to work." Another source of waste and the cause of much mental injury is the forced teaching of unsuitable subjects. As an illustration the regulations of the Board of Education which made Physiography a compulsory subject for girl pupil teachers may be mentioned. The feminine mind is usually not attracted by such a science, and all who have had experience in teaching pupil teachers will agree that the subject is greatly disliked, and that the whole of such crammed knowledge quickly disappears when the examination is over. The substitution of Physiology and Hygiene for Physiography would be very popular with the students, and would result in a large percentage of the girls continuing their studies in these most important subjects when they were no longer pupil teachers. In a short time there would be no lack of well qualified teachers for the systematic teaching of the principles of hygiene in our elementary schools.

From all sides the Board of Education is being urged to give proper attention to the health of the children and the subject of physical improvement. Among the recommendations of the Royal Commission on Physical Training in Scotland is one that says: "Education Committees should have the command of medical advice and assistance in the supervision of schools: a systematic record of physical and health statistics should be kept: and a number of medical and sanitary experts should be added to the inspecting staff under the Education Department." Moreover there was recently the important manifesto, so extensively signed by medical men all over the country, urging the Department to develop and organise systematic teaching of temperance and hygiene in all schools. More recently, at a Conference on School Hygiene, organised by the Royal Sanitary Institute, and held at the University of

London, the following resolutions were unanimously adopted :—

(1) That H.M. Inspectors of Schools should be qualified in hygiene and sanitation, and familiar with the development of child life. The Board of Education should therefore be urged to protect health in school life by appointing inspectors who are specialists in school hygiene.

(2) That there should be regular and systematic medical inspection of children in schools of all grades, and that this important matter should be brought before the educational authorities of the country.

Still more recently, at the Second International Congress on School Hygiene, held in London, similar opinions were expressed, and the recent Bill concerning the medical inspection of school children probably marks the commencement of a new era of educational work.

Of course the conditions of the home life of the child are beyond the control of the educational authorities, but it must be remembered that the child spends nearly one half of its waking hours (a child of ten requires about twelve hours' sleep) at school. Hygienic conditions at school will therefore greatly influence its future life. Moreover, if proper instruction is given to all children in such subjects, there may be fairly expected an improvement in the conditions of life at home for the next generation.

Early Injuries to the Body.

It is during the dawn of life that lasting mental impressions are made, and the body so affected that the framework and delicate machinery of the future man is made or marred. These impressions may lead the child on to happiness and health or to unhappiness and disease. The form of the body, the shape of the limbs, the development of the organs, the cultivation of the senses, may be easily interfered with during childhood. How many infants are killed every week by improper feeding! How many curved spines are due to a wrong position of sitting in school! How many eyes have been injured by small print, fine stitches, bad lighting, or holding the book at a wrong distance! How many lives are ruined by the effects of preventable disease caused by bad ventilation or the absence or inadequacy of medical supervision and inspection! Such injuries will continue to be produced until specially qualified inspectors are appointed by the Board of Education, and all education authorities employ the services of highly trained medical men.

While this book has been going through the press the Board of Education has been compelled to consider the subject by the recent Bill concerning the medical inspection of school children. The new department has been wisely placed in the hands of a well known sanitarian of wide experience, and under his control some very important developments may be expected.

Infantile Mortality.

The alarming mortality among infants and children is strikingly illustrated by Farr, who follows the progress of 1,000,000 children. Out of a million nearly 150,000 die during the first year of life. At the end of the second year nearly 210,000 are dead. There are only about 730,000 survivors at the end of five years, and these are reduced to 700,000 during the following five years. At the end of fifteen years the total number of deaths has amounted to almost 310,000. There is no doubt whatever that these figures could be enormously reduced by greater attention to hygiene. For instance, although thorough instruction in health subjects and perfect hygienic surroundings would not directly affect the infants under five years of age, yet the ultimate effects would undoubtedly result in the future diminution of this extraordinary death rate. This desirable result would be brought about chiefly by first effecting an improvement in the physique of the children at present at school: these will be the fathers and mothers of the next generation, and their children will not only share in this physical improvement but will also be more carefully reared if the instructions that have been received at school have been given in such a way as to produce a lasting impression.

The explanation of the failure at present is that we have lost sight of the essentials of education. Surely the most essential part of education should be a knowledge of the care of the body, the simple means of maintaining health, the avoidance of ill-health and disease, and the care of children. It is only by improving educational methods and making people really interested in themselves and their children that improvement in infantile mortality can be brought about. Improvement in sanitary conditions in towns and the surroundings of people can never bring about more than a very slight decrease in infantile mortality. It is often stated that people cannot be made temperate by Act of Parliament. It is much more true to say that people cannot be made healthy by Act of Parliament or by beneficial by-laws of towns. Many people put into sanitary houses amid the best of surroundings will live in a most disgusting way, and the health of infants reared by them is very little better than in the worst slum of a town.

The neglect of essentials in our educational system was attributed by many of the delegates at the recent Hygiene Conference to the fact that our education has been so long directed by graduates of the older Universities, the majority of whom are notoriously ignorant of the most elementary principles of science and are therefore incapable of understanding or realising the importance of the science of hygiene.

Non-essential subjects are being piled into the already overloaded time-table, and when it is suggested that the essential subjects of the health and the care of the children should be taught the teachers exclaim: "How can we find time for them?" The only way will be to severely prune and cut down the present list of subjects and restrict ourselves to essentials.

The good lady's contention that she was fully qualified to have the care of children because she had already buried 14 of her own might be paralleled by the present-day "educational experts" who, in proof of their knowledge and of the success of their system, might claim:—

(1) That a large percentage of children are permanently injured and handicapped for life by the present school conditions.

(2) That most children leave school in appalling ignorance of such essential matters as the care of their own health and the proper care of children; and

(3) That the average child leaves school with a smattering of a variety of non-essential subjects which it forgets altogether soon after its school life is finished.

We have got into a narrow mechanical way of teaching, probably owing to the antiquated ideas of inspectors. The teaching of hygiene must be on sound practical lines. If it is to be taught on lines similar to those adopted in the case of ordinary elementary school subjects—Grammar, Geography, and History—it will be useless. In present-day teaching there is an absurd lack of appreciation of the necessity for knowledge to be available and applicable to every-day life. If hygiene is properly taught in schools the constant opportunity to use such knowledge would prevent it being forgotten. Can we say as much of the present educational equipments of the average elementary school child?

Theory of "Survival of the Fittest."

It is sometimes asserted by apparently intelligent people that this infantile mortality is a good thing; that it weeds out from the masses the weak, the delicate, and the diseased, and leaves behind the stronger and better developed of the population; that it eliminates the unhealthy, and is a benefit to the rest of mankind; and that it therefore gives a teacher a better material to work upon.

Fallacies involved.

The argument is unsound. Leaving out of the question the morality of the result, there might be something to be said for it if the unhealthy conditions acted injuriously upon the weakly members of the community alone. But it is certain that the unhealthy surroundings at home and at school, and improper feeding and treatment during infancy and childhood, not only serve to kill off those who start life hampered with either actual disease or weak constitutions, but also lower the vitality and the resisting power of those who were originally perfectly healthy, and these, if they survive so long, grow up into men or women of indifferent physique. These injured children, moreover, are exceedingly poor material for the teacher and can never compete intellectually or physically with their more fortunate schoolfellows. Another result of these constitutional injuries that are received during infancy is that such children offer very small resistance to epidemic diseases. Schools in districts where the physical standard of the children is low are most likely to be nearly emptied during any severe epidemic. The death rate at such times and among such children is always abnormally high.

Suggested Remedies.

The question that naturally arises is, What can be done to stop this dreadful slaughter of the innocents and this enormous depreciation of national physique? The only hope appears to be in the direction of the schools. First the surroundings of the child when at school should be hygienically perfect. This will, at all events, help it to appreciate part of the value of its instruction on such matters. What impression is likely to be made on a child when the teacher gives a lesson on ventilation in an over-crowded stuffy class-room? Is such a child likely to advocate the open bedroom window at home? The health of the child is undoubtedly improved by perfect school hygiene.

Next is the proper training of all teachers in sound hygienic principles and the care and feeding of infants, so that every one of them will be able to give his or her class correct instruction. Both boys and girls should receive this instruction. School impressions often last throughout life, but the feminine mind is notoriously conservative and there is always the possibility of a girl, in after-life, managing her home and rearing her children on precisely the same lines as her mother did before her. Boys, on the other hand, if hygienic truths are sufficiently impressed upon them, are much more likely, when they get homes of their own, to see that such principles are carried out with regard to their house and their children. The effect would therefore be a tendency towards a substantial improvement in the national physique.

As a matter of fact great changes would be quickly produced in many of the homes if the children were properly instructed in cleanliness and general hygiene while at school. Improved cleanliness at home naturally follows when personal tidiness and cleanliness are insisted upon at school. "Slums" can only be prevented by eliminating the slum-maker. So long as the "slum-maker" continues to flourish, any collection of houses can be turned into a slum. The "housing problem" is not so simple as some well-meaning enthusiasts would have us believe. It seems almost incredible to believe that there is at present no systematic teaching of hygiene in the elementary schools in this country. The teaching of hygiene is made compulsory by education laws in America and by a decree of Parliament in Sweden. Also, in Denmark, Holland, and Italy hygiene is systematically taught.

In fact a considerable revision of our elementary school "education" is urgently necessary, particularly for girls. No one can say that the present system has not been given a fair trial. Thirty years have elapsed since compulsory education was introduced, but it has not proved to be an unqualified success. As a writer in the *British Medical Journal* says: "Under the head of knowledge of common phenomena of the external world Nature study is nearly always taken. Week after week children pull to pieces flowers, or are taught about the germination of seeds; no doubt this is useful and interesting by way of cultivating a child's artistic tendencies and of exercising its memory in remembering scientific names of the parts of a plant. But to the children of London and other great towns, who seldom have the happiness of seeing a flower, it can only be regarded as waste of time, since this teaching is given at the expense of such vitally important subjects as mental, moral, and physical hygiene.

"The present generation of mothers have all passed through the school curriculum, and their school training should be reflected in the upbringing of their children. As a matter of fact the grossest ignorance of matters bearing on daily life is manifested. It is well recognised that the cause of most of the degradation among the people is rather ignorance than poverty. Many a family has enough money to spend, but the women do not know how to expend it wisely. They are ignorant of the properties of food, of economical housekeeping, and of the management of a family. They may leave school able to read and write, and recite Tennyson, and sing glees, and pick flowers to pieces; but they have not learnt the degradation of sending their children to school in ragged clothes, with dirty skins, heads swarming with vermin, and often, in consequence, a mass of sores, with which hands and faces become inoculated." Such an indictment should surely be sufficiently powerful to stir even English public opinion. Also in all matters of personal hygiene there exists the greatest ignorance. Take the teeth for example. Practically all the poorer classes give no attention whatever to these important structures, neither towards preventing decay nor arresting it. No man or woman among them dreams of ever cleaning teeth or having a tooth stopped. The usual procedure is to wait until the tooth is badly decayed, and then, if it becomes very painful, to get it extracted. The importance of the care of the teeth is dealt with elsewhere, and so it is only necessary here to state that it is a subject intimately associated with the well-being and physical fitness of the race.

The chief aim of our elementary teaching should be to produce in the children a desire to lead clean wholesome lives and to possess vigorous healthy bodies. The instruction given should be of such a nature as will enable them to satisfy so desirable an ambition.

As far as medical supervision in educational matters is concerned England is behind other countries. The London County Council, it is true, are evidently appreciating the needs of the children in this direction, and have appointed a large staff of medical officers for education. Other large towns such as Manchester and Leicester have appointed whole time medical officers to the education committees, but there are still a large number of centres of population that are either without any medical officer at all, or that pay a small salary for some nominal services which have no practical result. What is worse still, the Board of Education have, up to the present year, failed to set an example in this direction, and have acted without the services of an expert in hygiene. As a result the building rules issued by the Department show a lack of exact directions with regard to light and ventilation, as well as erring on the question of cubic space per child.

At the present time the local medical officer of health has powers of control over the general sanitary arrangements of schools; they can be inspected by him at any time, and all requirements necessary thereto he can order the local administrative authority to have carried out without delay. The improvements effected under these powers are practically *nil*. He also has powers with regard to all notifiable infectious diseases, to prevent all infected persons being admitted to a school. The closure of schools by the public health authority is provided for by Art. 30 of the Education Code.

The Education Department exercises control over all school buildings, and can veto the erection of any new school. After the school is built the Department acts upon the report of their inspector, so that he really becomes the authority in connection with heating, ventilation, overcrowding, and all such matters. One naturally asks what capacity has this inspector for such work. It should really be the work of an expert in hygiene.

As regards the medical inspection of the children there has been no obligation upon authorities to undertake any such work, neither has there been departmental control of the work that is done. The recent Bill (1907), concerning the medical inspection of school children, will probably introduce medical inspection generally throughout this country. At present few towns attempt it at all, and those who do anything are usually satisfied with the examination of the eyes and ears, and a superficial inspection of mentally defective children. In many parts of Germany, France, Switzerland, Denmark, and Belgium all children are examined when they enter the State schools, and there are periodical visits for the inspection of every class in rotation. Regular visits are also paid in order to examine any cases which are considered by the teacher to require attention. In the United States a daily visit is paid to the schools, and all cases suspected of infectious disease are examined. The results have certainly justified such inspection. In one week there were 364 children excluded from school on account of some infectious disease (including parasites), and at Chicago, in three months, over 2000 children were found to present signs of infectious disease.

Austria, Norway, Turkey, and Hungary are rapidly taking up this important matter, while Japan, as usual, has gone further than any other country. In Japan there are more than eight thousand school doctors, every school and institution being under medical supervision; Germany has nearly seven hundred; America about five hundred: England boasts a score or so.

CHAPTER II.

THE SITE OF THE SCHOOL.

It must be clearly understood that schools are provided for that part of the population which is peculiarly susceptible to the influence of bad hygienic surroundings, and it is therefore especially necessary that the site, the building, and the general conditions of a school should be as nearly perfect as possible. But is this rule usually followed? Unfortunately sites are often chosen which would certainly never be selected for private residences, and, as a matter of fact, are undesirable from many points of view.

In selecting a site the chief points to carefully examine are:—

(1) The conditions as to natural drainage, and the ordinary level of the ground water.
(2) The nature of the soil and subsoil.
(3) The aspect and elevation.
(4) The surroundings.

The importance of the first two conditions can be made clear by considering the kinds of soil, the usual arrangement of soils and rocks, and the ground air and ground water.

Soil.

A subdivision of the soil into **surface soil** and **subsoil** is generally recognised, and is convenient. The upper layer is composed partly of inorganic materials from the subsoil below and partly of organic matter of animal and vegetable origin. This layer swarms with bacteria of various kinds. Some of these are known as nitrifying bacteria and are of the utmost importance, inasmuch as they convert waste nitrogenous material into salts of ammonium and ultimately into nitrites and nitrates. The subsoil is purely inorganic and contains no bacteria. It is formed by the gradual breaking up of the **rock** below. The term rock is of wide significance. It includes granite, slate, sandstone, clay, limestone, chalk, etc. The soil of every locality should therefore be merely the decayed upper surface of the rocks beneath, together with decayed and decaying animal and vegetable matter, but the action of rain and other forces causes the removal of material to a greater or less distance from its source, so that in many instances a soil derived from one rock is laid upon a totally different kind of rock.

Another convenient and important classification of soils is obtained by their action in preventing or allowing the percolation of water through them. Soils which allow water to pass readily through them are called **porous** or pervious, while those which prevent the passage of water are called **impervious**. Porous soils include sand, gravel, chalk, sandstone. The commonest impervious soil is clay, which, although it allows practically no water to pass through it, absorbs water and remains damp for long periods.

Ground Water.

In most districts there is a layer of porous soil on the surface. Below this, at variable depths, is an impervious layer. The rain falling on the surface soil will percolate downwards until it reaches the impervious layer, on the surface of which it will form an underground river. This collection of water, or underground river, resting on an impervious layer is called ground water. It is in constant movement, always flowing towards the nearest stream or towards the sea.

The level of this ground water is the depth of the water in shallow wells in the neighbourhood. This level is liable to fluctuation, being raised, for instance, by a heavy rainfall. It may be lowered by deepening and clearing out neighbouring watercourses, or by making fresh channels, whereby the rapidity of its flow may be increased. For a healthy site the level of the ground water should be more than 10 feet below the surface of the ground.

Ground Air.

The permeable soil, above the level of the ground water, contains quantities of air, varying according to the nature of the soil. All soils contain air, and the actual percentage depends upon the looseness, or otherwise, with which its particles are packed together. The porous soils such as gravels, sands, and sandstones can hold considerable volumes of air, even up to 50 per cent.

The composition of ground air varies according to the nature of the soil and the depth below the surface. It differs from ordinary air in the following particulars:

(1) *It contains a much larger percentage of carbon dioxide.* The amount varies from ·2 per cent. to 8 per cent., the latter figure representing the proportion in the ground air from gravelly soils at a depth of about 10 feet. This carbon dioxide is produced in two ways. Part is formed by the oxygen in the air combining with carbon derived from various animal or vegetable sources, and a further quantity is produced, by the action

of putrefactive micro-organisms, from the oxygen of organic substances and of nitrates in the soil.

(2) *It contains less oxygen than ordinary air.* This is due to the fact that part of the oxygen is used in producing carbon dioxide.

(3) *It contains a greater quantity of organic and other gases.* Marsh gas may be present as a result of the decomposition of certain organic substances. Occasionally sulphuretted hydrogen is found in ground air.

(4) It may contain great numbers of bacteria.

The amount of nitrogen in ground air is about the same as in ordinary air. It is an undoubted fact that if large quantities of this air gain access to a house or a school it is liable to produce serious injury to health. The presence of ground air in houses in towns is, for instance, probably one of the chief predisposing causes of diphtheria.

Movements of Ground Air.

The subterranean atmosphere is in continual movement. These movements are produced chiefly in four ways. These are :—

(1) Any variation in the level of the ground water will cause movement of the ground air above it. Thus a heavy rainfall will be followed by a sudden rise in the level of the ground water and this will force out large quantities of ground air.

(2) The outside air and the earth are nearly always at different temperatures. When these differences are greatest the widest range of movements of the ground air will occur. In autumn and winter, for instance, the soil is warmer than the air, and the ground air will therefore escape into the

atmosphere, and the colder atmospheric air will enter the pores of the soil.

(3) The above result is most marked when a small area of ground is covered by a house or school, and especially when the surface of the soil outside the house is ice-bound or macadamised, as it is in large towns. Under such circumstances,

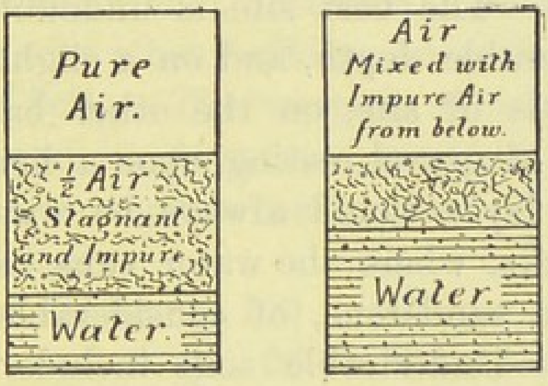

Fig. 1.

when the temperature inside the house is very much higher than that outside, the aspirating effect of fires, chimneys, and ventilation outlets will tend to draw large volumes of ground air from the soil unless the site is covered with a substantial layer of concrete. In towns the ground air is usually mixed with coal gas, and cases are recorded where the inhabitants of the house have been poisoned by air thus drawn from the soil.

(4) Small movements of ground air are also produced by variations in the barometric pressure: on the days of low pressure the ground air escapes from the soil. Other factors include the action of wind in sucking out the air from the soil, as well as in forcing air into the strata which are opposed to its path.

The upper layers of the earth may therefore be compared to a huge lung alternately expelling and taking in air.

Influence of Soil on Health.

1. **Damp.**—The dryness or otherwise of a site depends mainly upon the rapidity with which the rain water can run off or through the soil, together with the depth of the ground water. The best site is undoubtedly a gravelly soil of considerable depth, and on a slight slope. One of the worst kinds of site, on the other hand, would be a shallow layer of gravel resting upon a horizontal layer of clay: such a layer would always be water-logged. Impermeable rocks, where the water runs readily away, and also chalk and sandstone, of considerable depth, are dry and healthy. Undesirable soils include marl and clay, which are damp; peat soils, which contain a large amount of organic matter; and made soils.

It has been shown conclusively that an intimate connection exists between damp soil and all lung diseases, and it is extremely probable that damp is an important factor in the production of rheumatism, catarrh, neuralgia, throat affections (including diphtheria), and also favours the spread of measles and whooping cough. At Ely and Salisbury, for instance, the death rate due to consumption was reduced by fifty per cent. by efficient drainage of the soil, and a consequent lowering of the level of the ground water. It has already been stated that no site can be considered satisfactory where the level of the ground water is within 10 feet of the surface. If the soil is damp, the entire site below the foundations should be drained by laying unglazed agricultural pipes, with open joints, at the bottom of trenches filled with stones or gravel.

2. **Made Soils.**—Excavations made for the purpose of removing gravel, clay, sand, etc., are usually filled after-

wards with all kinds of rubbish. Such rubbish is sure to contain more or less organic matter, and this will exist in a state of putrefaction for years, rendering impure the air around and inside the building. Such sites should always be avoided, if possible, and should, at all events, not be built upon within five years after the excavation has been completely filled in. Even then the layer of concrete extending over the whole site, desirable in all cases, becomes an absolute necessity when building on such soil.

3. **Warmth of Soils.**—The warmth of any soil depends upon its nature and its dryness. Schübler has classified the various soils, as regards composition, in order of merit for warmth as follows:—

Sand with some lime	100	Clayey earth	68
Pure sand	96	Pure clay	67
Light clay	77	Fine chalk	62
Gypsum	72	Humus	49
Heavy clay	71		

If the soil is damp the evaporation from its surface keeps its temperature continuously much lower than that of the air above. Consequently a damp site is always a cold one.

4. **Diseases associated with Soils.**—Occasionally the actual bacteria which produce certain diseases are found in the soil. Thus the bacilli of tetanus (lockjaw), malignant œdema, and anthrax have been often demonstrated in soil. Also the close connection that exists between damp soils and certain diseases such as consumption, rheumatism, etc., has already been mentioned. In certain other diseases, although the specific germ may be either unknown or has not been actually found in soils, the relation between particular states of soil and prevalence of the disease has been clearly made out. Some observers, for instance, have noticed a relation between the height of the ground water

and epidemic outbreaks of typhoid fever and cholera. Epidemic summer diarrhœa, so fatal among children, has been conclusively shown to be associated with soils soaked with sewage or polluted in other ways. There also appears to be a relationship between epidemics of diphtheria and the fluctuations of the level of the ground water. Similarly yellow fever is associated with certain soil conditions. Malaria exists only where the soil is damp and marshy and capable of holding shallow pools of stagnant water. Thorough drainage of the soil, removal of jungle and dense vegetation, and tree planting have been successfully used to make malarious districts healthy.

Aspect and Elevation.

In choosing the site the questions of exposure to sun and to east or north winds should be considered. All rooms

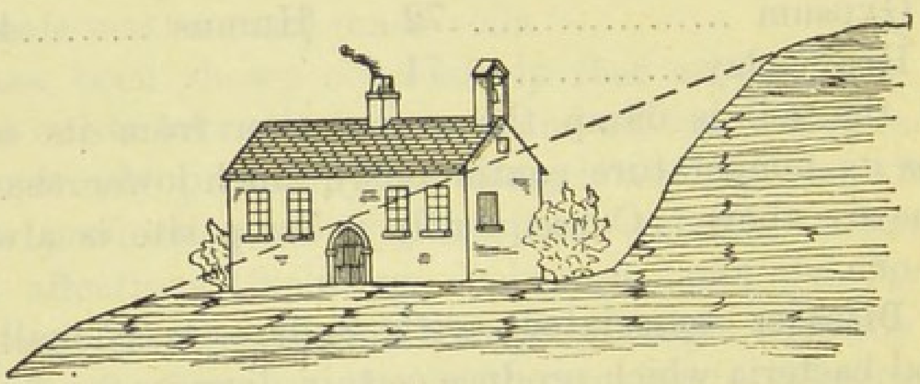

Fig. 2.

as far as possible should be exposed to direct sunlight some time during the day. Direct sunlight is probably Nature's most powerful disinfectant. Abundance of light is secured by selecting a southerly or south-westerly aspect. Hollows, whether on high or low land, should be avoided. The foot of a hill is undesirable. If it is proposed to place a school upon the side of a hill, the ground must not be dug out so that the cliff rises immediately behind. The excavated soil should be used to raise the site so as to leave a trench in the rear, between the building and the cliff.

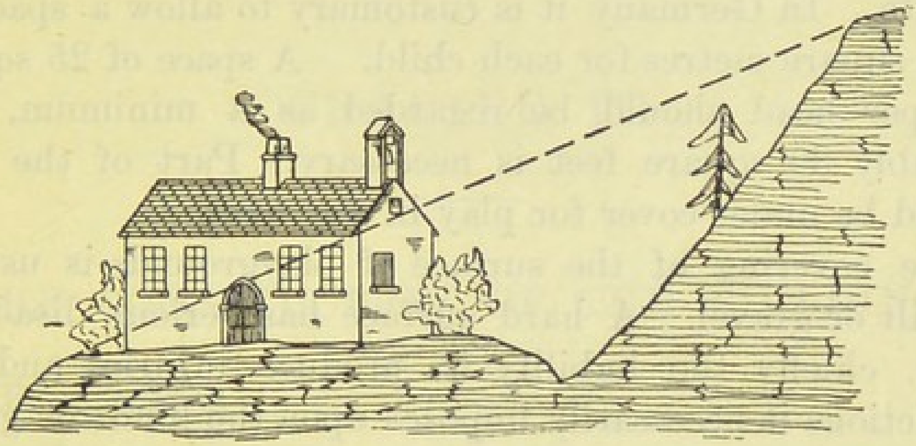

Fig. 3.

The soil should never rise immediately upwards from the building so as to allow superficial drainage or soakage to take place towards the foundations. There should be room for the free play of air on all sides.

Surroundings.

The building should not be situated near brickyards or any offensive works. It should be sheltered from cold winds as far as possible. Trees may afford valuable shelter, not only from cold winds but from fogs, but they must not be too close to the building, lest they impede the free circulation of air. They are best situated on the north and east sides. Everything which tends to allow stagnation of air in or around the school is to be avoided ; for this reason high walls and lofty buildings should be as far away as possible. A line drawn from the foot of the school building to the top of the nearest wall or building should make an angle with the horizontal of not more than 30°. In order to avoid dust and noise the building should stand as far back from the street as possible.

THE PLAYGROUND.

The playground necessarily forms a large proportion of the site. In Germany it is customary to allow a space of three square metres for each child. A space of 25 square feet per head should be regarded as a minimum, and probably 30 square feet is necessary. Part of the area should be under cover for play in wet weather.

The covering of the surface of playgrounds is usually asphalt or gravel. A hard surface has serious disadvantages, chiefly the liability to produce injuries and the restrictions it necessarily imposes upon the kinds of games and exercises that are possible. If part of the area is covered with turf it is a great advantage.

CHAPTER III.

THE CONSTRUCTION OF THE BUILDING.

The Foundations.

In the construction of school buildings not only should the best materials be obtained and put together in the most substantial way, but expert advice should be always obtained, so that a perfectly planned and thoroughly constructed building may be the result.

First of all the surface soil should be removed from the site until a hard layer of virgin earth is reached. The whole site should then be covered with a layer of concrete, rammed solid, at least six inches thick, and extending at least six inches beyond the footings of the outside walls. The depth of the concrete below the walls is regulated according to the weight of the wall which it has to support, but it should never be less than eighteen inches deep. The object of this layer of concrete is to prevent the passage of moisture and ground air from the ground beneath into the building.

The Walls.

The height of the footings of the walls should be at least two-thirds of the thickness of the wall above them, and the width of the bottom layer of the footings should be twice the thickness of the wall.

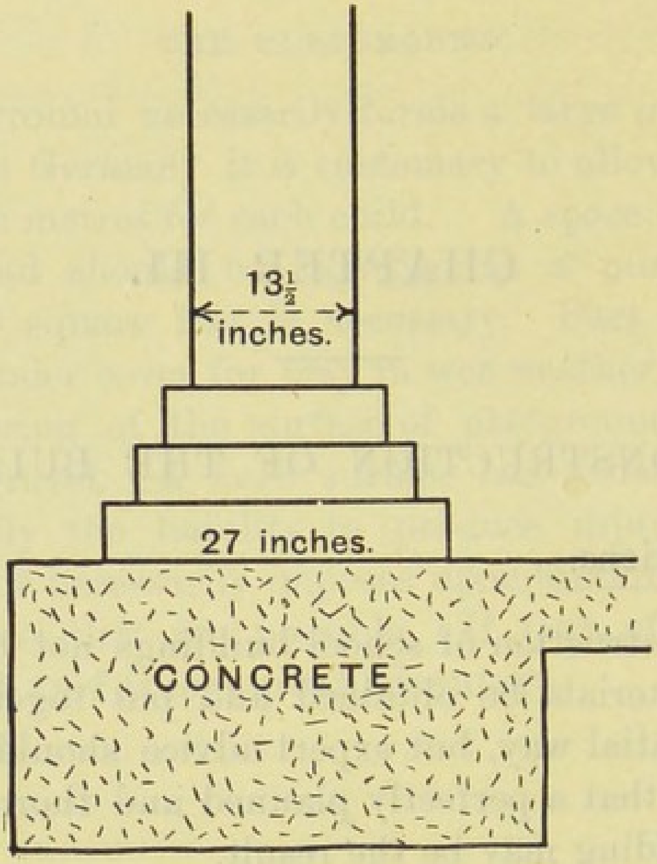

Fig. 4.

FOOTINGS OF WALL AND CONCRETE FOUNDATION.

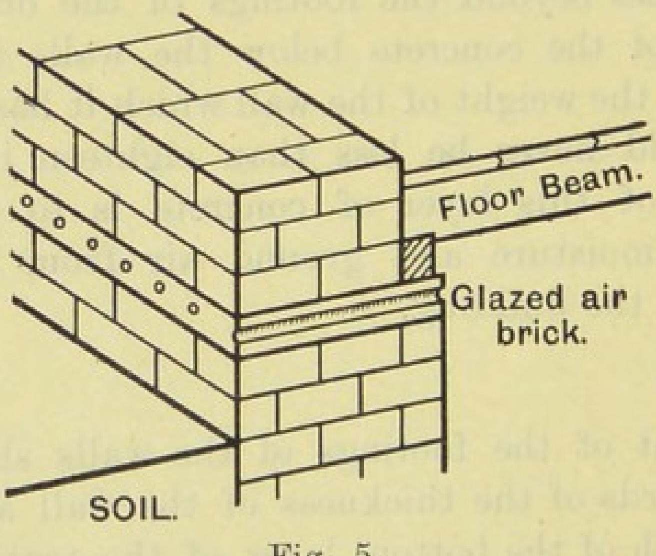

Fig. 5.

DAMP COURSE OF PERFORATED GLAZED AIR BRICKS.

The Prevention of Damp.

The walls must be provided with "a proper damp course of sheet lead, asphalt, or slates, or of other durable material impervious to moisture." This damp course should be placed beneath the level of the lowest timbers and not less than six inches above the level of the soil outside.

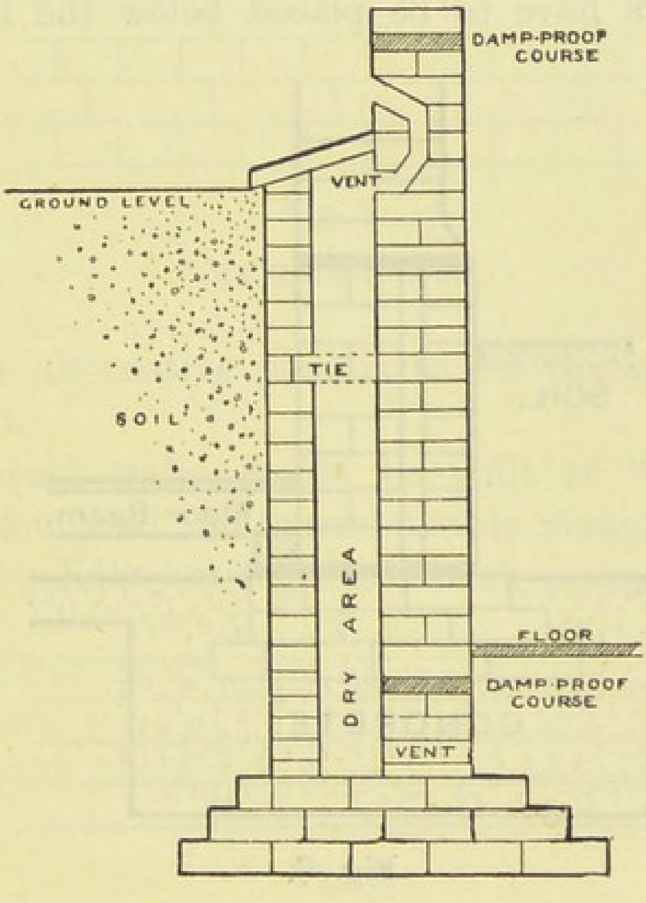

Fig. 6.

Unless these precautions are taken the moisture will be readily absorbed by the brickwork from the soil. An ordinary brick will absorb about one pint of water. This moisture will creep up the wall by capillary attraction, even to the level of the upper rooms, and will produce rotting of the woodwork and disfigurement of the paper, besides rendering the school damp and unhealthy.

The best damp-proof course is one made of specially manufactured slabs of glazed stoneware, perforated longitudinally, and thus ventilating the space beneath the floors as well as preventing the ascent of moisture.

The arrangement of the damp-proof course is quite simple where there is no basement, and where all floors are above the ground level. Where a basement is necessary, or floors have to be placed below the level of the

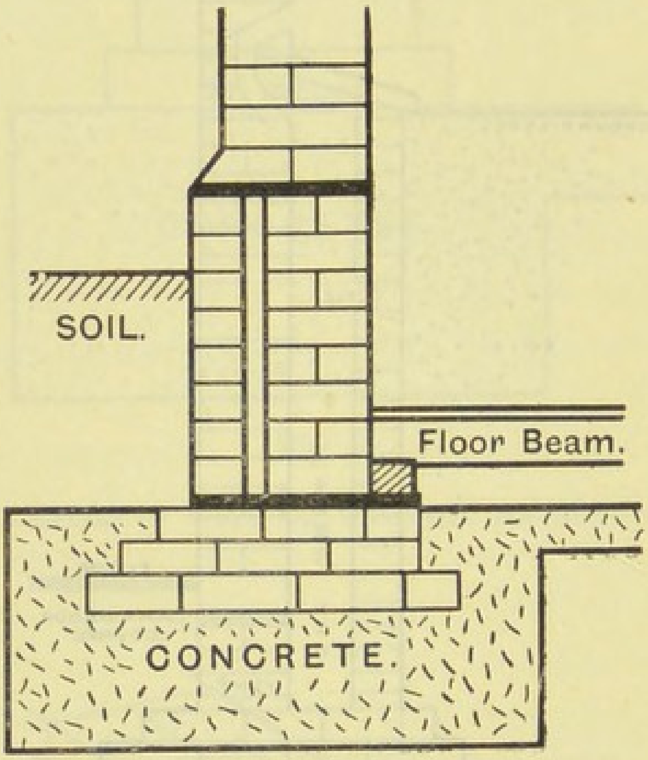

Fig. 7.

Double Wall.

surface of the outside soil, it is necessary to adopt one of the two devices known as "dry area" and "double wall." These are almost sufficiently illustrated by Figures 6 and 7. "Dry area" is a device to keep away the soil from the wall by building an additional wall some small distance from the main wall. A similar purpose is achieved by building the main wall double until about a foot above the ground level. In both cases the part of the wall which, from its contact with the soil, is bound to be perpetually damp, is entirely cut off from the remainder of the wall by damp-proof courses and air space.

In both cases it is necessary to provide ample openings for ventilation and to drain the bottom of the area or

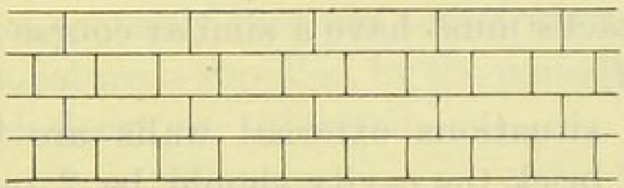

Fig. 8.

THE ENGLISH BOND.

cavity. An alternative plan is to fill the space entirely with asphalt.

The external walls should be built of "good bricks, stone, or other hard and incombustible materials, properly bonded and solidly put together" with mortar or cement.

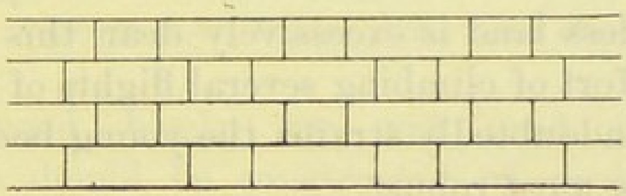

Fig. 9.

THE FLEMISH BOND.

The two usual methods of bonding are the Flemish bond, in which each course contains bricks laid alternately transversely and longitudinally, and the English bond, where the entire courses are alternately laid transversely and longitudinally. Where the wall is under 25 feet in height a 9-inch wall is usually considered sufficient (but 14 inches is much better), and the thickness must be increased for increased heights. The regulations of the Board of Education state that for walls of one storey high the thickness must be 1½ bricks, and if of stone, 20 inches thick.

All walls, including fence walls, must have a damp-proof course of asphalt, slate, or other approved material through their whole thickness immediately above the ground, and all chimney stacks must have a similar course immediately above the roof.

In exposed situations external walls are better built hollow. If of brick the cavity should be 2 inches across, with a 9-inch wall inside and a 4½-inch wall outside. Hollow walls must be bonded together with continuous courses of vitrified bonding bricks, one course to every three feet in height.

Number of Storeys.

It is advisable to limit the height of the building to two storeys above the level of the street. In this country a great number of the modern schools are only one storey high, and, unless land is excessively dear, this is the best plan. The effort of climbing several flights of stairs many times a day undoubtedly strains the young body except in the case of the most robust.

Floors.

Solid floors should be used on the ground floor. The best is the wood block floor. The wood blocks are usually 10 inches long by 3 inches wide and 1½ inches thick, and are laid upon concrete in a mixture of tar and asphalt. These floors are durable, clean, and noiseless, but require great care in cleaning. If joists and boarded floors are used, air bricks or air gratings must be inserted to ensure a through current of air below the floor. The wood used for floors should be well seasoned. Ordinary floor boards shrink after having been laid, and the spaces thus formed between the boards afford lodgment for dust and dirt. The collection of dirt that is always found under such floors in old schools and houses would greatly astonish most people. Part of this matter is organic and probably gives off gases which cannot fail to be injurious to health. Fermentation probably becomes active when the necessary amount of moisture is supplied by the periodic wet cleaning to which such floors are subjected.

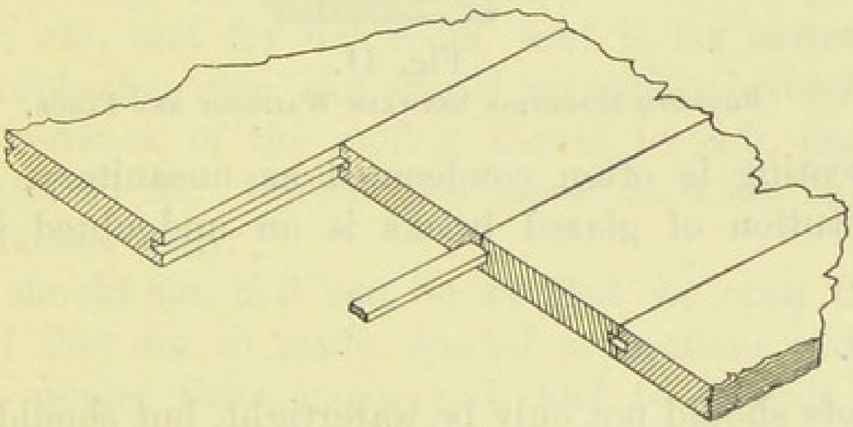

Fig. 10.
GROOVED FLOOR BOARDS FITTED WITH STRIP.

Where wood blocks are not used the floors of schoolrooms should be constructed of narrow planks of close-grained wood, such as oak or pitch pine. The edges should be "tongued and grooved," *i.e.* one edge of each board is ploughed to form a groove, while the other edge has a projection or tongue. The tongue of each board fits into the groove of the next. Another plan is to groove both edges of the board, so that a loose strip of wood or iron will fit exactly into the two grooves when side by side.

In all cases the junction of the wainscot with the floor should be completed by means of a rounded insertion, as shown in Fig. 11. This enables the sweeping and cleaning of the room to be done thoroughly and quickly. Wooden

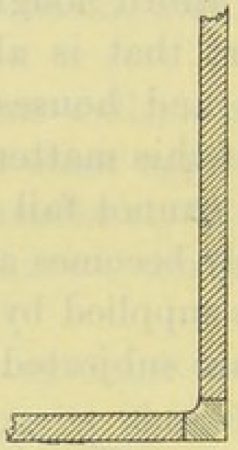

Fig. 11.
ROUNDED INSERTION BETWEEN WAINSCOT AND FLOOR.

wainscoting is often condemned as unsanitary, and the substitution of glazed bricks is an undoubted improvement.

Roofs.

Roofs should not only be watertight, but should serve as a protection against heat and cold. Of the various roofing materials (thatch, stone, slates, tiles, lead, zinc, etc.) the most serviceable for school purposes are slates and tiles. The **slates** should be of the best quality, hard without being brittle, and should be laid at about an angle of 30° to the horizon. They are often laid on laths, but the practice is not a good one, as the upper rooms are then insufficiently protected against heat and cold, and will be uncomfortably cold in winter and hot in summer. The best results are obtained by laying slates on boards covered with felt. They must be secured by strong copper nails, weighing not less than 10 lb. per thousand, two to each slate. Slates should be laid with a 3-inch lap, which means that each slate overlaps the next slate but one below it for 3 inches.

Tiles.

Tiles are more porous and absorbent than slates, but are worse conductors of heat. Water does not so readily run off them as in the case of slates, and so it is necessary to lay the tiles at greater angle (45°-50° with the horizon). Copper nails or oak pins, two to each tile, should be used to secure them. Ridge tiles should be jointed and bedded in cement.

Lead.

For covering irregularly shaped surfaces, gutters, flashings, etc., and for flat roofs, lead is far better and more durable than zinc, and should invariably be used.

The woodwork of the roofing should be oak, teak, or best Baltic red fir. Rafters and joists must not be more than 13 inches apart.

Roofs should not, if it can be avoided, be open to the apex. If they are so made, special precautions must be taken to render them impervious, and to provide apex ventilation.

Spouts.

The roof should be so planned as to carry off the water as quickly as possible, and the spouting arranged so as not to allow it to be blown upon the side walls. Every precaution should be taken to get rid of the rain-water, so that it does not saturate the subsoil around the building. The spouting must be equal to dealing with the maximum rainfall on any day in the year. Eaves, gutters, and rain-water pipes may be advantageously kept an inch or two away from the face of walls, so that, if stoppage or leakage occurs, the wall will not necessarily be made damp. Down-spouts should be made of iron. Eaves and gutters may either be iron or zinc. Zinc, if used, should be of substantial thickness.

Internal Wall Surfaces.

Probably the best plan is to leave the walls uncovered by either plaster, paint, or paper, but it is necessary to use impervious hard bricks set in cement if this course is adopted. Such wall surfaces can be easily kept clean and are very satisfactory. Glazed bricks or enamelled tiles are still more impervious and give excellent results from all points of view.

If the walls are plastered, a durable, smooth, non-porous variety should be selected. The plaster is then usually coloured by some colour wash, but more permanent and satisfactory results are obtained by painting and varnishing the walls. The aim should be to produce a surface that will be almost non-absorbent and which can be readily cleaned. Ordinary non-painted plaster absorbs moisture and organic matters. Analysis of the plaster of a hospital ward has shown the presence of 46 per cent. of organic matter. In such cases there is probably a continuous fermentation going on, giving rise to ill-health. White-washing and colour-washing does not remove or destroy such accumulations, but merely covers it all over with a layer that *looks* clean. When such surfaces require cleansing they should be carefully washed, and some disinfectant should be added to the new colouring matter.

Cornices, string courses, and projections of every kind upon which dust can gather should be ruthlessly prohibited on the walls or in any part of the room. The tops of the doors and windows should be levelled off, and indeed all kinds of irregularities taken away; even raised thresholds should be avoided: everything that will interfere with a clean sweep is wrong and must not be permitted on any account. Woodwork where visible should be stained and varnished.

Colour of Walls.

There are two points to be considered in connection with the selection of the colour for the wall. It is important to choose such a colour as will not tax the eye, and at the same time the colour must be such as will not absorb light to any appreciable extent. Thus, red colours absorb a large amount of light; yellows absorb the least amount of light but produce greater fatigue and nervousness than the other colours; while greens stand next to yellows in their absorption of light and are markedly restful to the eye. As a rule the best results are obtained by adopting a light greenish gray, with a dull surface. The wall should be painted, so that it may be washed.

Basements.

There should be a basement under the whole building if possible. If the basement has two-thirds of its height above the ground level, and has no direct communication with the rooms above, it may be used for cloak-rooms. The floor should be of good asphalt or cemented concrete. Under no circumstance should such rooms be used for teaching purposes. Part of the accommodation here will be taken up by the heating apparatus, and by store-rooms. The furnace-room should be shut off from the remainder of the floor by stout iron doors which serve to isolate this part in case of fire.

Cloak-rooms and Lavatories.

Special rooms must be available for such purposes, although it is unlikely that the demand for a cloak-room for each class-room will be met yet. They should be entered from well lighted and ventilated lobbies, and not from any room used for teaching. Basements may be used, but only when no other space is available. They must be heated and ventilated so as to dry any wet clothes and prevent damp or smell from entering the school. Lavatory fittings should not be placed in cloak-rooms. The practice of using parts of corridors as cloak-rooms is bad, not only because it disfigures the building, but also on account of the smell of damp clothes in wet weather.

Cloak-rooms should be well lighted from the end, and gangways at least four feet wide should be made between the hanging rails. Pegs for hats and cloaks should be

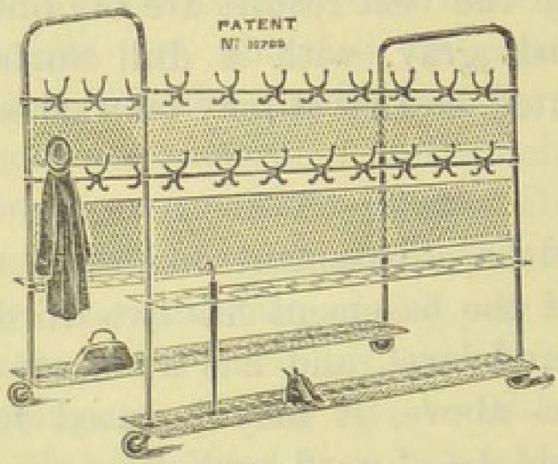

Fig. 12.

METAL CLOAK-ROOM FITTINGS.

numbered, placed not less than twelve inches apart, and not one above another. The floors should be of asphalt or cemented concrete, and the walls of glazed brick or tile. Glazed partitions should be used as far as possible.

The best plan for arranging the clothes is by means of metal ranges—usually steel coated with aluminium—so made that there is a free circulation of air around the clothing, thereby ensuring rapid drying (see Fig. 12). The methods that are usually adopted do not allow such free circulation as is desirable. The usual plan is either to fix a wide shelf round the room with double coat hooks underneath, fifteen inches apart, or to form a series of compartments by vertical partitions, placed ten inches apart, with coat hooks fixed on each side. Additional

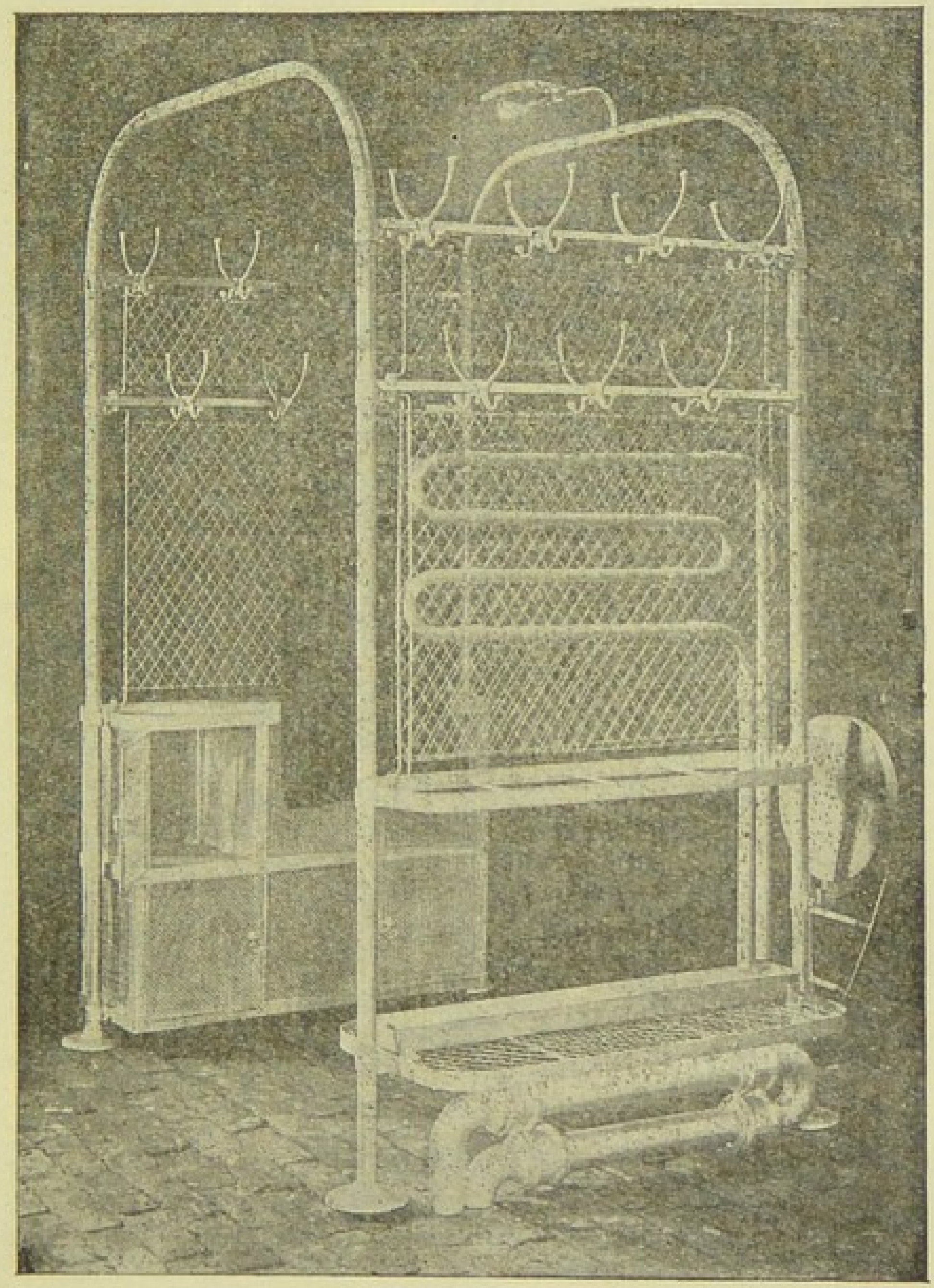

Fig. 12A.

METAL CLOAK-ROOM FITTINGS.

accommodation may be provided by fixing small shelves between the vertical partitions. The latter method appears

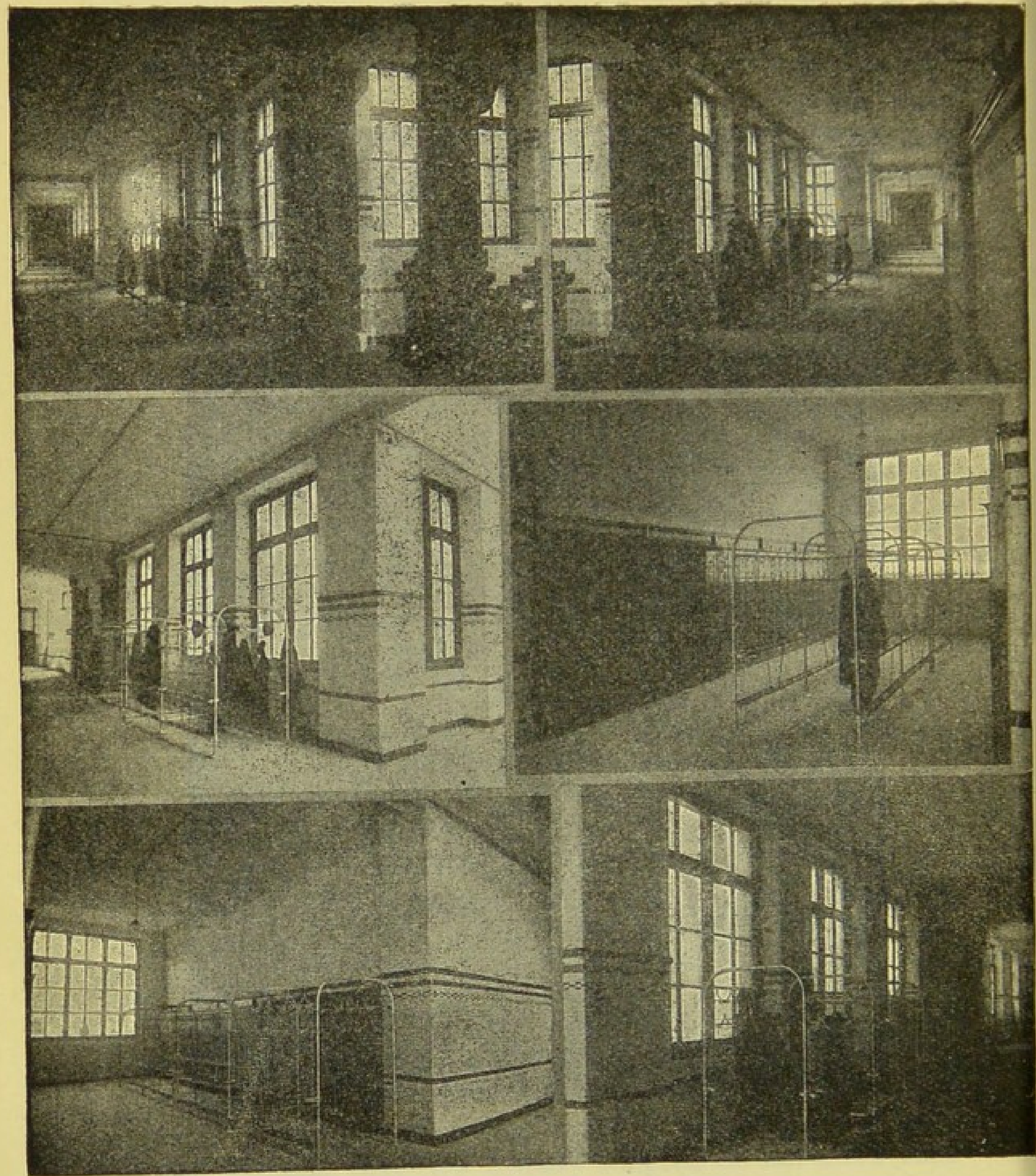

Fig. 12B.

Cloak-room Accommodation.

attractive, but it is unsatisfactory on account of the obstruction to the free circulation of air, resulting in delay to the drying process.

Entrances.

There should be a sufficient number of external doors to allow the school to be completely emptied in less than three minutes, and the doors should be wider than the stairs or passages leading to them. No school should have less than two entrances, and in mixed or dual schools there should be separate entrances for boys and girls. Where external doors have outside steps there should be a landing between door and steps. In all cases external doors should open outwards.

Staircases.

These should not be less than four feet and not more than six feet wide, and must not have more than fourteen steps to a flight. Where possible they should be constructed with solid walls on both sides of the flight, and every staircase must have at least one external wall. They must be of fire-resisting materials, such as iron and slate, or steel and lead, and well lighted in every part. In schools of more than 150 scholars with upstair rooms there must be at least two staircases. In fact, two staircases should be considered to be the minimum in all cases. In mixed schools one staircase should be used by boys and another by girls.

Numerous cases of children falling over banisters have led many authorities to insist that there should be no balustrade, but that the staircase should have walls on both sides. This arrangement may be considered less ornamental, but it is undoubtedly safer. On each side of the staircase a double handrail should be fixed, the lower rail being at a level suitable for smaller children, and a higher one for the taller scholars.

It is advisable that each staircase should be broken by a square or oblong landing, not only as affording a temporary rest for the muscles, but also as guarding against accidents.

The width of the steps (or treads) should be not less than eleven inches, and the height of one step above another (risers) should be six inches.

General Plan.

In order to secure proper organisation and supervision the various rooms should be grouped compactly and conveniently. The usual modern plan is that of a central hall, round which the other rooms are ranged, and from which they are entered by doors, the upper portions of which are glazed. If an upper storey is necessary the staircases and corridors should be on view from the central hall. Passages and corridors should be avoided as far as possible. Where unavoidable, they must be large, airy, and well lighted, and constructed of fire-resisting materials. In many cases there appears to be an inability to realise the importance of wide halls or corridors. Main corridors should be at least ten feet wide, but need not be more. Occasionally one meets schools with abnormally wide halls and corridors, simply representing waste of valuable space which might have been economically included in the schoolrooms.

The objection to the central hall type of school is that adequate ventilation by natural means is extremely difficult. In fact it is owing to this difficulty and the common adoption of the central hall type that mechanical ventilation has been forced upon school authorities, thereby

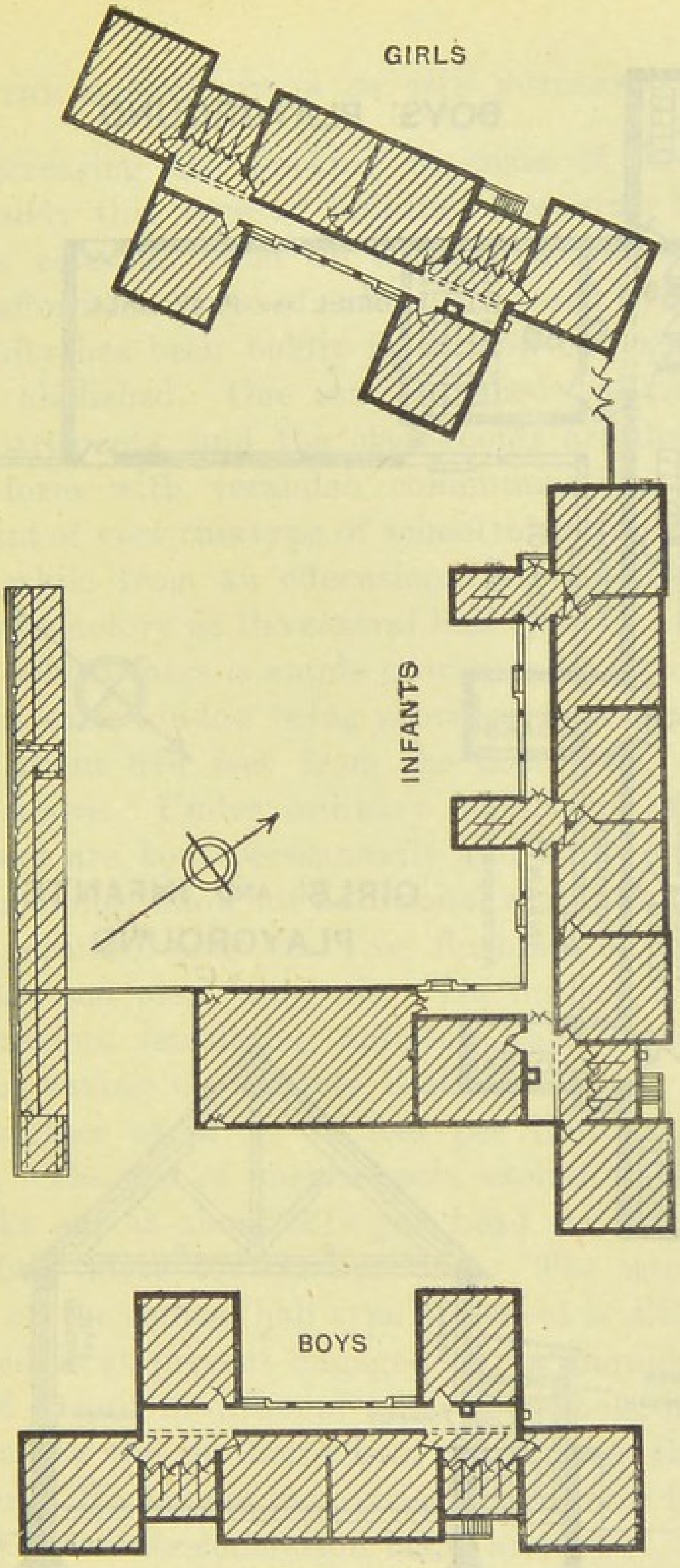

Fig. 13.

The Staffordshire Type of Elementary School.
Ground Plan showing Relative Arrangement of the Three Departments.

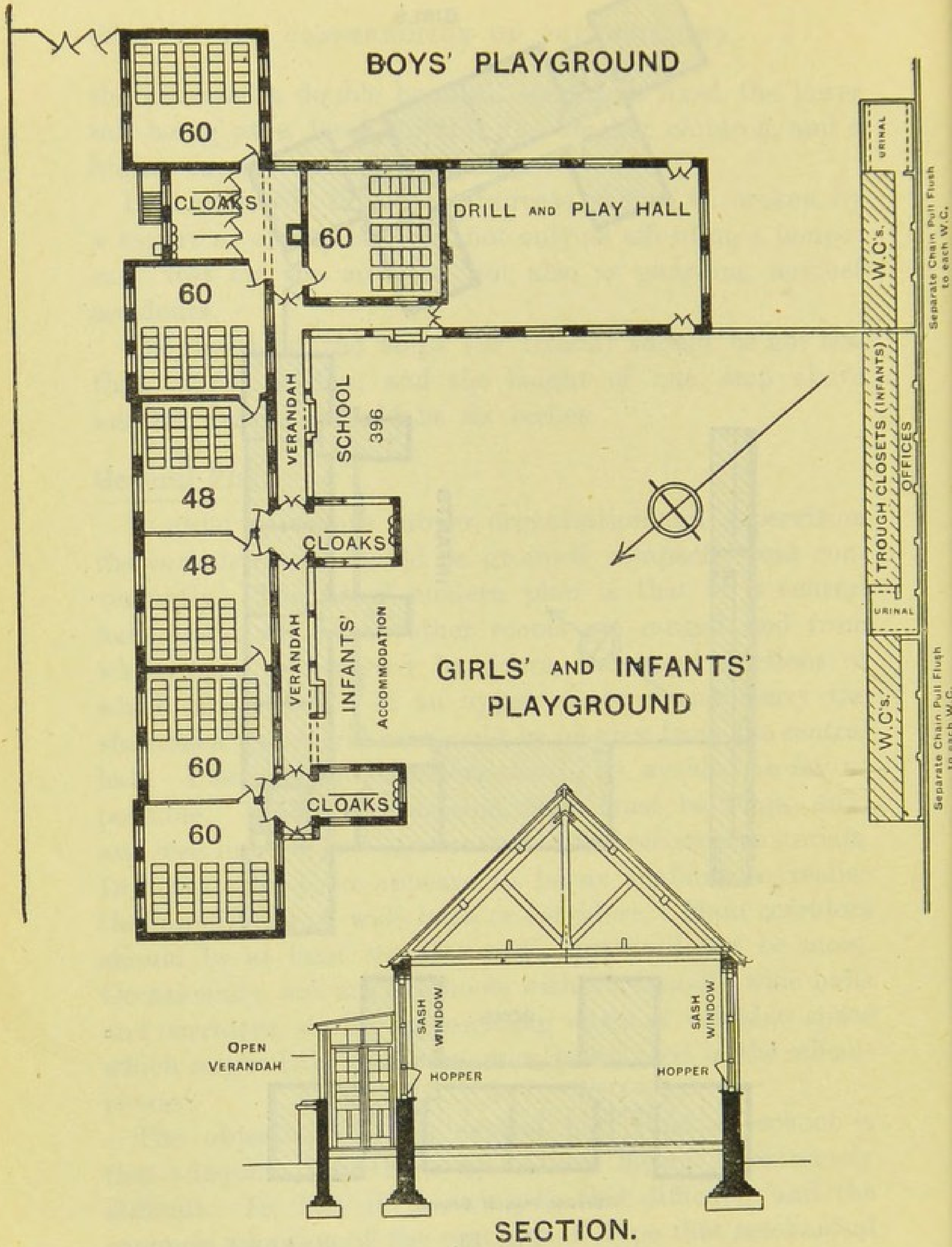

Fig. 14.

THE STAFFORDSHIRE TYPE OF ELEMENTARY SCHOOL. GROUND PLAN OF INFANTS' SCHOOL, WITH DRILL AND PLAY HALL. ALSO SECTION OF CLASS-ROOM.

greatly increasing the working expenses of the schools. Unfortunately this type of building has come to be regarded as essential from an educational point of view. In the Staffordshire type of school, proposed by Dr. Reid, the difficulty has been boldly faced, and the central hall has been abolished. One semi-detached hall serves for three departments, and the class-rooms are designed in pavilion form with verandah communication. From a health point of view this type of school makes an important advance, while from an educational standpoint it is at least as satisfactory as the central hall type.

In this school there is ample provision for cross window ventilation, each window being provided with large hopper openings about five feet from the floor level, and sash openings above. Under ordinary conditions of weather the hoppers are kept permanently and fully open, while the sash openings allow for additional ventilation so far as weather permits, and for free flushing of the rooms during play and meal intervals. The heating is provided by low pressure ventilating radiators, each department of the school having an entirely distinct circuit. A mean heating surface of 17 to 20 feet per 1000 cubic feet is provided. The cost of such schools, excluding the cost of site, works out at about £10 per head for large schools and slightly more for smaller ones. The average cost per head of the central hall type of school is £15.

Dr. Reid is at present engaged on an inquiry into the quality of the air in different types of schools, in order to determine how the pavilion school compares in this respect with others. He has not yet carried the inquiry far enough to justify a definite conclusion being arrived at, but so far as he has gone the figures indicate that the atmosphere in a central hall type of school without mechanical ventilation is at least four times as impure after 1½ hours' occupation as that of the pavilion school collected on the same day and under similar conditions.

All corridors should receive direct light from windows at each end and, if necessary, must be lighted from the adjoining class-rooms by windows fitted with clear ribbed glass. Ground glass is very unsatisfactory, as it absorbs a large percentage of the light.

THE CLASS-ROOM.

The best shape for the class-room is that of a rectangle with the greater sides about one-fifth longer than the smaller sides. The pupils should sit facing one of the shorter sides, *i.e.* with the long sides of the room on their right and left. Light is admitted on the left side. The necessary size is determined from certain factors. There should be 15 feet of floor space and 200 cubic feet of air space provided for each scholar.

[The Board of Education give 120 cubic feet per head for London elementary schools, and 100 cubic feet per head for provincial schools, and 18 square feet for every scholar in secondary schools.]

One of the commonest and most dangerous fallacies is that a smaller air space per head is required for primary schools than for secondary schools. Other factors to be considered are the distance for which the light admitted on the left will prove effective (this limits the width of the room to 25 feet); the distance at which the scholars with normal eyes can see writing on the blackboard; and the distance at which the words of the teacher are still clearly audible. The latter factors limit the length of the room to about 30 feet.

We thus arrive at the dimensions 30 feet by 25 feet. These give a floor space of 750 square feet, and allowing

13 feet for the height we have a room containing 9750 cubic feet of air. This will accommodate 48 scholars if the allowance of 15 square feet of floor space and 200 cubic feet of air space is considered to be sufficient. This is a very large class for one teacher, and, in practice, a class of 40 pupils should be considered a maximum.

CHAPTER IV.

LIGHTING AND HEATING.

SECTION I.—LIGHTING.

The continued increase in short sight among children may be ascribed without hesitation partly to deficient and faulty illumination of school-rooms. In order to understand the principles of perfect lighting it is best to consider under what natural circumstances reading can be best accomplished. The most perfect ease in reading or writing, or in doing any fine work which imposes a certain strain upon the eyes, is obtained in the open air on a dull day. Under such circumstances there is ample light, but it is so well diffused that it appears to come from no point in particular and therefore casts no shadow. This represents the ideal conditions. It is imitated in artificial lighting by concealed electric lights, the light from which is reflected to the ceiling and thence, well diffused, to all parts of the room. One of the most important rules is that the light should never fall directly upon the eyes. Illumination of the paper or object, with shading or protection of the eyes, is the aim of good lighting. Such is attained in the lighting of billiard tables, or by reading-lamps.

Windows.

Every part of a school-room should be fully lighted. The area of window glass must not be less than one-fifth the area of the floor in rooms used for teaching, and in other rooms not less than one-eighth; so that a school-room 30 feet by 25 feet should have a window area of not less than 150 square feet. At least half the glass area of every window must be made to open for ventilation and for cleaning. In rooms used for teaching the windows should have square heads, be as near the ceiling as possible, and of white glass only. There should be no wall space between the ceiling and the window. As a general rule one-third of the total light admitted by a window is furnished by the upper fourth. The height from the floor to the bottom of the window should be four feet in order to prevent reflections from the top of the desks, and so that the light should not be on a level with the eyes of the pupils. Provision for cross ventilation should be made. A convenient arrangement of windows is to have the lower portion fitted as double-hung sashes and the upper as a fanlight hung at the bottom to fall inwards. Another good plan is to arrange below the sashes a hopper opening that cannot be closed. If the top of the window does not open, or if the window does not reach up to the ceiling, there will be a layer of foul air continually occupying the upper part of the room.

The light should, as far as possible, be admitted from the left side of the scholars; but when a left light is impossible, a right light is next best, in which case the window sills should not be very low. The objection to a light from the right is that it casts a shadow from the pen over the writing. The worst light is that which comes directly from the front of the scholar. This is very dazzling and is injurious to the eyes. Light from the back throws a shadow over the work of the scholars, and is unpleasant and injurious to the teacher. Moreover, such a position decreases the power of the teacher of overlooking the scholars. The number of panes of glass to each window should be not more than four. The best plan is to have one pane for the upper sash and one for the lower. Such windows are more easily cleaned, and give more light than those with more panes.

Abundant light is absolutely necessary, and it should be arranged to strike the desk at a considerable angle. A "dim religious" light is opposed to healthiness of mind, and tends to develop that hysterical state greatly admired and so much promoted by some schools of religious thought. It depresses a healthy mind, and impedes the vigorous action of brain matter. Light goes with knowledge, and assists to develop mental power. A dim light probably impedes the formation of the habit of private judgment, and leads the person under its influence to lean upon somebody else: to follow the lead of the teacher in blind obedience; but it does not tend to health. That which does not produce a perfect state of bodily health, or impedes its growth, cannot be good for any body of people, and this applies to children much more than adults. Lighting should be provided on a scale suitable for dull days: the mere passing of a dark cloud over the sun may decrease the illumination in a room by 66 per cent.

Light should be diffused as equally as possible through the room: dark corners and dark ends should be got rid of by opening windows in the blank walls, or putting in skylights if the walls are not outside walls.

Amount of Illumination.

To test the sufficiency of illumination in a room the light upon the desk placed in the most unfavourable position should be examined. It is usual to compare the illumination at any place with that afforded by a standard candle placed one metre away. This is called a candle metre. The illumination upon the desk in the darkest part of the room should be at least fifty candle metres. If it is below the standard the eyes of the pupil will be subjected to an undue amount of strain.

Windows with Obstructed Sky Line.

Unfortunately many school buildings have some windows which give a poor light because the neighbouring walls and houses obstruct the sky line. Under such circumstances it is necessary to deflect the light into the room by means of special contrivances such as ribbed glass, or glass prisms.

A series of tests on the diffusion of light through ribbed and prismatic glasses were made by C. L. Norton at Massachusetts. The ribbed glass giving the best results was plane on one side and had twenty-one ribs to the inch on the other. The ribs should be set horizontally. Its cost is not excessive. It is claimed that for average-sized school-rooms with obstructed sky line the illumination can be increased, on dull days, by more than fifty per cent. if the upper sash is glazed with ribbed glass.

Fig. 15. Ribbed Glass.

Lighting by prisms is also very satisfactory in those cases where the windows open upon narrow streets or dark courts. Panes are made with projecting prisms on one side, the angles of the prisms varying for different cases. By refraction and reflection the light from the sky above is directed into the room. The most satisfactory method of using these prisms is so to arrange the angle that the light is deflected to the white ceiling, thereby affording an ideal light.

The space between the windows should be as narrow as possible. Wide spaces produce bands of light and dark shadows which strain the eyes. The best arrangement is to use cast-iron mullions between the windows, so that brickwork is altogether unnecessary in these positions.

In many schools the windows are seldom cleaned. Small panes should be avoided on account of the increased tendency to become dirty, as well as affording less light. Regular cleaning of the windows is as important as the scrubbing of the floors.

Blinds.

When the direct rays of a bright summer sun are pouring into a room the light may become dazzling. Direct sunlight should never fall upon a desk. Opaque shades, rolling from the *bottom*, should then be used in order to regulate the amount of light. The light entering near the ceiling is then evenly diffused.

Artificial Lighting.

The incandescent electric light is by far the best. As a general rule, three 16 candle-power lamps, placed eight feet above the floor, will be required for every 100 square feet of floor space. The glowing film itself, if visible, injures the eye, and some shield is therefore necessary. Most shields, ground glass for instance, greatly decrease the illumination. Shaw, of New York University, strongly recommends the adoption of the Holophane glass globe. This globe increases the effectiveness of the lighting at all points below the horizontal. They should be used as close to the ceiling as possible. Gas has the great disadvantage of giving a considerable amount of impurities to the air, as well as using up the oxygen. One cubic foot of gas will, in burning, consume the entire oxygen of eight cubic feet of air, and also give to the air about half its volume of carbon dioxide as well as compounds of sulphur, which are par-

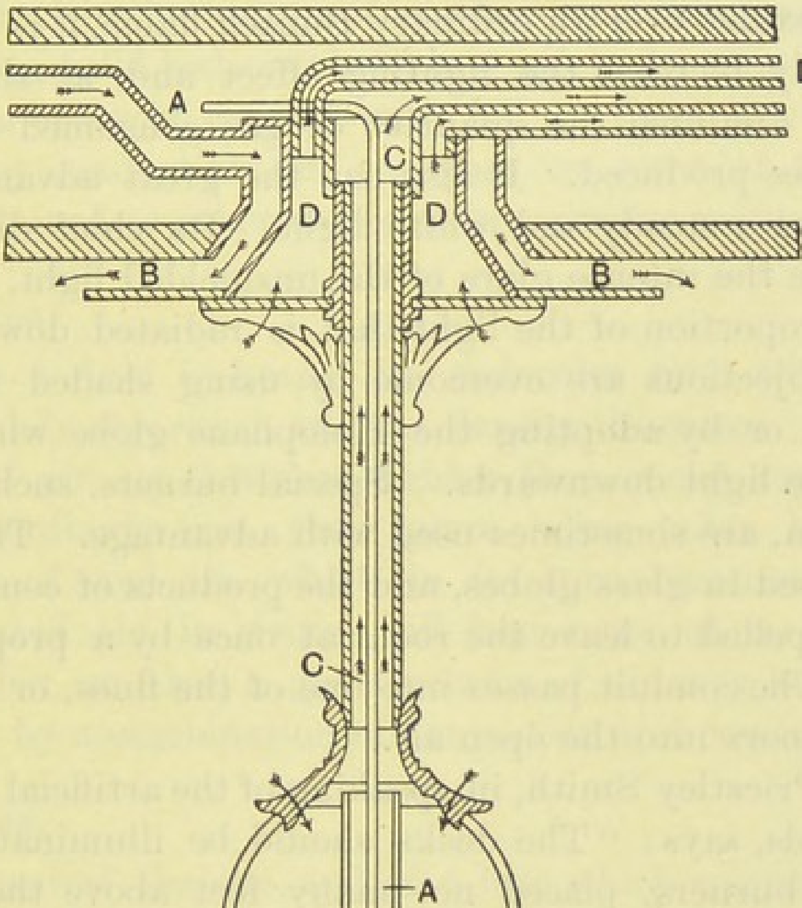

Fig. 16.

WENHAM'S GAS-BURNER.

A, Burner and gas pipe.
B, Inlets into room and globe for fresh air, as shown by the arrows.
C, Outlet for products of combustion.
D, Outlet for foul air from room.

ticularly injurious. An ordinary batswing burner, of 16 candle-power, consumes $5\frac{1}{2}$ cubic feet of gas per hour, and is estimated to produce, in that time, 2·8 cubic feet of CO_2, and 7·3 cubic feet of water vapour, thereby polluting the air to about the same extent as would be produced by the process of respiration of five adults. By using Welsbach incandescent burners, in which incandescence is produced by placing a mantle composed of a network containing certain oxides over an ordinary Bunsen flame, it is possible to greatly increase the lighting effect and, at the same time, to diminish the quantity of gas consumed and the impurities produced. It also has the great advantage of producing a steady and white light. Its chief disadvantages are the intense glare of the unshielded light, and the small proportion of the light that is radiated downwards. These objections are overcome by using shaded inverted burners, or by adopting the Holophane globe which diffuses the light downwards. Special burners, such as the Wenham, are sometimes used with advantage. The flame is enclosed in glass globes, and the products of combustion are compelled to leave the room at once by a proper conduit. The conduit passes into one of the flues, or directly out of doors into the open air.

Mr. Priestley Smith, in speaking of the artificial lighting of schools, says: "The desks should be illuminated by a row of burners, placed not many feet above them, and somewhat to the left. Ground glass globes, which greatly diminish the intensity of the light, should be replaced by transparent chimneys for the sake of clearness and steadiness, and reflectors may be added with great advantage."

SECTION II.—HEATING.

The heating of the school is, or should be, closely associated with its ventilation, and the subject will therefore be constantly alluded to in considering the question of ventilation. Heat tends to pass from warmer to colder bodies in three ways—by conduction, by convection, and by radiation.

Conduction.

Heat passes from hot particles to cooler particles in contact with them by means of conduction. The passage of heat along solid bodies takes place solely by this method. Particles of air in contact with hot surfaces also become heated by conduction, and can pass on some of the heat thus obtained to other particles in a similar manner.

Convection.

When a fluid is heated its molecules tend to become more widely separated, and its density decreases. Heated layers of air are therefore lighter than cooler layers and will accordingly rise, their place being taken by equal volumes of cool air, which in its turn becomes heated. The heated air, in rising, will lose some of its heat by conduction, so that a given volume of air may be quickly warmed by a combination of convection and conduction.

Radiation.

The heat of the sun, and of a fire, which warms objects at a distance without raising the temperature of the intervening air, is said to pass by radiation. Objects thus warmed may raise the temperature of adjacent air by conduction, and of large volumes of air by conduction and convection.

For school purposes we may consider the following methods as available for heating:—

I. Open Fires.

This is the most popular method of heating in this country, but it cannot be recommended as the sole source of heat for schools. They have the following disadvantages:—

(1) They are very wasteful. Between 10 and 20 per cent. of the actual amount of heat that is produced is really used in warming the room, the 80 or 90 per cent. being wasted largely by the rush of heated air up the chimney. To prevent as much of this loss as possible the opening into the flue should be narrow and adjustable; also the grate should be made with as little metal work and as much fireclay as possible. The bars beneath should be so close together as to allow small ash only to pass, and the bars in front should be narrow so as not to obstruct radiation. The back of the grate should slope over the fire to deflect the heat into the room. The space under the fire should be shut off so as to allow no air to pass. In order to increase radiation the fireplace should be brought into the room as much as possible. The heat is also economised by building fireplaces against *inside* walls only.

(2) Open fireplaces heat a room very unequally. On cold days one side of a room feels comfortably warm, while the side farthest away from the fire is very chilly.

(3) They create a large amount of dust and ashes, and require a large amount of attention in stoking and cleaning.

On the other hand the open fireplace possesses very important advantages, namely, the cheerful appearance and the efficient aid that it gives to ventilation.

No system of warming can ever give such pleasant effects as those of an open fire. Nearly the whole of its heat is in the radiant form, and as a result the walls and furniture of a room are kept at a higher temperature than the air. Under such circumstances the body is surrounded with comparatively cool air, which is much more healthy to breathe than hot air, but the neighbouring objects, such as walls and furniture, are warmer. The result is that the body loses far less heat, by the process of radiation, than it does in a room filled with warm air but where the walls are cold. In a room heated by hot water pipes or warmed air, the walls not being heated in the same proportion, although the air may feel warm, the walls will remain cold, so that the heat of the body passes rapidly by radiation to the walls, and gives rise to a chill.

Ventilating Grates.

If open fireplaces are used they should always be of the Galton type in order to introduce a constant supply of warm fresh air. At the back of these grates, and surrounding the lower part of the flue, is an air chamber communicating on the one hand with the outer air, and on the other with the room. Fresh air enters the air chamber from outside, becomes warmed by contact with the hot back of the grate and the heated sides of the flue, and enters the room by openings placed either between the mantel-piece and the ceiling or just below the mantel-shelf.

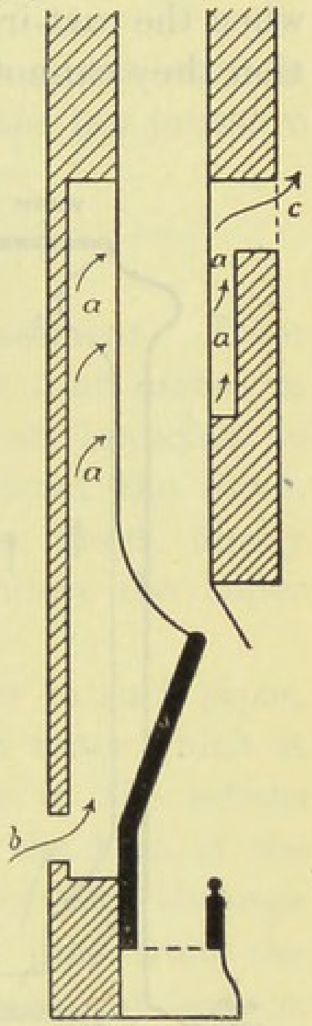

Fig. 17.
THE GALTON GRATE.
a, Hot-air chamber surrounding flue; *b*, opening for fresh air; *c*, inlet into room.

II. Stoves.

These have certain advantages over open fires, being more economical, cleaner, and more uniform sources of heat. Moreover the best forms of stoves require very little attention. On the other hand they dry the air, giving rise to unpleasant sensations, and may actually cause a smell of burning owing to the charring of the dust and organic matter in the air. Another unpleasant feature is the tendency of cast-iron stoves to give off carbon monoxide, a highly poisonous gas, to the air. This only takes place when the cast-iron is red-hot. For the purpose of ventilation they cannot compare with open fires.

III. Gas Fires or Stoves.

These are rarely used for school purposes except for small rooms which are occupied occasionally. The advantages claimed for them are that they are clean, easily regulated, and economical when the room is required at intervals only. It is important to remember that no stove of any kind is permissible unless it is fitted with a proper flue to carry off the products of the combustion.

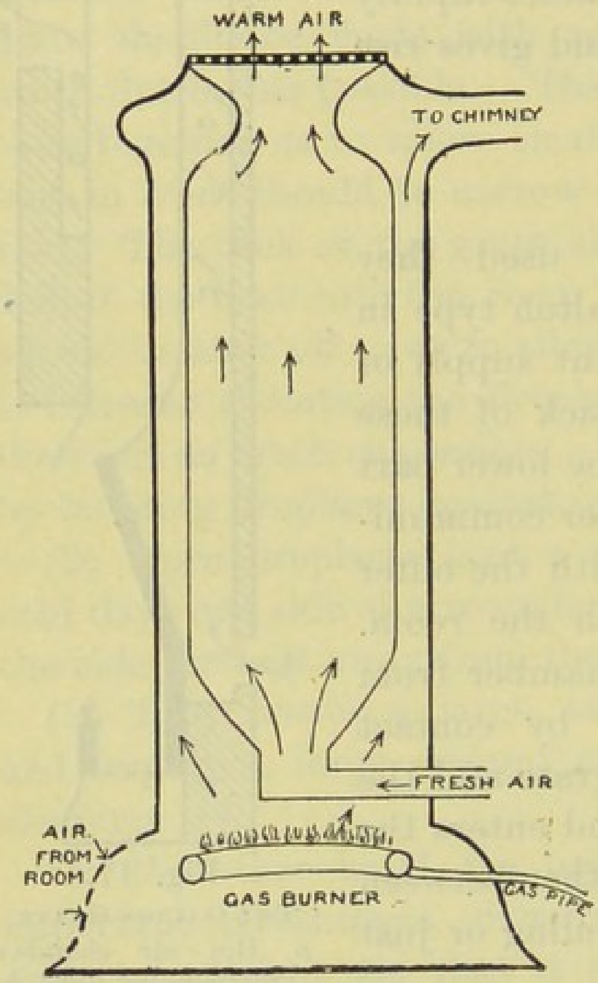

Fig. 18.

VENTILATING STOVE.

Ventilating Stoves.

The most satisfactory form of stove is the ventilating stove, which deserves much more general use. There are several varieties, but the principle is clearly shown in the accompanying diagram. Fresh air enters the room from outside and is warmed on the way by passing through a tube or chamber which is heated by a gas flame (Bunsen burners). The air which is vitiated by the combustion of the gas is led either into the chimney or directly outside.

IV. Hot-Water Pipes.

The heating of buildings by hot water pipes may be accomplished in one of two ways; viz. by the low pressure system or the high pressure system.

Low Pressure System.

The water is heated in a boiler in the basement. From the top of the boiler runs a cast-iron pipe, four inches in diameter, vertically upwards. This gives off branches to all the rooms. Each branch pipe goes round the room, and then returns by bending back under itself, finally uniting with the main return pipe which enters the boiler at the bottom.

There is a continual circulation of water in such pipes, because the outgoing one is filled with hot water which is lighter than the comparatively cool water in the return pipe, such conditions being maintained by the heat of the boiler and the cooling of the water as it circulates through the pipes in the various rooms. A feed pipe from the cistern enters the return pipe and makes good any leakage or waste from evaporation. An escape for air or steam is provided at the highest point. The average temperature at which such pipes are maintained is generally between 160° and 180° F. The pressure in the boiler only exceeds the atmospheric pressure by the pressure due to the weight of a column of water whose height is the vertical distance between the boiler and the highest point of the system.

Roughly speaking, it is usually found that about 12 feet of the 4-inch pipe are required for each 1000 cubic feet in a room in order to maintain a temperature of 65° F.

High Pressure System.

When water is heated while it is exposed to the ordinary atmospheric pressure it boils at 212° F. If the steam is prevented from escaping the pressure inside the closed vessel will be increased and the water will not boil until a higher temperature is reached. The greater the pressure upon the water the higher is the temperature at which it boils. The following table gives the boiling-point of water at different pressures:—

Pressure (in atmospheres).	Boiling Point.
1	212° F.
1·4	230° F.
1·96	248° F.
2·67	266° F.
4·7	302° F.
9·9	356° F.
15·4	392° F.
27·5	446° F.

The high pressure system is composed of a single, continuous, closed pipe, made of $\frac{1}{2}$-inch wrought iron, and with $\frac{7}{8}$-inch internal diameter. From $\frac{1}{6}$ to $\frac{1}{12}$ of the entire length of the pipe is arranged as a coil in the furnace in the basement. The pipe is completely filled with water. From the coil in the furnace the pipe proceeds vertically, and goes round each room in turn and returns to the bottom of the coil.

The water is usually heated to 300° F. (representing about four or five atmospheres pressure). At the top of the system are fixed wider tubes, called expansion tubes, partly filled with air. These allow for the expansion of the water by the heat. About eight feet of this piping is equivalent, in its heating power, to 12 feet of the low

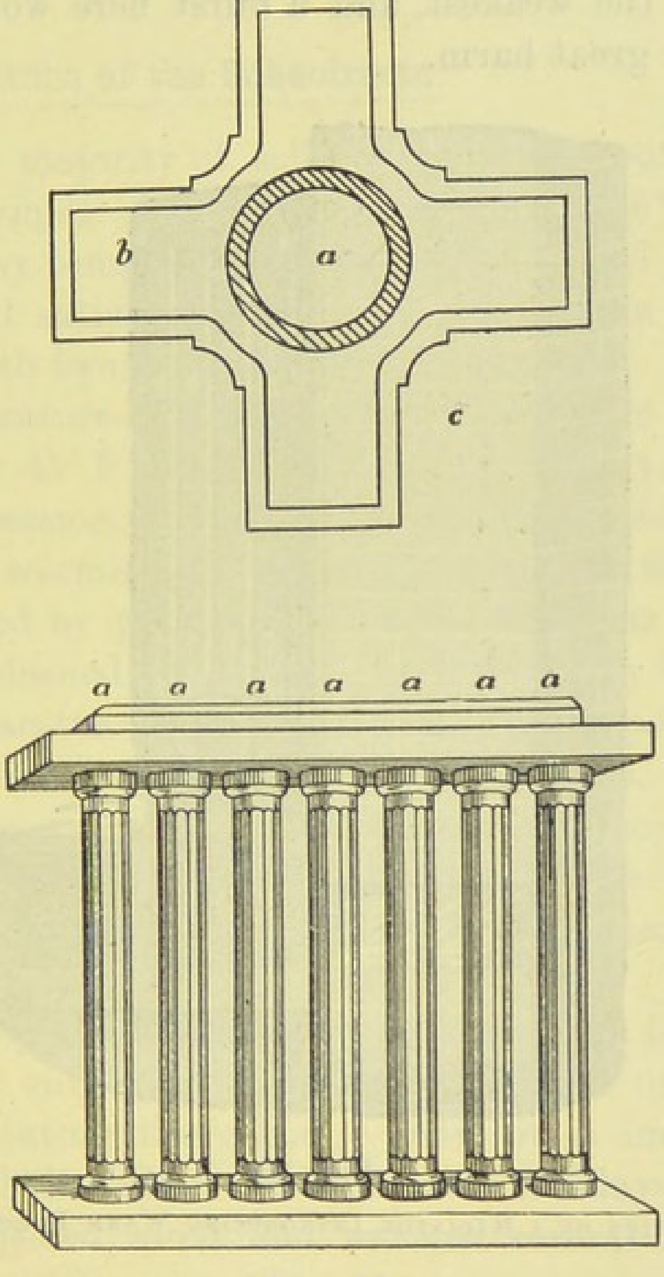

Fig. 19.

WENHAM AND WATERS' HOT-WATER COIL.

pressure piping. As a rule the results given by the system are not so satisfactory as those obtained by the low pressure system, owing to its liability to over-heat the air.

Moreover, unless the furnace receives constant attention, the temperature of the pipes may alter very suddenly. As regards the danger from the high pressure the part in the furnace is the weakest, and a burst here would probably not do any great harm.

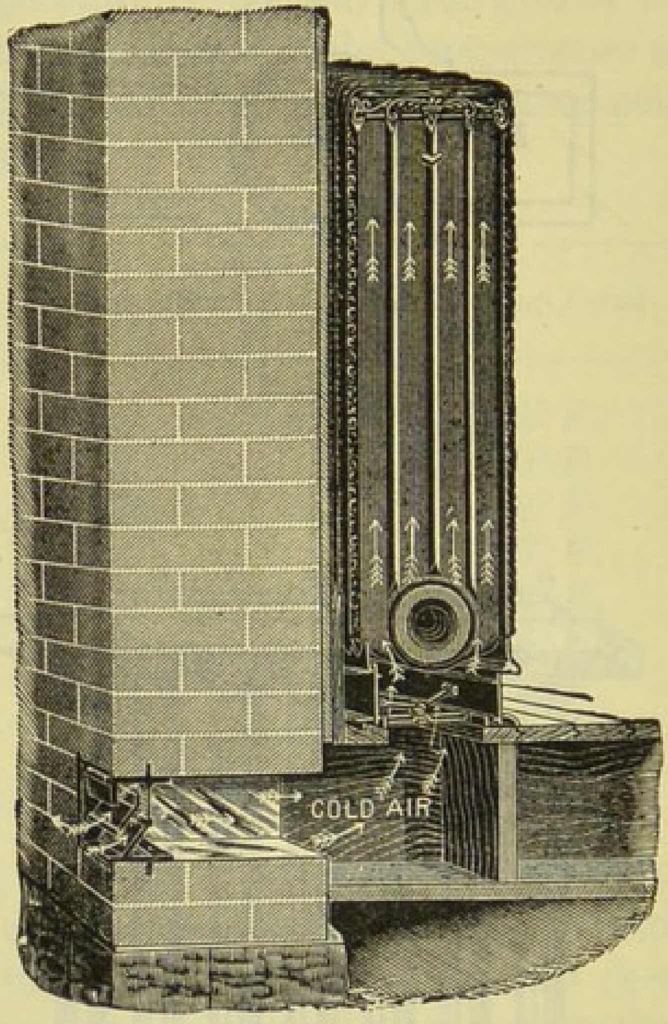

Fig. 20.

SECTION OF A RADIATOR INTRODUCING WARM FRESH AIR.

No system of hot water or steam pipes is admissible unless proper inlets and outlets are provided for ventilation. A convenient method is to substitute for the 4-inch pipes and coils radiators composed of hollow columns connected below with an opening in the wall through which air enters and, after passing through the radiator, is discharged into the room fresh and warm, as shown in Figs. 19 and 20.

The Temperature of the Schoolroom.

In a large majority of schools the temperature is kept too high in winter. The best temperature is 60° F. or just below, but any temperature between 56° F. and 60° F. may be considered satisfactory. Every schoolroom should be furnished with two or three thermometers.

The temperature of a schoolroom should not be allowed to fall below 45° F. at any time, night or day, while the school is in session. If the walls get quite cold there is a difficulty in warming them again; whilst if the room is well ventilated by perflation after the class has separated, thoroughly cleaned up at once, as it ought to be, and the heating apparatus kept on at a lower temperature, the room need never get quite cold. The children, under such circumstances, are comfortable as soon as they enter the room on a cold winter morning, instead of shivering and being quite unable to take in the teacher's meaning, as is too often now the case.

It should be hardly necessary to state that temperature must be the only guide as to whether it is necessary to commence heating the school. Also it is important to bear in mind that after the Christmas holidays the rooms should be opened, aired, and warmed several days before they are required.

Comparison of the Various Systems of Heating.

The following summary is given by Carnelley in his report to the Dundee School Board :—

Open Fires.

Advantages.

(1) More cheerful.

(2) First cost much less than hot-pipe systems.

(3) Keeps air fresher than hot pipes, owing to draft up chimney.

(4) So far as the Dundee schools are concerned, the temperature in the open fire schools was higher than those heated by other systems.

(5) The rooms of these schools will probably need painting less frequently than those heated by other systems.

Disadvantages.

(1) Greater labour in service.

(2) Slightly greater annual cost than stoves or steam-pipes or large hot-water pipes.

(3) Unequal distribution of heat.

(4) Air more highly charged with micro-organisms.

Stoves.

Advantages.

(1) Smallest first cost.

(2) Least annual cost.

(3) Probably more effective heaters than open fires.

Disadvantages.

(1) Greater labour in service.

(2) Require more attention than open fires.

(3) More liable to smoke than open fires.

(4) More liable to get out of repair than open fires.

Hot Pipes.

Advantages.

(1) Less labour in service than either open fires or stoves.

(2) The class is not disturbed as in the case of mending open fires and stoves.

(3) More equal distribution of heat.

(4) Air less charged with micro-organisms than when open fires are used.

(5) On the whole the annual cost is probably *slightly* less than with open fires, but more than with stoves.

Disadvantages.

(1) Not so cheerful as open fires.
(2) First cost much more than in the case of open fires or stoves.
(3) Air not so fresh as with open fires.

Comparison of Hot-pipe Schools.

(1) Small high-pressure pipes are cheaper in first cost than large low-pressure pipes.
(2) In those schools examined the air was better in rooms heated by small high-pressure pipes than in those heated by large low-pressure pipes.
(3) It takes longer to get up the heat with large than with small pipes.
(4) Small pipes are less obtrusive in rooms.

CHAPTER V.

VENTILATION.

"One of the most important subjects connected with health at school is that which deals with overcrowding. '*Too many children in the school*' is the impression which is upon the mind of every lover of fresh air as soon as he sets foot in a school the pupils of which have been assembled for an hour or two and have remained in the room all the time. One seldom goes into any school in the middle of working-time, especially in cold weather, without being struck with the fact that the air is too impure for perfect health. The impurity arises from overcrowding connected with a want of ventilation. These two subjects are mixed up very much together; one school with a hundred boys or girls in it may have a much purer air than another of the same size with only fifty, because in the one case the products of respiration are rapidly removed, and in the other in a great measure retained. The question of floor space is an important one, but not nearly so important as that of ventilation."—(*Carpenter.*) It is important to remember that the question of floor space or cubic space per head in no way affects the question of the quantity of fresh air per hour that it is necessary to provide. The effect of a large area of floor space is simply to delay the time when the air would become poisonous. Cubic as well as floor space is a delusion in various ways; one room ten feet high will ventilate better than another fifteen or even twenty, because in the one case the windows are carried up to the ceiling, and in the other there is seven or eight feet of wall between the top of the window and the ceiling itself. The age of the children will be a factor in the case, though not so great as is often represented; for a child of six or seven requires nearly as much fresh air as one double that age.

THE ATMOSPHERE.

Ordinary fresh air has the following percentage composition:—

Nitrogen (including Argon 1%)	79
Oxygen	20·96
Carbon Dioxide	·04
	100·00

There are also variable quantities of water vapour, organic matter, ozone, oxides of nitrogen and sulphur, and sulphuretted hydrogen in the air; the first substance being usually present, and the others in air under certain conditions only. There are also suspended particles in the air, composed of inorganic and organic materials, and various bacteria.

Expired Air.

Air that is breathed out of the lungs differs materially from ordinary air in its composition. Its percentage composition may be represented thus:—

Nitrogen (with Argon)	79
Oxygen	16
Carbon Dioxide ..	4·4
	99·4

This shows that expired air has less oxygen and more carbon dioxide than inspired air. It also is saturated with water vapour, is warmer, and contains a considerable quantity of organic impurities. This organic matter is usually regarded as the most injurious of the impurities produced by respiration, although some recent investigations are said to negative this statement. There is at present no reasonable ground to consider that the injurious effects of bad ventilation are not due to the organic constituents of expired air.

School Air.

The air in a schoolroom therefore will differ from ordinary air in many particulars which may be thus enumerated:—

(1) There will be more than ·04 per cent. of carbon dioxide present in the air. Most of this excess of carbon dioxide will have been produced by respiration, but part may have been evolved as a product of the combustion of coal, coal gas, or lamps.

(2) Organic matter from the lungs and skin will be present. This is probably the chief source of the offensive odour so obvious to anyone entering a badly ventilated room from the outer air.

(3) There will be a decrease in the amount of oxygen, resulting in a lowering of the vitality.

(4) A large increase in the quantity of water vapour will take place. This causes discomfort and interferes with the proper evaporation of moisture from the surfaces of the body.

(5) The temperature is higher. This increases the discomfort caused by the excess of water vapour in the air.

(6) Decomposition of organic matters upon the clothing

and the skin often occurs in schools, especially in poor districts, giving rise to offensive odours.

(7) An increase in the amount of dust, or suspended impurity, is common in schools. These particles of dust are of the most varied composition, some of the commonest being scales of skin, hair, fragments of wool, cotton, silk, soot, and common salt, and include many forms of bacterial life, and there may be disease germs present. Dust, of itself, is injurious, and for this reason the use of crayons, which adds considerably to the quantity of dust, is not to be recommended.

(8) There may be some special gaseous impurities present, such as carbon monoxide from coal gas, and oxides of sulphur, and other gases from the combustion of coal gas.

Carbon Dioxide.

The most constant of all these impurities is the carbon dioxide, and, as the estimation of the quantity of the gas is comparatively easy, it is usual to test the sufficiency or otherwise of ventilation by determining the percentage of this gas that is present. The method of estimation does not concern us here, but a simple test of the purity of the air is as follows:—Take a stoppered bottle with a capacity of 10½ oz. Fill it with the air to be tested by pumping through it by means of foot-bellows. Add ½ oz. of clear limewater, put in the stopper, and shake up. If the limewater is turned milky there is an excess of carbon dioxide present. This gives a very rough and ready test only. Systematic examinations of the air of schools at all times of the day by the Education Medical Officer should be regarded as essential; it is only by such tests that the ventilation of any school can be regarded as sufficient or otherwise.

One of the simpler but fairly exact methods of ascertaining the amount of carbon dioxide in the air in a school is by the use of Scurfield's apparatus. This consists of a cylindrical aspirator holding two pints of water, and a rack carrying seven tubes which are filled to a given height with a weak baryta solution coloured pink by phenolphthalein. One tube is connected to the aspirator for each estimation. The aspirator is furnished with a vertical gauge divided into tenths, each division representing 0·1 of the cubical contents of the aspirator.

To use it the aspirator is filled with water, and connected with one of the tubes. Then the air is drawn through the baryta solution until the pink colour disappears. The amount of air required to do this is measured by the aspirator. If the experiment is made first in the open air and repeated in the different rooms of the school it is obvious that strictly comparative results will be obtained. In the school there will be more carbon dioxide present and a proportionally smaller quantity of air will be necessary to remove the colour from the liquid. Assuming that the outside air contains ·04 per cent. of carbon dioxide, it is easy to calculate from the results of these experiments the amount of carbon dioxide in the air that has been tested.

Permissible quantity of Carbon Dioxide.

The amount of carbon dioxide in fresh air remains fairly constant at about ·04 per cent. Any excess over this amount is regarded as an impurity. Thus, if a sample of air was found to contain ·07 per cent. of carbon dioxide we should say that there was an impurity of ·03 per cent. of tne gas. An impurity of ·02 per cent. is usually regarded as harmless, although a room containing this amount of impurity due to respiration smells slightly close

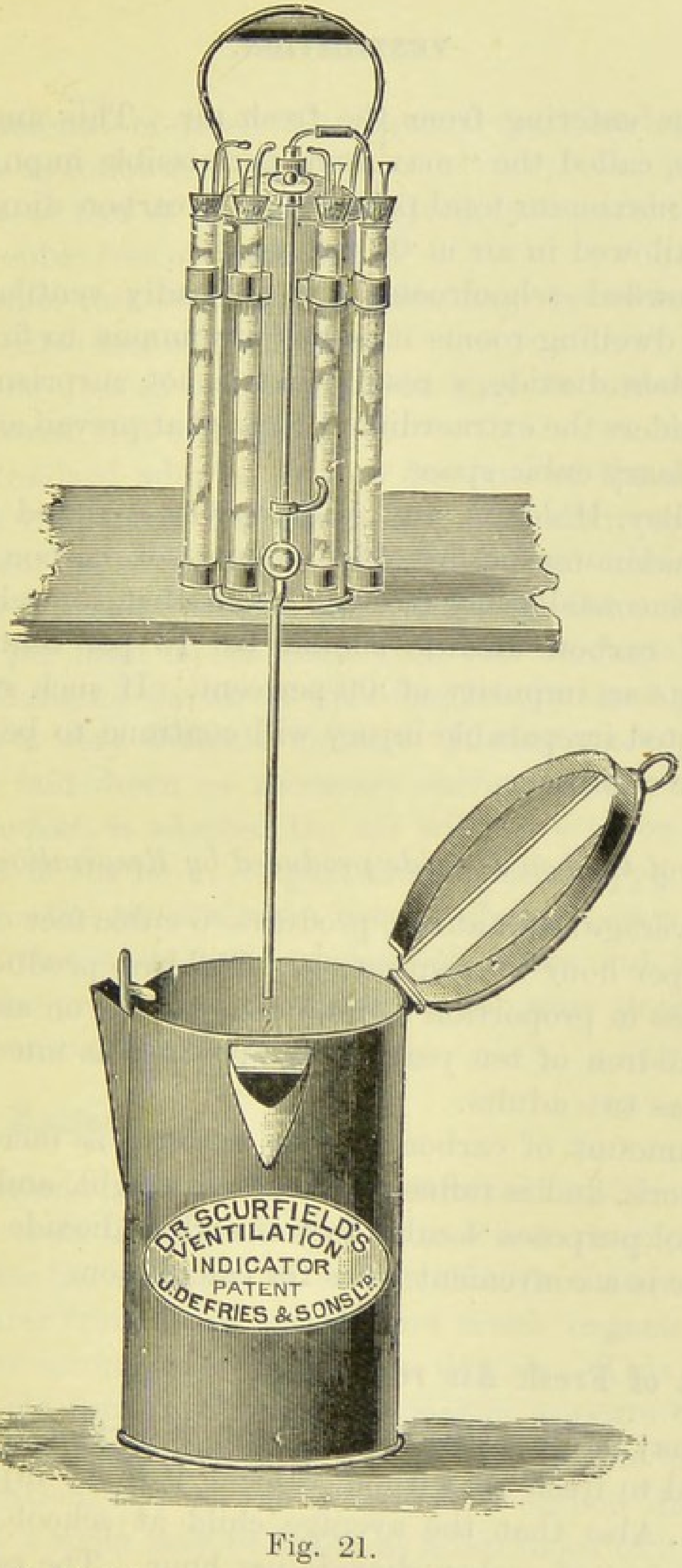

Fig. 21.

Dr. Scurfield's Apparatus for determining the amount of Carbon Dioxide in the Air in a Room.

to anyone entering from the fresh air. This amount is, therefore, called the "maximum permissible impurity," so that the maximum total percentage of carbon dioxide that may be allowed in air is ·06 per cent.

In crowded schoolrooms and in badly ventilated and crowded dwelling-rooms it is not uncommon to find ·3 per cent. carbon dioxide, a result that is not surprising when one considers the extraordinary ideas that prevail as regards the necessary cubic space.

Carnelley, Haldane, and Anderson have stated that the above maximum permissible amount of carbon dioxide should be considerably increased, and that for schools the limit of carbon dioxide should be ·13 per cent., which represents an impurity of ·09 per cent. If such standards are adopted irreparable injury will continue to be inflicted upon the children.

Amount of Carbon Dioxide produced by Respiration.

The average adult at rest produces ·6 cubic feet of carbon dioxide per hour by respiration. Children produce larger quantities in proportion to their weight, and on an average three children of ten years of age produce as much carbon dioxide as two adults.

The amount of carbon dioxide expired is increased by active work, and is influenced by diet, weight, and sex, but for school purposes ·4 cubic feet of carbon dioxide per head per hour is a convenient basis for calculation.

Amount of Fresh Air required.

We may assume that ·02 per cent. of carbon dioxide can be added to fresh air without causing it to be injurious to health. Also that the average child at school produces ·4 cubic feet of carbon dioxide per hour. The calculation of the amount of fresh air required per head per hour proceeds as follows:—

·02 cubic feet of carbon dioxide may be added to 100 cubic feet of fresh air;

∴ ·04 cubic feet of carbon dioxide may be added to 200 cubic feet of fresh air;

∴ ·4 cubic feet of carbon dioxide may be added to 2000 cubic feet of fresh air.

The standard adopted by law in some of the American States is 1800 cubic feet per hour. The above calculation shows that there should be supplied 2000 cubic feet of fresh air for each scholar per hour. If the cubic space allowed per head is 100 cubic feet, this amounts to completely changing the air of the room twenty times per hour, which is a very difficult matter. If the space per head which is laid down as necessary earlier in this book, viz. 200 cubic feet, is adopted the air will have to be changed ten times in the hour. Apart from special appliances for ventilation the air in a room usually changes once an hour through the walls and crevices of doors and windows, leaving the problem at changing the air nine times in the hour, or once every seven minutes.

Organic Matter.

The organic impurity in air is estimated with much more difficulty than the carbon dioxide, and it is therefore usual to estimate the quantity of carbon dioxide that is present, and to infer from these results how much organic matter must have accompanied the carbon dioxide. This is generally reliable because the organic matter appears to be an invariable accompaniment of the carbon dioxide produced by respiration, and so the quantity of carbon dioxide in the air of a room may be taken as a fair index of its purity.

The *detection* of the organic matter is comparatively simple. If a large amount of the air is drawn through some distilled water the organic impurities are retained by the water, and, if kept a short time, quickly decompose and evolve a very offensive smell. Or the air may be drawn through strong sulphuric acid, which chars the organic matter and becomes brown. Still another method is to draw the air through water rendered pink by acidified permanganate of potash. Organic matter soon removes the bright pink colour.

Effects of Bad Ventilation.

Living in a badly ventilated room for a few hours produces drowsiness and headache, a sense of oppression and discomfort, slowing of the heart's action, and quickening of respiration, and interferes greatly with the efficiency of the teacher and the scholars. The power of concentration on the part of the scholars is also greatly decreased. Unfortunately the evil does not stop here. A lowering of the vitality results, and there is an increased tendency to contract diseases of all kinds. Under such conditions consumption very often occurs, and infectious diseases, when once started, spread very rapidly. Anaemia, loss of appetite, and impairment of nutrition commonly result from bad ventilation. A striking illustration of the relationship between foul air and consumption is given by the following statistics contained in the report of the Army Sanitary Commission. Foot Guards had been allowed 331 cubic feet of space per man in their barracks, and the death-rate from consumption among them amounted to 13·8 per 1000; while the Horse Guards, with a cubic space of 572 feet per man, showed a mortality of only 7·3 per 1000. On increasing the cubic space per head there was a very marked diminution of the mortality from all causes. Under the greatly improved conditions the death-rate from consumption in the Army at the present time is slightly below that of the male civil population at the same age, whereas fifty years ago it was in notable excess of that amount. The frequent occurrence of the disease in animals kept in confinement serves as another illustration of the relationship that undoubtedly exists between consumption and the breathing of a vitiated atmosphere.

Hamer says, "The evidence which has accumulated in recent years as to the dissemination of certain diseases, particularly diphtheria, scarlet fever, and measles, in school class-rooms, is quite conclusive as to the risk incurred by bringing together a number of children within a confined space, unless the most thorough precautionary measures are undertaken with a view to the detection and exclusion of sufferers from the maladies referred to." As a matter of fact the absolute exclusion of every one of these cases is not possible at present, and probably never will be. But the risk of contagion would be greatly decreased if the ventilation of our schools were brought up to a higher standard. Improved ventilation would not only effect this by simple dilution, but would also result in an improved physical condition of the children, so that they would not be so liable to contract any disease. Shutting up children in badly ventilated rooms brings about a bodily condition which offers little or no resistance to invasion by the micro-organisms of disease.

Extreme cases, such as are illustrated by the incident of the Black Hole of Calcutta, show that when the products of respiration are breathed in a concentrated condition rapid poisoning results. At Calcutta 146 persons were imprisoned in a room about 18 feet square, and with only two small windows. In the morning there were 123 dead and, of the 23 who were living, several afterwards died of putrid fever, the effects of the organic poison they had inhaled. A similar catastrophe befell the steerage passengers of the *Londonderry* who, in 1848, were shut down in the cabin during a storm. Among those who recovered from the immediate ill-effects many suffered from fever and mal-nutrition. Such extreme cases are not likely to occur in schools and are mentioned simply in order to illustrate the fact that we have to deal with a poisonous pollution of the air.

Methods of Ventilation.

The efficient ventilation of schools is undoubtedly one of the most important problems of the hour. In a great number of the older schools the question of ventilation does not appear to have been considered in any way, while in the more modern ones elaborate installations have been fixed at a great cost without any corresponding satisfaction.

The methods of ventilation may be divided into two kinds—the natural and the artificial. By **natural ventilation** we mean any method that depends upon the natural forces which set air in motion, and does not involve the use of any mechanical means for the renewal of the air. **Artificial ventilation**, on the other hand, depends upon the use of pumps, fans, bellows, etc.

NATURAL VENTILATION.

Two properties of gases play a very important part in the theory of ventilation; these are (1) diffusion, and (2) changes in the density of the air produced by heat.

Diffusion is the property of gases to mix thoroughly and completely even against gravity, *i.e.* a heavy gas will diffuse upwards and completely mix with a lighter gas, and a light gas will diffuse downwards and mix with a heavier one, For instance, if in Fig. 22 the upper jar is filled with coal gas, which is a light gas, and the lower jar with air, which is a comparatively heavy one, then, on removing the plates between them and allowing them to diffuse about half an hour, the lower jar will be found to contain just as much coal gas as the upper jar, and both may be lighted. Of course, if the heavy gas is placed above the light one, the mixing will take place more rapidly. The same result would be obtained, after a longer time, if a partition of some porous substance, such as unglazed earthenware, were placed between the jars. It is found that the lighter a gas is the faster it diffuses, and that if a light gas is on one side of a porous partition and a heavier gas on the other, then the light gas will diffuse through into the heavy one faster than the heavy gas will diffuse into the light one.

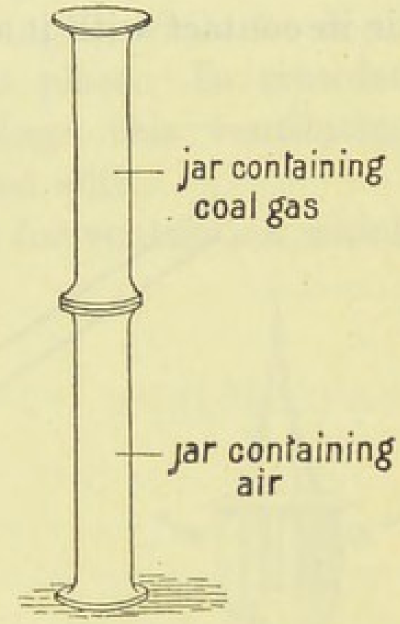

Fig. 22.
DIFFUSION.

Now in an ordinary room the air is warmer and, as we shall see, lighter than the cold air outside. Diffusion outwards, therefore, will take place at a greater rate than diffusion inwards, and fresh air will enter the room not only as the result of this process of diffusion, but also in order to equalise the pressure inside and outside the room. Diffusion through the walls of a room is greatly interfered with by the paper, plaster, and paint with which the walls are covered. As an example of the power of diffusion as a ventilating force it is said that in the case of a cubical room with brick walls, contents 3000 cubic feet, and difference of temperature between the inside and outside air being 35° Fahr., the air would be completely changed in one hour by diffusion alone.

Changes in Density of Air.

When air is heated it expands. For this reason a pint of cold air will weigh heavier than a pint of hot air. Hot air therefore rises and cold air will take its place. This is exactly how **winds** are produced. The surface of part of the earth becomes heated by the sun; this warms the air in contact with it and causes it to expand and rise; the

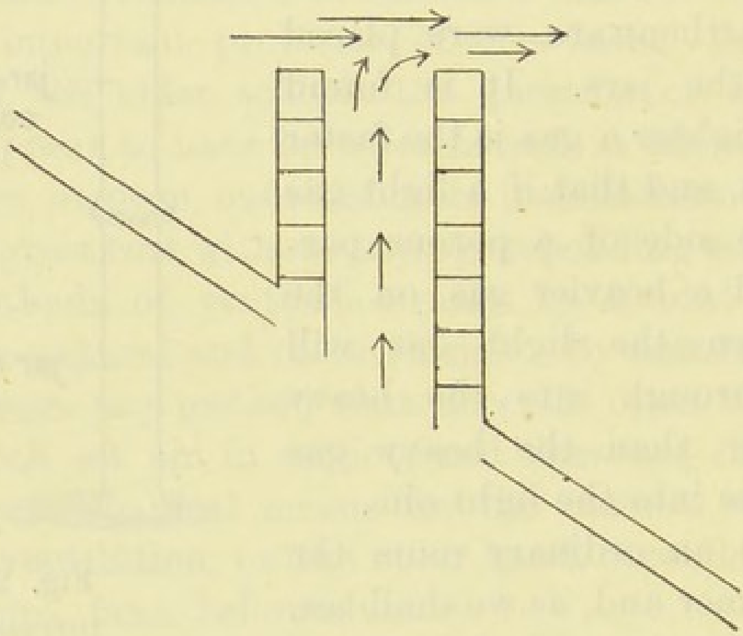

Fig. 23.

Aspirating Effect of Chimney.

colder surrounding air then rushes in to take its place and a wind is produced.

The application of this to ventilation is easy. Foul air —being a product of respiration and combustion—is always hotter than the fresh air, and so it will rise, and if an opening is provided, it will escape. Fresh air will then enter through any opening to take its place. For the same reason the hot air over a fire goes up the chimney, and is replaced by fresh and colder air entering by windows, door, keyholes, and cracks.

Wind, as a ventilating agent, may act in two ways :—

(1) By perflation, *i.e.* by blowing through a room when the doors and windows are open.

(2) By aspiration. This is illustrated by the draught up a chimney when there is no fire below. The wind blowing over the top of the chimney lessens the pressure of air in the chimney, producing an up-draught, while fresh air is drawn into the room to take its place. In crowded courts surrounded by higher buildings this ventilating action of the wind is greatly interfered with.

There are a number of appliances for ventilation which make use of this aspirating effect of the wind. Boyle's ventilators and Banner's cowls are two forms which are widely used.

Boyle's *Air-pump Ventilator* has fixed openings on different sides. (See Fig. 24.) The wind, blowing from almost any direction, passes through some of the openings and out of the opposite ones. In doing so, air is extracted from the tube or air-exit over which the ventilator is placed.

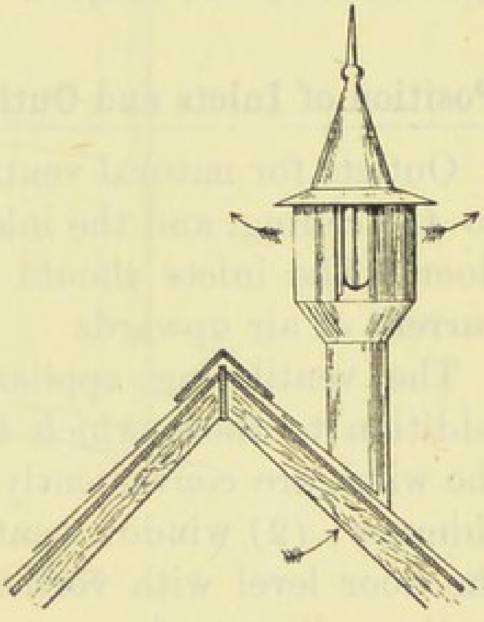

Fig. 24.

Boyle's Air Pump Ventilator.

Banner's Cowl sets itself, by means of a wind vane, so that the opening is always directed to face the wind.

OPENINGS FOR VENTILATION.

Outlets for foul air and inlets for fresh air must both be provided. It is a common practice to provide the outlet only and to make no provision for the entrance of fresh air. In order to provide the necessary 2000 cubic feet of fresh air per hour an opening of 16 square inches must be provided, assuming the air to enter the room at an average velocity of 5 feet per second. An outlet of the same or larger size is necessary. In a class-room for 48 scholars the inlets should therefore have a minimum total area of $5\frac{1}{3}$ square feet and the outlets the same or rather more. The ventilation inlet opening recommended by the Board of Education is certainly inadequate, and betrays an entire ignorance of the subject.

Position of Inlets and Outlets.

Outlets for natural ventilation are usually provided close to the ceiling, and the inlets at about five feet above the floor. The inlets should be so arranged as to direct the current of air upwards.

The ventilating appliances for natural ventilation, in addition to those which take advantage of the action of the wind, are conveniently divided in four groups, (1) the chimney; (2) window ventilation; (3) openings at or near the floor level with vertical tubes or shafts; (4) openings in the wall or roof.

The Chimney.

The chimney, if present, acts as an excellent and most efficient outlet. If a fire is burning in the grate the action is to rush air out of the room at a great rate, and when there is no fire the chimney is still a valuable outlet.

Window Ventilation.

(*a*) The simplest and most obvious method of ventilation is that of open windows; and in warm weather it is undoubtedly the best. In cold weather, however, it is very liable to produce draughts.

(*b*) The upper part of the window can be made to work

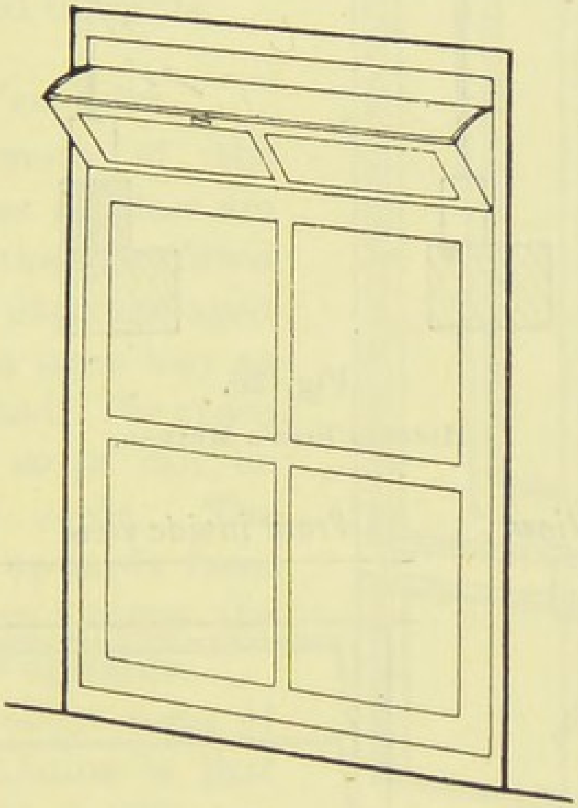

Fig. 25.

Hinged Top to Window.

on a hinge so that the top moves into the room. Triangular pieces of glass or wood should be placed at the sides to prevent down draught. The current of fresh air will then be directed upwards, as is the case with all efficient ventilators. Similar hopper openings can be arranged 6 feet from the floor and may act as inlets or outlets.

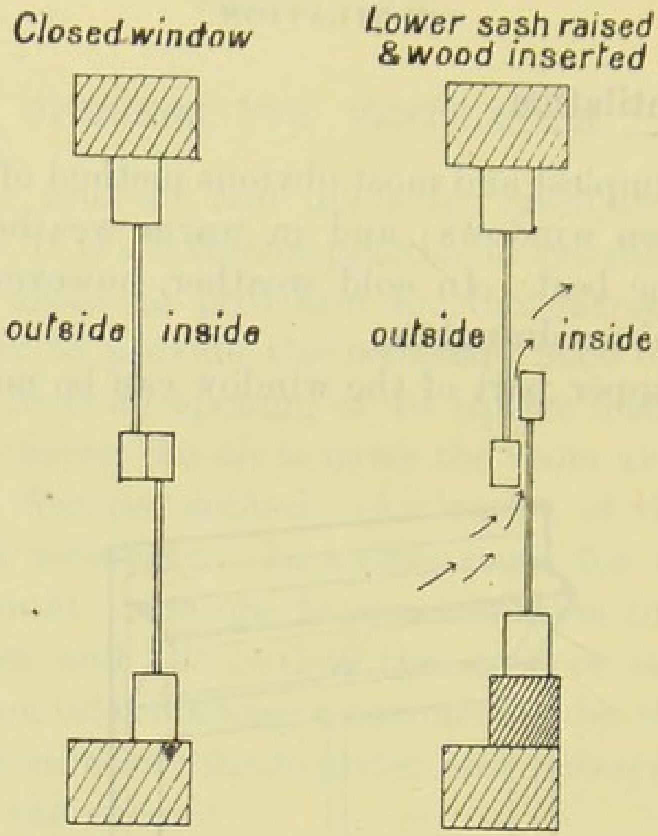

Fig. 26.

HINCKES BIRD'S METHOD.

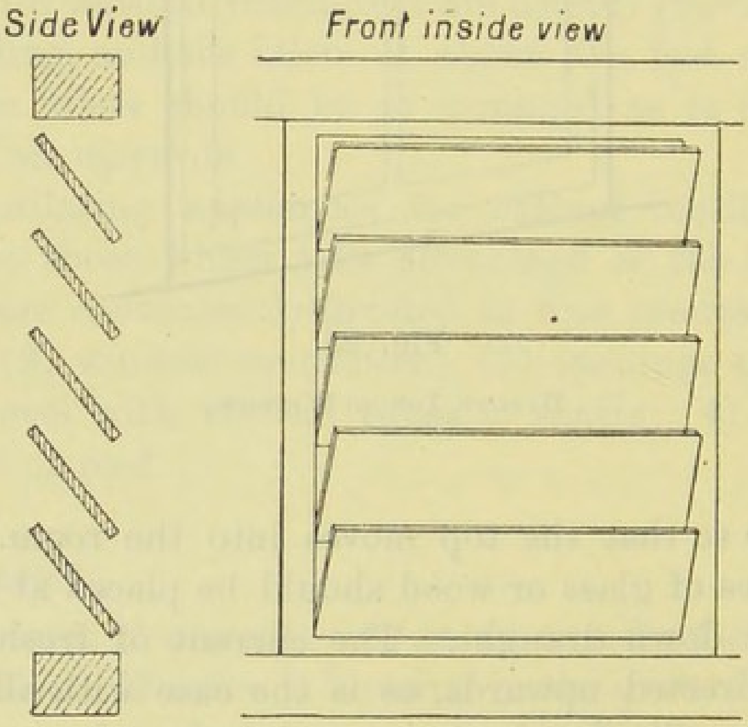

Fig. 27.

LOUVRE VENTILATOR.

(*c*) A very simple and excellent method of window ventilation is that suggested by **Hinckes Bird**. The lower sash is raised, and a block of wood is accurately fitted in the opening below so as to completely close it. Fresh air enters between the two sashes and is directed upwards.

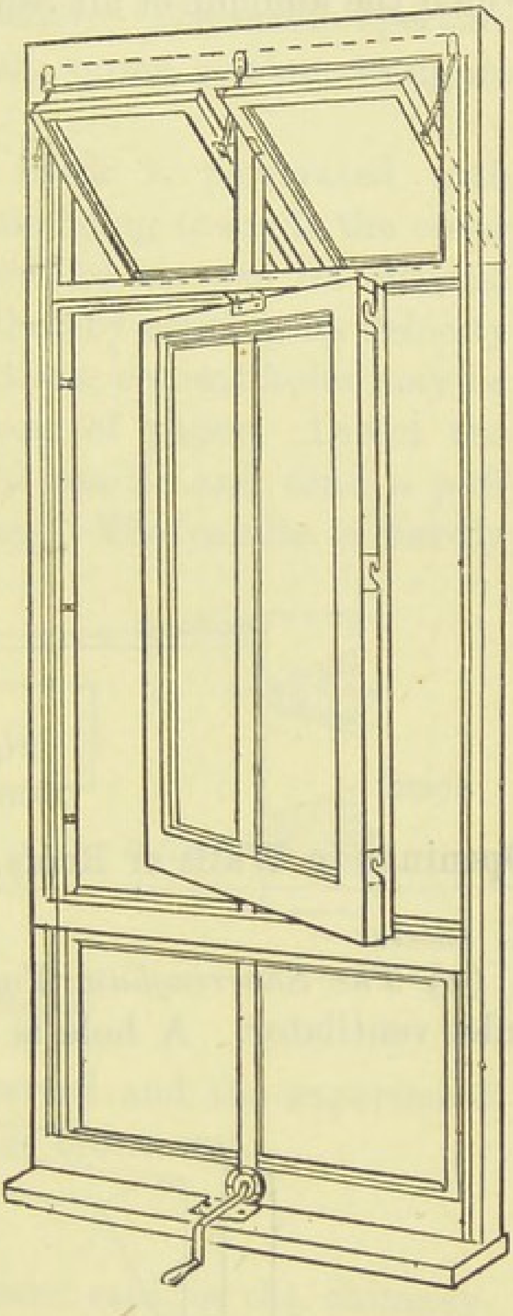

Fig. 28.
THE CHADDOCK WINDOW.

(*d*) *Louvre Ventilator.*

One or more of the ordinary panes of glass are removed and the space fitted with strips of glass arranged in exactly the same way as a Venetian blind. The space between the strips can be adjusted by cords. The strips slant upwards from the outside, and direct the current of air upwards.

(*e*) An excellent form of window ventilation is that of the Chaddock Window (Fig. 28). The ease of manipulation is remarkable, and the results obtained are extremely satisfactory.

Openings near Floor with Vertical Shafts:—

Tobin's Tubes. The air enters from the outside through an opening in the wall at the floor level; it is then directed upwards by the vertical shaft or tube about six feet high.

At the top the tube is fitted with a valve by means of which the amount of air coming in may be regulated.

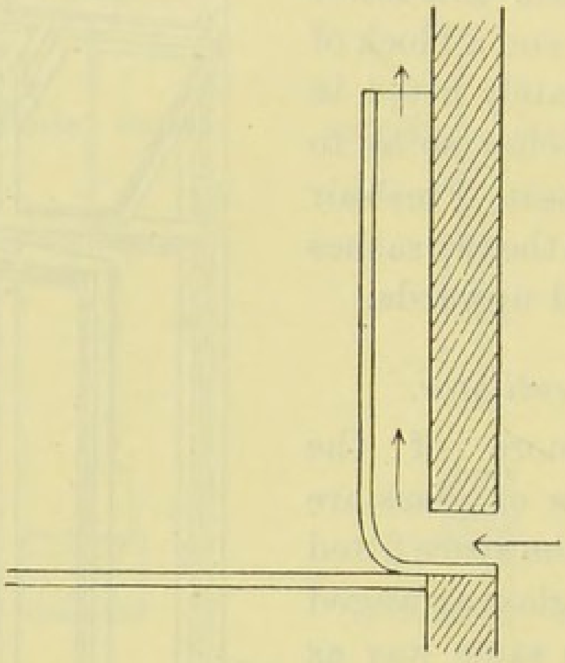

Fig. 29.
Tobin's Tube.

Openings in Walls or Roofs.

I. *Inlets:—*

(*a*) *The Sherringham Valve* is a simple and a very good inlet ventilator. A hole is made in the wall about seven

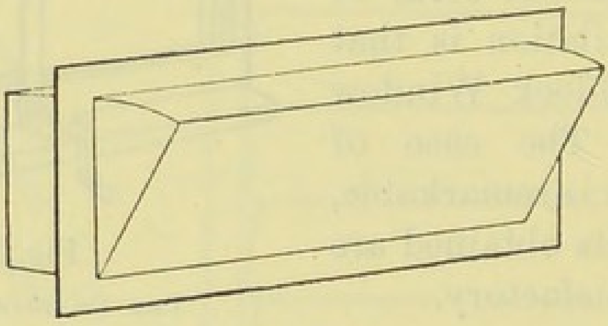

Fig. 30.
Sherringham Valve.

or eight feet from the floor. Into this is fitted an iron box, with a grating on the outside and a hopper valve on the inside. The air passes from the outside through the grating and into the room through the valve, the size of which may be regulated by a pulley. The inside aperture of the ventilator is larger than the outer, so that draughts are not usually produced.

(*b*) *Ellison's Bricks.* Each brick is perforated with conical holes, the apex of the cone being towards the outer air, so that the incoming current of air has its channel continuously increased in size, thereby causing its velocity to be decreased. The action of these conical holes may be very simply illustrated by a cone of paper. Direct the large opening towards a lighted candle and send a puff of breath down the small opening. The candle is hardly

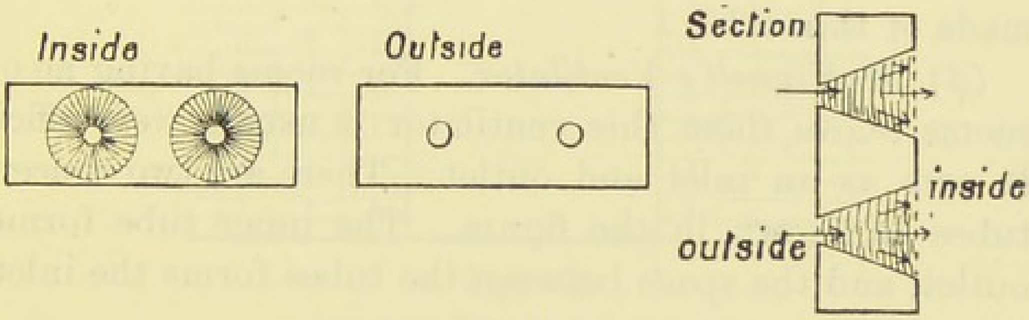

Fig. 31.

Ellison's Air Bricks.

affected. If the cone is now reversed and the experiment repeated the candle will at once be blown out.

II. *Outlets* :—

(*a*) The chief outlet, as we have said, is the **chimney**. When a fire is burning, from 5,000 to 25,000 cubic feet of air pass up the chimney per hour.

(*b*) *Arnott's Valve* is an outlet made to be fixed in the wall so as to open into the chimney. It consists of an iron box with a light metal valve capable of swinging towards the chimney, but not into the room. The foul air can therefore pass up the chimney, but the smoke cannot pass into the room. An objectionable feature of these ventilators is the clicking noise they make. Also, when in any way out of order, they admit smoke from the chimney. Fig. 32 shows an improved method. The outlet shaft is built alongside the chimney shaft and acts as an efficient outlet.

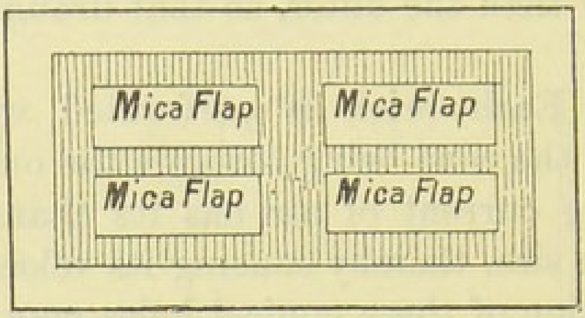

Fig. 32.
BOYLE'S MICA FLAP VENTILATOR.

(*c*) *Boyle's Mica Flap Ventilator* is simply an improvement upon Arnott's valve. Instead of one valve there are four or more small ones made of thin talc.

(*d*) *McKinnell's Ventilator.* For rooms having no other rooms above them this ventilator is usually very efficient. It acts as an inlet and outlet. There are two concentric tubes as shown in the figure. The inner tube forms an outlet, and the space between the tubes forms the inlet.

Value of Natural Ventilation.

It is necessary to preface any remarks upon the subject with the statement that attempts to ventilate schools by natural ventilation are usually of the most crude and elementary description. When a building is to be ventilated by artificial means very careful calculations are made, and the whole system is fully planned and thought out from beginning to end; but with natural ventilation little or no trouble is taken, and there is usually no systematic attempt to deal with the difficulty. If the same serious efforts were devoted towards effecting efficient ventilation by natural means as are always given to the provision and maintenance of artificial ventilation, it is at all events possible that much more satisfactory results would be obtained.

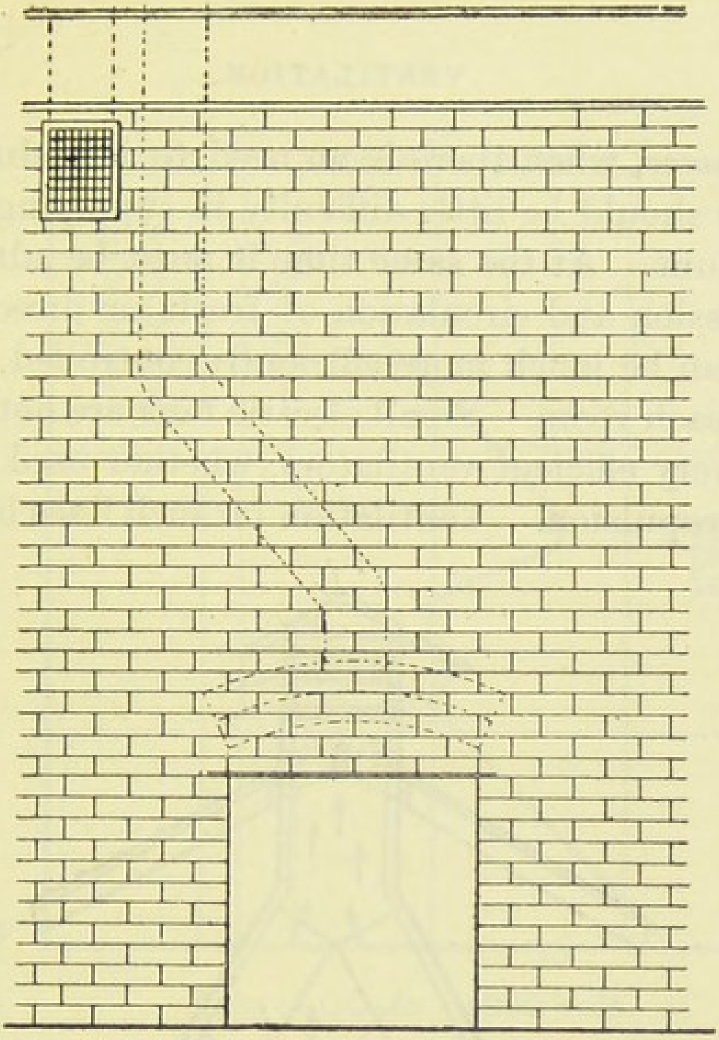

Fig. 33.
CHIMNEY BREAST AIR OUTLET.

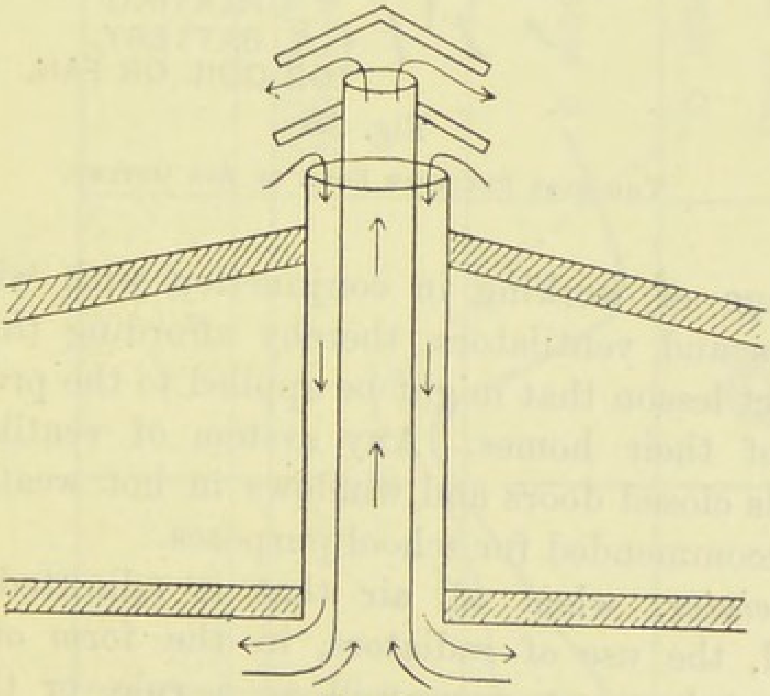

Fig. 34.
McKINNELL'S VENTILATOR.

In summer, when there is no need to introduce warmed air, there should be little difficulty in supplying the necessary amount. At the same time it must be admitted that the admission and circulation of fresh air direct from the outside can be much more efficiently controlled by separate fans for each room. Small electric fans are not very costly and are very efficient ventilators, whether used for extraction or propulsion. Ventilation on such lines has the great

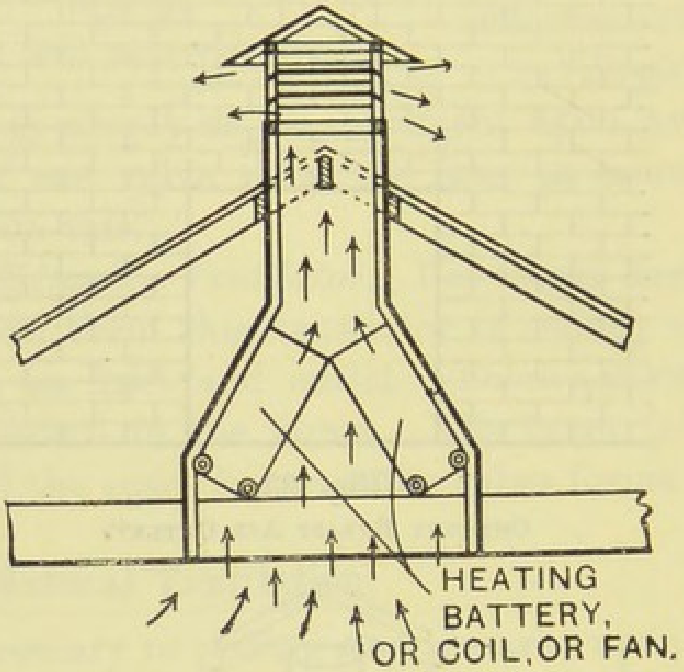

Fig. 35.

The most Reliable Form of Air Outlet.

advantage of working in conjunction with widely open windows and ventilators, thereby affording the children an object lesson that might be applied to the proper ventilation of their homes. Any system of ventilation that demands closed doors and windows in hot weather is not to be recommended for school purposes.

In winter, when all air that is admitted must be warmed, the use of radiators, in the form of modified Tobin's tubes, act very well as a rule, or the various

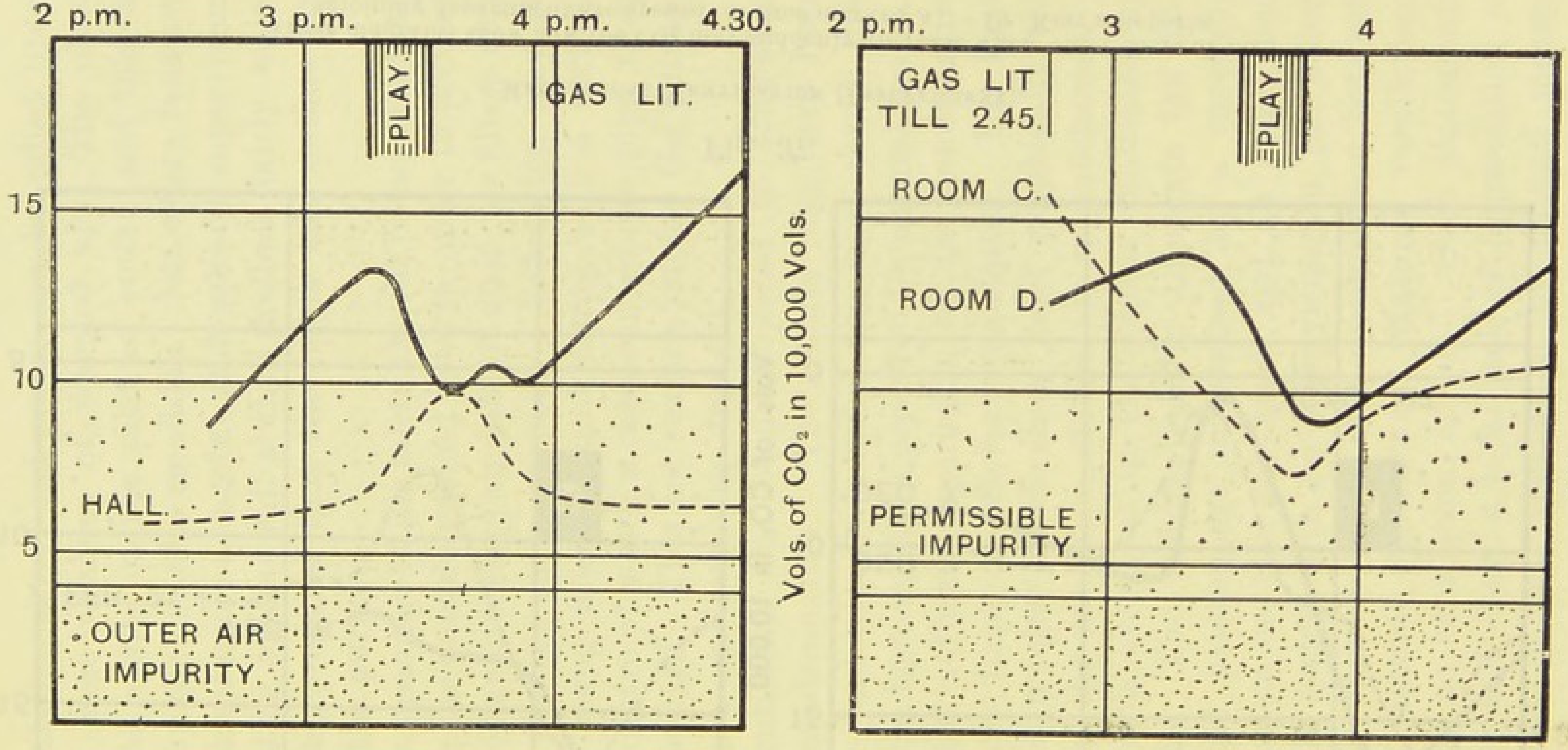

Fig. 36.

Natural Ventilation.

These diagrams show the variation in the CO_2 due to perflation during recess.
Also effect of gas lights.—Dr. Kerr's Reports.

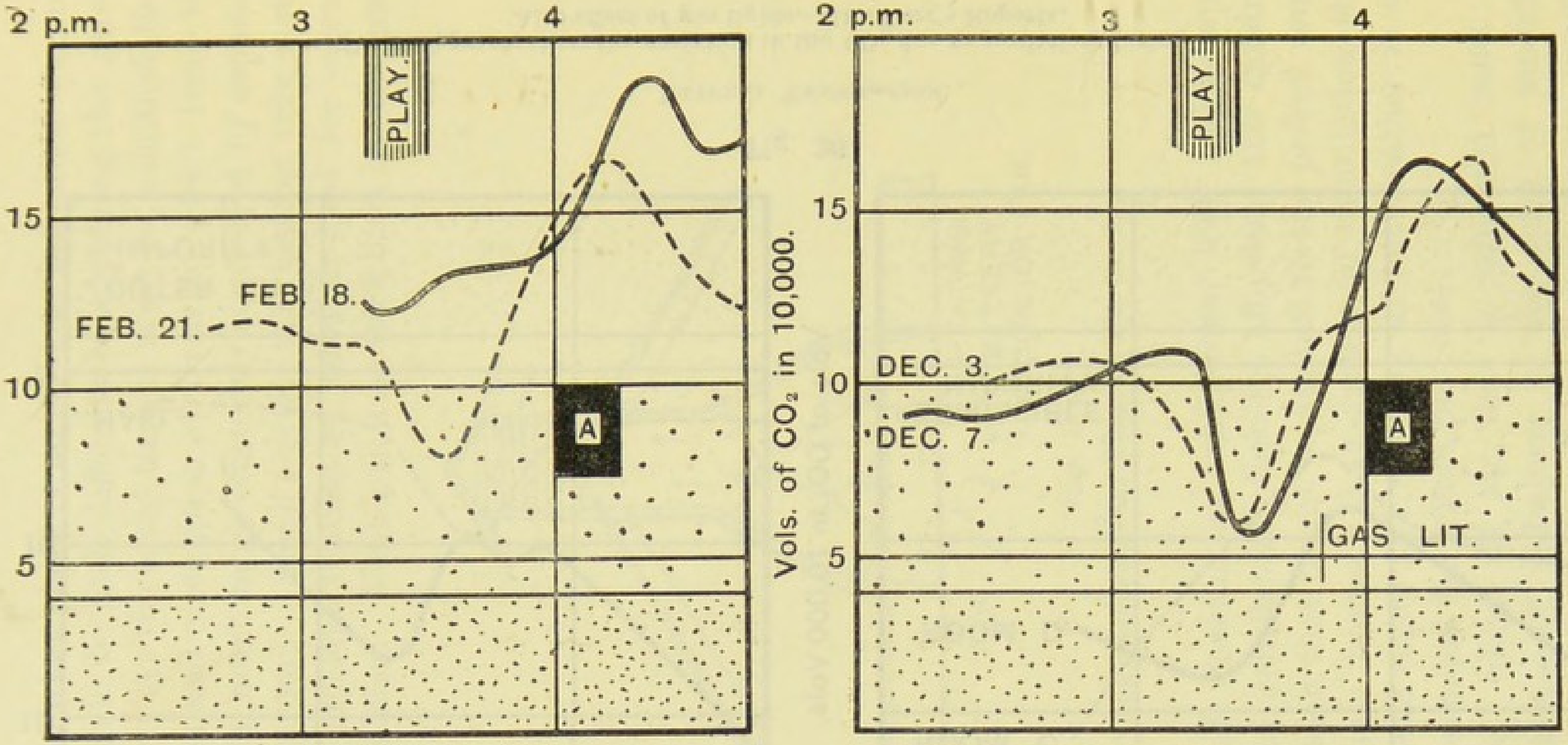

Fig. 37.

MECHANICAL VENTILATION (INSUFFICIENT).

These diagrams show how the CO_2 may suddenly increase when outer doors of an adjoining department are opened (at time marked A).—Dr. Kerr's Reports.

forms of ventilating stoves and grates can be relied upon to introduce large volumes of warmed air. The chief difficulty is the *control* of the inlet or outlet, and this is best secured by the use of a small fan; but where fans are too costly or impossible a careful and serious supervision of the ventilating scheme will always produce fairly satisfactory results, provided that the inlets and outlets are sufficient for the purpose.

The outside openings of air inlets should be not less than six feet above the outside ground level in order to prevent the entrance of an excessive amount of dust; or filters may be arranged for the same purpose. Extraction may be controlled by using flues communicating with a vertical shaft, in the centre of which a cast-iron smoke pipe, from the furnace, is fixed. This hot surface rarefies the vitiated air and causes a continuous up-draught.

Natural ventilation has been subjected to somewhat exaggerated condemnation. The results that have been obtained have undoubtedly merited the most severe disapproval; these have not been produced by natural ventilation, but, in the author's experience, by an almost entire absence of any form of efficient ventilators. Dr. Kerr has published results which show most graphically the superiority in the condition of the air in mechanically ventilated schools over that in the schools ventilated by natural means. The results possibly illustrate the difference in the atmosphere maintained by a carefully supervised system on the one hand, and an ill-planned and inadequate system with no supervision on the other. In Dr. Kerr's opinion "there is no comparison between artificial and natural ventilation. Natural ventilation, in fact, means no ventilation at all." Such statements are deplorable and show a total lack of appreciation of the possibilities of real ventilation by natural means.

Dr. Reid's experiments with the Staffordshire type of school show conclusively that excellent ventilation may be achieved by natural means, and experiments carried out by the author serve to show that if intelligent supervision is exercised over these methods the results are as good as those obtained by mechanical means, while the educational effect is greatly superior. On the other hand, Dr. Kerr admits that "the artificial systems mean that doors and windows must be shut, and that alone gives a feeling of 'closed-in-ness' to the people who work in the room."

ARTIFICIAL VENTILATION.

The methods of artificial ventilation depend either upon one of the following processes, or upon the two combined:—

1. Extraction processes, or vacuum methods, in which the vitiated air is forced out of the room, and fresh air enters mainly through inlets provided.
2. Propulsion processes, or plenum methods, in which the fresh air is forced into the room, and the foul air escapes through the usual outlets.

A combination of the two systems is usually advisable, but where one only is adopted the propulsion process is usually regarded as preferable, because the air can then be obtained from a known inlet, and can be warmed, filtered, and otherwise treated before it enters the rooms. If extraction is employed the sources of fresh air cannot be controlled so easily as in the case of propulsion, but it is possible that this method may be found eventually to be the more satisfactory.

Fans.

Fans are usually relied upon in all systems for the artificial ventilation of schools. The open-blade types of fan are preferable, as they are easily kept in order and are economical. An electric fan ten feet in diameter, running at ninety revolutions per minute, and delivering 2,115,000 cubic feet of air per hour is used in the Bradford schools, and costs the astonishingly small sum of 1·3 pence per hour.

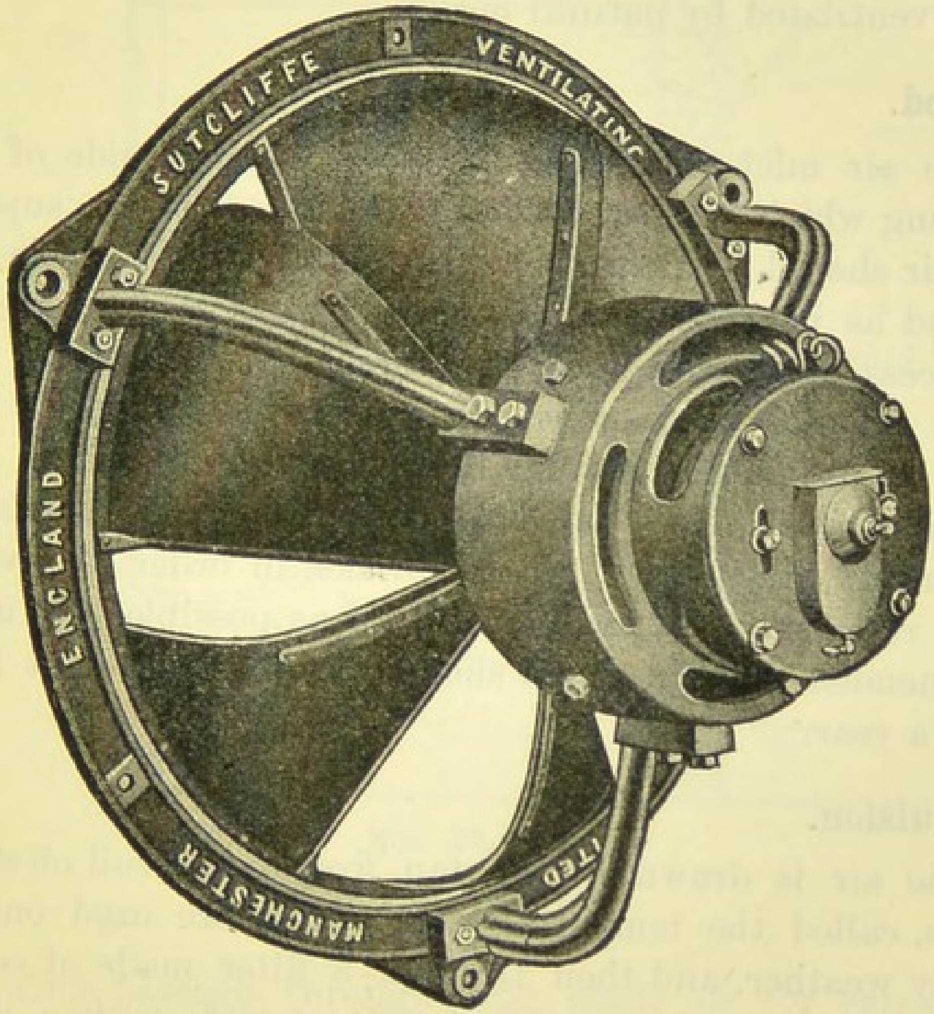

Fig. 38.

COMBINED FAN AND MOTOR.

Fans may be driven by electric motors, by steam, or by a gas engine. Electricity should always be used where possible, as it possesses the combined advantages of being cheap, noiseless, and inodorous.

Cost.

The cost of fuel in schools ventilated by mechanical means should be less than in schools which rely upon natural methods. In Bradford the cost for fuel per ten square feet floor space is slightly over tenpence in mechanically ventilated schools, and nearly elevenpence halfpenny in those ventilated by natural means.

Method.

The air inlet should be arranged on that side of the building which is most likely to yield the purest supply. The air should be drawn from a point as high above the ground as possible. It should be of ample size, greatly in excess of its theoretical requirements. The main air-ducts should be very large, and not less than six feet high, in order that regular and thorough inspection may be maintained. They must be made with smooth surfaces; preferably lined with glazed bricks, in order to give as little resistance to the inflowing air as possible. It is recommended that the ducts should be limewashed at least once a year.

Propulsion.

The air is drawn by the fan first over a coil of steam pipes, called the tempering coil, which are used only in frosty weather, and then through a filter made of coarse jute cloth, or other satisfactory material, with a water spray attached. A layer of coke between wire netting makes a satisfactory filter. Cheese cloth screens have also proved to be very efficient. The use of the water spray in warm weather probably makes the air too humid. It is necessary when the air is being warmed, and additional moisture should be supplied. The current of air then passes through the fan and along the main duct, from which it enters the branch ducts which lead to the different parts of the building. At the entrances of branch ducts additional steam coils may be placed if it is desirable to keep one part of the building at a higher temperature than the rest, or to afford increased heat to provide for

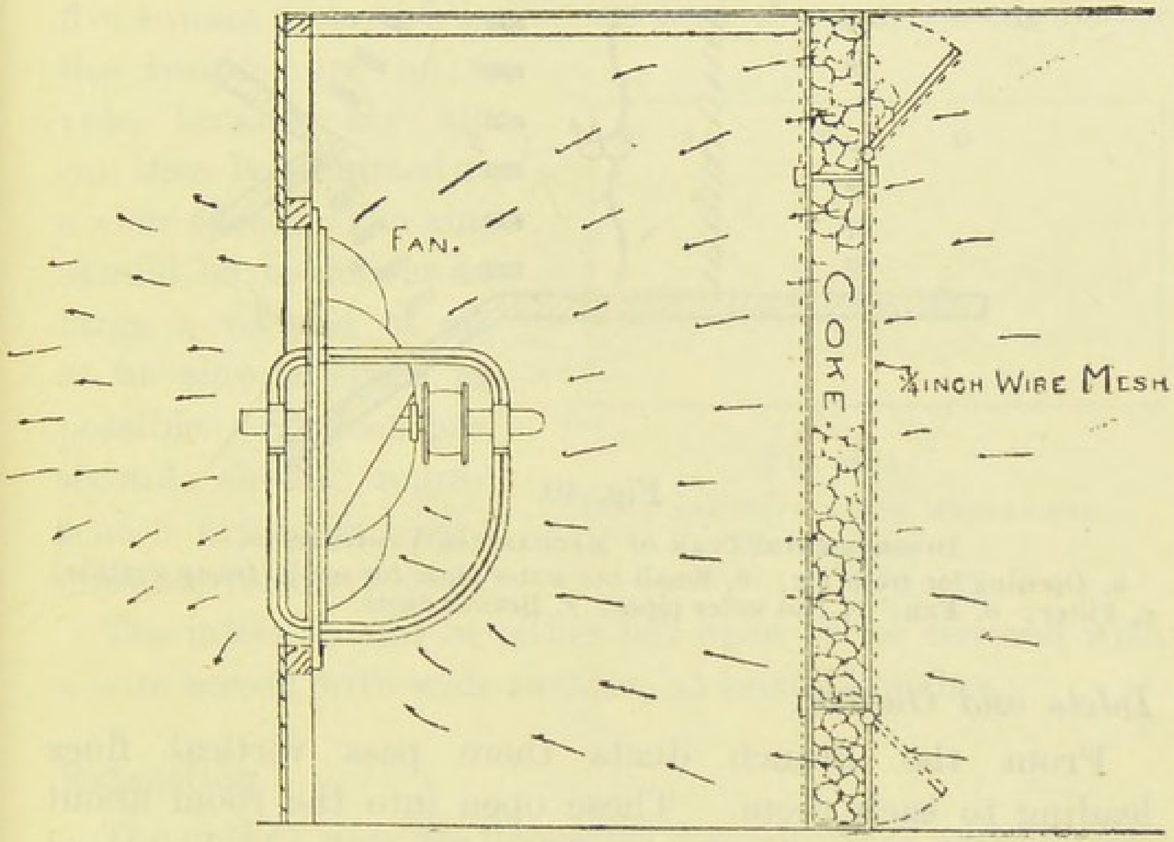

Fig. 39.

FAN AND COKE FILTER.

loss during passage through long ducts or for exposed rooms.

Source of Heat.

It is important to avoid the use of excessively hot pipes. A maximum limit of 228° F., equal to a pressure of 5 lbs. on the boiler, should be adopted. If higher temperatures are used, the air becomes "burnt" or "dead," and loses its "vitality." Possibly a great deal of the feeling of oppression that many people experience in mechanically ventilated buildings is due to this cause.

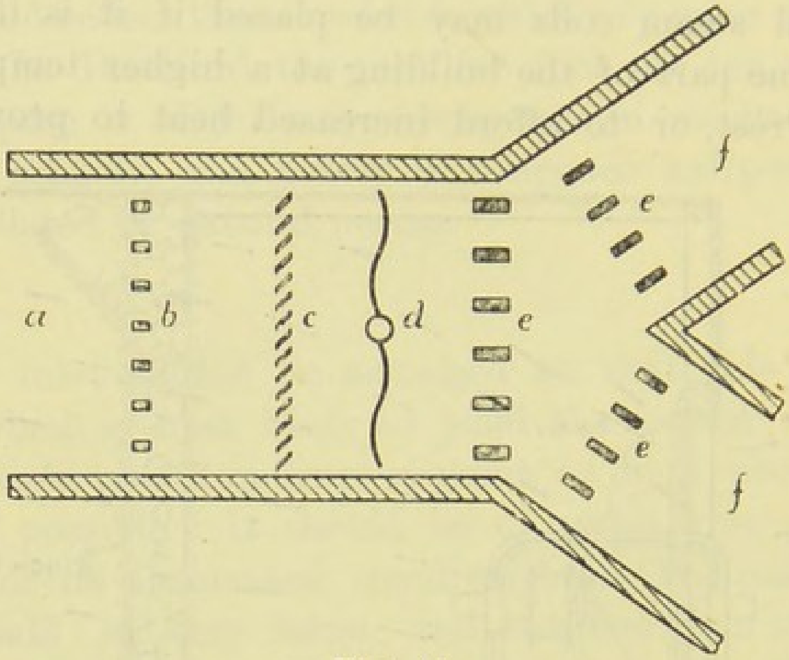

Fig. 40.

Diagrammatic Plan of Mechanical Ventilation.

a, Opening for fresh air; *b*, Small hot water pipes for use in frosty weather; *c*, Filter; *d*, Fan; *e*, Hot water pipes; *f*, Branch ducts.

Inlets and Outlets.

From the branch ducts there pass vertical flues leading to each room. These open into the room about eight feet above the floor. The outlet should be placed on the same wall, quite close to the floor. These positions for the inlet and outlet respectively are the outcome of a series of experiments made with a view of determining the respective positions for the inlet and outlet which would result in the most complete change in the air of the room. All other positions for the inlet and outlet were found to leave almost unchanged the layer of air, four feet deep, that rests on the floor. This layer is, of course, the air which is of the greatest importance, as the scholars live in it. The above arrangement not only produces a better distribution of the fresh air, but is more economical in the working, as there is a greater amount of heat extracted from the air before it is finally discharged.

The inlet should be as large as possible: it is an advantage to arrange several inlets along the same wall, and the same number of outlets below. The total area of inlet for a room 30 feet by 25 feet should not be less than five square feet; the larger the area of openings the better the results are as a rule, because the air can then be admitted at a slow speed. The aim should be to deliver as large a volume of air at as slow a speed as possible. Six feet per second should represent a maximum permissible velocity.

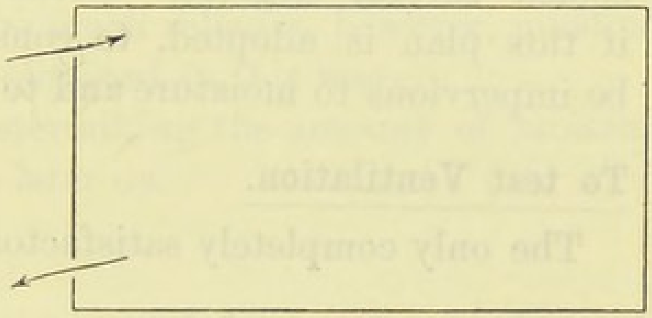

Fig. 40A.
INLET AND OUTLET FOR MECHANICAL VENTILATION.

The inlets should be either left open or be covered with a wire screen with wide meshes, at least 1½ inches.

Extraction.

The outlets near the floor level communicate with the foul air duct which, in its turn, communicates with a vertical upcast shaft. The vertical shaft should be of very large sectional area and, as a rule, some assistance is necessary in order to secure a strong up-draught here. The methods that may be adopted for this purpose include—

(1) A fan fixed near the top of the vertical shaft. This is by far the best arrangment, as the whole system is then duplicated to a certain extent, so that, if the plenum fan breaks down, the other can still carry on a certain amount of ventilation. Another important advantage is that the amount of extraction can be regulated.

(2) A central cast-iron pipe bearing hot waste gases from the furnace.

(3) Lighted gas jets or steam jets at the bottom of the shaft.

Cool Air in Summer.

If the fresh air duct is carried underneath the basement the air supplied during the hot weather will be cooled several degrees. Great care should be taken, if this plan is adopted, to construct the duct so as to be impervious to moisture and to ground air.

To test Ventilation.

The only completely satisfactory test is to analyse the

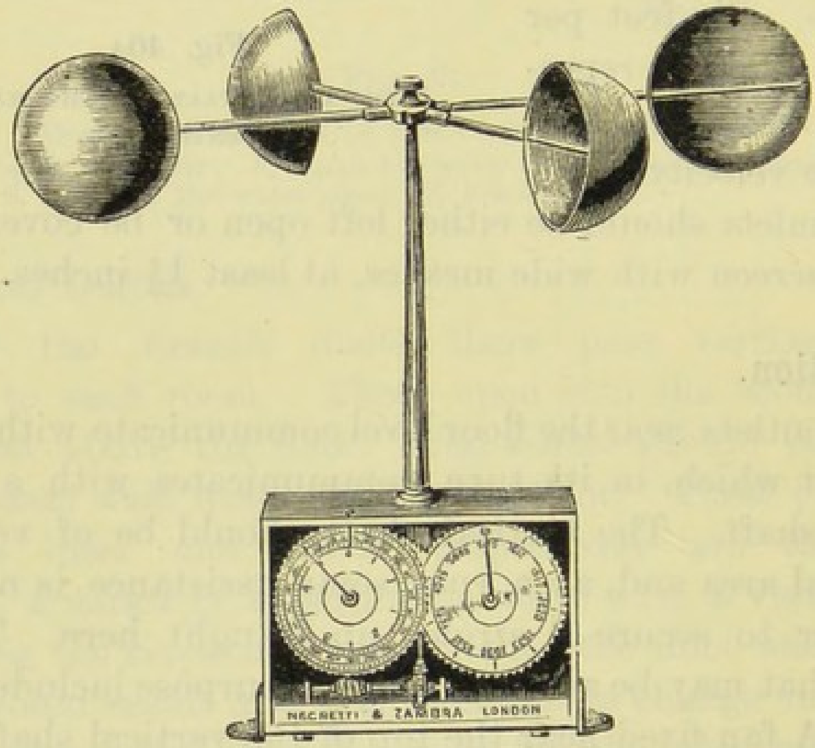

Fig. 41.
ANEMOMETER.

air in the rooms at short intervals throughout the day. Another method is to measure by an anemometer the speed of the incoming fresh air as it passes the inlet, estimate from this and the area of the inlet the volume of air that is entering per minute, and compare this with the necessary amount, which is, as we have said above, 30 cubic feet per scholar. The anemometer is placed in the aperture of the inlet, about two-fifths of the distance between the centre and the margin, and the delicate blades are driven by the current of air. These turn an axis with an endless screw running on small toothed wheels which record the results on the dial. Too much reliance, however, must not be placed upon results obtained in this way.

The importance of determining the amount of moisture in the air is referred to later on.

Town Schools.

The method usually advocated for town schools is the one already described, *i.e.* a combination of extraction with propulsion. This, if properly planned and intelligently supervised, gives excellent results, but suffers from the serious disadvantage of necessitating closed windows for its efficient working. In winter, before entering the room, the air may be warmed to the extent necessary to keep the room at the desired temperature, or, as is often advisable, it is simply introduced at the desired temperature, and the warmth of the room is maintained by coils or radiators placed along the walls of the room. This separate method for heating and ventilating has the advantage of making it possible to maintain the temperature of the school, through the night in winter, without keeping up the ventilation as well—a very economical arrangement.

Large Village Schools.

The cost of any mechanical system is usually too great for these schools. Many of them are heated by hot-water pipes under the high or the low pressure system, and some plan should be adopted, such as ventilating radiators, whereby warm air can be admitted. Additional pipes to warm the room should be available for very cold weather. Ventilating grates and stoves may also be adopted in such cases. Attention should be directed to the adequate provision of outlets, which, in order to be under some control, may be connected with a main vertical shaft fitted with some appliance for heating and causing a continuous current of air. In summer some system of natural ventilation, preferably by windows, should be carefully arranged.

Rural Schools.

Some form of ventilating stoves or grates is necessary in winter. Stoves are often used. Willoughby recommends a form which is much used in Canadian schools. It can be arranged to introduce fresh warm air and also to aid extraction. The opening for the purpose of supplying the stove with fuel should be as narrow as possible. The fresh air passes from the outside along the duct beneath the floor into the space between the stove and its sheet-iron jacket, where it is warmed, and then into the room. The space between the jacket and the stove should be at least eighteen inches.

On the opposite side of the room a tin extraction duct should be constructed with its open end about one foot above the floor. Cross section dimensions of 12 × 6 inches are recommended, but for large rooms there should be two such ducts. The duct passes up vertically, then bends and passes horizontally along the ceiling, and communicates with a large flue, in the centre of which the stove pipe is fixed. The heat of the pipe causes this flue to act as an extraction force. For summer use there should be ample ventilation possible by doors, windows, or special ventilation openings.

WATER VAPOUR.

Evaporation is constantly going on from the surface of water and from moist earth, but the rate is continually varying. At the same time large quantities of water vapour are being poured into the air by the respiration of animals and many cases of combustion.

If the temperature were kept fixed, a limit would soon be reached and the air would then be incapable of receiving any more water vapour, and no more evaporation would go on from the surface of water. When the air at any given temperature contains as much water vapour as it can hold it is said to be *saturated*, and while it is capable of holding more it is *unsaturated*. The warmer the air the greater is the amount of water vapour that it can hold. If, therefore, the temperature of a certain quantity of saturated air be raised it ceases to be saturated and becomes unsaturated, because it is now capable of taking up more water vapour. On the other hand, if the temperature of a given volume of saturated air is lowered it becomes incapable of holding so much water, therefore some of it appears in the form of rain or dew. If some unsaturated air is cooled sufficiently a temperature is eventually reached at which the amount of moisture is sufficient to make the air saturated. This temperature is called the "**dew point.**" If the air is now still further cooled a deposit of dew takes place. This is easily illustrated by placing a flask filled with cold water in a hot room. It soon becomes covered with a deposit of dew.

When air is close to its saturation point it is said to be moist, and when far from saturated it is called dry air. As a rule the atmosphere contains from 1 to 1½ per cent. of water vapour. The amount of water vapour present in the air is not usually expressed as a percentage, *i.e.* the number of grains of water contained in 100 grains of air. It is more usually expressed in terms of the "**relative humidity**," which gives far more useful information than the simple percentage does. Relative humidity may be defined as:—

The amount of—

$$\frac{\text{water vapour actually present in a given volume of air}}{\text{water vapour that would be present if the air were saturated}} \times 100.$$

This is best illustrated by actual figures. The following table shows roughly the number of grains of water that will saturate a cubic foot of air at the given temperatures:

2 grains	at 30° F.	8½ grains	at 72° F.
3 ,,	,, 41° F.	9 ,,	,, 74° F.
3½ ,,	,, 45° F.	9½ ,,	,, 75·5° F.
4 ,,	,, 49° F.	10 ,,	,, 77° F.
4½ ,,	,, 53° F.	10½ ,,	,, 78·5° F.
5 ,,	,, 56° F.	11 ,,	,, 80° F.
5½ ,,	,, 59° F.	11½ ,,	,, 81·5° F.
6 ,,	,, 61° F.	12 ,,	,, 83° F.
6½ ,,	,, 64° F.	12½ ,,	,, 84·5° F.
7 ,,	,, 66° F.	13 ,,	,, 86° F.
7½ ,,	,, 68° F.	13½ ,,	,, 87° F.
8 ,,	,, 70° F.	14 ,,	,, 88° F.

Thus if air at 49° F. contained 4 grains of water per cubic foot it would be saturated, or its relative humidity would be

$$\tfrac{4}{4} \times 100 = 100 \text{ degrees of humidity.}$$

Again, if air at 70° F. contained 4 grains of water per cubic foot it has only four grains out of a possible eight, and the relative humidity would be

$$\tfrac{4}{8} \times 100 = 50 \text{ degrees.}$$

If this air cooled down to 40° F. it would become saturated, because the 4 grains of water are all that it can hold now, so that 49° would be the dew point.

The sensations of moisture and dryness of the air depend entirely upon the relative humidity and not upon the actual quantity of water vapour that may be present; so that there may be a far greater quantity of water in the air on a hot dry summer's day than on a cold damp winter's day.

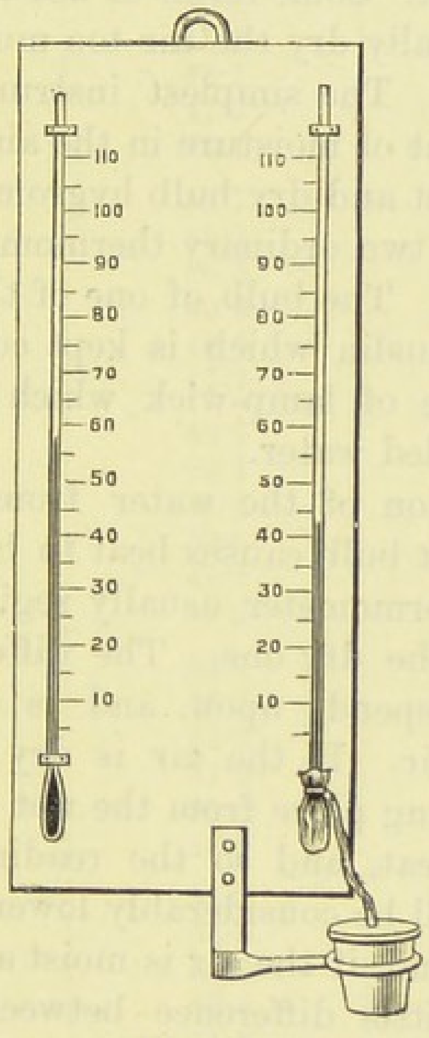

Fig. 42.

WET AND DRY BULB HYGROMETER.

With moderate temperatures the most agreeable degree of humidity is between 65 and 75 degrees. Excessive humidity of the air is undoubtedly depressing and enervating.

A hot moist atmosphere is particularly unpleasant, while very high temperatures may be borne without discomfort if the air is dry. A low degree of humidity appears to suit persons suffering from the early stages of phthisis, and their removal to such a climate is often attended by most satisfactory results.

The humidity of the air in a school should be between 55 and 60 per cent. Some forms of heating appliances, such as hot pipes, usually dry the air too much, and so vapour must be added. The simplest instrument by means of which the amount of moisture in the air can be determined is called the "wet and dry bulb hygrometer." The instrument consists of two ordinary thermometers fixed side by side on a frame. The bulb of one of the thermometers is covered with muslin which is kept constantly moist by means of a piece of lamp-wick which dips into a vessel containing distilled water.

The evaporation of the water from the muslin surrounding the wet bulb causes heat to be absorbed, and so the wet-bulb thermometer usually registers a lower temperature than the dry one. The difference between the two readings depends upon, and is a measure of, the dryness of the air. If the air is dry there will be rapid evaporation taking place from the wet bulb, causing rapid absorption of heat, and so the reading of the wet-bulb thermometer will be considerably lower than the dry one. On the other hand, if the air is moist and nearly saturated there will be little difference between the two, because evaporation takes place very slowly under these conditions. If the air is saturated there will be no evaporation and the readings will be the same.

The instrument should be hung in the room in a situation where there are not likely to be draughts or direct sunlight. The readings of the two thermometers should be noted, and the relative humidity of the air calculated from the following tables (Newsholme).

Reading of dry bulb.	Reading of wet bulb.	Relative humidity.
56	51·8	75
	50·8	70
	49·8	65
	48·7	60
	47·7	55
	46·1	50
57	52·7	75
	51·7	70
	50·3	65
	49·6	60
	48·6	55
	47·7	50
58	53·7	75
	52·7	70
	51·6	65
	50·6	60
	49·5	55
	48·2	50
59	54·7	75
	53·7	70
	52·2	65
	51·5	60
	50·5	55
	48·9	50
60	55·7	75
	54·6	70
	53·6	65
	52·5	60
	51·4	55
	49·8	50

If the relative humidity is never to fall below 55 per cent. the wet bulb must not differ from the dry bulb by more than 9° F.

An examination of the table on p. 98 shows that by raising the temperature of air by about 19° F. its capacity to absorb moisture is doubled, *i.e.* its relative humidity is halved. This is an effect that is frequently produced in schools without any attempt to remedy the evil. Hot dry air causes rapid evaporation from the skin and makes it dry and rough. It also probably has an injurious effect upon the mucous membrane of the throat and pharynx and may lead to or aggravate catarrh. If the children lived in the dry air altogether the ill effects would not be so obvious or would disappear, but the fact that they are exposed every day to three very different degrees of humidity and temperature is certain to have a bad effect upon the mucous membrane of the throat and, possibly, the bronchi. The three degrees of humidity exist respectively in the home, the outside air, and the school. The average humidity of the air in this country is about 75 per cent. ; in winter it is often 80 per cent. or more. In the school it is a matter of common experience to find the humidity as low as 25 per cent. This excessive dryness of the air not only produces the injurious effects described above, but also may actually cause chills by the rapid evaporation from the skin that takes place in it, particularly when the body is exposed to a current of such air. A humidity of 50 per cent. should be regarded as the minimum. On the other hand too great a humidity is enervating and depressing, so that a humidity above 65 per cent. is undesirable. It is important to bear in mind that the question of supplying sufficient moisture is most important in those schools where ventilation is most thoroughly carried out. In badly ventilated schools the air is laden with moisture produced by respiration.

The Supply of Moisture.

In those buildings which are heated by radiators or hot pipes the most satisfactory plan is to place porous clay vessels upon the radiators or pipes. The vessels should cover the top of the radiator entirely; and it should be the duty of someone to see that they always contain water.

Hot-air furnaces are often provided with a vessel for water, the evaporation from which is supposed to increase the humidity of the air sufficiently. As a rule, however, such means are found to be totally insufficient for the purpose, and are only likely to work well when the vessel is very large and is kept filled by some automatic arrangement.

An escape of steam from the radiator is occasionally adopted, but unfortunately it produces a limited area of excessive dampness.

The adoption of porous vessels seems to give the most satisfactory results, as the number can be increased or decreased until the wet and dry bulb hygrometer indicates a humidity between 50 and 65 per cent.

CHAPTER VI.

SANITARY APPLIANCES.

Water Supply.

The bountiful supply of pure water is now a popular demand and, in most districts in this country, it is met. The school, in all urban districts, must share the general water supply, but in rural districts it may be necessary to arrange for its own water supply either by the sinking of a well, or by providing for the collection and storage of rain-water. In all cases the supply should be carefully examined. If it comes from shallow wells or springs there should be no suspicion of pollution by drains or cesspools. After the vacations such wells should be inspected, and the water pumped out just before the opening of the schools. It is advisable for all country schools to possess a private deep or "Artesian" well, because shallow wells are so liable to pollution.

If the water supplied is not altogether satisfactory it should be filtered. The only satisfactory filters are the Berkfeld and the Pasteur-Chamberland varieties.

Where it is necessary to store water that is to be used for drinking purposes a separate cistern must always be used for this purpose, and such cistern should have no connection with the water-closet.

A plentiful supply of pure drinking water must always be accessible in schools and playgrounds. Children require a frequent drink of water, and their health suffers if such is not available. In playgrounds a drinking fountain is best. These are so constructed that a small steady stream issues from an upright pipe for about three inches. The scholar drinks by receiving this stream in his mouth. Any form of continuous fountain is superior to the use of drinking cups in common, which are often the means of spreading such diseases as diphtheria. In country schools where there is no public water supply such fountains are impossible, and a tank or keg must be provided, from which the water may be drawn by a tap.

Cisterns.

In those cases where cisterns are necessary they must fulfil the following conditions:—

1. *Material.* The best material is either galvanised iron or slate with cement joints. Neither of these impart any injurious quality to the water. Lead cisterns are durable but dangerous, owing to metallic contamination.

2. *Position.* A cistern should be shielded from the sun's rays, but must be in an easily accessible position, so that it is readily inspected and cleaned. Covering and ventilation should be provided.

3. *Fittings.* The overflow pipe must be carried through the nearest outside wall, where it should be cut short. It must on no account communicate with any drain or soil pipe. The supply pipe for the water-closet must not pass direct from the cistern, a smaller cistern for this purpose being necessary.

School Drains.

The drains for schools do not differ essentially from those of any large building for public or residential purposes. Before any pipes are laid the whole system of drainage should be mapped out from beginning to end.

The whole length of the trenches should be dug and covered with concrete to a depth of four inches. Earthenware pipes should be used; they should be well glazed and free from flaws or cracks. Six-inch pipes, laid with a fall of 1 in 60 are

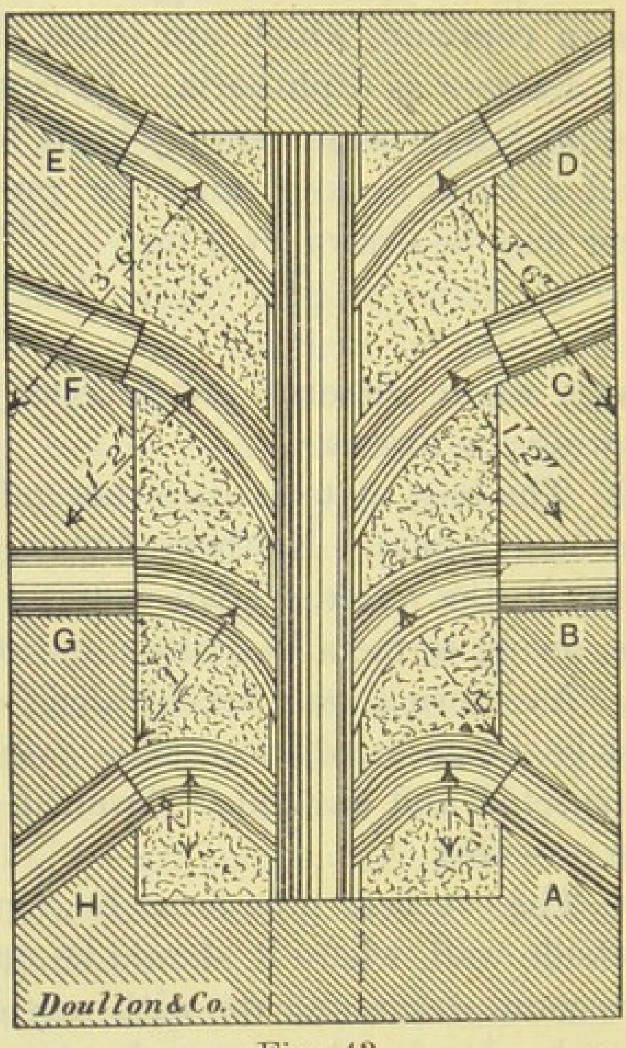

Fig. 43.

INSPECTION CHAMBER.

A, Rain-water; B, Butler's pantry; C, Housemaid's closet; D and E, Soil pipes from water-closet; F, Waste water from bath; G, Waste from kitchen sink; H, Rain-water pipe. The pipes at exposed part are half cylinders only. *N.B.*—Letters only refer to proposed positions, which may be varied according to plans of architect.

usually the best for ordinary use, but some of the branches, leading from single water-closets or gullies, may be made with four-inch pipes and have a fall of 1 in 40. All drains should be laid as straight as possible. If it is necessary to alter the direction of the drain a proper bent pipe should be used. Branches should join the main drain at acute angles and by means of junction pipes. Old-fashioned drains nearly always effect a junction as quickly as possible, so that these points of union are scattered about and are difficult to locate. The modern plan is to make all junctions as near together as possible, at some convenient spot, where an inspection chamber is built. This is a small chamber built of brickwork set in cement. The drain and its tributaries meet in this chamber, being continued along the floor in the form of half-pipes set in concrete. A man entering the inspection chamber will therefore be able to tell at a glance whether there is any deposit at the junction. The chamber itself is easily cleared and rods can be passed up the different branches.

Joints.

Particular attention should be given to making good joints. The usual method is to soak a piece of yarn in some fluid cement, and to ram this well into the joint all round so as to about half fill it. The joint should then be filled up with stiff cement. Only the best Portland cement should be used.

Traps.

A trap is a contrivance which is placed in the course

Fig. 44.
SIMPLE BEND.

of pipes and drains with a view to prevent the passage of sewer air into a building. The only traps admissible are the various forms of siphon traps. Figures 44 and 45 show the simplest form of such traps. Buchanan's disconnecting and ventilating trap is used to disconnect

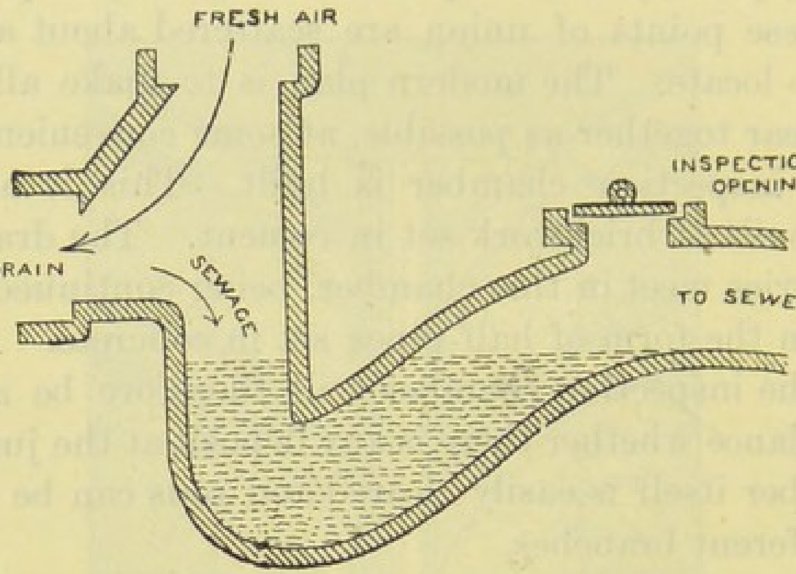

Fig. 45.

the drain from the sewer. It may be used alone, but more often a modification of it is adapted to use with an inspection chamber. A convenient trap for use with sinks or lavatory basins is shown in Fig. 46. It is fitted with a movable screw plug which is useful for removing any solid matter that may be stopping the pipe. The various forms of water-closets depend upon siphon traps to prevent the passage of gas from the soil pipe and drain into the building.

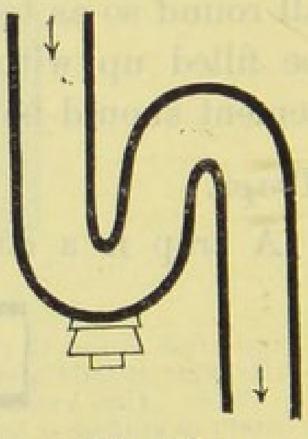

Fig. 46.
TRAP FOR SINK WASTE PIPES.

Ventilation of Drain.

The soil pipe (if water-closets are placed in part of the school building) or a special ventilating pipe (if there are only closets on the ground level and away from the building) acts as the chief ventilator on the near end of the drain. It acts usually as an outlet. The grating over the inspection chamber, or a short ventilating pipe attached to a disconnecting and ventilating trap, is the ventilator at the far end of the drain, and this is usually the inlet. If the drain is well and evenly laid, and these two ventilators are properly fixed and remain open, there should never be any foul gases in the drain, and no bad smell ought to be observable near either of the ventilators.

Testing Drains.

Before the trenches are filled in, the drains must be carefully tested. Each opening in the inspection chamber should be plugged and the different branches of the drain separately filled up with water. If the water remains at the same level for an hour the drain is satisfactory. If the level falls an examination of the joints will reveal the faulty place.

Lavatories.

There should be ample lavatory accommodation in all schools. One lavatory basin to twenty scholars should be regarded as a minimum, and one to ten scholars is desirable. How is it possible to properly teach and encourage habits of cleanliness in children when schools are so often provided with a dark, dirty, and bad-smelling room called the lavatory, into which the children are rarely permitted to enter? The basin should be of hard, durable material, and the simplest means of outlet, an opening filled by a movable plug, is the best. The waste pipe and overflow pipe must be arranged as shown in the figure. The waste pipe must not communicate with any soil pipe, drain, or sewer, but must pass as quickly as possible through the outside wall and immediately discharge upon a slanting surface sloping down to a gully trap, if the lavatory is on the

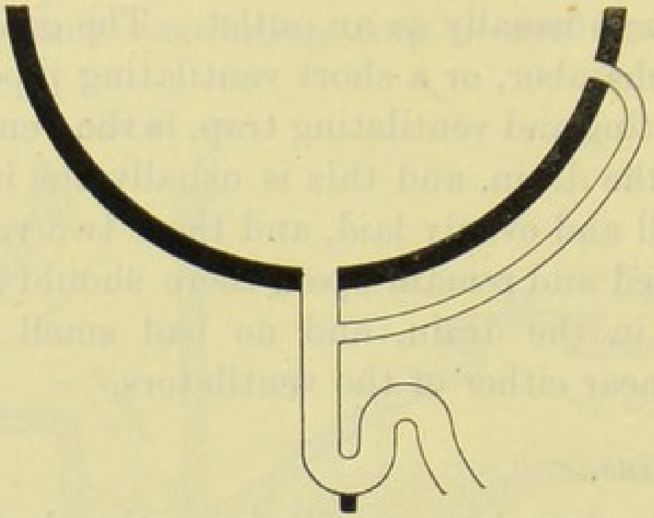

Fig. 47.
LAVATORY BASIN.

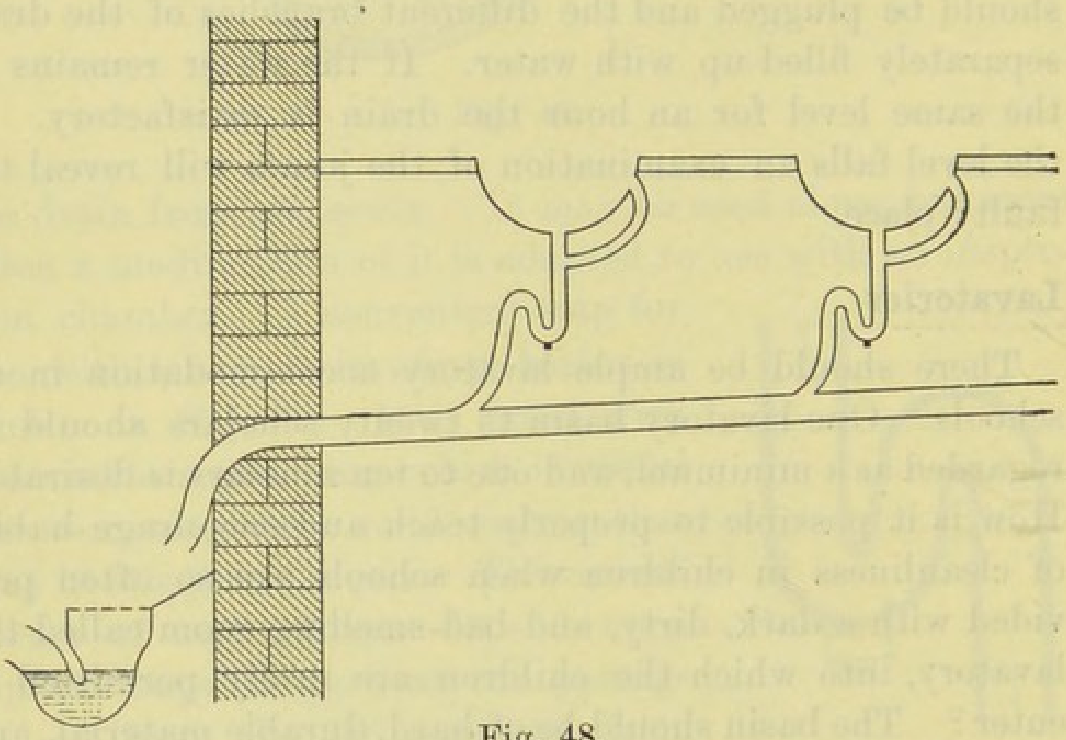

Fig. 48.
ROW OF LAVATORY BASINS. (For sake of clearness the antisiphonage pipes are omitted.)

ground floor, or into the open end of a vertical pipe which discharges on such a sloping surface, if the lavatory is on one of the upper floors.

In school lavatories the best arrangement is to place rows of basins round three sides of a room. The three rows of basins should be separately connected, *i.e.* there should be a separate waste pipe for each row. Each waste pipe should be trapped, and each trap provided with an air pipe to prevent siphonage. If these air pipes are not supplied the discharge of the end basin will suck out the water from the traps of those basins nearer the outlet, leaving an open pipe.

Baths.

The consideration of the subject of baths may seem to some to be superfluous in considering the needs of day schools. Few people, especially those who serve on education committees, appear to realise what has already been done in the direction of providing swimming baths for the purpose of physical exercise and health, and warm baths in pans or warm shower baths for producing cleanliness and also for educating the children in bodily cleanliness. There are swimming baths in connection with schools at Edinburgh and Govan in Scotland, the latter tank measuring 27 × 59 feet, and the depth varying from about 5 feet to a little over 3 feet. The temperature of the water is kept at about 70° F. Shower baths and soap must be provided in the same building, so that persons whose bodies are not sufficiently clean can be required to wash themselves thoroughly before entering the swimming bath. The cost of heating the water during the winter months is a very serious item, and for this reason it is not advisable to keep the bath in use during the whole year. Its maintenance from May to October entails little expense, and, especially if the bath is kept open during the summer vacation, it is an immense boon to the children of the locality.

At Giessen the school bathing facilities consist of eight large zinc pans, five feet in diameter, for eight hundred pupils. The children bathe three together, and are allowed five minutes for the bath. The most satisfactory form of bath, however, is the shower bath, which is rapidly coming into use for school purposes. This has very great advantages over any other kind from every point of view. These advantages may be summed up as follows :—

(1) The original cost of the simpler forms is not at all excessive.

(2) It is economical. Only a moderate amount of water per head is necessary.

(3) The risk of contagion from one child to another is entirely removed, because the water that has touched a bather runs off at once down the waste pipe.

(4) No time is wasted. There is no filling and emptying. Immediately one child has finished another can commence.

(5) This form of bath is found to possess a great attraction for children.

In Berlin there are many schools fitted with shower baths. The temperature of the water at the commencement of a shower is 113° F., and it gradually cools down to about 86° F. In Boston, school baths have now been provided for the past six or seven years.

For a school with 800 scholars a set of ten shower baths and thirty dressing closets are found to be sufficient. A convenient and simple form of bath is that adopted by the Boston school. The bath closet is constructed of marble, and measures 3 feet by 3½ feet and 6 feet high. There is no door, but a sliding rubber curtain hangs in front. An iron pipe supplies the water and descends vertically about half-way down the closet. On this is fixed a rubber tube, with a spray at the end, which reaches to the floor of the closet. The bather can vary the amount and the direction of the water, but the temperature is kept at 90° F. Dressing closets are made slightly smaller than the bath. The average cost for both is said to be under twopence, but there is no reason why it should not be reduced to about one halfpenny per bath.

The floor of the bath should be of asphalt or lead sloping towards the waste outlet, which should be on one side or at the back. The waste pipes must be treated in the same way as has already been described for lavatory wastes.

Closet Accommodation.

There should be no closets in the school building for the scholars. Those provided for teachers should be separated from the building by cross ventilated lobbies. Each closet must be not less than 2 feet 3 inches wide, nor more than 3 feet, and must be fully lighted and cross ventilated. They are best divided by partitions carried up 6 feet only. Doors, if any, should be separated from the threshold by at least 4 inches, and from the head by at least 6 inches. The number of closets required by the Education Department is given by the following table:—

	Number of Closets.		
	For Girls.	For Boys.	For Infants.
Under 30 children.	2	1	2
,, 50 ,,	3	2	3
,, 70 ,,	4	2	3
,, 100 ,,	5	3	4
,, 150 ,,	6	3	5
,, 200 ,,	7	4	6
,, 300 ,,	8	5	7
		Urinals in proportion.	

The above numbers should certainly be exceeded where-ever possible. The buildings and approaches to them must be wholly separate for the two sexes.

The floor should slope towards the door, and must be made of blue bricks set in cement or asphalt, so that it will dry rapidly after the daily washing which it must receive.

The walls should be lined with glazed bricks, and all corners should be rounded off.

Kind of Closet.

Where there is a proper water supply some system of water-closets must be provided, but if the public water supply is deficient or if there is no public supply, as is the case in country districts, the earth-closet should be used.

Earth-Closet.

The principle upon which this depends is that faecal matter, with which dry earth has been mixed, becomes not only inoffensive, but after a short time, unrecognisable as such. This absorbent and deodorising action of earth is dependent upon minute organisms or bacteria which are in the soil. These effect the conversion of nitrogenous matter into ammoniacal compounds, and these, by processes of oxidation are resolved into nitrites and nitrates. The best soils for this purpose are moderately dry and loose loams, garden soils, dry clay, and brick earth. Sand, gravel, and chalk are unsuitable and inefficient. The method of use is to cover each stool at once with one and a half pounds of dry earth. This is found to be sufficient to remove all smell and to form a "compost" which is suitable for potting plants, but is by no means a rich or valuable manure. When the pail is full its contents may either be applied at once to the garden or removed to a dry shed where, after frequent turning over and exposure to the air, the earth may be used again as many as eight or ten times. Automatic closets, which apply a measured quantity of dry earth at each use, are obtainable. One is shown in Fig. 49. The handle of the closet is connected with a

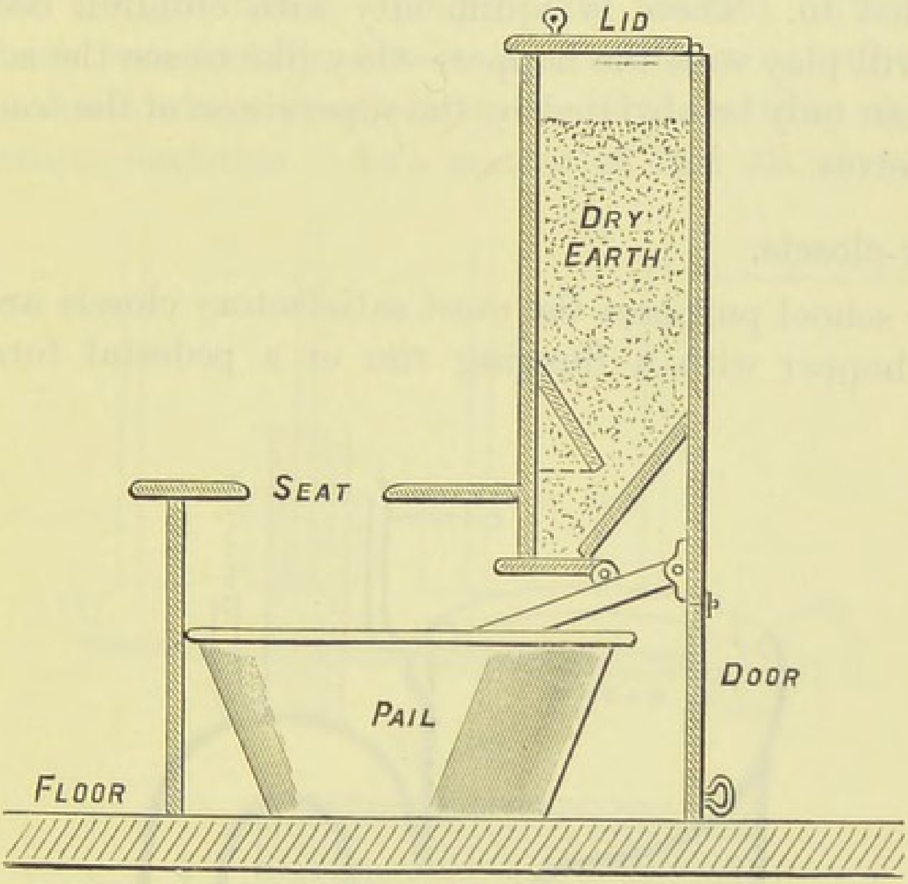

Fig. 49.

AUTOMATIC EARTH CLOSET.

receptacle behind and above the seat, which delivers the regulated quantity into the pail when it is raised.

The earth-closet requires the closest attention and the most constant supervision if it is to be quite free from smell. It should never be placed inside a school. The personal attention which it requires and the difficulty of disposing of the large bulk of residue should prevent this method from ever being adopted in towns.

It must be remembered that earth-closets require the services of a special attendant to remove the soil, provide a fresh supply, and to prepare a stock of dry soil in the store-house for use during the winter. The head master should inspect them every day and see that things are properly attended to. There is a difficulty with children because they will play with the hopper—they like to see the action. This can only be obviated by the supervision of the teachers themselves.

Water-closets.

For school purposes the most satisfactory closets are the short hopper with a flushing rim or a pedestal form of

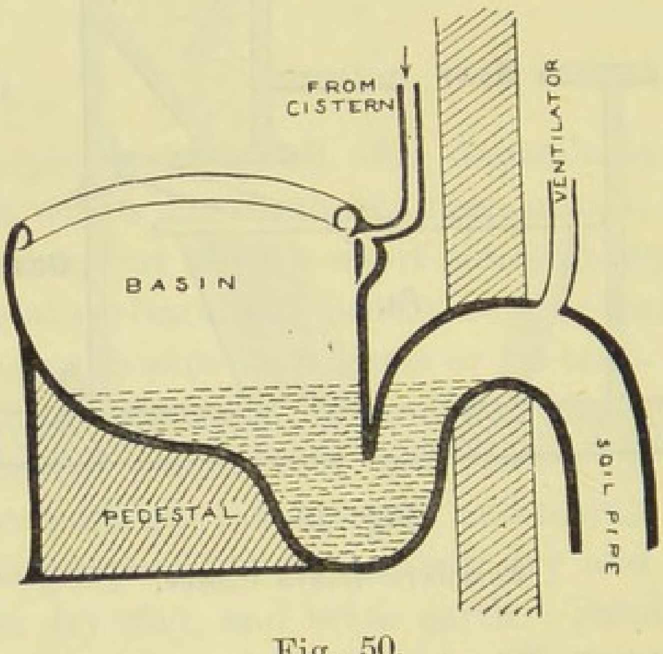

Fig. 50.

Pedestal (Hopper Type) with Flushing Rim.

wash-down closet. Each closet should have its own flushing cistern. It is more usual to provide trough closets with automatic flush cisterns, but it should be considered a necessary part of a child's education to know how to use, and not abuse, an ordinary water-closet. All joints must be tested thoroughly before they are passed, and every precaution should be taken to ensure that the work is done in a first-rate manner.

Trough Closets.

The usual form of water-closet for school purposes is the trough closet. If properly looked after they are fairly satisfactory, but it is a common experience to visit schools where these closets are foul smelling and in a disgusting condition. As a matter of fact all closets are

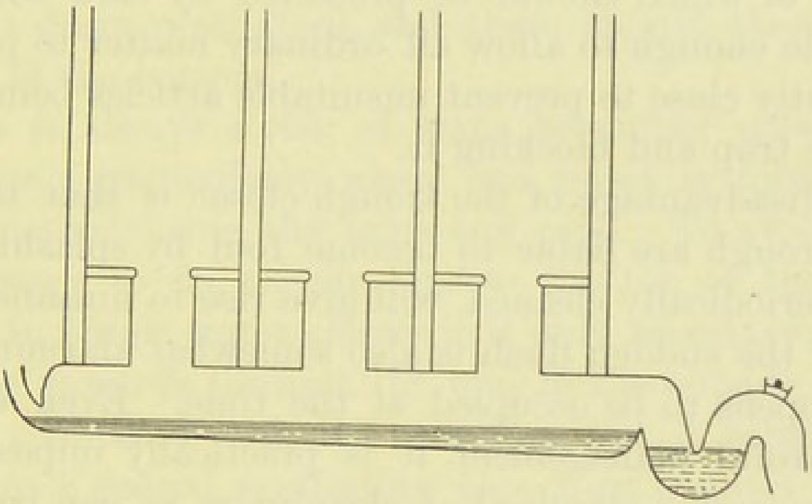

Fig. 51.

TROUGH CLOSET.

liable to become a disgrace to the school unless they are personally inspected by the head teacher every day. Such inspection should be made in the interests of the school and the scholars. An inculcation of maxims connected with the observance of decency in these places will have a good effect upon the children in every way, and is really an important part of their education, and any teacher who fails in this duty is neglecting an important branch of the child's instruction.

A form of trough closet is shown in Fig. 51. It is simply a series of closets with a common flush. The trough should be of stoneware, and slopes downwards towards the outlet. At the end of the trough its floor turns upwards so that there is always a depth of from one to four inches of water in it. At the upper end of the trough, and four or five feet above it, is an automatic flush tank which should be arranged to discharge every six hours *at least*. The frequency of the flush is arranged by regulating the tap. Cases are unfortunately common where the cistern is discharged once or twice a week. The lower end of the trough connects with a siphon trap, the opening of which should be protected by bars with intervals wide enough to allow all ordinary matter to pass, but sufficiently close to prevent unsuitable articles being swept into the trap and blocking it.

One disadvantage of the trough closet is that the sides of the trough are liable to become foul by splashing and, if not periodically cleaned, will give rise to nuisance. The noise of the sudden flush is also somewhat alarming if the seat happens to be occupied at the time. Even with the most careful management it is practically impossible to maintain such a standard of cleanliness as can be secured where separate closets are employed, and all education authorities would be well advised to substitute ordinary water-closets for all trough closets in their district. No deodorisers should be permitted in closets, as they are merely palliative, and serve only to disguise and cover some evil which ought to be remedied. If there is any offensive smell in the closets there is something wrong either with the closets or their management.

Soil Pipe.

Mention has already been made that any water-closets in the school must be separated from the main building by cross ventilated lobbies. In schools of more than one storey it is usual and convenient to place such water-closets above each other. The soil pipes, or pipes which carry the excreta from the water-closet to the drain, must be altogether outside the building, and ventilated by being continued, without any bend or alteration in diameter, above the eaves. Their termination should be protected by a wire cage to prevent their occupation by birds' nests. The best material for the soil pipe is drawn-lead. If iron pipes are used they must be of the water-main type, with caulked lead joints. A diameter of four inches is the most satisfactory size. Soil pipes are excellent drain ventilators, and there should therefore be no trap at the bottom.

There is always a risk of traps becoming unsealed by siphonage: particularly when one closet is immediately above another, using the same soil pipe. To avoid this it is necessary to fix an air pipe to the top of the siphon bend. In single water-closets it is only necessary to carry this pipe upwards through the wall to the outside, where it may be connected with the soil pipe, but if other closets are above, a special ventilating pipe must connect together all these air pipes and enter the soil pipe above the level of the highest closet.

Urinals.

All surfaces with which the urine comes in contact must be smooth and non-absorbent, the best materials being plate-glass, glazed earthenware, and slate. There should be either a continuous flow of water over such surfaces or an automatic flush of water at very short intervals. Dukes recommends a plate-glass trough, nine inches wide and six inches deep, kept full of water, and fitted with a self-acting outlet. Such urinals are devoid of smell. It is an unfortunate but obvious fact that, owing to bad construction and lack of care, school urinals are often unsanitary and offensive in the highest degree. There is no excuse whatever for such a condition in those districts which have a plentiful public water supply.

Cesspools.

A cesspool would only be permissible for a school in a district with an excellent public water supply, so that water-closets are possible, but where there are no public sewers. Such districts are very rare. If there is no public water supply, or if it is inadequate, earth closets should be provided. Also if there are no public sewers the district must be somewhat rural, and here again earth closets would be the best arrangement.

If a cesspool system is regarded as indispensable, the cesspool must be as far removed from the school and playground as possible, be fenced in, properly ventilated, and perfectly watertight. It is somewhat beyond the scope of this book to give details of the necessary construction and management.

PART II.

THE SCHOLAR:

PHYSICAL TRAINING AND THE LAWS OF HEALTH.

CHAPTER I.

SCHOOL FITTINGS.

DESKS.

THE problem of the desk is still with us, but is, perhaps, nearing solution, or at all events proper appreciation. Excellent desks are now made which will give fairly satisfactory results if the teacher thoroughly grasps the principle that the maximum length of time at a stretch that a child should remain seated in any form of desk is one hour, and that periods of half or three quarters of an hour are much to be preferred to the longer period. In fact there are few desks that will injure a child if the time during which they are occupied is strictly limited. The habit, which probably still prevails in some schools, of keeping children seated for a whole morning of about three hours has undoubtedly been the cause of a great deal of deformity and ill-health. Up to the age of fourteen the sitting posture should be regarded merely as a convenience, which is, nevertheless, unhealthy and unnatural for children. If this fact is properly appreciated there will be universal limitation of sitting-down periods to three-quarters of an hour, with intervals of play and of lessons given with the children standing upright. The ideal desk is probably still an unsolved problem, but that is no reason why the most elementary and obvious rules concerning desks should be systematically ignored by so many education authorities even of large and important boroughs and districts. A desk should be just as accurately fitted for the child as its clothes are, and children require just as great a variation in desk sizes as they do in the measurements of their garments. A visit to the ordinary elementary school shows hundreds of children sitting in desks which are obviously unsuitable for them, and which cause them to bend their spines to the left, as well as to stoop forward with chest contracted, heart and lungs compressed, and cramped abdominal viscera.

It is necessary to remember that children of the same age and in the same standard at school vary greatly in height, a fact that is obviously unappreciated by the Board of Education, because the Rules for Elementary schools say "seats and desks should be graduated according to *ages*." Some interesting figures have been obtained by Bowditch as illustrating this important fact:—

Age.	Sex.	Height. From ... to	Difference.
6 years	Boys	40½...47 inches	6½ inches
	Girls	40½...47½ ,,	7 ,,
11 ,,	Boys	49½...57½ ,,	8 ,,
	Girls	49½...58 ,,	8½ ,,
15 ,,	Boys	56½...68 ,,	11½ ,,
	Girls	57½...65 ,,	7½ ,,

Another important point is the variation in the rate of growth at different ages. Girls grow most rapidly between twelve and fourteen years of age, while boys grow most from fourteen to sixteen. Still another matter to be allowed for is the greater "sitting height" of girls compared with boys of the same total stature. A very small amount of thought, therefore, should convince anyone that desks must be adjusted to the children, and that to order a roomful of desks all the same size for each standard is just as ridiculous, and far more harmful than to order the same sized clothes for all these children. It is by no means common, in towns that pride themselves in being quite up-to-date, to find children who vary a foot in height sitting in desks of exactly the same size.

If the desk is of suitable size and structure it will allow the child to sit in accordance with the following conditions:—

1. The two ischial tuberosities rest equally on the seat.
2. The body is erect, and the back supported.
3. The head is in such a position that a line joining the centres of gravity of the head and the body bisects the line between the two ischial tuberosities.
4. The thighs are horizontal, the legs vertical, and the feet rest flat on the floor.

In this position there is the greatest possible economy of energy because the body is symmetrical and equally balanced. With the body so placed the eyes most easily look forwards and downwards. To raise them in order to look horizontally forward requires an effort. The least possible work will be given the eyes if the reading matter rests on a desk at an angle of 45° with the horizon, because in this position the bottom of the page will be at the same distance from the eye as the upper part, and the eye will be able to read all the type thereon without changing its focus to any appreciable extent.

For writing, however, a desk top at an angle of 45°

would have serious disadvantages. For instance, the ink would not flow properly from the pen at this angle, and moreover the arms and hands would have to be held in an irksome and tiring position. The most convenient slant for the writing-desk is an angle of 15° with the horizontal. The only objection to such a slope is that the lower part of the page will be nearer the eye than the upper portion. The surface of the desk must be adjusted to such a height that the forearms may be easily placed upon it by moving the elbows three or four inches away from the sides.

VARIETIES OF DESKS.

In describing desks there are certain terms applied to different measurements.

1. The vertical distance from the edge of the desk to the level of the seat is called the "difference." This measurement should be such as to bring the edge of the desk

Fig. 52.

RELATION OF SEAT TO DESK.

opposite the navel of the pupil. The child will then be able to place the arms on the desk by moving the elbows slightly away from the sides.

2. The measurement from the edge of the seat to the vertical line dropped from the edge of the desk is called the "distance." This classifies desks into three varieties: (1) The "plus" desk, *i.e.* where there is a space between the edge of the seat and the vertical line from the desk. (2) The

"zero" desk, *i.e.* where the edge of the seat touches the vertical line from the desk. (3) The "minus" desk, *i.e.* where the vertical from the desk passes through the seat.

For writing the desk which involves the least deviation from the ideal position described above is the minus one. Nevertheless it is exceedingly common to find large schools without a single minus desk. The common desk is the plus variety, the use of which causes various ill effects: (*a*) The head and body are thrown forward so that the thorax,

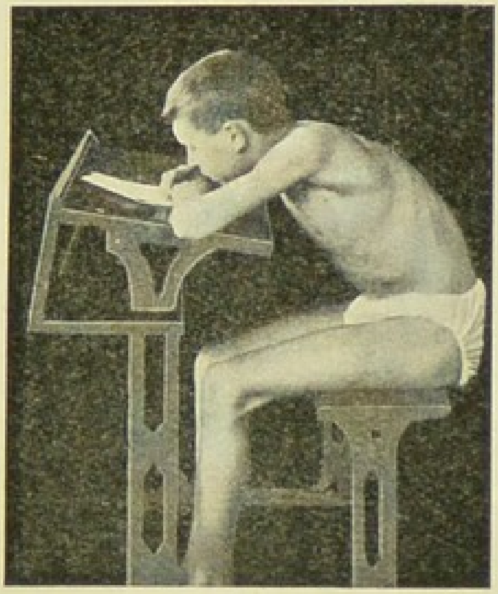

Fig. 53.

COMMON POSITION FOR WRITING IN A PLUS DESK.

lungs, heart, and abdominal viscera are pressed upon and cramped. (*b*) The abdominal wall is folded and the viscera pressed out of place, thereby interfering with the functions of the different organs. (*c*) The vertical line from the centre of gravity of the body falls in front of the line joining the ischial tuberosities. This causes part of the weight of the body to be borne by the part of the thigh resting on the anterior edge of the seat, and some also by the elbows on the desk. (*d*) The effort of holding the head and body in this position is a waste of energy, there being no balance. The muscles of the neck tire, and the head droops down. Fatigue is thus rapidly brought on. (*e*) The bending forward of the head brings the object nearer than twelve inches from the eyes, as well as causing congestion round those organs. If the desk is too low for the child the above effects are intensified.

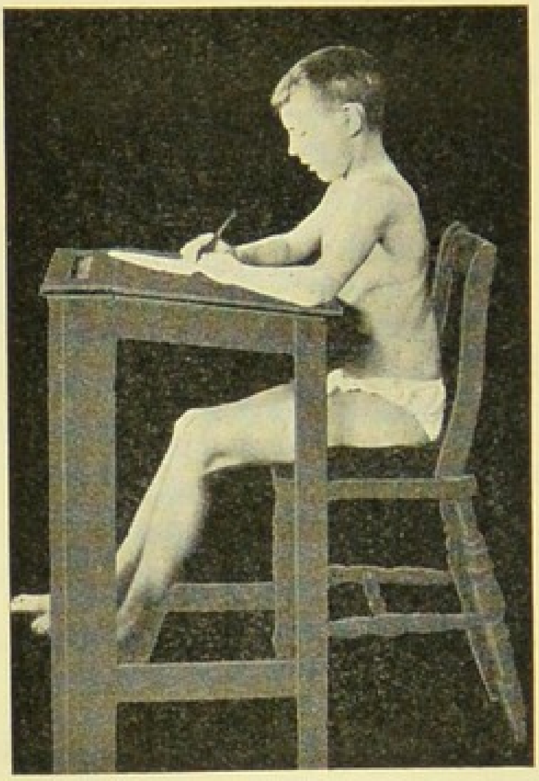

Fig. 54.

DESK AND SEAT ARRANGED IN MINUS POSITION.

The minus desk is undoubtedly the best for school use, but will only give satisfactory results if each child has the right size of desk for its requirements. The amount to which the desk overlaps the seat must be adjusted so that the edge of the desk just touches the child's abdomen without pressing upon it. If a fixed minus desk is used it is apt to become somewhat tiring owing to the shut in sensation it imparts and the absence of free movements.

Standing up is also irksome. Many of these desks have, therefore, been devised with the middle hinged, in order that the lower part may be lifted up and folded back on itself, so that the under surface is now turned up at an angle of 45° and presents the ideal desk for reading. In this position it is a plus or zero desk, and the reading matter is a little over twelve inches from the eyes of the pupil. Sometimes the seats are made to turn vertical in order to allow the child to stand. This plan, however, involves the use of the same shaped desk for reading and writing. As an alternative to the jointed desk-top there is the desk with a sliding top. In its ordinary position it is a plus or zero desk, but the top will slide down towards the child and so become one of the minus variety. It is undoubtedly desirable that a desk should be adjustable for plus and minus distances. A small plus distance gives a child more freedom of movement, and enables him to rise from the desk and to sit down with much greater ease.

DESK ADJUSTMENT.

In almost all schools, from the highest to the humblest, the bodies of scholars have to accommodate themselves to fixed seats and benches. The evil results of such a system appear later in the form of eye and spinal trouble, as well as consumption. Not only is it most harmful in the case of young children, but the injury and inconvenience is also very pronounced in the case of youths and young men and women who attend technical and evening classes held in elementary school buildings. This aspect of the case is often ignored, and the writer well remembers one instance where, after protests had been received on behalf of such adult students, members of the local education authority denounced the " luxurious tendency" of the present race of students. Real progress must necessarily be slow in the face of gross ignorance and petty economy.

Most of the adjustable desks at present on the market possess merely a vertical movement, and the height is laboriously altered and fixed by means of a key, a screw, or a pinion. These methods have the serious defects that they are not easily adjustable and also are very liable to injure the hands and fingers of those who attempt to manipulate them. Adjustable desks of better and more convenient patterns are now being produced.

It should be distinctly understood that for day schools an adjustable desk will no longer be a necessity when the time-tables are under the control of medical men who have made a special study of hygiene as applied to child life. With three sizes of desks and seats for the ordinary standards it is possible to fit 95 per cent. of ordinary children sufficiently exactly to produce no ill effects **if the children are kept seated in them for short periods only.** But if the present system is maintained, then the adjustable desk is a necessity. Mr. Priestley Smith considers that four sizes of desks are desirable, and gives the following scale:—

Height of Scholar.	Height of seat from floor.	Width of seat.	Height of desk and back from seat.
$3\frac{1}{2}$ to 4 feet	13 ins.	10 ins.	8 ins.
4 ,, $4\frac{1}{2}$,,	$14\frac{1}{2}$,,	11 ,,	$8\frac{3}{4}$,,
$4\frac{1}{2}$,, 5 ,,	16 ,,	12 ,,	$9\frac{1}{2}$,,
5 ,, $5\frac{1}{2}$,,	18 ,,	13 ,,	$10\frac{1}{2}$,,

The old-fashioned private school inflicted far less physical injury upon the children than the public elementary school of to-day. In such schools at least half the children stood while receiving instruction, and, chiefly owing probably to a deficiency of desk accommodation, the period of each child's occupation of a desk was brief. It cannot be too often repeated that the possibility of injury resulting from the use of any desk is very remote if the time of occupation is made short.

Under present conditions each desk must be accurately adjusted to the needs of the child who has to use it. This being the case, it is indispensable that every desk and every seat should be adjustable. The desk seat must be of such a height that the thigh of the pupil is exactly horizontal when the leg is vertical and the foot resting flat on the floor. In such a position, obviously, the knee is bent at a right angle. In order to obtain such conditions for every child it is necessary that the seat should be adjustable to quarter inches. The front edge of the seat must be rounded off in order to prevent pressure upon the blood vessels and nerves of the thigh. For additional comfort and also in order to counteract the tendency to slide forward, the seat should be hollowed out to a depth of about $\frac{3}{8}$ inch, the concavity commencing $1\frac{1}{2}$ inch from the front edge of the seat, and deepest where the ischial tuberosities rest. The width of the seat should be at least two-thirds of the length of the child's thigh.

Each seat should be provided with a proper back, presenting a concave surface forward, and extending sufficiently far up the back to afford support to the lower parts of the shoulder blades.

Each child is measured carefully, so that the seat may be adjusted accurately to its requirements. The knee is bent at a right angle, while the foot rests squarely on the floor, and the distance from the floor to the under side of the thigh near the knee is measured. This measurement is best made with special measuring rods for that purpose. These consist of a vertical scale with a sliding horizontal arm which is raised until it touches the under surface of the thigh.

Foot-rests are unnecessary and undesirable. By preventing free movement of the feet and legs they tend to increase the liability to cramp and stiffness. Another objectionable feature is that they prevent thorough cleaning of the floor.

The desk tops must be adjusted so that the child, when in the position for writing, does not bend the spine or have the shoulders raised. The edge of the desk should touch the navel, and the forearms should rest easily on the top without moving the elbows more than three or four inches from the sides.

It is desirable that all desks should be adjusted carefully twice a year, and the best times are March and September. No desk that can only be adjusted with difficulty should be allowed.

Single or Multiple Desks.

The Board of Education in the Rules for Elementary Schools distinctly discourage single desks, apparently on the ground of expense. According to these rules desks 12 feet long are permitted, and eight children (and even nine infants) are allowed to be packed on such a desk. Surely such rules must have been framed by people who have no knowledge whatever of the simplest hygienic principles. Under such circumstances it is no wonder that occasionally schools serve as hot-beds of infectious diseases, and that as a general rule most children are free from disease until they begin to attend school. Even dual desks should be discouraged, not only on account of the increased possibilities of the spread of infection that they bring about, but also as tending to produce contorted attitudes. Entirely separate desks are undoubtedly the best, but if economy must be studied the Sheffield system should be adopted. These are long desks (without seats attached) of half a dozen places and are used with separate pedestal chairs. The advantages claimed for such an arrangement are :—

1. That the seats are isolated.
2. Each child is accessible.
3. Each child can stand up in its place, and drill can be taken for a minute or two with the children in their places.
4. The rooms cannot be overcrowded.
5. The cleaning operations are very much simplified.

Such an arrangement demands about 1,000 square inches of floor space per seat.

Infants.

For the young children the most suitable plan is to have flat tables or desks, and it is undoubtedly an advantage to provide sufficient of these to accommodate half the children only, so that the other half are compelled to stand. Those standing may do blackboard or other work, and take turn and turn about with those seated. For children under six years no desks should be provided at all; the babies should play about on the floor, or stools could be provided that they could move about themselves. It is very interesting to note that these babies are allowed for recreation a quarter of an hour in the morning and ten minutes in the afternoon. Is it to be wondered at that consumption continues to be such a dreadful scourge among young adults who have passed through the ordeal of such an "education," or that the subject of physical degeneration of the race is assuming a most serious aspect?

ARRANGEMENT OF DESKS.

The desks should be arranged in the lightest part of the room, *i.e.* near the windows. It is advisable to arrange the desks so that the scholars face the long way of the

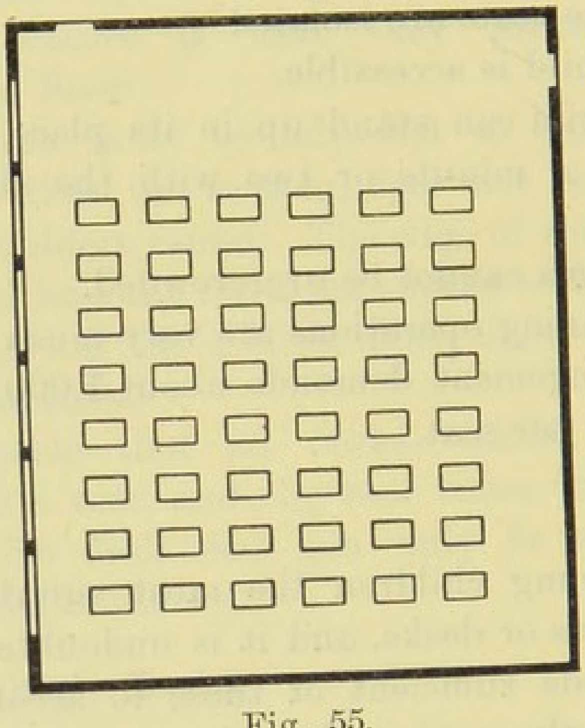

Fig. 55.

Desks arranged in Class-room.

room, in order to avoid as far as possible a foreshortened view of any apparatus shown them, or maps or diagrams on the blackboard. The typical class-room mentioned earlier in the book measured 25 × 30 feet. Such a room should accommodate 40 scholars only, whether the school be an elementary or a secondary one. The gangways mentioned in the Board of Education Regulations are 16 inches between dual desks, and 18 inches between multiple desks. Single desks with gangways of 15 or 16 inches should be introduced into every school.

BLACKBOARDS.

The slate blackboard should be preferred to all other kinds because it can be washed without injury. The slate should be of a green or black colour. All teachers should remember that the inhalation of chalk dust is most injurious and may tend to predispose to consumption. For this reason it is advisable to always use a slightly damp duster. After a few trials it will be quite easy to obtain just that degree of dampness of the duster that will suffice to prevent the wafting of any chalk dust in the air, and yet will not appreciably wet the surface of the blackboard.

Blackboards should be all round the available walls of the room. There cannot be too much blackboard in any class-room. One of the best methods of preventing or affording relief from cramp and fatigue is to send scholars in batches to the blackboard to write various exercises. The width of the board should be 4 feet, and the height from the floor varied from 26 inches to 36 inches according to the size of the children who are to use the room. An excellent plan is to provide a trough about 2 to 3 inches wide at the bottom of the board and covered with an open wire cover. Most of the dust will fall into this trough and can be periodically removed.

Teachers' Platforms.

A platform for the teacher's desk and chair is undoubtedly a great convenience, especially to teachers of small stature. They are, however, unsanitary, because dust and dirt collect all round and beneath them. They also seriously interfere with the free movement of pupils about the room and at the blackboards.

SCHOOL CLEANING.

I. Desks.

It should be clearly understood that desks and seats accumulate grease and dirt rapidly, and that regular cleaning is necessary if it is desired that they should not become dangerous to health. Every desk and seat should be cleaned thoroughly with paraffin oil during each of the three vacations.

II. Windows.

Dirty windows not only decrease the amount of light that can enter the room, but also tend to render useless and ridiculous any instruction given by the teacher upon general cleanliness. It cannot be too often repeated that the teaching of hygiene will never produce much real effect upon the mass of the children until the schools themselves are object-lessons on this subject.

III. Walls.

The walls, which should be painted, must be thoroughly washed down during each of the three vacations, and it may be necessary to wipe them over more frequently as high as the scholars can reach, There should be no ledges or projections where dust can lodge, but if there are they should be carefully cleaned at the three thorough cleanings each year.

IV. Floors.

Every floor should be thoroughly swept at the close of each day that the school is occupied. Such cleaning is best carried out with all doors and windows widely open. The floors should be first liberally sprinkled with wet sawdust, and a wet broom should always be used. In many schools no such care is taken to prevent the dust rising in the air, and where sawdust is used the quantity supplied is quite inadequate. A visit to such schools at the time when the daily "cleaning" is finished will reveal an atmosphere like a fog. Such conditions are injurious to the sweepers, and the dust so scattered in the air settles down on floors, desks, shelves, walls, etc., and adds to the general dirtiness and unhealthiness of the school. In fact it would probably be better to clean it thoroughly once a week than to go through such a farce as is usually represented by the daily "cleaning." Dust should be regarded as a most potent cause of ill health, and every effort should be made to prevent a dusty atmosphere in schools.

CHAPTER II.

POSTURES. PHYSICAL EXERCISES.

POSTURES.

Bad positions in writing, drawing, reading, and standing, or sitting on a simple form, are prominent causes of deformity. Twisted spinal columns, malformations in chest, injured eyes, stooping habits, and shuffling gait,

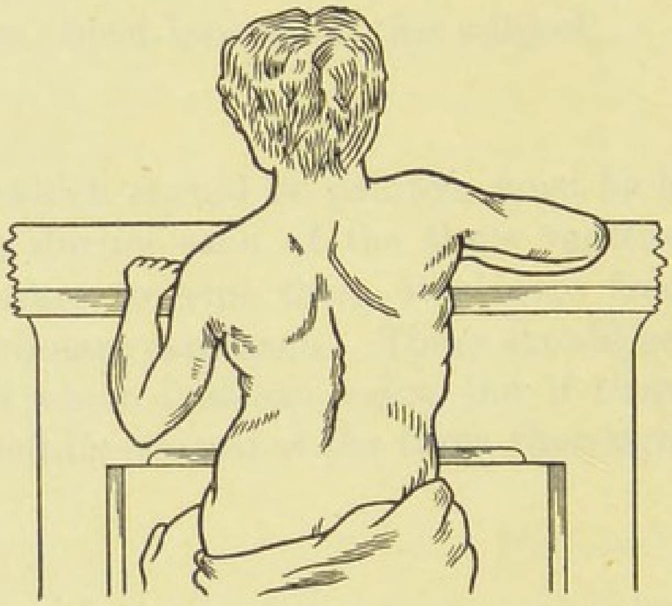

Fig. 56.

with many kinds of bodily ailments, follow a want of knowledge upon these subjects. Fig. 56 illustrates a kind of injurious position which is very common.

The division of postures into four chief classes is convenient, namely the respective positions for reading, writing, receiving instruction, and standing. They might also be divided into (1) correct postures, (2) those caused by bad desks, and (3) those which are simply due to lack of training and proper and intelligent supervision, such as the injurious postures assumed by children owing to inactivity from long confinement.

1. FOR RECEIVING INSTRUCTION.

The ideal sitting posture is the one in which the pupil's body is symmetrically placed and which economises mus-

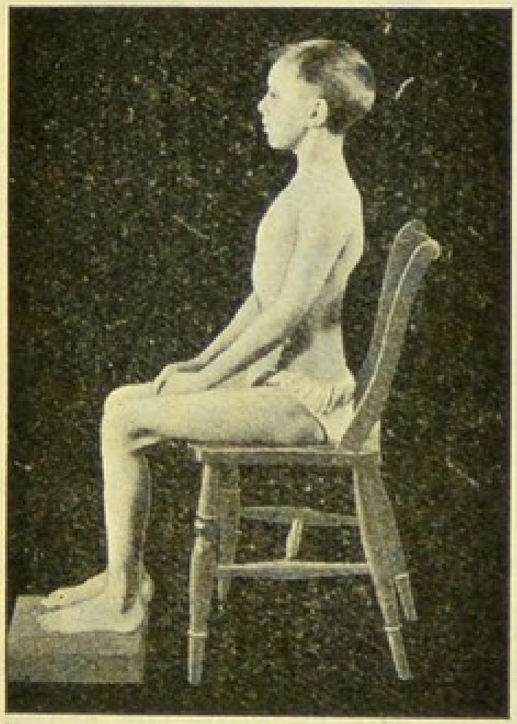

Fig. 57.

CORRECT POSITION. VERY TIRING IF NO SUPPORT TO THE BACK.

cular effort. In such a position the pelvis rests equally on the seat of the desk, the spinal column is erect and shows clearly its normal four curves, the head is so poised as to afford relief to the muscles in front and at the back of the neck, the arms balance, and the hands rest upon the thighs, which are horizontal. It is best described as a position of balance, in which the force of gravity largely replaces muscular exertion. It is not one which can be maintained, however, for longer periods than a few minutes unless some support is given to the back and the support to the feet is at the correct level, which is an indirect way

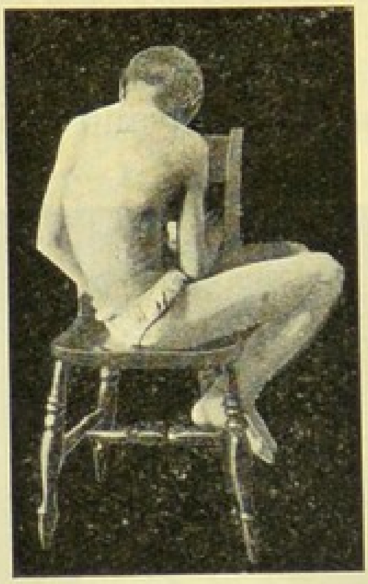

Fig. 58.

Position involving Twist of Spine.

of saying that the height of the seat must be accurately adjusted to the physical needs of each and every scholar.

Positions causing any twist of the spinal column, such as is illustrated in Fig. 58, are very injurious. Here the vertebral column is twisted through 45°, the effect of which is to overstretch some of the ligaments connecting the vertebrae, as well as to put undue pressure and strain upon some of the bony parts.

2. FOR READING.

Faulty positions for reading are potent causes of short sight. Children are allowed and encouraged to read small print at far too early an age, the result being that the eye becomes strained and permanently injured. The greatest possible care and attention is necessary in order to prevent modern educational methods from producing such disastrous results. Reading and writing are liable to be exceedingly

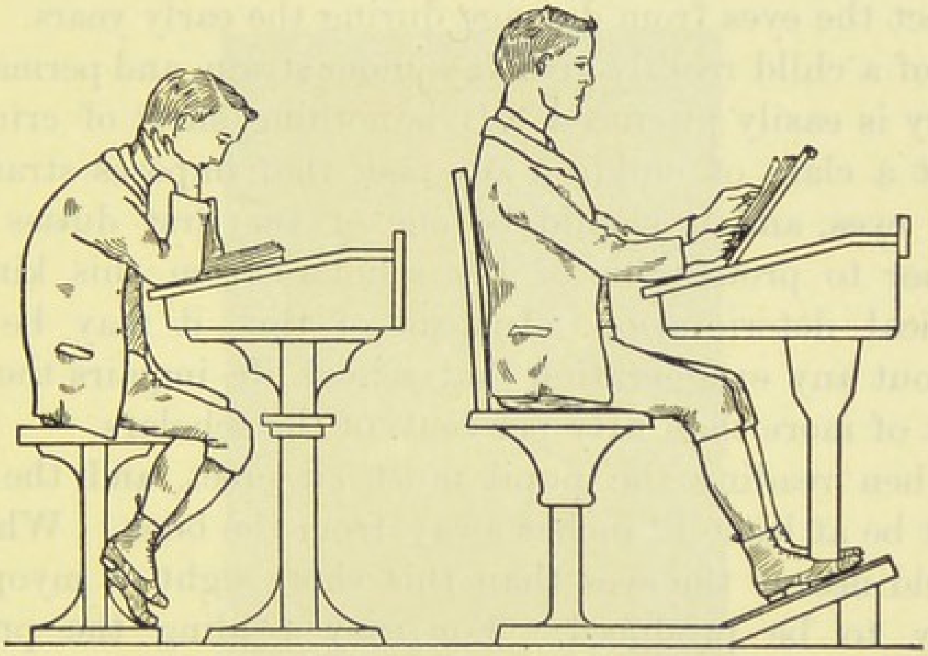

Fig. 59. Fig. 60.

injurious to children under ten. Short sight is rare among people who have not received the present-day "book education," but have been reared among healthy surroundings and have spent a large proportion of their life out of doors. On the other hand the studious individual, and one who has won distinctions at school and college, usually is compelled to rely upon spectacles in order to obtain normal vision. A great deal of this injury received during early education is preventable and should be prevented, but it will probably continue to exist as long as a university degree or diploma is considered of greater importance to a teacher than a thorough grasp of anatomy, physiology, and hygiene so far as they apply to school life. Such knowledge is of vital importance, and yet it is only acquired by an odd teacher here and there who makes this subject his or her hobby.

It is an undoubted fact that modern life makes great demands upon our eyes, so that it is a national duty to protect the eyes from damage during the early years. The eyes of a child readily give way under strain, and permanent injury is easily produced. It is nothing short of criminal to set a class of children any task that imposes strain on their eyes, and it should be one of the first duties of a teacher to protect his or her scholars from this kind of physical deterioration. Instead of this, it may be said without any exaggeration that school life impairs the eyesight of more than fifty per cent. of the scholars.

When reading the pupil must sit erect, and the eyes must be at least 12 inches away from the book. When it is held nearer the eyes than this short sight or myopia is likely to be produced. For easy reading the printed matter should be held at an angle of 45° to the horizontal, and not too much below the level of the eyes, if the head is to be kept comfortably in a good posture. The eyes become fatigued much sooner if they are directed upwards or horizontally.

A position often assumed by children is shown by Fig. 61. Here the chest is contracted and respiration becomes shallow. The shoulder-blades are widely separated and, instead of lying evenly upon the ribs, their posterior borders are thrust outwards. The dorsal curve of the spinal column is increased, while the lumbar curve is reversed. An increase in the obliquity of the ribs is also produced, resulting in a further reduction in the capacity of the chest. Added to this the anterior abdominal wall becomes folded, and the contents of the abdomen are unduly pressed upon. The greater part of the weight of the head has to be borne by the muscles at the back of the neck, and these, in common with many of the back muscles, become weakened and stretched. A frequent cause of this posture is unduly long periods of confinement.

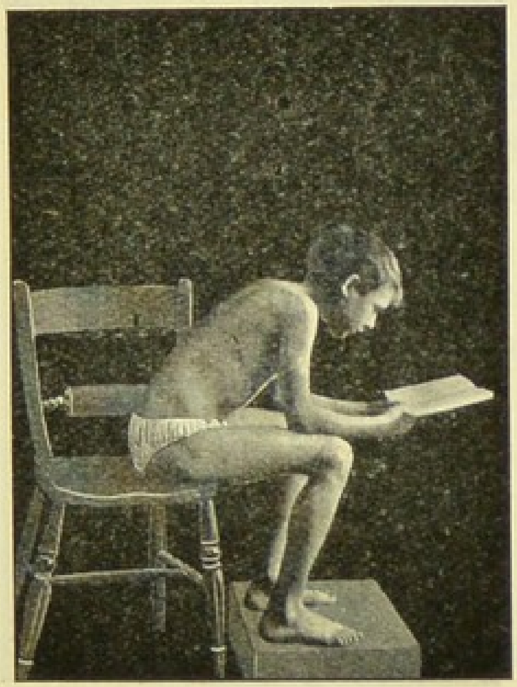

Fig. 61.
INJURIOUS POSITION.

Another position often assumed by children who have been kept sitting too long is shown in Fig. 62, where the child has slipped forward upon his seat, and nearly the whole of the body weight falls upon the sacrum, coccyx, and shoulder-blades. It is said that prolonged inactivity at the hip joint is the chief factor in causing a scholar to assume this position. Adults are often seen to adopt this posture as affording a relief after prolonged sitting. Such a position is undoubtedly injurious for children. With the head dropped forward and the chest contracted there can only be inefficient breathing. A decrease in the amount of oxygen inhaled causes an immediate diminution in the vitality and mental activity, so that any position which hampers free expansion of the lungs is to be condemned. The muscles at the back of the neck become tired and

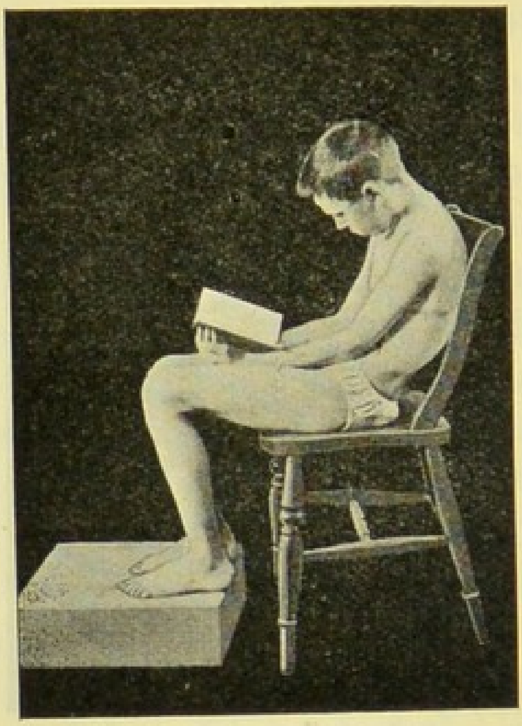

Fig. 62.

INJURIOUS POSITION.

stretched, and the child acquires a stooping and drooping habit. The proper shape of the body is further distorted by the reversal of the cervical and lumbar curves of the spine, thereby reducing the four natural curves to one long one. This again causes undue stretching of ligaments and muscles.

The flattened chest, contracted shoulder girdle, and stooping head are constantly seen in practically every school. Such postures cause short sight, interfere with respiration and general thoracic development, and throw unnecessary labour upon the heart. The abdominal organs are compressed and forced into unnatural positions, and the production of round shoulders, curved spine, and drooping head is also the effect of such postures.

3. FOR WRITING.

Bad positions for writing are universal still and are the common causes of spinal curvature. The curve thus produced has its convexity to the right, and is produced largely by the fact that the right arm and hand are supported by the desk, while the left arm hangs idle and unsupported.

It is not yet clearly understood that writing is a severe trial to a child. It is easy for a teacher to set a copy and to tell children to imitate it, but he or she is apt to forget that writing is an act which involves a complicated coordination of muscular movement. The child is not yet able to use a few muscles at a time—his tendency is to use groups of muscles together—but writing involves the use of a few muscles from several groups. The result is that he finds the labour involved is painful and very tiring: he uses more muscles than are necessary, and, in order to balance the undesired effect of the unnecessary ones, he brings into use still more of them. The effect of this is to produce an unnatural strain and rigidity of most of the muscles, especially those in the hand and arm, followed by a desire to constantly alter the posture of the body in the vain effort to release the tension and fatigue so produced. Writing is an extremely complicated and special act. It not only involves careful control over those muscles which are required for such fine and exact movements, but also inhibition of many muscles which, for other actions, are accustomed to act in unison with them. This fact should be properly appreciated by all teachers. Many of the injurious postures assumed by children while writing are the direct result of an attempt, on their part, to release the tension and fatigue produced by so complicated an act.

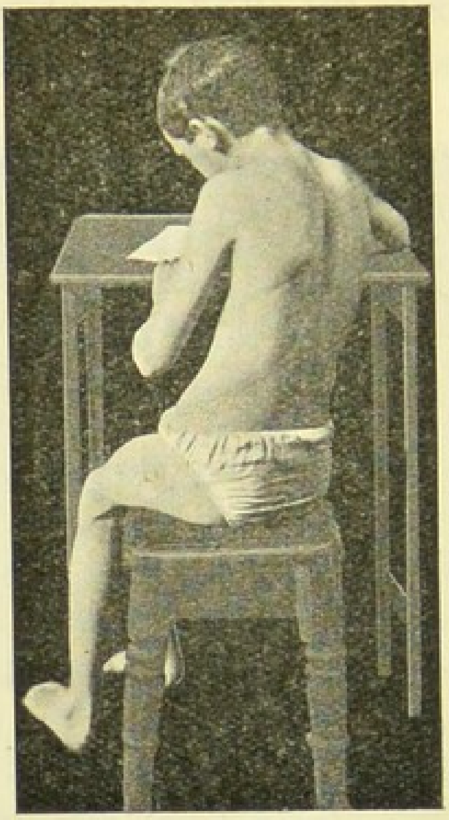

Fig. 63.

COMMON POSITION FOR WRITING. SPINE CURVED WITH CONVEXITY TO RIGHT.

Many of the undesirable results can be prevented by proper attention to the following points :—

1. The method of writing for beginners.
2. The style of writing.
3. The manner of holding the pen.
4. The use of the left hand.
5. The position for writing.

All these points are so closely connected with the subject of posture that it will be best to discuss them forthwith.

Writing for Beginners.

Children should practise strokes, curves, and letter forms upon a blackboard, using crayons, for the first twelve months. Strokes at different angles should first be tried, then simple curves, and finally letter forms. The child should be allowed to draw the letter as large or as small as he desires. Many children succeed best when they first write a letter about 6 inches in height, and smaller sizes should not be practised until considerable facility has been acquired in drawing letters of the chosen size. Ultimately letters of 2 inches in height should be written by first year scholars. By starting under such conditions the child is relieved of part of the strain that is inseparable from writing upon paper at a desk. While he is standing at the blackboard he is using many more muscles than when sitting; thereby removing a common cause of fatigue. Also the movements are coarser and more free, and he can move along as he writes. Further relief from strain and fatigue is afforded by the more convenient position of a blackboard compared with the top of a desk.

At the end of the first year the scholar may commence writing on paper at a desk. Pens and pencils, however, should not yet be introduced: it is best to begin with black smooth crayon. Writing and drawing with these crayons should occupy the second year, or the greater part of it. The use of the pencil should be introduced afterwards, as this involves the additional strain of fixed attention upon a moving point, as well as the production of much finer lines. Lastly the pen should be used, but coarse pens are best at first.

No movements of the fingers should be expected or allowed for several years. The whole arm in motion should produce the necessary shapes, and freedom and ease of movement are the ideals to be aimed at. These, together with precision, are sufficient to occupy six or seven years.

The Style of Writing.

The choice of the proper style of writing is important because the common injurious postures are connected, to some extent, with certain fashions of letter formation. It is convenient to divide the various scripts into the slanting, the intermediate, and the upright or vertical varieties.

Slanting Style.

In the slanting writing the letters have a slope of about 52°. In order that a proper view of the line to be followed by the writing may be obtained, it is necessary to place the paper to the right of the body and in an oblique position, so that the top and bottom of the paper are not parallel with the top and bottom of the desk. The head is also bent towards the left for the same purpose. Another explanation is that the eye more readily follows vertical strokes than slanting ones, and by these manœuvres the strokes which are slanting to the line on the paper are thereby made almost vertical to the eye. An additional reason is that by the usual method of holding it the fingers would obscure the tip of the pen altogether if the paper were placed squarely in front of the body.

The result is that the right shoulder is raised, the spine is curved to the left, the eyes are at unequal distances from the writing, and there is additional muscular and nervous strain caused by the fact that the child is working up hill.

The Intermediate Style.

In this script the letters have a slant of 75°. From a physiological point of view this is a great advance upon the slanting style, and has met with much favour in business circles. Unfortunately it possesses practically all the disadvantages, modified in extent, which have been mentioned in connection with the slanting script.

The Vertical Style.

This is the only possible style of writing if the child is to sit in a proper position. It has the following characteristics:—

(*a*) Vertical down strokes.
(*b*) Short loops.
(*c*) Round letters.
(*d*) It is the only writing possible in a correct position.

In its favour may be urged many points, the chief of which are: (1) That it is more legible than the slanting style, and so does not strain the eyes so much. (2) It is more easily learned by children. When children begin to write they usually make vertical strokes, and have to be taught, with difficulty, to acquire a slant. (3) The writing point is at equal distances from the two eyes, so that eye strain is again relieved. (4) It can be used by the pupil sitting squarely in the desk, upright, and with the paper parallel with the edges of the top of the desk.

Holding the Pen.

The old-fashioned way of holding the pen is shown in Fig. 64. If it is held in this manner it is impossible to write upon paper set squarely in front of the body, because the fingers altogether hide the tip of the pen. The result is that the improper conditions already alluded to are assumed. Moreover this way of holding the pen is difficult for children to acquire, and is very fatiguing, partly owing to the fact that in this position the radius and the ulna are crossed.

For vertical writing a considerable amount of individual freedom may be allowed the children, but the usual position is with the hand resting on its ulnar side, *i.e.* on the little finger and the side of the hand, so that the palm of the hand can be seen, while the penholder lies nearly in

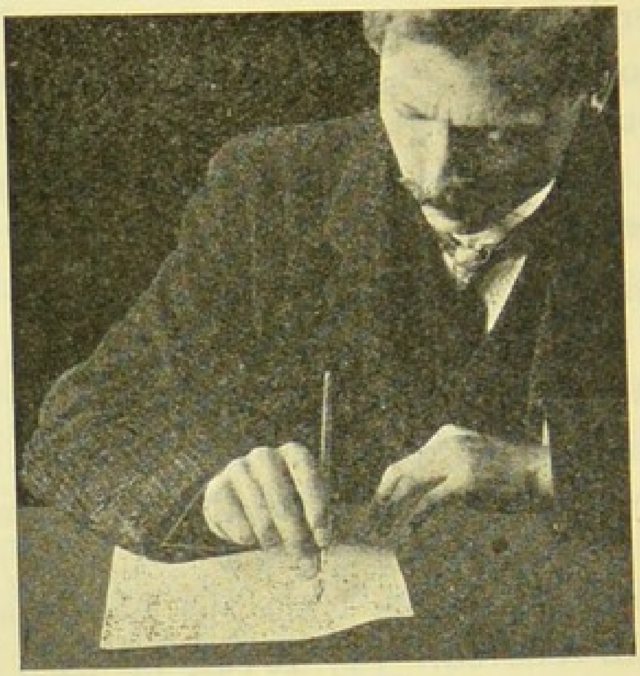

Fig. 64.

Old-fashioned Way of Holding Pen.

the depression between the index finger and the thumb, and points in a direction quite outside the right shoulder. When the hand is in this position the radius and ulna lie practically parallel, and no muscular effort is required to hold them so. The hand moves along on the outer side of the little finger, and the ulnar side of the hand.

The Left Hand.

In the ordinary slanting method of writing, with the pen held in the old-fashioned way, there is little for the left hand to do. The left hand and arm are left practically idle. As a result the left hand tends to be drawn towards the

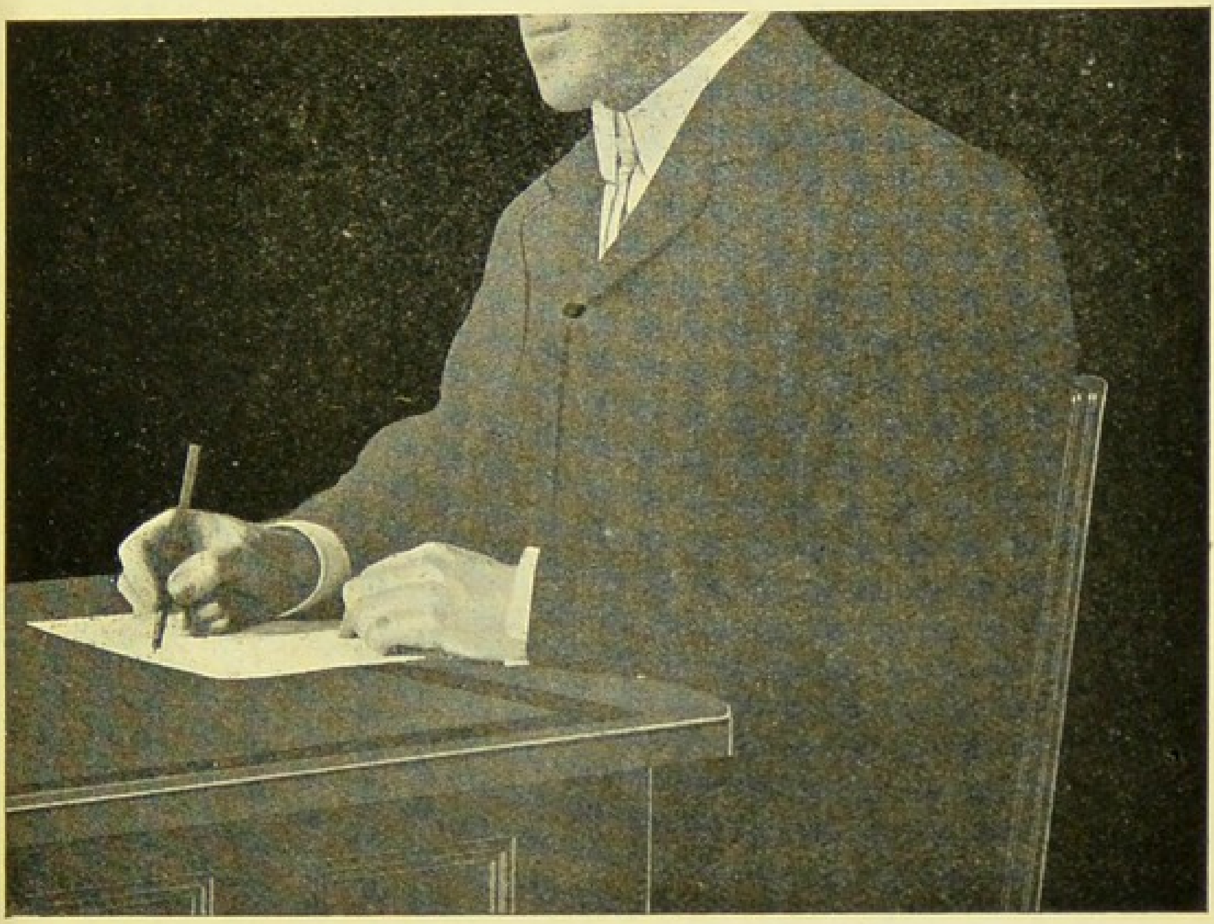

Fig. 65.
PROPER WAY OF HOLDING PEN.
Note position of hands and pose of shoulders.

side, the head is bent to the left, and a position of exaggerated lateral curvature of the spine is assumed. Exercises for the left hand often afford great relief to the child, especially while in the early stages of learning to write. Writing exercises with the left hand will often cause a child to advance much more rapidly with its right-hand writing. While writing with the right hand the left should hold the paper on the desk. In order to give the left hand more active employment while learning to write it has been suggested that strips of paper 5 to 6 inches wide and 2 to 3 feet long should be used. The left hand is

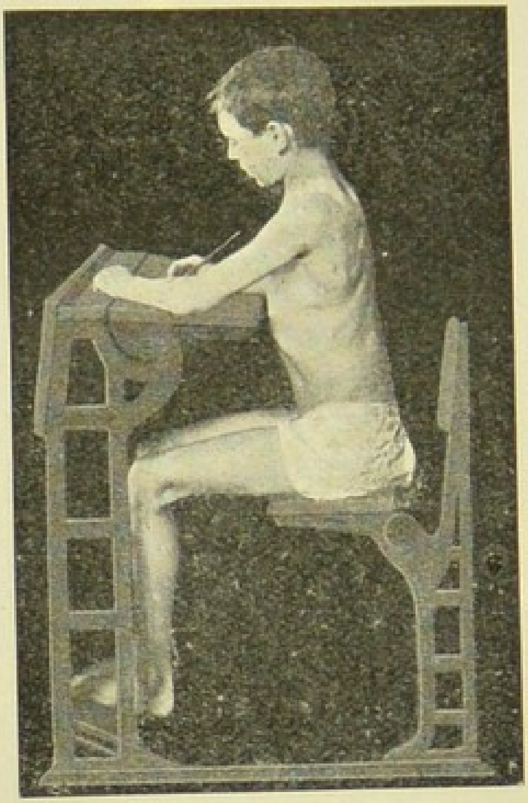

Fig. 66.

Good Position in Minus Desk.

Tiring in zero desk because no support for back.

then constantly employed in moving the paper along so as to keep the writing directly in front.

The Position for Writing.

The paper should be placed directly in front of the child, with its edges parallel to the edges of the desk. It should not exceed $5\frac{1}{2}$ inches in width. The pupil sits squarely in front; the forearms placed equally on the desk; and the elbows at equal distances (about a hand's-breadth) from the sides. The feet should rest fully on the floor, and the top of the desk be drawn to a minus distance of about 3 inches. The desk of course must be adapted to the height of the child, or it will be impossible for such a position to be easily assumed.

4. FOR STANDING.

The position for standing should be modified according to the length of time that the child is kept in that position. For short periods the best position is shown in Fig. 67, where the heels are placed slightly apart and opposite each other, the weight being equally divided between the two legs. The whole body is symmetrically placed. The weight should be thrown slightly on the balls of the feet, the hips drawn back, the lumbar curve of the vertebral column accentuated, the head held well back with the chin drawn in, and the chest thrown forward. Unfortunately such an ideal position cannot be maintained for long periods, because both legs are kept under the same tension and both get tired together. In order to obtain muscular relief and change, the child often adopts the injurious position shown in Fig. 68. For longer periods the best position is shown in Figs. 69 and 70. Here the trunk of the body is in the same position as in Fig. 67, but one foot is in advance of the other. The weight of the body is carried by the posterior leg, the knee of which is held rigid, while the muscles of the other leg are relaxed and at rest. The position is varied from time to time by placing the other foot in advance, and bringing the weight of the body upon the leg that has been rested. This position should not be exaggerated as shown in Fig. 71.

General Rules about Postures.

As a general rule girls are more liable to assume injurious postures than boys, and the results are also much more serious. Sitting with the knees crossed should not

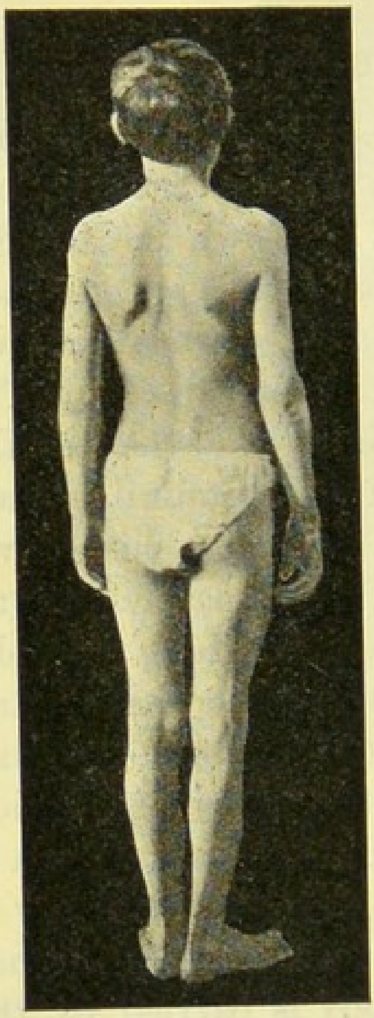

Fig. 67.

POSITION FOR STANDING FOR SHORT PERIODS.

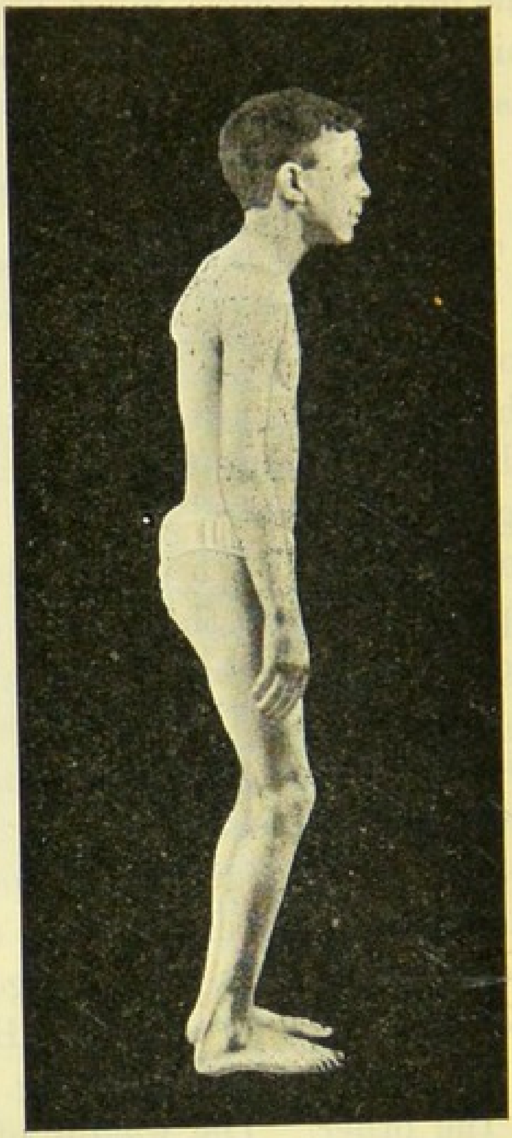

Fig. 68.

COMMON POSITION ASSUMED BY CHILDREN.

be allowed, because of possible distortion of the pelvis. The practice of carrying a load of books in a satchel propped upon one hip is also bad, because it tends to pull down one shoulder, curve the spine, and injuriously strain the pelvis. A common injurious position at home is shown in Fig. 72.

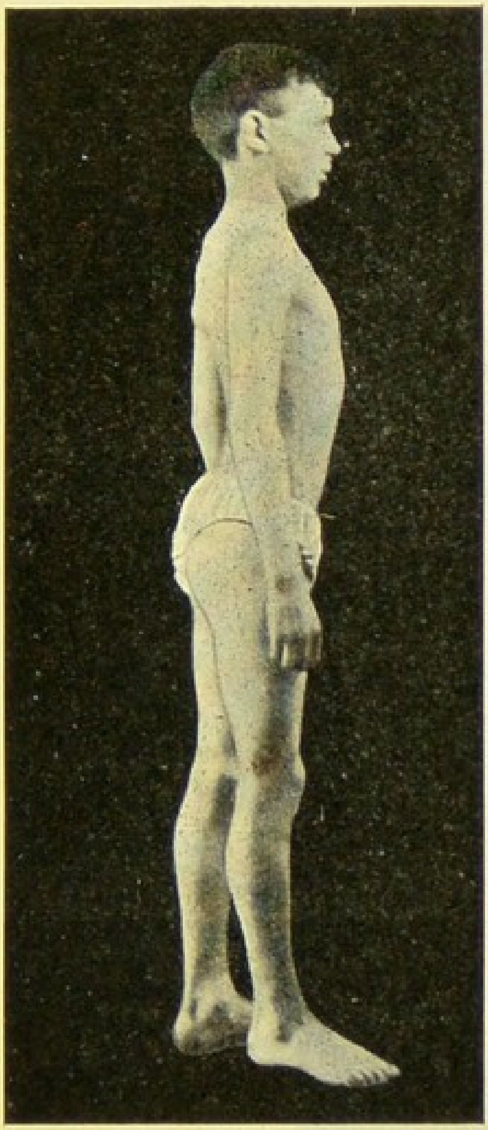

Fig. 69.
Position for Longer Standing.
(Side View.)

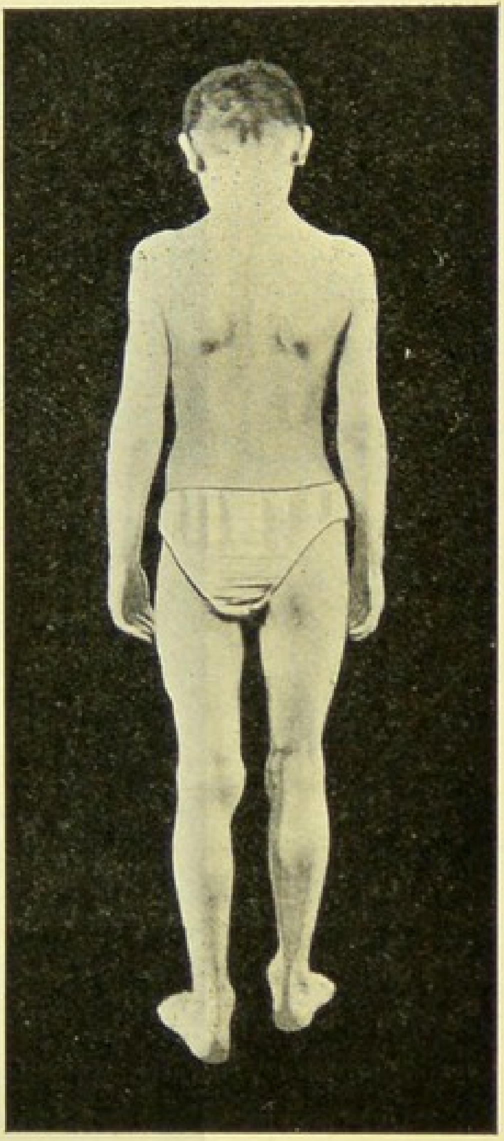

Fig. 70.
Position for Longer Standing.
(Back View.)

It is usually necessary only to exercise vigilance over the postures assumed while the children are in the school or at home. When they are at play, and free to move when and how they like, there is very little likelihood of any injury being produced in this way. The greater the amount of time available for games in the open air the better for the child. Drill, especially for young children, is not advisable,

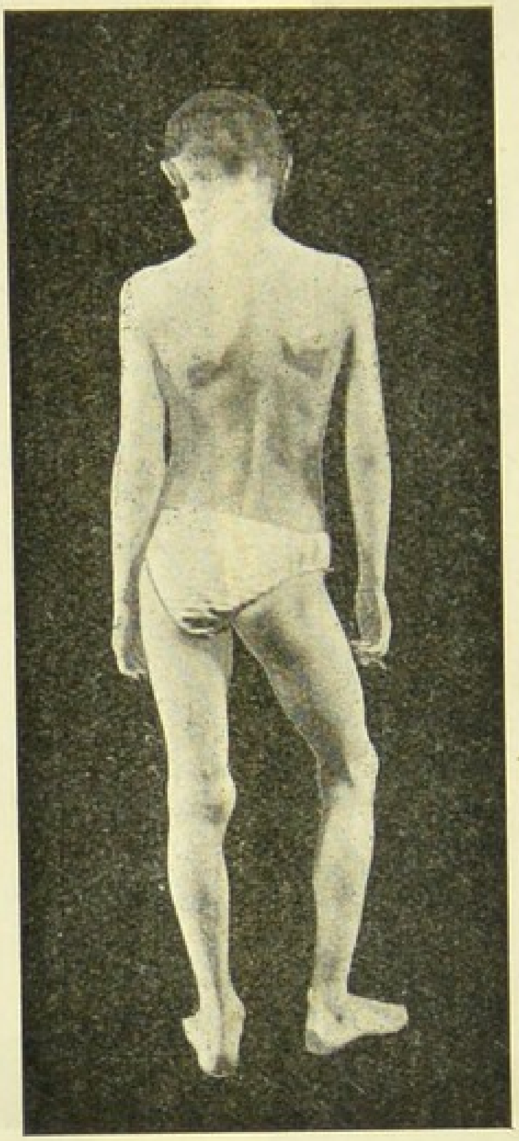

Fig. 71.

Exaggerated Position often assumed by Children, and laterally curving the Spine.

as it rapidly produces a condition of mental and physical exhaustion.

It should always be borne in mind that a child *must* be injuriously affected if compelled to sit in a desk, however well constructed the desk may be, beyond a short period. Young children should not be kept sitting for longer periods than 20 minutes, and for not more than one third of the total school hours. Short periods of sitting should be followed by intervals of activity twice as long out of the seat. These periods of activity should not be

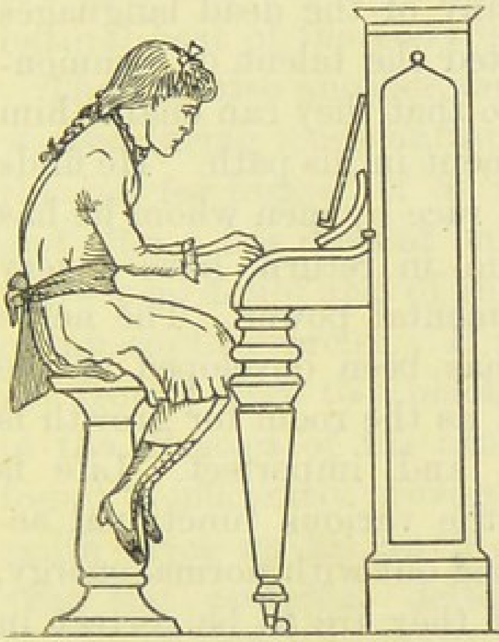

Fig. 72.

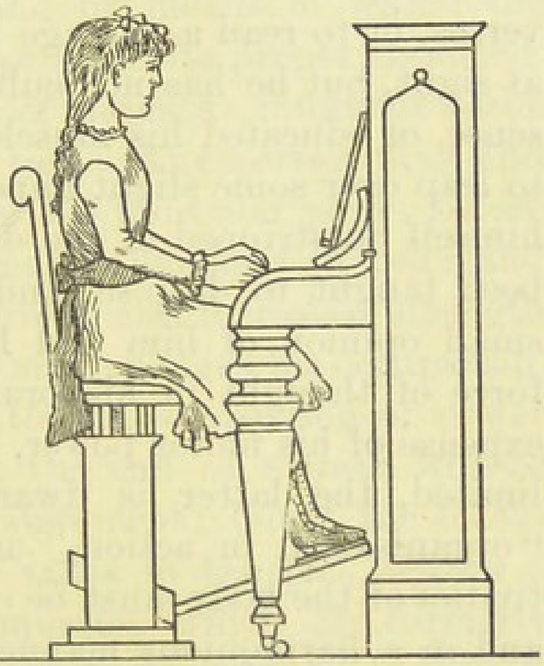

Fig. 73.

occupied by drill in any form, but certainly need not be devoted to play.

PHYSICAL EXERCISES.

The narrow view of the function of the schoolmaster is well exemplified in some schools, by the entire banishment of physical exercise from the rota of school-work. We send our children to school for the purpose of training them for the battle of life, which they will have to encounter when they reach to man's estate. It is by the equal and continuous development of each and every part of the body that this battle will be fought with success, and if one part developes at the expense of another, or by its more rapid development puts a bar to the progress of the others, the subject of it is at disadvantage in his future struggles. Many a Cambridge wrangler and Oxford first-class man has found this out in after life. He is able to solve a problem in differential calculus, to make Latin verses, or to read a passage in any of the dead languages at sight, but he has not cultivated the talent of common-sense, or educated his muscles so that they can enable him to leap over some slight impediment in his path. He finds himself outstripped in the daily race by men whom he has been taught to despise, and who, in return, have a very small opinion of him and his mental power. The nerve force of thought in his brain has been developed at the expense of his motor power, and as the room for growth is limited, the latter is dwarfed and imperfect. Life is "organisation in action," and the various functional activities of the body must be carried out with normal energy, and in a harmonious manner, if they are to be correct in their responses to any and every call that may be made upon them. Physical exercise is indispensable; and it is quite impossible for the functions of respiration and circulation to be carried on in a proper manner if the muscular system is not developed, or if the material which is necessary for the formation of the muscle is not used up in its proper order. If the muscles are not used equally with the brain tissue, some used-up matter is kept back, and will sooner or later act as an impediment to proper brain work, by getting in the way of the latter when it requires all the room which ought to be at its command. The assimilative and disarranging processes of the body are greatly influenced by the activity or inactivity of the muscular system. Hence it follows that no school is properly constituted which does not provide an exercise ground for its pupils, and make the cultivation of muscular force a part of its daily routine. This is not the place to deal with the general effects of exercise, but it will not be out of order to call to mind the fact that, the natural heat of the body being 98·4, it follows that something must be produced in the blood which is the *débris* of the continuous fire that is always burning, and by means of which the natural heat of the body is kept up to its proper standard.

There is also another aspect of the case: muscular tissue wastes during long-continued rest. Any person may find this out for himself if he notes his muscular power before and after a few days of enforced confinement in bed; and there is no doubt also of the growth and increased strength of muscle by exercise. If any man changes his occupation, say from a clerk to a blacksmith, the comparison of power in the muscles of his arm at the end of a year will be found to efficiently prove this statement; but if the blacksmith gives up his anvil and takes to the pen, within a year the powerful deltoid muscles which he formerly possessed will be dwarfed and comparatively impotent. Let a man or a boy have sufficient intervals of rest between his times of labour, and whether that labour is brain work or muscle work it will tend to increase the power of the organ exercised, and the action of the one will by its own work clear the blood from the *débris* which has been produced by the work of the other. The more powerful minds will therefore be found among those men who do not neglect their muscular development; whilst the total neglect of mental work, which bodily labour sometimes compels the sons of toil to submit to, keeps them at a lower level in the scale of humanity than will be the case when both systems are allowed a chance by being worked alternately, as they ought to be in every well-ordered school. We must bear in mind that by exercise the individual fibres of a muscle increase in size. The contraction of the muscle is one of the means by which an ample supply of blood is brought for the nourishment of the new tissue. If exercise is not forthcoming, the tissue dwindles and becomes fatty in its character, loses its proper elasticity, and does not leave room for new cells to take its place, for it is not removed in the way that a regularly-exercised muscle is. (Carpenter.)

There is no doubt whatever that in practically all the chief public schools the two extreme types are continually met. There are a number of lads who are encouraged to devote themselves to games in order to bring the school renown in the athletic world. Provided that the lad does sufficiently well there are often influences at work on his behalf, and instances are not uncommon of those who are by no means mentally distinguished being placed in positions that should be reserved for those who have at all events acquitted themselves creditably in mental contests. On the other hand the boys who show unusual brightness of intellect are encouraged to undertake excessive mental tasks, and are systematically "crammed" in order to advertise the school by winning some scholarship. A little more attention in both directions might be profitably given to the "average" boy.

The judicious combination of exercise, rest, and sleep plays a very important part in the health of the individual. Lack of exercise is soon followed by atrophy, or wasting away of the parts that are not used. A muscle that is not exercised, but lies idle, soon wastes away and becomes useless. This is particularly noticeable in the case of a broken or paralysed limb. The lack of use soon produces wasting and loss of power of the limb. The brain also, when not exercised by study and reading, does not develop to its fullest possible extent. On the other hand, unless the exercise is combined with the proper amount of rest, the results are even more disastrous, as the body becomes overworked and exhausted.

Exercise is necessary at all periods of life, but especially so during childhood and early manhood or womanhood. It is the duty of all parents to see that their children enter into the school games, and spend a great deal of time in the open air. Practically all schools have now adopted physical exercises as part of their curriculum in recognition of the importance of these to the children. In the case of adults the exercise that should be indulged in must depend upon the nature of the daily work. Thus, if a man is doing bodily work all day, his muscles have had quite sufficient exercise, and mental exercise is what he needs for his spare time. On the other hand, those whose occupation is sedentary, such as clerks, students, etc., need physical exercise in their spare time, in order to bring their muscular, circulatory, and respiratory systems to the proper pitch of development.

For any beneficial result, the exercise taken must be systematic and regular, and not indulged in by fits and starts. By gradually and steadily increasing the work done by them, a set of muscles may be greatly increased in size, but there is a limit to this increase, and if the work be carried to excess the muscles will begin to waste away. Care should be taken to give every muscle of the body its necessary exercise. Many of our sports are faulty in leaving most of the muscles idle. The best real exercise for all the muscles is probably obtained by boxing, lawn tennis, and Rugby football.

Violent exercise should never be taken without proper training. By training, we do not mean the old-fashioned idea of feeding a man on limited rations of half-raw meat, but simply an outdoor life, with plenty of good, nourishing food, and no lack of exercise for all the muscles. Violent exercise, without proper training of this kind, is likely to lead to most disastrous results, the commonest of which is heart disease resulting from overstrain.

Some of the physiological effects of exercise deserve special mention. We have already mentioned that the muscles are increased in size and are rendered capable of doing more work. By exercise they are also brought more under the control of the will. The first effect of exercise is, perhaps, the quickening of the heart beat and the rate of respiration. The heart beats more rapidly and more forcibly, causing an increased flow of blood through the blood vessels all over the body. If the exercise be sudden and violent, the heart may be incapable of meeting this sudden demand upon it, and the valves may be rendered incompetent, giving rise to heart disease. But by gradually increasing the exercise the heart is strengthened and the coats of the arteries are made stronger and healthier.

Respiration is also quickened by exercise. The amount of air taken in at each inspiration is increased, and larger quantities of water and carbon dioxide are given out in the expired air. Thus, a man at rest draws into his lungs each minute about 480 cubic inches of air, but if walking at the rate of three miles per hour he takes in 1550 cubic inches of air, and if he increases his rate to six miles per hour, the amount of air that he inspires is raised to 3250 cubic inches.

The skin acts freely while exercise is being taken. The blood vessels surrounding the sweat glands are distended with blood, and the secretion of sweat is increased. In this way an extra quantity of waste matter is removed from the body by the skin.

Other effects of exercise include the exhilaration and strengthening of the nervous system, the improvement of the appetite and digestion, and the stimulation of the kidneys and bowels, thereby aiding the elimination of waste matters from the body.

For the scholars in our schools there is little to choose between the various games. Cricket, football, rounders, rackets, tennis, fives, leapfrog, hopscotch, blindman's buff, skipping, swimming, and many others may be said to be almost equally good for children. Any game that organises children to perform free and natural movements in the open air or in well ventilated rooms should be encouraged. All that the child requires is to be taught a few games. Most healthy children may be safely left to themselves after that, so far as active supervision is concerned. A child who has had the proper amount of both mental and physical exercise during the day will sleep soundly at night, and will be completely refreshed after its proper night's rest.

One of the natural results of the increased circulation followed by increased secretion and evaporation which are caused by exercise is an increased desire for water. This should always be gratified, and children should be encouraged to drink freely, particularly after exercise. Ice-cold drinks should be avoided, but it is not dangerous to drink cold liquids while the body is heated provided it is taken in sips. A plentiful supply of water is needed by the body to dissolve the waste products which are formed, and to convey them in the dissolved condition to the excretory organs.

While discussing physical exercise for children a word about drill would not be out of place. It has been pointed out that systematic exercise for children is an imperative necessity if they are to be healthy physically and mentally. The mental level of any school will inevitably be low if physical exercise is not recognised as a necessary part of the time-table. But all that is necessary is proper organisation of *games*. Games, no matter how simple or how trivial, are all that are necessary. Personally I regard drill in schools, particularly for children under 14 years of age, as an unmitigated evil. As the result of close observation extending over a long period and a wide area of educational work I am convinced that a comparatively short period of drill rapidly reduces a child to a condition of physical and mental exhaustion. The movements of drill are stiff, unnatural, strained, and monotonous, and are performed under physical and mental stress. A child can play hard for an hour or two and then be ready for good mental work, but after twenty minutes drill the average child returns to work with a dulled intelligence and a lack of energy for further work of any kind. The attention is strained during the whole period of drill. During my lectures to teachers all over the West Riding of Yorkshire (West Riding County Council Lectures) I vigorously preached this doctrine and was particularly pleased to receive obvious signs of approval from the teachers. Most practical teachers are agreed that drill is undesirable for the child. All "systems" of drill must be kept out of the schools: they are useful only in special, individual, and peculiar cases; they do the average child more harm than good. Dr. Carpenter in his *School Hygiene* advocates drill for schools, but, curiously enough, illustrates his contention with an event that serves to prove rather conclusively the opposite theory. The circumstance occurred at the Anerley School, where the introduction of a drill master and drill served to exhaust the boys to such an extent that horseplay and mischief in the dormitories disappeared.

The healthy boy who is too tired for mischief, when a slack discipline permits it, is overtired, which is another way of saying that he is exhausted. It should be unnecessary to remark that the excellent practice of causing the children to stand out of the desks for a few seconds between lessons and to make a few simple movements is beneficial in many ways, as it relieves cramp and promotes the circulation. No precision of movement or correct position should be insisted on.

The Recess.

In order that physical exercise may be possible there should be at least a fifteen minute recess in the middle of the morning and also of the afternoon school. This is the absolute minimum, and twenty minutes is desirable in every school. These intervals should be fully occupied by simple games that can be commenced instantly by groups of the scholars, and it should be the duty of the teachers to organise some such system. Most of the children in our schools are taught no games properly, and the result is that the precious moments of the inadequate recess are wasted, except that the children are in the open air. Proper activity during these times will tend to counteract the tendency towards malformations which improper postures have commenced. The deeper breathing purifies the blood and removes some of the ill effects of insufficient ventilation, and in every way the recess should be regarded as the absolutely unalterable part of the school time-table.

The Games.

But it must not be thought that these intervals of recess give sufficient physical exercise for the children. The systematic organisation of school sports should include the summer evenings and the two half-holidays for secondary schools, and the evenings and Saturday mornings for primary schools. This organisation, if expected from any of the teaching staff, ought to be rewarded by proper payment. It is no exaggeration to claim that if any town or district devoted proper attention to this subject in its primary schools there would be an immediate improvement in the mental, moral, and physical condition of the children, and benefits would be conferred that would be lifelong. All teachers of experience are agreed upon this. In those schools which muster a team for cricket, football, jumping, or swimming competitions, the effect upon those children who are fortunate enough to get selected for such training is most marked. The labour involved is not excessive. The energy of the British child is usually naturally exuberant, and simply requires directing along the right lines. A training in games and school contests tends to give perception and judgment, courage and skill, coolness and quick decision. The benefits of these in after life, particularly if they are not conferred by the sacrifice of proper mental training, are incalculable.

Dr. Dukes says: "No question in the training of the young is of more general importance than the mode of employing the *out-of-school* hours. Are the young as fully and wisely occupied in that time as during the hours of work? If not, moral discipline must be absent. Do the boys take regular and vigorous exercise? If not, no sound health can result. Is their freedom from work a period of cheerful recreation, and constant lively occupation; or is every hour a time of weariness and idle lounging? If the latter, then no guarantee for conduct exists, and the character and tone of the boys must deteriorate."

The essential idea should be that *all* must play. Among primary schools at present, even under the best conditions, there are a few scholars selected for the teams and all the attention is devoted to them. Also the necessary time and trouble are given quite voluntarily by usually one enthusiastic and good-natured member of the staff. The education authorities quite fail to recognise that physical education demands quite as much deliberate study, care, and method as mental training, and that it confers qualities which are *at least* as valuable in after life as those obtained by usual "education" as we know it at present.

It should be remembered that all violent forms of exercise should be discouraged among girls. I am convinced that violent exercise at hockey or tennis is calculated to produce injury. The best and most uniform results are obtained by organising the simpler and less exhausting games among girls.

A **gymnasium** is not desirable for primary schools. It has many advantages for a secondary school, but it must not be allowed to take the place of games. In fact the use of the gymnasium should be mainly limited to the winter, after dark, and on wet days. Like drill it is not recreation, but merely a change of work, and the exercise of the young must be recreation as well as exercise.

Before dismissing the subject of physical exercises and games it is necessary to point out that there should be a physical examination of all scholars on entrance to the school. This should be carried out as carefully and as thoroughly as though for life assurance. Unless this is done those children who are most in need of physical education may receive grievous injury by indiscriminate, unregulated, and unwise exercise.

BREATHING EXERCISES.

The well-known injunction, "Shut your mouth; keep your mouth shut," should be one of the golden rules of childhood. Respiration can only be carried out properly when the air enters through the nose. A vast number of children, however, habitually breathe through the mouth. Many of these are unable to use the nose because it is partly or wholly blocked by adenoid vegetations, attacks of catarrh, or some other cause. Such children are usually of low vitality, and they soon give up all attempt to breathe through the nose. Where there is a mechanical obstruction it is obvious that breathing exercises are of little or no use until the obstruction is removed. On the other hand there are a great many children, and probably a rapidly increasing number, who have simply acquired the bad habit of mouth breathing, and to this bad habit may probably be traced the increase in the numbers of adenoid children. Mouth breathing as a bad habit is often acquired by weakly children, and in such cases it is practically always followed by nasal obstruction.

Whether the mouth breathing be due to a mechanical obstruction or to a bad habit it has a great and far-reaching effect upon the health, development, activity, and usefulness of the child throughout life. Lack of use is always followed by arrest in development, and as the nasal passages are mainly for respiration it necessarily follows that those regions will not take part in the general growth of the child if they are no longer used. The respiratory system as a whole remains undeveloped owing to partial use only, and the whole body and life of the child is necessarily affected. "A debilitated child, with low vitality, impaired energy, and lax tissues, will, if nasal obstruction be added to the other defects by which it is handicapped, find it too much trouble to breathe fully. It gives up running or playing games which would compel it to expand its chest; it muddles through life at a low level of respiratory exchange." (*British Medical Journal*, 1905.) Weakly children of this type in fact breathe almost wholly by the contraction of the diaphragm, and where these respiratory peculiarities are combined with softness of the bones, as in rickety children, the contraction of the diaphragm will usually cause a well-marked depression, running outwards and downwards on each side of the chest wall, and marking the attachments of the muscle to the ribs.

Breathing exercises will be found very useful to occupy an odd minute or two between lessons. Of course they are useless, or nearly so, if the air is impure, so that all windows should be widely open at the time. No child can breathe properly when in a stooping position. The position of the shoulder-blades is important; they should be forced downwards and towards each other. A good plan is to teach the children to sit and stand with the hands firmly held on the hips, the shoulders pulled back and held steady, and the shoulder-blades pulled downwards and onwards. The child should then be taught to take slow steady breaths through the nose, the mouth being firmly closed, raising the chest to accommodate the extra quantity of air, and keeping the shoulders fixed. The object should not necessarily be to increase the permanent growth of the chest, but to make as great as possible the *difference* between the fullest expansion and the greatest contraction. The most vital measurement is the difference between the full and the empty chest. The power of emptying the chest, as well as the capacity for increased expansion, will be found to improve wonderfully with a little practice. The above mode of breathing should be practised several times daily, but not for long at a time. It will be found, in a large number of cases, to induce a habit of calm, deep, steady breathing, and a marked difference will be noticeable in the shape of the chest, as well as in the general bearing and health. Such exercises, in fact, if generally and thoroughly carried out in every school, and by all children, would do more than anything else to cause a rapid diminution in the number of cases of adenoids in children and consumption in young adults, and, in addition, practically wipe away such complaints as indigestion and anaemia.

The following exercises are recommended by a writer in the *British Medical Journal*, 1905:—

"1. Extend the hands and stretch the arms forwards from the shoulders, leaving about a foot between the hands, which should be turned with the palms inwards and fingers stretched out straight. Slowly move the arms backwards as far as they will go (while deeply inspiring), and slowly bring them forwards until they are in the same position as at starting (while deeply expiring). Repeat this from three to six times.

"2. Hold the hands down with the palms against the legs. Raise them with palms inwards (inspiring), and when they are immediately above the head turn the palms outward and slowly bring them down to the sides (expiring). Repeat from three to six times.

"3. Hold the hands against the thorax, with the fingers pointing inwards and touching back to back. Then with a swift movement swing the arms out as far as they will go (while inspiring). Begin again (expiring), and repeat half-a-dozen times.

"4. Keep the arms down, the palms touching the sides, slowly turn the palms outwards as far as they will go (inspiring), and slowly bring them back to the sides (expiring). This may be done six or eight times. This exercise, apparently so simple, expands the chest and presses together the shoulder-blades."

It would be difficult to improve upon this simple and valuable set of exercises.

It may be useful to reproduce here the syllabus of breathing exercises recommended by the Inter-departmental Committee on the Model Course of Physical Exercises as presented to Parliament:—

DEEP BREATHING EXERCISES.

These exercises are of great value, and should form part of the daily training of every scholar. It is of great importance that the correct method of nasal breathing should be taught from the beginning of school life.

1. *For Infants*, a simple imitative exercise is the most easily acquired.

The infants, standing or sitting, and watching the teacher, place the left hand over the pit of the stomach and breathe in as she does, noticing the hand rise during inhalation. The child then breathes out slowly, the hand at the same time sinking. On each occasion the teacher must watch the class carefully, and note that all the mouths are firmly closed, and that all breathing is through the nostrils only.

This exercise should be repeated about 6 times at least twice daily.

2. *For Older Pupils.*

The teacher, starting from the position of attention, should see that all the mouths are firmly shut; then on the command *Breathe—In* (slowly given) instruct the pupils to breathe in slowly and deeply through the nostrils only, until the chest is fully expanded; then on the command *Breathe—Out* (slowly given) to breathe out quietly and steadily; this exercise should be repeated about 10 times at least twice daily. When the exercise is repeated the commands *In*, *Out* only should be used.

Note.—Care must be taken that during inhalation the head and chest be not thrown too far back, nor the abdomen thrust forward.

When the exercise has been thoroughly acquired, it can be gradually combined with the slow arm movements, which bring into play the auxiliary muscles of respiration.

3. *Combined Breathing and Slow Arm Exercises.*

When a combined movement is used, the caution, *With Deep Breathing*, should always precede the command for the arm movements, *e.g.*—*With Deep Breathing, Arms Sideways—Raise.* The arm movements employed should follow the rhythm of normal respiration (inhalation, exhalation—pause; inhalation, exhalation—pause), etc., and the breathing act must not be made to follow any artificial or arbitrary rhythm like that of music. It is also impossible that all members of a class should do the movements in absolute unison, for no two persons breathe naturally exactly alike.

The most suitable arm movements to combine with the deep breathing exercises are:—

WITH DEEP BREATHING—ARMS SIDEWAYS RAISING.

With Deep Breathing, Arms Sideways—Raise (One).	Raise the arms sideways in line with the shoulders, fingers extended, and palms downward, and at the same time breathe in slowly through the nostrils until the chest is fully expanded.
Lower (Two).	Breathe out naturally, and at the same time lower the arms to the sides.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing, Arms Sideways Raising, Heels and Arms—Raise (One); Lower (Two).*

WITH DEEP BREATHING—ARMS SIDEWAYS AND UPWARD RAISING.

(To be done as a continuous movement.)

With Deep Breathing, Arms Sideways and Upward—Raise (One).	Raise the arms as above, keeping the arms straight and well back, turn the palms smartly upward, and immediately raise the arms until they are vertical above the shoulders, and at the same time breathe in slowly through the nostrils until the chest is fully expanded.

Lower (*Two*) { Breathe out naturally, and at the same time lower the arms sideways and downward.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing*, *Arms Sideways and Upward*, *Heels and Arms—Raise* (*One*) ; *Lower* (*Two*).

WITH DEEP BREATHING—ARMS CIRCLING.

With Deep Breathing, Arms Circling —Raise (*One*). { Raise the arms forward to the level of the shoulders, palms inward, elbows and fingers straight, arms parallel, continue the movement upwards till the arms are vertical, and, at the same time, breathe in slowly through the nostrils until the chest is fully expanded.

Lower (*Two*). { Breathe out naturally, and at the same time lower the arms sideways, first to the level of the shoulders, keeping palms upward and arms well back, then turning the palms downward and lower the arms to the sides.

(*a*) This exercise may also be combined with *Heels Raising*, the commands being *With Deep Breathing*, *Arms Circling*, *Heels and Arms—Raise* (*One*) ; *Lower* (*Two*).

N.B. *Breathing Exercises* should always be taken at the end of a physical training lesson, in order to prepare for rest, and also to aid in the elimination of the carbonic acid accumulated by the repeated contractions of the muscles during the lesson. They may also with advantage be taken in the course of Physical Training lessons or other school work.

In connection with these exercises the attention of the teacher is specially directed to the fact that the object of such exercises is the healthy functioning of the lungs, not mere increase of chest capacity. The vital measurement is not chest capacity simply, but difference between the full and the empty chest.

CHAPTER III.

THE EYES AND EYESIGHT.

DURING school life it is important to realise that the body of a child is an organism highly susceptible to the effects of injurious influences. Also that while a child is at school it is surrounded by influences that are more or less injurious to its physical well-being. Most of the parts of the child's body, however, although highly susceptible to injury, have a wonderfully great recuperative power, so that although injury is undoubtedly produced during school hours it is recovered from during the intervals. Some of the organs unfortunately have little of this power of recovery, and the eye is one of these. If the eye of a child is injured by the school conditions there is little possibility of repair. The defect may, of course, be remedied by proper glasses, but these do not repair the mischief. The greatest care should therefore be taken in order to prevent injury to the eyes of school children. Under modern conditions it is a serious thing for the worker to show signs of advancing age, and the wearing of spectacles does not improve a man's chances. At all events no one will deny that it is better to remove the initial causes of eye strain as far as possible rather than to attempt to correct the effects. With regard to children suffering from eye defects it should be remembered that they are not only handicapped in the struggle to keep the educational pace with children of normal vision, but in many cases suffer from the nervous results of defective vision—headaches, irritability, exhaustion, loss of interest, feebleness of will.

Before describing how eye strain affects the eyes, it is necessary to have an elementary knowledge of the structure of the eye.

STRUCTURE OF THE EYE.

The human eye is often likened to a camera, and, as most people have had to do with photography either in the active or the passive sense, the comparison is a convenient one. The essential parts of a camera are a box to give and maintain the necessary shape to the instrument, a convex lens to produce the picture, and a sensitive plate to receive and record it. In addition to this the box must be blackened inside to prevent reflection of light, and there must be some mechanism for focussing if pictures of objects at varying distances are to be photographed.

Coats.

The eye has three coats or layers—

1. The sclerotic and cornea.
2. The choroid and iris.
3. The retina.

The sclerotic or the white of the eye is a tough, dense, fibrous membrane forming the greater part of the substance of the eyeball. It is the only part of the eye that is capable of resisting any strain, so that if by any chance it stretches or gives way the rest of the structures will at once follow suit. In front it is continued as the cornea, which, being transparent, forms the window of the eye.

The choroid lies internal to the sclerotic, and is a network of blood-vessels. Its inner surface is black in order to prevent reflection, which would cause confusion of the images. This layer of black pigment is absent in albinoes, who, in consequence, are almost blind in bright daylight. Under the cornea the choroid is represented by a specialised structure called the iris, which is a circular contractile diaphragm. The central hole is called the pupil. Varying proportions and distribution of pigment deposited here give the different colours to different eyes.

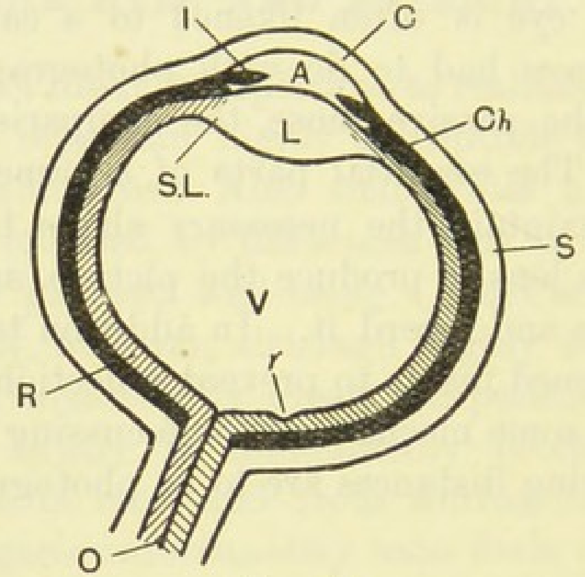

Fig. 74.

DIAGRAMMATIC SECTION OF EYE.

A, Anterior chamber filled with aqueous humour; C, Cornea; Ch, Choroid; I, Iris; L, Crystalline lens; O, Optic nerve; R, Retina; S, Sclerotic; SL, Suspensory ligament; V, Vitreous humour; Y, Yellow spot.

The retina forms the inner coat of the eye, and represents the sensitive plate of a camera. It is extremely delicate and thin, averaging only about $\frac{1}{80}$ inch in thickness. It has a complicated structure, being made up of a vast number of minute bodies, placed together side by side like the squares of a mosaic, and is really an elaborate signalling apparatus for sending signals to the brain referring to the kind of impressions that it is receiving. One spot of the retina, called the yellow spot, differs from the remainder in its structure. It is the region of most distinct vision—*i.e.* the spot upon which objects are focussed when they must be seen distinctly, as in the case of all special work such as reading, writing, or sewing. The enormous number of tiny nerve fibres from all parts of the retina are collected together at the back into a large trunk or cable called the optic nerve. The messages pass along these fibres to the part of the brain that has to deal with them. This part of the brain is best regarded as a kind of central office for receiving and interpreting these multitudes of messages.

Contents.

The contents of the eyeball are:

1. The aqueous humour.
2. The crystalline lens.
3. The vitreous humour.

The aqueous humour is a watery liquid occupying the chamber between the crystalline lens and the cornea. The crystalline lens is a translucent solid body, composed of soft gelatinous living tissue, situated immediately behind the pupil and partly imbedded in the vitreous humour. It is convex on both sides, but more so behind. In early life it is nearly spherical and soft, but becomes more flattened, firmer, and amber-coloured with advancing age. The lens is held in position by its capsule and suspensory ligament. The vitreous humour is a jelly-like material lying at the back of the lens and occupying about four-fifths of the interior of the globe. The above three substances are transparent, and with the cornea constitute the refractive media of the eye, which conjointly act as a converging lens, the function of which is to bring the rays of light to a focus upon the retina.

Muscles.

Attached to the outside of the eye are six muscles, four straight and two oblique. The four straight muscles

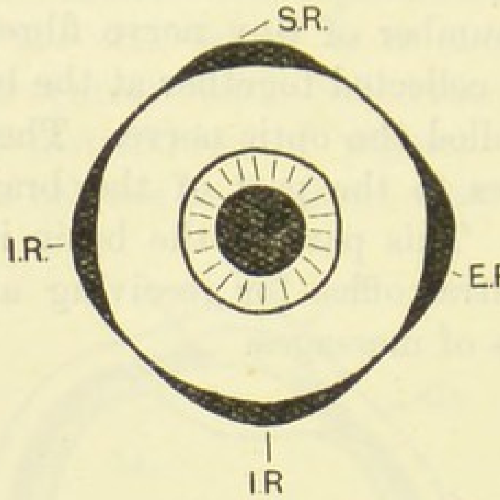

Fig. 75.

INSERTION OF THE STRAIGHT MUSCLES.

SR, Superior Rectus; IR (below), Inferior Rectus; ER, External Rectus; IR, Internal Rectus.

are attached symmetrically round the globe, above, below, right, left. These muscles, by their contractions, enable us to direct the eye towards different points. It is obvious that by the single action of one, or the combined action of two, the eye can be turned towards any direction. The two oblique muscles are inserted, slantwise, one above and one below the eye. By their contraction they can rotate the eye on its axis. Their action is best understood if a mark in the iris be watched while the head is moved from side to side. It will be then seen that the eye does not rotate with the head,

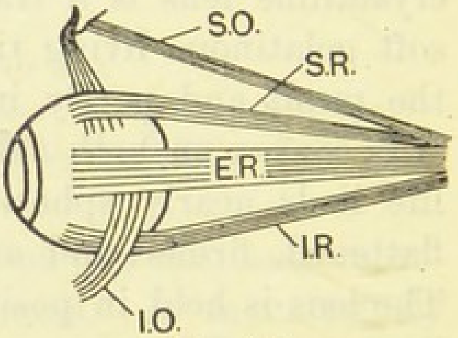

Fig. 76.

MUSCLES OF THE EYE.

SO, Superior Oblique; IO, Inferior Oblique; SR, Superior Rectus; IR, Inferior Rectus; ER, External Rectus.

but keeps its vertical meridian always vertical, during moderate movements of the head, by the contraction of its oblique muscles.

ACCOMMODATION.

If a candle, a convex lens, and a screen are held in line it is easy, by adjusting the distances separating them, to get a clearly defined image of the candle flame upon the screen. The image is then said to be *in focus.* If the candle is moved further away or nearer to the lens the image on the screen will become indistinct and is out of focus. In the same way it is necessary to adjust, or focus, a telescope or field-glass in order that the desired object

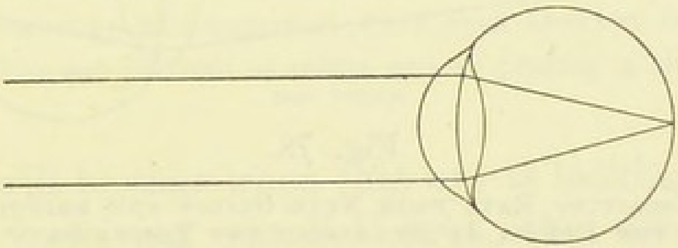

Fig. 77.

Normal Eye receiving Parallel Rays (from distant objects) and bringing them to a Focus on the Retina.

may be seen clearly. Now we know that the normal eye has the power to direct its attention to a distant object and see it clearly, and then immediately to turn its attention to a near object and see that equally clearly. This is called accommodation. It is accomplished by altering the convexity of the lens. The convexity of the lens is increased by the contraction of a small muscle inside the eye. The more convex the lens the greater the power it has of turning the rays of light out of their original path and causing them to come to a focus. When the eye is looking at distant objects it is receiving light composed of rays that are practically parallel to each other, and the normal lens is capable of bringing these to a focus on the retina. Rays are practically parallel when springing from a point 20 feet or more distant. From near objects, however, the rays are divergent, and need more turning to bring them to a focus. In order to focus such rays the convexity of the lens is altered to the necessary extent by the contraction of the muscle already referred to. So that when looking at distant objects there is no muscular strain, and hence no fatigue, but looking at near objects involves contraction of the muscles and is liable to bring

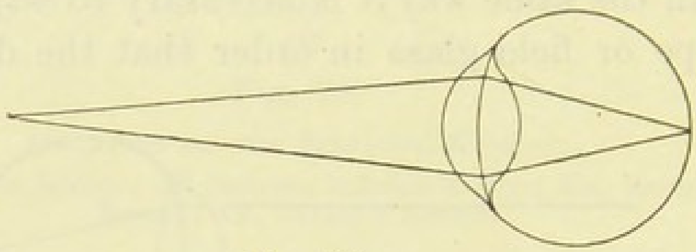

Fig. 78.

NORMAL EYE RECEIVING RAYS FROM NEAR OBJECT AND BRINGING THEM TO A FOCUS ON THE RETINA BY INCREASING THE THICKNESS OF ITS LENS (ACCOMMODATION).

about strain and fatigue. Also when looking at near objects there is necessarily contraction of the external muscles of the eye in order to pull the eyes towards each other, and so that the axis of each eye is directed towards the object to be seen. It therefore follows that the nearer the object is that we look at the greater is the muscular strain inside the eye, the greater the tension on the sclerotic by the muscles pulling outside, and the greater the pressure exerted by the semi-liquid contents of the eyeball. These strains are likely to distort the shape of the eye. Looking at near objects involves muscular effort and exertion, and if unduly prolonged will cause fatigue, a condition which still further increases the tendency towards distortion.

DEFECTIVE EYES.

Short-sighted Eye.

When the strain upon the sclerotic coat becomes too great for it to withstand it stretches. Like all materials it stretches at its weakest part, which happens to be at the back. Stretching in this region will cause the eye to become longer than normal in its axis from front to back.

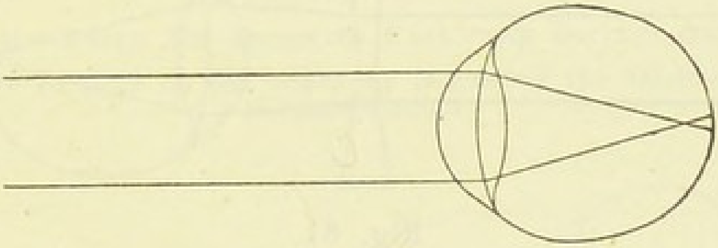

Fig. 79.

SHORT-SIGHTED EYE RECEIVING RAYS FROM DISTANT OBJECT.

These rays are focussed in front of retina and so produce a blurred picture on the retina.

The result will be that when this eye is looking at distant objects, *i.e.* receiving parallel light, the usual amount

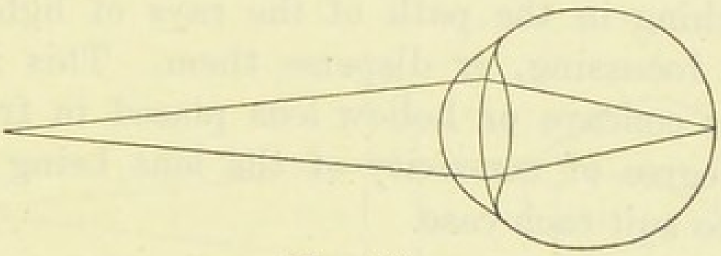

Fig. 80.

SHORT-SIGHTED EYE RECEIVING RAYS FROM NEAR OBJECT.

These rays are accurately focussed on the retina and produce a clear picture.

of focussing will form the image in front of the retina (because the retina is farther back than usual). The picture thrown upon the retina will therefore be blurred and indistinct. But when this eye looks at near objects the light that it receives consists of divergent rays which require more turning to bring them to a focus, and which therefore tend to come to a focus farther back. The result is that a clear picture is formed on the retina in this case and the eye sees the near objects quite well. Such an eye is therefore called short-sighted (or myopic). It is important to remember that a child is never born

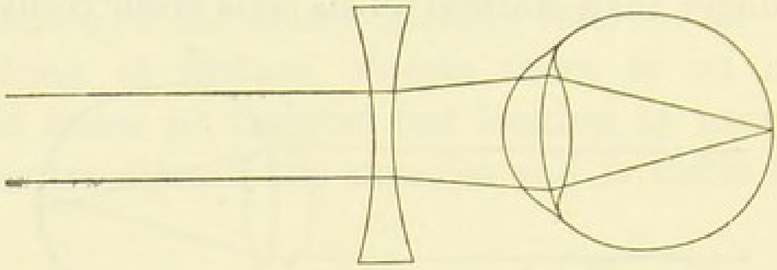

Fig. 81.

SHORT-SIGHTED EYE WITH SUITABLE LENS IN FRONT.

The hollow lens disperses the rays of light before they enter the eye. The eye then brings them to a focus on the retina.

with this elongation of the eye. It is always an acquired defect, and is very rare even at the age of five.

The remedy is fairly obvious. It is only necessary to put something in the path of the rays of light that will delay the focussing, or disperse them. This is brought about by a concave or hollow lens placed in front of the eye, the degree of concavity of the lens being accurately adjusted to suit each case.

Long-sighted Eye.

This is a congenital defect. The eye is developed with its axis from front to back shorter than usual, and the child is born with the eye in this condition. The result is that a picture of a distant object formed in the usual way would be focussed behind the retina, and only a blurred impression would be received. In order to see such a distant object clearly the eye then accommodates and brings the rays more quickly to a focus, and so produces a clear picture on the retina. But if this eye now turns its

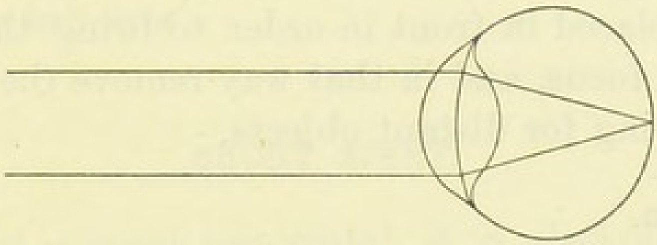

Fig. 82.

Long-sighted Eye receiving Rays from Distant Object.

These rays are focussed on the retina by increasing the thickness of the lens (accommodation).

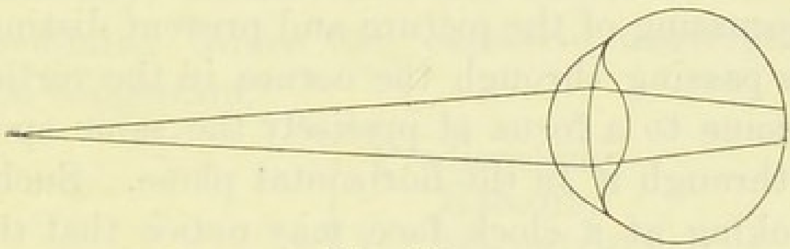

Fig. 83.

Long-sighted Eye receiving Rays from Near Object.

These cannot be focussed on the retina because the eye has already used its power of accommodation.

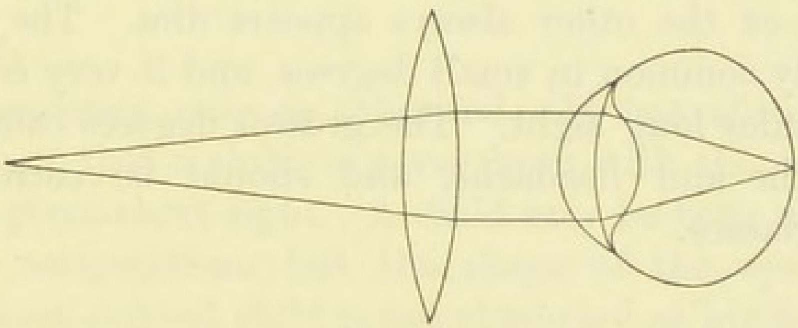

Fig. 84.

Long-sighted Eye with Suitable Lens in Front.

This lens assists the lens of the eye to bring the rays to a focus more quickly.

attention to near objects it cannot possibly see them clearly because it has already used its powers of accommodation to view distant ones. The result is that such an eye fails to see the near objects distinctly, and is therefore called long-sighted.

The remedy is simple. A convex lens (like the one in the eye) is placed in front in order to bring the rays more quickly to a focus, and in that way remove the necessity of accommodating for distant objects.

Astigmatism.

This is another congenital defect. Some children are born with the surface of the cornea unequally convex, the convexity being greater in the vertical meridian than in the horizontal, or *vice versa.* This will interfere with the proper focussing of the picture and prevent distinct vision. The rays passing through the cornea in the vertical plane do not come to a focus at precisely the same spot as rays passing through it in the horizontal plane. Such a child, when looking at a clock face, may notice that the figures XII. and VI. (vertical) are clear and black, while the IX. and III. (horizontal) are dim and grey, or *vice versa.* If a cross is held in front of the child the vertical and the horizontal sticks cannot be focussed at the same time, so that one or the other always appears dim. The defect is extremely common in small degrees, and it very commonly accompanies long sight. The greater degrees cause severe eye strain and headache, and should be corrected by proper glasses.

Squint.

Squint is the term applied when the eyes are not both directed towards the object looked at. One eye may turn inward more than the other, or one eye may turn outward. Occasionally one meets a case where one eye squints at one time and the other at another. The recognition and treatment of these cases is very important, because an eye that habitually squints from any cause, muscular or nervous, tends to deteriorate and become useless, and may eventually become blind. A common cause of squint is inequality of vision in the two eyes.

SHORT SIGHT.

Short sight is never congenital, it is always acquired as the result of certain injurious influences. The causes, like the causes of any disease, are best classified into the predisposing and the determining. The predisposing causes include heredity, malnutrition and constitutional disease. The determining causes are excessive convergence, eye strain, and congestion.

Causes of Short Sight:
- Predisposing—
  - Heredity
  - Malnutrition
  - Constitutional Disease
- Determining—
  - Excessive Convergence
  - Congestion

Heredity.

The tendency only is inherited. It has already been pointed out that a child is never born with the elongated eye that gives short sight. A child may be born with long sight or astigmatism, but the shape of the eye of the future short-sighted child is not elongated at birth. But a weak sclerotic may have been inherited from one or both parents, and this will, of course, predispose to short sight. Such a child may grow up with perfectly normal eyes; in fact, if it never went to school it would almost certainly do so, but the chances are in favour of the strains of school life stretching the abnormally weak sclerotic. On the other hand, although many myopic children have parents who suffer from the same defect, it is usually found that the parents of nearly half the short-sighted children are not themselves myopic. It is a significant fact that myopia usually first begins to become troublesome at the age of eight or nine, *i.e.* when the strain of school conditions have had time to produce the necessary distortion. Myopia once acquired tends to increase if the causes which produce it are allowed to continue.

Malnutrition.

Defective nutrition plays another important part as a predisposing cause of short sight. It is usual to find more defects among weakly and underfed children than among the more healthy and better fed. In these cases the sclerotic simply shares in the general deterioration of tissue, and is less capable of withstanding strain than the normal sclerotic.

Disease.

Constitutional disease may be a factor in any case of myopia. A commonly occurring case is that of a healthy child with normal vision in attendance at school. Some acute illness supervenes, necessitating absence from school for some weeks. The child recovers and returns to school, still with normal vision, but in a comparatively short time the strain of school life has caused the sclerotic to stretch, and the child becomes short-sighted. The previously healthy sclerotic was able to withstand the strain, but when it was suffering, with the other tissues of the body, from the defective nutrition caused by the illness, it could no longer resist the pulling and straining that it received.

Professor Priestley Smith says: "A sound physique, a healthy, vigorous condition of the body generally is antagonistic to the working of almost every morbid process, and even in the case of short sight, the causes of which are mainly local rather than constitutional in their operation, it has a powerful deterrent influence. An ill-nourished, pale, and lax condition of the body lowers the resisting power of the eye, as of every other organ; an impaired physique brings with it, among other evils, an impaired resistance to the active causes of short sight."

Eye Strain or Excessive Convergence.

It has already been pointed out that when the eye is looking at objects 20 feet or more away it is at rest, and no muscular effort is required. On the other hand, in looking at a near object, the eyes assume a position of convergence. Each eye is pulled towards the other by the muscle which is attached to its inner side. The nearer the object the greater the pulling required. The object of convergence is to bring the yellow spot of each retina to bear on the same point. This pull puts the sclerotic coat on the stretch, and is the direct mechanical cause leading to the production of short sight. If the twenty-first year, or perhaps to be quite safe it should be the twenty-fifth year, is reached without any stretching of the sclerotic coat it is extremely unlikely that short sight will ever be developed. By that age the coat is sufficiently tough to resist all ordinary strain.

It has been proved beyond all doubt that our educational methods are chiefly to blame for the production of short sight. Dr. Seggel, for instance, examined the eyes of 1600 soldiers, and divided the men into classes according to their previous histories.

Previous History.	Percentage of Short-sighted Men.
Countrymen, educated in village schools ...	2
Labourers, porters, etc., from towns	4
Artisans	9
Tradesmen, clerks, compositors	44
University students	58—65

Another observer, Dr. Cohn, as the result of extensive and laborious investigations, found that short sight was present in one per cent. of the children in village schools, in six per cent. of elementary town schools, and rose to twenty-six per cent. in the advanced schools. Statistics also tend to prove conclusively that the proportion of children suffering from myopia steadily increases from the lower to the upper classes in schools. Among children between seven and nine years of age about two or three per cent. are short-sighted, while among those between ten and eleven years about eight per cent., and of those between twelve and thirteen years about fifteen per cent. Dr. Kerr, on examining infants, found that fifteen per cent. of seven-year-old children had a moderate deficiency of vision, and four-and-a-half per cent. had bad vision. At the age of eight these numbers had increased to sixteen and seven respectively. The chief factors in the production of eye strain are fine work, bad light, improper attitudes, bad methods of writing, and small and indistinct type.

Small print, fine stitches, small writing, and all such work should be regarded as unnecessary torture for children. Nothing could possibly have been devised to do more harm than the needlework that is usually taught infants. It is undoubtedly the cause of the excess of short sight among girls. Mr. Priestley Smith found myopia in $7\frac{1}{2}$ per cent. of the girls and $4\frac{1}{2}$ per cent. of the boys he examined.

Type.

For school books a plain legible type of the proper size should be used. For children under seven years old there should be no smaller type than English, and larger type is preferable, while for older children the best type is Pica.

[English.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns

[Pica.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns

[Small Pica.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns the busy part of mankind not to

[Long Primer.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to think themselves

[Bourgeois.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to think themselves excused. He now reprinted

Clearness and spacing are quite as important as size. All type in school books should be leaded. The great effect of this in increasing legibility is shown by the following examples :—

[Solid Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures; a duty, from which he warns the busy part of mankind not to

[Thin Leaded Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns the busy part of mankind not to

[Double Leaded Type.]

He has, however, something better. As the best preservative against Popery, he recommends the diligent perusal of the Scriptures ; a duty, from which he warns the busy part of mankind not to

The intervals between words should be not less than double the width of a single letter, and for beginners it is an advantage to have still greater intervals.

The length of the line of print is also important. The shorter the line the less fatigue it produces, because the eyes have to be moved less. The maximum length of line should be from 3 to $3\frac{1}{2}$ inches, and no double column arrangement should be allowed. The printer's habit of splitting a word at the end of a line is trying to the eye, and should not be allowed in school books. It is a further advantage for the page to be well broken up into sections and paragraphs.

The kind of paper must be considered. It should be opaque and sufficiently stout to prevent the print on the other side showing through. In fact there should be no indication whatever that there is printed matter on the other side of the paper. The surface must be dull and smooth, and the best colour is a faint neutral cream or grey.

The colour of the ink, both for writing and printing, should be jet black. The question of handwriting has already been discussed, but it should be noted here that children under seven years of age should not be expected to write letters less than half an inch in height.

There is undoubtedly far too much reading and writing inflicted upon young children. All fine work should be avoided, if it is desired that the child should grow up uninjured by its educational experience. Map-reading and map-drawing are common tortures for the eyes, most of the print and writing thereon being necessarily very small. Most maps present a mass of bewildering detail that no young child should be expected to decipher. The sprawling of the names of districts and provinces among the names of the towns, the shading which is intended to represent mountains, and the winding in and out of the rivers unite to produce utter confusion. Small maps should be abolished, and large wall maps and those drawn on blackboards, by teacher or scholars, substituted.

Congestion.

Congestion, or overfilling of the small blood vessels in the neighbourhood of the eye, is an active cause of the stretching that brings about short sight. It is produced by many of the conditions common to school life. Bending, either due to bad desks, bad light, or very fine work, or a combination of two or more of such common conditions, quickly causes congestion in these regions. In girls' classes it is often brought about rapidly by tight collars, while a cause which is common to all the standards, but particularly infants, is mental fatigue.

Signs of Short Sight.

The signs of short sight are very obvious when the deficiency is pronounced, but only very careful testing will detect it at the early stages. The pronounced signs are that the child holds its work close to the eyes, and can read easily from a book held near, but makes mistakes when copying work from a diagram or from the blackboard at a distance. The child often acquires a habit of peering, and knitting its brows. Headache and pain are also common indications of eye trouble.

Signs of Long Sight.

Long sight usually does not give rise to such obvious symptoms as short sight. These eyes can distinguish distant objects with ease, and often manage nearer ones if the effort is not prolonged. Such a child in a reading lesson will read accurately for a few lines, then stop or make a mistake, and when questioned as to the cause will complain that "the letters are dancing about." The continued effort at exaggerated accommodation has exhausted the muscles and they refuse to maintain the strain. After a short rest, or a rub, the task can be resumed. Headache, blinking, red and watery eyes are other signs and symptoms of this defect.

Treatment of Eye Defects.

In the majority of cases it will be found that the defective vision can be improved by the proper glasses. The eye is then relieved from much of its strain, and the deficiency may not increase. On the other hand, there could be no greater mistake than to suppose that every child with defective vision requires glasses. A few will regain normal vision in a few years, without glasses, if the eyes are relieved from the strain of fine work. There are considerable numbers of children attending school whose vision is bad and whom glasses will not help. The only way to treat such children is to apply to them a considerable modification of our educational system. Special provision is made for the blind already, but these children are much more worth educating than the blind, and yet are being severely injured by the ordinary school education.

It should be clearly understood that myopia in children, even though not severe at the time, must be regarded as a serious condition, inasmuch as it not only tends to increase in severity, but it also may cause disease of the eye which diminishes the acuteness of vision and may lead to blindness.

To Prevent Injury to Eyes at School.

To sum up, we may say that the essential points to be observed in order to prevent injury to the eyes of school children are :—

1. The room must be well lighted in every part. No room should be deemed satisfactory by a casual inspection. The light ought to be actually tested in those places farthest away from the windows. A simple test that has

been suggested is that a scholar, should be able to read at 12 inches distance, and without strain, diamond type. For example :—

In fact, the occasion had brought to light one of the many contradictions in the Roman constitution. On the one hand Cicero, as commissioned to use the dictatorial powers, was within his rights in executing the prisoners; on the other, it was contrary to law to assail the life of any citizen without the sanction of the people. Cicero was at once right and wrong, and moreover, apart from the mere question of legality, the crisis was grave enough—if all was true that Cicero's informants alleged to be the facts—to condone stern measures; but unfortunately it came at the very time when

2. The direction of the light should be from the left if possible. At all events there must be no window or any source of light in front of the children.

3. No unreasonably fine objects should be used. Everything that the children use should be easily distinguished.

4. There should be no stooping over the work.

5. The work must not be held nearer to the eyes than 12 inches.

6. This is the most important rule of all. No child under seven years old should read ordinary book print, nor write ordinary small handwriting, nor should do any sewing whatever. Until this fundamental principle is observed in every school in the country there will continue to be unnecessary damage done to children's eyes.

Dr. Kerr, in his evidence before the Committee on Physical Deterioration, said he considered that the methods pursued in many infant schools were responsible for the development of visual defects; 95 per cent. of over 1000 infants examined for the purpose between the age of 6 and $6\frac{1}{2}$ managed to reach the standard of normal visual acuity in London, but among older children it was found that 10 per cent. had exceedingly defective vision. The conditions are bad for infants' eyesight in every way; the work is too fine.

TESTING OF EYESIGHT.

The usual test type is that for use at 20 feet distance. Under each line of type is a number signifying the distance in feet that the type should be legible to the normal eye. The largest type is usually numbered 200 feet, and the others range down 100, 70, 50, 40, 30, and the smallest 20 feet. The child should stand, facing the type, at a distance of 20 feet from it. He then reads the letters row by row, beginning at the top. If all the letters are read correctly from top to bottom the child is passed as normal. As a matter of fact a child's vision should be better than what is called "normal." The method of recording results is usually to express them as fractions, all having a common numerator, 20, and having as denominator the figure representing the distance at which a normal eye could read the smallest letters that were correctly read by the child in question. The normal child would thus be recorded $\frac{20}{20}$. Another child might make a mistake with the "30 feet type," so that the smallest type that he has read correctly is the "40 feet type." His vision, recorded as $\frac{20}{40}$. Some test cards record the distances in metres, the 20 feet type being represented by 6 metres. This causes all the numerators to become 6 instead of 20.

U T P V O

20 Type.

O L T Z B

40 Type.

It is, however, desirable that teachers should devote themselves solely to detecting children with eyes below the normal, without trying to determine the exact degree of deficiency. For this purpose the writer (in consultation with Dr. J. R. Kaye, County Medical Officer) drew up the following rules for use in the schools of the West Riding of Yorkshire.

WEST RIDING COUNTY COUNCIL.

SIGHT-TESTING OF SCHOOL CHILDREN.

General Scheme.

It is considered advisable that the teacher should roughly divide the children into three chief classes:—

A. Normal Vision.—Those children who can easily read "20 type" at 20 feet.

B. Moderate Deficiency.—Those children who fail to read "20 type" correctly at 20 feet, but can read "40 type" at 20 feet.

C. More Serious Defects.—Those children who fail to read "20 type" *and* "40 type" at 20 feet.

Directions for Testing.

The Type.—Several selections of "20 type" and "40 type" are provided in order that the children may not acquire any degree of familiarity with the letters and their order. The letters should be hung in a good light, but *not* in direct sunlight, five feet from the floor.

The Scholar.—The child should stand, facing the type, at a distance of 20 feet. No window or any source of light should be opposite the scholar. Any straining or guessing should be prevented as far as possible.

Method.—All the Scholars are first tested with the "40 type." Those who fail with this test constitute Class C. The *others* are submitted to the test with "20 type" which will serve to divide them into groups A and B. (If time allows, group C may also be tested with the "20 type.")

A Register should be previously prepared with the names and columns ruled as follows:—

Name.	Stand-ard.	(1) Date.	(2) 40 Type.	(3) 20 Type.	(4) Class of Vision.	Remarks.
Jones, John . .			+	+	A	
Robinson, Mary			—		C	
Smith, Thos. .			+	—	B	

The Register should contain at least four sets of the columns marked 1 to 4, so as to hold the results of four consecutive examinations.

Each child's sight should be tested as soon after entering the school as possible, and twice a year after.

Children Requiring Attention.

Short of actual testing of the eyesight the following list may prove useful in helping the teacher to select suitable cases requiring the attention of the Medical Officer:—

1. All those with sore eyes.
2. All those whose eyes are congested and red.

3. All those who peer and blink when they wish to see anything particularly well.

4. All those who appear to be in difficulty when they are reading from map or diagram or blackboard.

5. All those who complain of headache, or who appear to fear a bright light.

6. All those who turn the head sideways or slanting in order to read.

7. All those who hold the book nearer than one foot when reading. Also those who hold the book at arm's length.

8. All those who squint constantly or occasionally.

CHAPTER IV.

THE EAR, THROAT, AND VOICE.

THE EAR.

THE organ of hearing is not greatly affected by school life, but there are certain conditions common in childhood that should be mentioned. The exact structure of the ear, being rather complicated, and impossible to explain without elaborate diagrams or models, is beyond the scope of this book, but an elementary description is necessary. The ear is divided into three parts, the external, middle, and internal ear. The external ear is that external structure which is usually described as "the" ear. It serves as a means of collecting waves of sound. An open tube, called the auditory canal, leads inwards from it. The canal is about an inch long, and is set near its mouth with fine hairs, while within, embedded in the walls, lie some small glands, which secrete wax. The hairs help to prevent the entrance of insects. The wax serves to entangle bacteria and insects that have gained admission. If the wax collects in too great quantity it will block the passage and cause deafness. This can easily be removed by syringing with hot water.

The external auditory canal ends at the tympanum or ear-drum. This is a membrane, like the top of a drum, and vibrates to the sound waves that reach it. On the other side of the drum is a small cavity called the middle ear. This contains three small bones, whose functions are to pass on the vibrations of the drum, and the remainder of the cavity is filled with air. From the floor of the middle ear there passes downwards a tube (the Eustachian tube) which opens into the pharynx. The walls of the middle ear, and the blood in the capillaries there, absorb the air, and would cause a decrease in pressure in that cavity if the Eustachian tube did not admit air, and so equalise the pressure on both sides. If the tube gets blocked, by a severe cold, or by the pressure of adenoid growths, for instance, this absorption takes place, the pressure in the middle ear falls, the tympanic membrane becomes tense and is unable to vibrate, and deafness results.

The internal ear has a complicated structure which it is not necessary to consider here.

Deafness.

The deafness of a child may be due to some comparatively simple cause, such as an accumulation of wax in the external auditory canal, or adenoids blocking up the Eustachian tube; but on the other hand it may be due to more serious and complicated defects, such as diseases of the middle or inner ear, interference with the auditory nerve, or defective development of, or damage to, the hearing centre situated in the brain. All cases of deafness should be selected by the teacher and presented for medical examination when opportunity occurs. At the very lowest estimate such a defect will cause part of the instruction given to the child to be wasted. Hearing is sometimes apparently deficient when the real deficiency is that of attention. Mentally feeble children often hear perfectly well, but will not take the trouble to listen and to distinguish sounds. Patience and the presentation of pleasant musical sounds will often work wonders in developing this important sense.

Earache and Ear Discharge.

These are unfortunately of frequent occurrence in school children. At least one per cent. of the children have discharging ears. Earache should always receive attention, because it is the first signal that some mischief is being done. In many cases it is due to inflammation in the middle ear. This part of the ear is liable to bacterial invasion along the Eustachian tube. If the inflammation is severe it may lead to the formation of matter or pus in the middle ear. Then the drum is perforated, and the pus trickles down the external auditory canal as "ear discharge." It is of the utmost importance that such a discharge should be medically treated and cured at once. A child with an ear discharge should be likened to a person living on the edge of a precipice: it may continue for years, but disaster may occur at any moment. If treated at once the discharge will stop, and the hole in the drum will probably heal up, and the loss of hearing will only be very slight. If it is neglected it will become chronic and the ear may be permanently damaged. If it is treated afterwards it is very difficult to cure, and the hole in the drum will not heal up, so that some loss of hearing is inevitable. Moreover the trouble may cause death at practically any time. There is only a thin plate of bone separating the middle ear from the brain, and this may be attacked and perforated by the inflammatory process. The next step would be the formation of an abscess in the brain, and death may be rapidly brought about.

In the case of children who have recently been away from school on account of an attack of scarlet fever or diphtheria, a discharge from the ears may be of a highly infectious character, and may cause a school epidemic. In such cases the child should be sent home at once, and the matter reported. The discharge in other cases may not be capable of setting up any definite disease in the other children, but if some of the matter finds its way into the eyes, ears, throats, or noses of other children, it may cause a great deal of injury. At all events it is desirable that all children suffering from ear discharge should be excluded from school.

TESTS OF HEARING.

Statistics are available to show that about twenty per cent. of school children possess some defect of hearing, either in one or in both ears. It is impossible to estimate the real meaning of apparent dulness or inattention until the hearing has been tested.

The test may be made in one of two ways, either by a watch or by the voice. For the older scholars the watch method gives good results, but for younger children the voice test is more reliable.

The same watch should be used for all the children. It is first of all tested with some good ears, and its correct ticking distance ascertained. Members of the staff may test each other for this purpose. Watches vary in the loudness of the tick, but the average one can be heard by the normal ear through a distance of about 4 feet. A very loud one may be heard 10 feet. A stop-watch is to be preferred, because the ticking is then under control. The quietest room in the school should be selected for the test. The child should be seated, and a tape measure is stretched horizontally backwards from the back of his head. The child's eyes should be closed. The person who is making the test brings up the watch (which we will suppose to have a 48-inch tick) from a distance to the 48th mark on the tape. If the child can hear the ticking at this distance it has normal hearing, and is passed on. If the ticking cannot be heard the watch is moved inch by inch nearer until the ticking becomes audible. The tape must touch neither the child's head nor the watch, because it will convey the sound better than the air. The tape is provided simply as a convenience for reading off the distances and for providing a level. In order to get reliable results it is necessary to repeat the tests several times. If a louder watch is used a chalk line on the floor, with divisions, representing half a foot each, will be sufficiently exact for recording distances.

For testing by the voice the ordinary speaking voice is not sufficiently exact to give good results. For instance, it would be difficult to be quite sure that one is giving exactly the same test in six months' time as one is to-day, *i.e.* to be sure of the exact pitch and tone, etc. But if a forced whisper is used the test is much more exact. By a forced whisper is meant a loud whisper with a forced expiration helping it. This is fairly constant in the same person, and can be heard a considerable distance (varying from 30 to 60 feet about). One person must test the whole school, and the hearing distance of his forced whisper is first ascertained by testing good ears. Suppose it is found to be 60 feet. The test should be made in a quiet playground or room. A line 60 feet long, marked in feet, is chalked or painted on the floor: the child stands at one end with the back to the observer; the one performing the test stands at the other end, and an assistant stands by the child. The observer whispers various words (single syllable numbers are the best), and the child tells the assistant what he has heard. If the child cannot hear at all at this distance, or makes a mistake, the observer moves foot by foot nearer and repeats the test. Finally, the distance at which the child can hear this sound is ascertained and recorded. The advantage of this method is that it is independent of the child's possible misinterpretation of the sound. In the watch method mistakes are constantly made by the child saying it can hear the ticking when it really does not. All children showing a deficiency of hearing should be presented for medical examination.

Deaf and Dumb Children.

Children born deaf are also dumb, because they do not hear words spoken, and so do not learn to speak. By training a dumb child to watch carefully the shape and movements of the teacher's mouth when the latter is naming an object, he may learn to imitate these and so come to speak. If a child becomes deaf before he is six years old, he tends to forget the language he has learned and is in danger of becoming dumb.

THE THROAT. AFFECTIONS OF THE THROAT.

On examining a child's mouth there can be seen the tongue, teeth, and gums in front, the hard alate pabove, and at the back the soft palate spanning over the root of the tongue like a fleshy arch, and dipping down at its highest point in a little process called the uvula. On each side of the arch are the pillars of the throat, enclosing the tonsils. The tonsils are variable in size, and it is not at all uncommon to find about 30 per cent. of the children in a school with tonsils which practically meet in the middle line. Such schools are often situated in country places, but usually where the housing conditions are poor.

The opening at the back of the mouth leads into a funnel-shaped cavity called the pharynx. The openings of the nose lead into the same cavity, but the part of it at the back of the nose is sometimes called the naso-pharynx. These cavities are lined with a smooth covering called mucous membrane. When healthy this membrane is smooth and shining, and a bright pink in colour. In this condition it can resist the attacks of disease germs, but when it is unhealthy, as shown by it becoming rough and red, or rough and abnormally pale, it offers an excellent breeding place for bacteria. The membrane is rapidly affected by impure air, and if the child continually breathes vitiated air the lining of the nose and throat are certain to be injured. Liability to take cold in the head is one of the early indications of an abnormal condition of these parts.

ADENOIDS.

From an educational point of view the most important condition for diagnosis in this region is the presence of adenoid growths. These are very common in children under 14 years. After that age they tend to dry up and disappear, but the injuries that they have caused are permanent. They are fleshy growths produced by hypertrophy of the adenoid tissue which is so abundant in this neighbourhood, and are usually situated in the naso-pharynx, quite out of sight. To the finger thrust behind the palate they feel soft, pulpy, and velvety, "like a bag of earthworms." All classes of the community appear to be equally affected, and they are found about equally in the better class and the poorer schools. Heredity undoubtedly plays some part in their appearance, and there is no doubt whatever that the number of the children affected by this condition is rapidly increasing in the schools.

Effects of Adenoids.

The effects of these growths, by which means they can usually be easily identified, are numerous, and are of great importance. The obstruction to the natural breathing process is accompanied with and followed by dulness, stupidity, peculiarities of appearance, expression, and speech, as well as characteristic deformities. These are fully discussed in Chapter IV. of Part III.

SORE THROATS.

A sore throat is the common beginning of an attack of scarlet fever, measles, or diphtheria, as well as acute inflammation in that region, and quinsy. Of course it is quite possible that any sore throat may be a simple local inflammation that will rapidly subside, but that does not affect the rule that no child with a sore throat should be admitted to school under any circumstances. It should be remembered that it is quite impossible to distinguish a simple sore throat from a mild attack of diphtheria except by bacteriological methods, and the epidemics of mild sore throat that are quite common among school children are often mild diphtheria. The infection will be handed from one to another, keeping its mild characteristics for a time, but occasionally developing an extreme virulence and causing a number of deaths in rapid succession. An instructive case has just occurred in the writer's district. A boy attending school contracted a sore throat. Soon afterwards his mother and the servant also had mild sore throats. A week later the father was very ill with inflamed throat, and the doctor who was summoned pronounced this case to be typical severe diphtheria. The throats of the boy, the mother, and the servant were then examined bacteriologically, and were found to be swarming with diphtheria bacilli, although they had apparently quite recovered from the attack of "sore throat."

A morbid and enlarged condition of the tonsils always offers a resting-place to bacteria. The germs of consumption, or tubercle bacilli, often gain their first foothold in the body either through the tonsils or bad teeth. The bacilli next invade the glands in the neighbourhood of the jaw and throat, and give rise to a great amount of suffering and disease.

THE VOICE.

At the bottom of the funnel-shaped pharynx the windpipe and the gullet pass respectively to the lungs and the

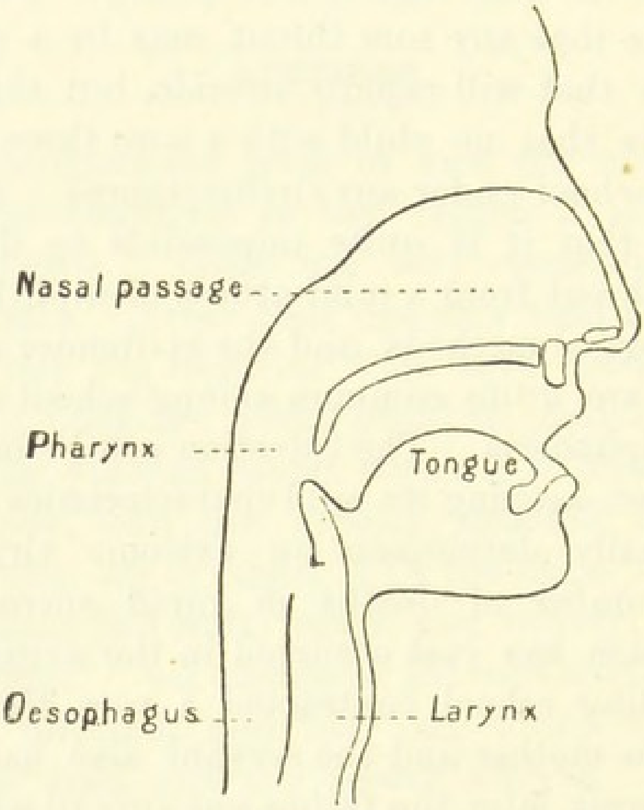

Fig. 85.

THE PHARYNX.

stomach. The windpipe is placed in front of the gullet. At the top part of the windpipe lies the larynx or voice-box.

The opening into the larynx lies at the root of the tongue; this is known as the glottis, and over it there projects a valve-like flap, the epiglottis. The larynx consists of cartilages, various muscles, and ligaments. The cartilages are called the thyroid, the arytenoid, and the cricoid. The thyroid cartilage in front forms the projection in the neck called "Adam's apple." The vocal cords—so called from their being concerned in the production of the voice—are two bands of yellow elastic tissue

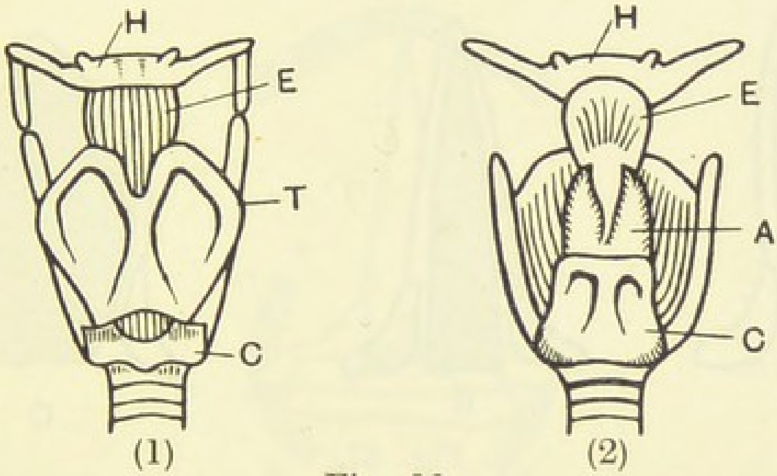

Fig. 86.

THE CARTILAGES OF THE LARYNX.
1. Seen from the front. 2. Seen from behind.
A, Arytenoid Cartilage; C, Cricoid Cartilage; E, Epiglottis; H, Hyoid; T, Thyroid Cartilage.

covered with mucous membrane, attached in front to the thyroid cartilage, and to the arytenoid cartilages behind Their free edges are directed upwards. The space between the cords is called the glottis and appears as a V-shaped chink when the vocal cords are at rest. During inspiration the cords move away from each other and the space widens, and during expiration the glottis becomes narrower. During the utterance of a sound they are brought closely together. These movements are produced by the muscles of the larynx.

Production of the Voice.

The sound of the voice is produced by vibrations of the vocal cords. The note given out by a vibrating cord depends upon its length and its tension. The greater the tension or the shorter the cord the higher is the note sounded. Conversely the note is lowered by lengthening the cord or decreasing the tension. Thus individuals with tenor voices have shorter cords than those with bass voices, and the vocal cords in men are longer than in women or

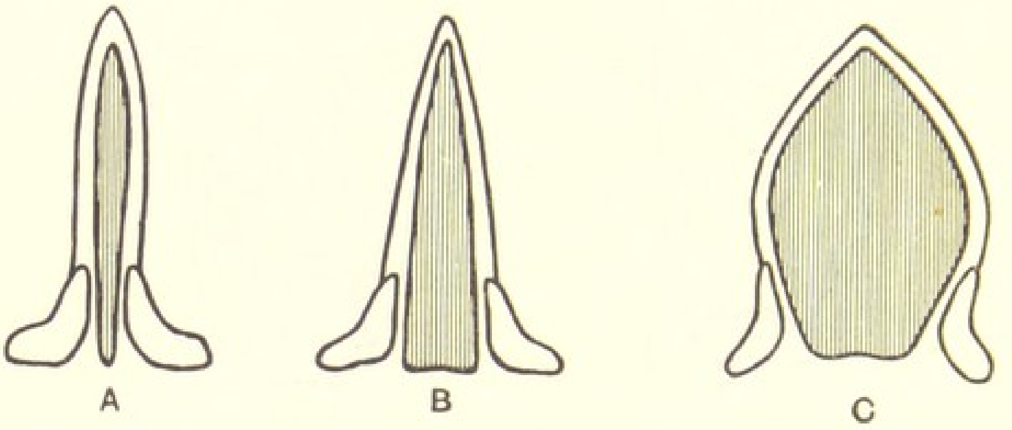

Fig. 87.

POSITION OF THE VOCAL CORDS.

A, during the emission of a high note in singing; B, during easy inhalation; C, while taking a deep breath. The shaded part represents the space between the cords.

boys. Length and tension influence the rate of vibration of the cords, and the "pitch" depends upon the rate of vibration. The cords are approximated where a high note is being made, and are separated during a low note. The range of the voice seldom exceeds two and a half octaves.

The loudness or intensity of the voice depends upon the amplitude or range of vibratory movement, which in its turn depends upon the force of the expiratory blast.

The quality or timbre of the voice depends upon the smoothness, elasticity, and thickness of the cords, as well as the form and size of the air passages, larynx, pharynx, and mouth, which act as resonating cavities. We distinguish one voice from another, or the sound of the harp from that of the violin, by means of the quality of the notes. Adenoids, or any cause of obstruction in the nose, throat, or pharynx alters the quality of the voice.

Production of Speech.

It is possible to speak without using the vocal cords. When one speaks in whispers the slight sound produced

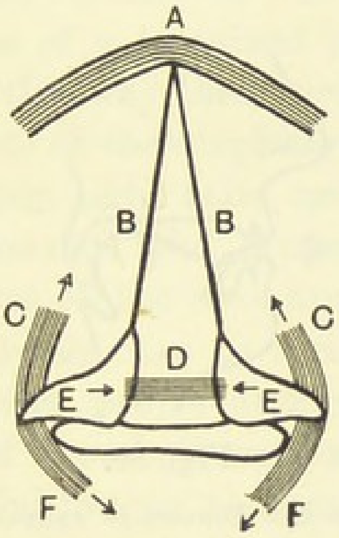

Fig. 88.

DIAGRAM SHOWING THE ACTION OF THE MUSCLES THAT ALTER THE POSITION AND TENSION OF THE VOCAL CORDS.

A, Front of Thyroid Cartilage ; B, Vocal Cords ; C, Muscles which move the Arytenoid Cartilages (E) as on a pivot and so bring together the Vocal Cords and increase their tension ; D, Muscle that by its contraction pulls the Arytenoid Cartilages (E) nearer together and so approximates the cords also ; F, Muscles which move the Arytenoid Cartilages (E) as on a pivot and so separate the cords.

by the air passing through the air passages is modified into speech by movements of the tongue and lips. In the same way ordinary speech is produced by modifying and modulating the sounds produced by the vibrating vocal cords.

Vowel sounds are produced by varying the form of the cavity of the mouth and the shape of the opening. This is easily verified by producing the pure vowel sounds, *A* as in *ay*, *E* as in *he*, *O* as in *oh*, *Oo* as in *coo*, and *A* as in *ah*. The consonants, with the exception of *H*, which is pronounced by increasing the expiratory force with which the vowel is spoken, are produced by closing, more or less, certain of the exits of the expiratory blast. Aspirates are pronounced by partly closing the outlet, so that the air rushes through with a hiss. Thus *F*, *V*, and *W* are produced by partial closure with the lips, *S*, *Z*, *L*, *Sch*, and

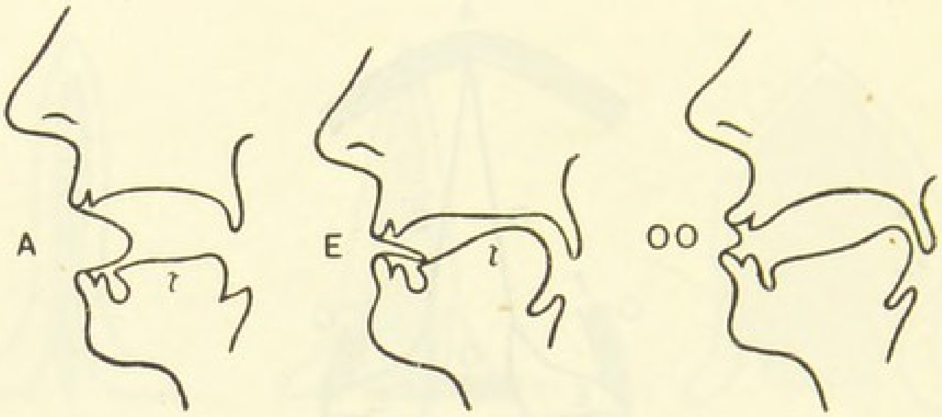

Fig. 89.

THE POSITION OF LIPS AND TONGUE IN PRODUCING VOWEL SOUNDS.

Th by the tongue and hard palate, and *Ch* by the tongue and soft palate.

The "resonants" *M* and *N* are formed by sending the current of air through the nose, the lips being closed in the case of *M*, and applied to the palate to pronounce *N*.

The consonants *B*, *P*, *T*, *D*, *K*, *G* (hard) are called "explosives," because the mouth is first closed and then suddenly burst open. In the case of *B* and *P* the lips close the mouth; for *T* and *D* the tongue is applied to the teeth or the front of the palate; while for *K* and *G* (hard) the middle or back of the tongue is forced against the back of the palate.

Care of the Voice.

As puberty is reached the vocal organs enlarge and there is an alteration in the voice. This change occurs at about 12 or 13 years in girls and 14 or 15 in boys, and is complete in one or two years. While the voice is "breaking" there should be no sustained vocal exercise. For clear articulation the manner of breathing is important. Children should be encouraged to use their abdominal muscles for respiration quite as much as those which raise the chest. Breathing by means of the abdominal muscles decreases the fatigue of a sustained use of the voice. To breathe properly in this way there must be no obstruction to the free movements of the diaphragm and the abdominal muscles. Tight lacing, tight belts, an overloaded stomach, or flatulence, all prevent the proper production of the voice. If the muscles of the neck are brought into visible play and the collar bones rise to a considerable extent, it is extremely likely that proper abdominal movements are impossible for one of the above reasons.

Children should be taught to speak up and articulate clearly, and to use their natural voice when reading aloud. It is possible by habitual exercise to educate the voice so that continued speaking is not painful or injurious.

STAMMERING.

A common nervous affection, interfering with the proper enunciation of words, is stammering or stuttering. This is much more common among boys than girls. As a result of a lack of proper coordination of the various acts involved in fluent speech these children exaggerate the movements concerned with articulation, and under-estimate the force of the expiratory blast necessary to produce the voice. The muscles of the tongue and lips (and sometimes those of the neck and face as well) are over-stimulated and get out of control by being thrown into a condition of irregular spasm. Stammerers usually have no difficulty in singing, partly owing to the fact that the expiratory blast is stronger and the lips are not used so much as in speaking, and partly because the attention is diverted from the consideration of the possibility of stammering.

For the successful treatment of such cases it is necessary to devote attention to the following points :—

1. Find out which letters give the greatest difficulty, and insist upon continuous practice with words and sentences containing these letters in large numbers. Vowel sounds usually give no difficulty because they are formed mainly in the larynx. The consonants are the difficulty, especially those in connection with which the pharynx plays no part, viz. *P*, *F*, *Th*, *S*, *Sh*, *T*, *K*, *B*, *H*, *Ch*, *D*, *G* (hard), the most difficult of all being the explosives *B*, *P*, *T*, *D*, *K*, *G* (hard).

2. Insist upon the chin being raised and the chest being fully inflated before beginning to speak. All speaking should be performed with a full resonant voice. In bad cases the child may be encouraged to adopt a sing-song or intoning method of speech.

3. In order to assist the acquirement of proper nervous control the child should be encouraged in every way to use the vocal apparatus continually. In many cases mimicry and teasing by other children have made the child lose all its confidence.

CHAPTER V

PERSONAL HYGIENE.

CLOTHING : CLEANLINESS : TEETH : SLEEP : FOOD.

CLOTHING.

THE value of a material for clothing depends upon its non-conducting properties with regard to heat. By a good conductor of heat we mean a substance through which heat rapidly travels. In other words, if one part of a good conductor becomes warm, then the heat will rapidly spread over the whole of it. A bad conductor of heat, or a non-conductor, has the opposite properties, so that if one part of a non-conductor becomes heated, the heat spreads very slowly to the other parts. The application of this to clothing is easily understood when we remember that the temperature of the body is always about 98·6° F., while the external temperature rarely exceeds 90° F. in Great Britain. The temperature of the body is therefore higher than that of the surrounding air, and so the inside of our clothing will be warmer than the outside. Now if the clothing material is a good conductor of heat, the heat will rapidly pass from the inside to the outside, and on the outside it will be lost in warming the air in contact with it. On the other hand, if the material be a non-conductor, the heat will only very slowly pass to the outside and very little will be lost.

As a matter of fact the body loses heat in several ways, *e.g.* (1) By the skin. This is probably about 90 per cent. of the total loss. (2) By respiration, the expired air being warmer than the inspired air. Moreover, heat is lost by evaporation in the breath, the expired air being saturated with water vapour. (3) With the excreta. The first of these, the loss by the skin, is the only one that we can in any way control.

The loss of heat by the skin takes place in three ways:

1. By conduction, as we have explained above. This loss is very greatly augmented by wearing clothes made of a good conducting material.
2. By radiation of the heat. The result of radiation is best illustrated by the warmth experienced when sitting near a bright fire. In this case the body receives the heat which is radiated from the fire. Similarly the body itself radiates heat.
3. By evaporation. When the body is heated by exercise the surface of the skin becomes covered with moisture, which evaporates more or less rapidly according to the circumstances. In doing this it absorbs a large amount of heat from the body. It is at these times that the body is particularly liable to take a chill. The absorption of heat by evaporation is well illustrated by pouring a little spirit or ether on the hand, when a feeling of cold is experienced which is increased by blowing across the liquid. The loss of heat by the skin is greatly influenced by the weather. In hot weather very little heat is lost by conduction or radiation, but a large quantity is lost by evaporation. In cold weather this is reversed.

The chief objects of clothing are—(1) To prevent loss of heat. (2) To protect parts of the body that are especially liable to injury, *e.g.* the feet. (3) For ornament. The following rules should be observed with regard to clothing:—

(1) It should be light. If proper attention is paid to material, there is no need for heavy clothes. In fact light clothes made of a non-conducting material are much warmer than heavy clothes made of material which conducts heat well.

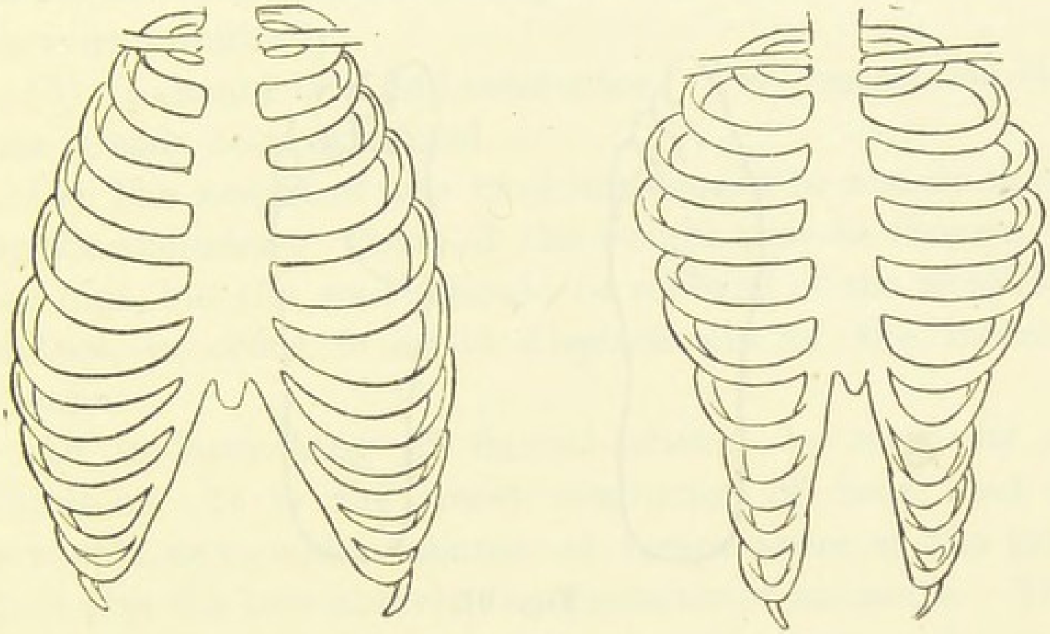

Fig. 90.

NATURAL THORAX. THORAX DEFORMED BY CORSETS.

(2) It should be loose. Every one knows how cold a pair of tight gloves are on a cold day. Air is a bad conductor of heat, and fluffy materials which contain much air in their interstices are far warmer than those which are closely woven. In the same way loosely fitting clothes are much warmer than those which fit tightly. Certain parts of the body are peculiarly liable to be constricted by clothing. For instance, the head is often surrounded with a tightly fitting hat which must press upon the blood vessels

and prevent the proper circulation of blood, thereby increasing the tendency to baldness. The neck is often constricted by a tight collar which interferes with the circulation and gives rise to headache. In women the lower part of the chest and the upper part of the abdomen are habitually constricted by corsets in order to produce the "waist." As a result of the constant pressure—which is often begun at a very early age—the ribs are permanently distorted and displaced inwards, causing compression and displacement of the lungs, heart, liver, stomach, and

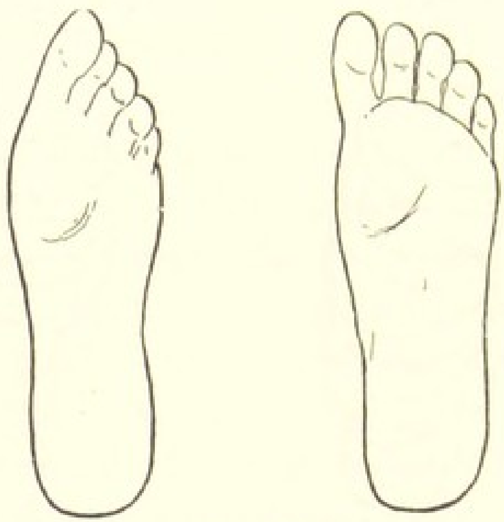

Fig. 91.

FOOT DEFORMED BY POINTED BOOTS. NATURAL FOOT.

intestines. The natural waist is below the ribs and above the hips.

The knee is often constricted with garters. The pressure here prevents the return of the blood through the veins, giving rise to varicose veins. The foot is almost always distorted by misshapen boots. In a properly made boot the great toe should be in a straight line with the inside of the foot, whereas it is usually bent towards the other toes in order to make the foot come to an unnatural point.

In summing up we may say that tight clothes possess the following disadvantages:—(*a*) They are less warm than loose clothes. (*b*) They are also less comfortable, and prevent the free movements of the limbs. (*c*) Any tightness across the chest will interfere with free respiration. (*d*) They are very liable to displace internal organs and produce various ill effects in different parts of the body.

(3) It should be porous. If clothing is not porous it will interfere with the evaporation resulting from perspiration. For this reason waterproof materials should never be worn habitually.

(4) It should be a bad conductor. The reason for this has already been explained.

(5) The weight of the clothing should be mainly borne by the shoulders. Some of the weight may be thrown on the hips, but the waist should be relieved of the weight of clothes, in order to avoid displacement of the internal organs.

An underclothing of flannel should be worn by all children. It is the worst conductor of heat, and so prevents any sudden change of temperature of the skin. It is also the best absorber and retainer of moisture. This underclothing should be worn by day throughout the year, but its consistency may be varied in winter and summer according to the temperature. It is just as important to remember that children may easily be overclothed. It is by no means uncommon to find several layers of flannel (even four or six) on some children. The result is that their skin becomes excessively sensitive and delicate, is never dry, and loses its power of reaction when chilled. Such children are continually catching cold, and are subject to all kinds of ailments.

Many parents at present fail to recognise any disgrace in sending children to school with torn and dirty clothes.

It is by no means a question of poverty only; in fact the worst instances of child neglect that the writer has met have come from homes where the father is earning plenty of money to keep his home decent and his children respectable, but the mother is either drunken or grossly incapable, or both. If the kind of sewing taught during the last thirty years in our elementary schools is ever to bear fruit, surely it is time now for it to appear. What these people require is to be taught to patch their clothes and to darn their stockings, and there is no reason why this should not be done in school, instead of wasting these children's time with fancy work. Another important point is to educate the popular taste towards hygienic, neat, durable garments, instead of torn soiled cheap finery that so often forms the ideal of dress among this unfortunate class.

Intimately associated with the dress of children attending primary schools, and with their squalor, filth, and untidiness, is that vile institution the pawnshop. Any decent apparel possessed by the children is regarded, and is used, as a kind of floating capital, and many of them outgrow a good garment before they have had the chance of wearing it out. To the pawnshop largely should also be attributed the sinking of the individual and the spread of disease and vermin, and until pawnshops are put down and a regular school uniform made compulsory, a great battle will have to be waged against untidiness, rags, and dirt in children.

All children in attendance at an elementary school should be required to wear some simple, neat, hygienic dress. This would not only be a great advance from a hygienic point of view, but would also be economical and becoming. As things are at present the clothing of a large proportion of the children can only be described as a miscellaneous collection of rags. The atmosphere of an elementary school on a wet morning is usually sickening. The woollen clothes have been worn for months or years, are perspiration-soaked, and reek with unhealthy miasm. These exhalations continue until the clothes are dry. It has been suggested that "a school uniform should be kept at the school for each scholar, and the children would change their out-of-school attire on reaching the cloak-room. Here any wet garments could be thoroughly dried. The uniform might be quite simple and light; it should consist of linen in summer, of woollen in winter, and should be provided by the parents as a part of the school outfit, unless they are absolutely poor, in which case the State should provide it."

Boys should wear a flannel vest and a simple blouse or woollen jersey, fitting loosely, and the material varying according to the season. The knickerbockers should be suspended round the hips, and if these fit properly above the thigh bones with an elastic band there will be no need for braces. The girls should wear a flannel chemise, blue serge knickerbockers fitted upon the thigh bones with an elastic band, and no stays, or any substitute for stays, of any kind. Next there should be a woollen jersey (or a cotton blouse in summer), and an overdress with shoulder straps fastened into the waist. In summer the children require no head covering.

If some simple dress as the above could be universally adopted what a revolution would take place in the appearance, comfort, and health of our schools! The children would gain self-respect, and the whole tone of the schools would be altered.

The boots of children, in our climate, are important articles of clothing during more than half the year, Careful attention to the fitting of boots and shoes during childhood will save a lot of trouble in after life. Children should be taught that it is a sign of weakmindedness to wear boots that are too tight, or that hurt the feet in any way. Unfortunately a majority of the children in our elementary schools have no choice, and are compelled to wear anything that comes to hand. If they do get a pair of good boots they rarely wear them, because the inevitable pawnshop has intervened. Proper boots should be of sufficient length and breadth, should be practically straight along the inner edge in order to prevent distortion of the great toe, and should have low broad heels. Shoes are far better than boots. Dry boots, and warm woollen socks or stockings—never cotton—are requisite for the preservation of health.

Clothing for Games.

The boys should be encouraged to obtain special clothes for the games, both on the ground of economy and health. A loose flannel shirt and a short loose pair of knickers are all that are required (except for Rugby football, which requires a tight woollen jersey). Immediately after the game these clothes must be changed again, and the playing clothes carefully dried. The wearing of any tight band or belt round the waist should be discouraged, as it greatly increases the possibility of a "rupture." This should be definitely taught the boys, as the popular belief is to the contrary. If no tight belts and no corsets were worn the number of ruptures would be decreased by more than fifty per cent.

HABITS.

Habits are formed and deep impressions made very early in life. Children are singularly imitative, and school impressions are often of lifelong endurance. The teacher should therefore be an example of personal cleanliness and neatness, with hair, linen, and finger nails neat and beyond reproach. The children should be directly encouraged to be neat and clean, and no capable teacher will submit to teach children in a room with dirty floors and dim, closed windows.

Definite direct instruction, preferably distinct and apart from the teaching of any scientific details and reasons, should be given to all children concerning the care of the teeth, cleanliness of the skin, regularity in the action of the bowels, sufficient sleep, and the avoidance of such bad habits as spitting.

Parents constantly neglect to teach their children that the daily regular action of the bowels is a necessity for health, and that absolute regularity can only be ensured by keeping to the same hour (best just before or just after breakfast) each day. If children were only reared with such habits the necessity for aperients would disappear, and many of the intestinal disturbances so common among town children would disappear. Teachers should instil this thoroughly into the minds of the children, and explain that to allow refuse to accumulate inside the body, which it does if not removed daily, will cause it to putrefy and poison the whole system. In fact such a practice should be regarded as a mark of personal uncleanliness. Sir Lauder Brunton has well said, "As a rule, people are now fully alive to the risks they run from poisoning by sewer gas, or, to put it more widely, from poisoning by products of decomposition outside the body; but perhaps we do not all of us keep so clearly before us as we ought the fact that inside the body there are all the conditions for the formation of putrefactive products, and the most favourable arrangement for their rapid absorption."

One of the most objectionable of the early acquired habits is that of spitting. The children should be taught that, apart from the filthiness of it, there is considerable risk of thereby spreading disease, so that it is to everyone's advantage to assist in suppressing the habit. The dual lesson of self-control and duty to one's neighbour should be taught. It is extremely likely that in the schools we have the primary source of infection of a vast number of consumptives, and there is no doubt that here there are the most promising possibilities of prevention. This dreadful disease is discussed elsewhere and other means are mentioned which ought to be employed to cope with the scourge, but it is evident that the responsibility rests with the school authorities not only to prevent already infected children becoming a source of infection to others, but also to give all children definite instruction with regard to the prevention of the disease.

Many teachers will find it very interesting to experiment with some left-hand exercises for the children. The formation of the right-hand habit leads to unequal development of nerves and muscles. It is therefore much to be desired that children should be encouraged to practise exercises of all kinds with the left hand as well as the right. Occasional practice in writing with the left hand is beneficial. Some people find that a few minutes' writing with the left hand will relieve the nervous tension and headache set up by overwork and study.

PERSONAL CLEANLINESS.

The test of the cleanliness of the children in our elementary schools is the condition of their heads. The condition of the hair and scalp of the girls is usually infinitely worse than the boys'. It should be compulsory that the hair of all the children be cropped short. In France and other countries such a cropping of hair in the elementary schools is universal. The cleaner the parents are the more energetically they should support such a suggestion, because it would help to prevent their children being contaminated by dirty schoolmates.

Dirt and neglect constitute two of the primary evils of child life. Much of the disease and injury to health is the result of personal uncleanliness. Defects of vision, ulcerated corneas, inflamed eyelids, and other conditions are often the direct results of dirtiness, while wounds and sores, chilblains and discharging ears are aggravated by such conditions.

Unclean heads are unfortunately only too common in our schools. It is nothing short of a public scandal that most large towns are taking no steps to prevent this. Under the present conditions it is almost impossible for a clean child to attend our public elementary schools without being infected with parasites on the scalp. It should be the duty of the education authority to insist upon clean heads among the children attending school. The following is Dr. Kerr's scheme adopted by the London County Council :—

"The nurses visit the schools and select all children with unclean heads. A card, enclosed in a sealed envelope, with a part easily separated (line of perforation) is given to each child to take home.

"The card has on it simple directions for treatment and a statement that children not treated after a few days will be separated from the others. The parent is requested to read the instructions and sign and return the attached portion, or the child will be separated from the other children forthwith.

"On the front of the card there is printed :—

Private Notice.

Your attention is drawn to the condition of this child's head, which has been noticed in school. The school nurse has examined it and states that by attention to the directions given on the other side it can be rendered permanently clean within a week. If cleansing is not effected by that time the child will have to be kept separated from the others in school until the unclean condition is remedied.

"On the back of the card :—

Instructions for Cleansing Heads.

Where there are sore places, scabs, or enlarged glands, these will generally get better on removing all lice and nits.

It is possible to effect a cure in about a week.

All hairs with nits and all hair within a quarter of an inch of a sore must be cut off.

The head must be washed and scrubbed daily with paraffin oil, to which an equal quantity of olive oil may be added. If there are scabs, these when softened should be removed.

Repeat this treatment daily for a week, then weekly till all signs of lice are gone.

Where there is difficulty in keeping a child's head clean the hair should be worn cut short.

Iron the collar of the clothes with a hot iron.

Caution.—Do not use paraffin near a fire or naked light.

"The attached portion reads :—

I have read instructions on the back of the card and will endeavour during the ensuing week to get ——— into a healthy and clean condition.

Signed ———————

"At the end of a week from the nurse's first visit all cases not treated or not returning the card are separated from the other children, and cases not returning the card signed by the parent have a home visit by the nurse ; if at the nurse's fourth school visit no attempt at treatment has been made, the case is notified to the School Attendance Officer, and a second card left at the house by him on which the treatment is again set forth, the failure to adopt remedy pointed out, and a statement that if at the end of a week (nurse's sixth visit) the child has not had treatment it will be excluded from the school, and that the parents or guardians will be liable to immediate prosecution. The Medical Officer visits the school and personally examines these children, as far as possible, at or between the nurse's fourth or sixth visit.

"On the front of the second card there is printed :—

Second Warning.—To the Parents or Guardians of ———.
A Private Notice regarding the condition of this child's head having been sent you, and as this condition, which could be remedied in a week, is still allowed to persist, the child has now been separated in school as unfit to be in the ordinary class. You are required to take steps to cleanse its head within the next week, failing which the child will be excluded from school and you will be liable to prosecution and fine for not sending it in a fit state to school. The means for cleansing these heads is given on the other side of this card.

"On the back of the second card the instructions on the first card are repeated.

"By the end of three weeks the habitual offenders are weeded out for prosecution, and the others have been cleansed. The whole treatment was much resented by many mothers, but with tact and patient explanation their good sense asserted itself and few children remained unclean."

The results of this scheme in eight of the schools are as follows :—

Department.	Number Examined.	Clean.	Verminous.	First Notice.	Second Notice.	Partly Cleansed.	Proposed for Exclusion.
Boys	2492	2450	42	22	2	—	2
Girls	2422	1355	1067	740	183	163	15
Infants	2593	2207	386	269	55	99	4

Probably most towns and districts have found it possible to arrange similar schemes without employing any nurses at all, or at all events without allowing the nurses to play quite so prominent a part as they appear to do under the London County Council schemes. The author's experience is that the average teacher is quite as skilful and probably at least as intelligent as the average nurse. In most schools there are some members of the staff who have made a special study of the hygiene of child life. For a great deal of the work the employment of such teachers will be more economical and quite as effective as the employment of nurses.

The plan adopted by the author for the cleansing of heads of children from vermin is to instruct the parents to give the child on the first night a hot bath, using plenty of soap, and paying particular attention to the thorough cleansing of the scalp and hair. Paraffin oil is then thoroughly rubbed over the hair and scalp, after careful drying. This treatment is repeated on each of the two successive evenings, *i.e.* the scalp and hair are thoroughly soaped, washed, and dried, and then paraffin rubbed on. These three applications result in a complete cure in practically every case.

Verminous heads are comparatively rare among the shorter-haired boys, while about one in three or four girls is usually found to need attention in this respect. In many cases the clothing and body are badly infected, and vermin are to be found in every seam and clinging to the skin. A great source of the spread of vermin is second-hand clothing and the pawnshop. The houses from which such children come are usually infected in the same way. If only the home could be disinfected and cleansed a splendid work would be carried out.

In all towns the children attending schools in the poorer districts are nearly all more or less infected with vermin. This should at once receive the attention of all education authorities, as the bodily cleanliness of the children should be regarded as the essential commencement of all school hygiene.

"There are among the teachers a few, excellent and enlightened, who give practical teaching; who insist in every possible case upon the children wearing collars and pinafores; who insist on tidy hair and clean faces. But unfortunately some are easily discouraged, for it is uphill work, and what they do is often done during their well-earned leisure."

All teachers should insist upon each child appearing with clean face and hands. If they fail to do this they should be obliged to wash in the school lavatories. The quantity of towels supplied in most school lavatories is grossly insufficient.

The problem of the personal cleanliness of the children can only be satisfactorily solved by the provision of school baths. These are neither costly to provide nor to maintain, and the real difficulty is not the trivial expense, but whether all responsibility in this direction should be removed from the parent, and also who is to superintend the bathing. Professor Shaw quotes an excellent plan adopted in a school in Chicago. A bath, soap, towels, and hot and cold water were all provided. "Pupils who came to school unclean were sent to the principal, and the principal sent for the parent, usually the mother, and talked with her of the child's condition, explaining to her what was necessary, and then asked her to use the facilities provided and render the pupil fit to take his or her place in the class. This plan in its effect upon the district had proved, it is claimed, most salutary. It gave the parents an object-lesson in cleanliness; it heightened their appreciation of its necessity; and in the best way the school reacted upon the homes of a certain part of the population without taking upon itself the duties which belong to the home."

The provision of baths for schools is essential for the purpose of educating certain portions of the community in bodily cleanliness. The institution of school baths and more or less compulsory cleaning is followed by an increase in the self-respect, an improvement in discipline, cleaner clothing, and the formation of habits which cling to the child for life.

In Berlin there are many schools with baths. A bath is allowed each scholar once a week, and it usually takes five minutes. Bathing is not compulsory. Similarly at Zürich, In a Boston school of 800 children 125 are bathed daily, and the children have a bath once a week throughout the year. There is no compulsion, but practically every scholar welcomes the bath. A matron has charge of the girls' baths, and a man looks after the boys'.

CARE OF THE TEETH.

Intimately associated with the general cleanliness of the body, as well as the early formation of good habits, is the care of the teeth.

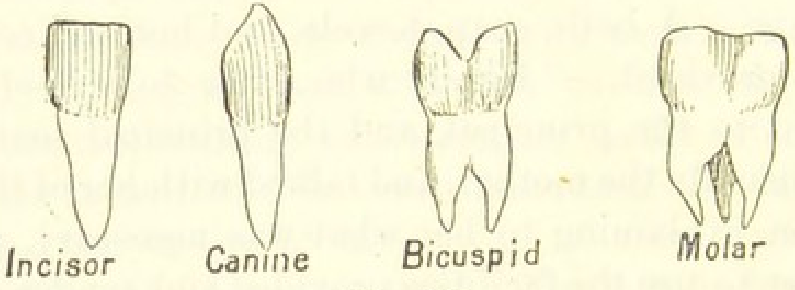

Fig. 92.
KINDS OF TEETH.

The teeth are divided into four classes according to their shape. In front are the incisors—the flat sharp-edged biting teeth. The long narrow fang-like teeth at each side of the incisors are called canines. Still further along the jaw are teeth which seem to be partly split into two at the top—these are the bicuspids. The molars are the broad-topped grinding teeth which are placed at the back.

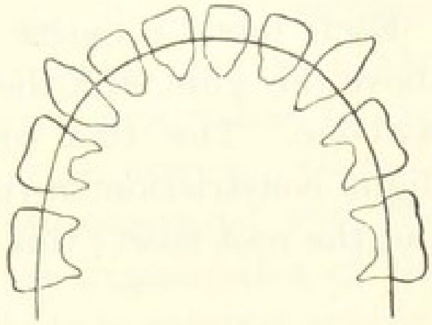

Fig. 93.
MILK TEETH (upper or lower jaw).

There are two sets of teeth, the first set or the temporary teeth, and the second set which are more or less permanent. The first set are called the milk teeth. They are twenty in number, and consist of eight incisors, four canines, and eight molars; each half of each jaw being provided with two incisors, one canine, and two molars. This set is usually complete at three years. They begin to drop out about the seventh year, and have all gone at twelve. By the fourteenth year all the permanent set have appeared except the last four molars, called the wisdom teeth. These may not be cut until the twenty-fifth year.

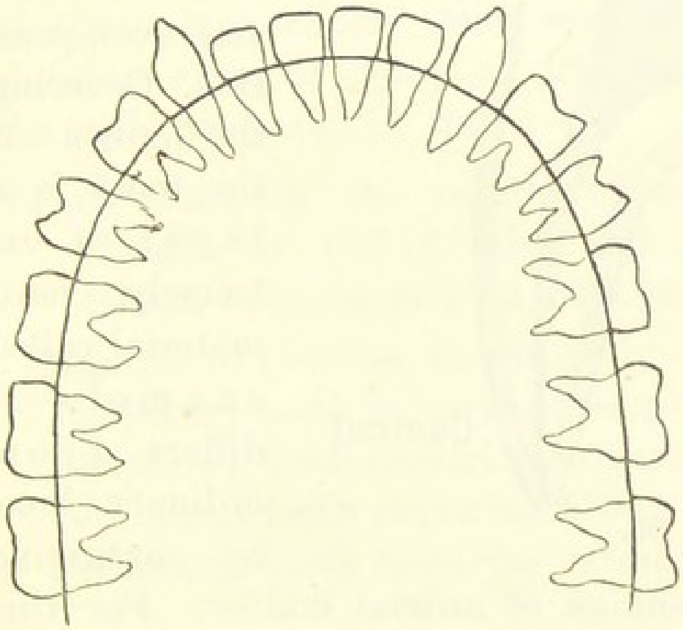

Fig. 94.
PERMANENT TEETH (upper or lower jaw).

The permanent teeth are thirty-two in number, and are divided into eight incisors, four canines, eight bicuspids, and twelve molars. At about fourteen years there would be twenty-eight teeth, the last four molars not being cut at this age.

Structure of a Tooth.

Each tooth consists of a crown, or the part showing above the gum, and the root, or the part imbedded in the jawbone. The root consists of one or more fangs. A slight constriction is visible at the line where the crown and the root meet; this is called the neck. The main body of a tooth is made of a substance called dentine which closely resembles bone in its structure and composition. Covering the crown of the tooth is a layer of extremely hard material called enamel. It differs from ordinary bone by containing a much smaller percentage of animal matter. For this reason the enamel rarely or never decays; but when it gets chipped off, decay at once attacks the softer dentine. The fang of the tooth is covered by a bony layer called cement which fixes the fang securely in its socket.

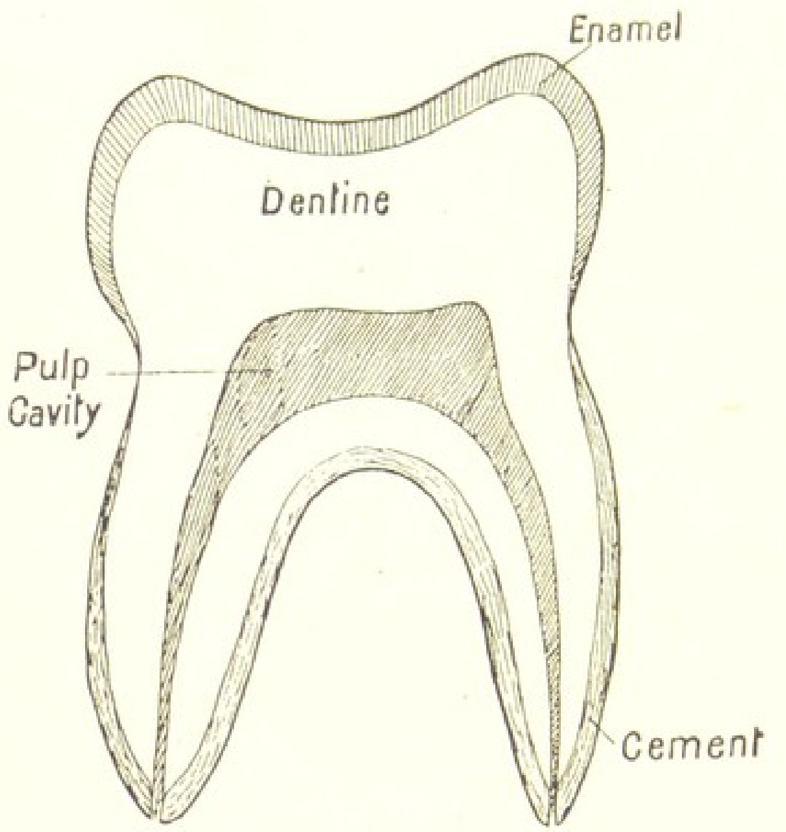

Fig. 95.

In the body of the tooth is a cavity which is filled with a pulpy substance containing nerves and blood-vessels.

These enter the tooth at the tip of each fang, and pass into the pulp cavity. Ordinary toothache is caused by the inflammation of this pulp in the tooth.

The question of children's teeth constitutes one of the most vexing and hopeless problems of child hygiene. Moreover it is a subject intimately associated with the national physique, and of the utmost importance to the well-being of the race. In spite of this, however, there is general public apathy on the subject, compared with the attention that is being devoted to the examination of the children's eyes and ears. The ophthalmic surgeon appears at the present time to constitute "the be all and the end all" of the child's necessities, but it is to be hoped that a broader view of the subject may soon be taken. The Committee of the British Dental Association found that among the children of the average age of 12 years in attendance at elementary schools there were more than 85 per cent. showing signs of decay of the teeth. The following is the table presented by them:—

TABLE showing the results of an examination of the mouths of 10,517 boys and girls in English and Scotch Schools, with an average age of about 12 years.

Number of children examined... ...	10,517	
Temporary teeth requiring filling ...	9,573	18,009
Temporary teeth requiring extraction	8,436	
Permanent teeth requiring filling ...	13,017	19,096
Permanent teeth requiring extraction...	6,079	
Total unsound teeth		37,105
Teeth already extracted		2,174

Sets of teeth free from decay 1,508 = 14·2 per cent.

An examination of ancient skulls shows that caries or decay of the teeth was formerly almost entirely absent, and it is also an undoubted fact that it is now rapidly increasing.

The attitude of the lower classes towards the subject can only be compared to a kind of Oriental fatalism. A decayed tooth is regarded as one of the unpreventable dispensations of Providence, and it is ignored until the pain can no longer be tolerated, when it is hauled out by some more or less competent individual. Then they wait for the next to come on. At an early age the whole of the working teeth are often gone or are useless. The result is that the food cannot be chewed properly, and the digestion is upset. Dyspepsia with all its attendant evils follows, and the constitution of the individual rapidly deteriorates. Unfortunately these are not the only results. While decay is going on the condition of the mouth cannot be otherwise than foul and unhealthy, and the gums, throat, and tonsils are affected. Undoubtedly there is thus produced an increased tendency to such diseases as diphtheria, pneumonia, and rheumatic fever. In such a mouth bacterial life flourishes to an unimaginable extent, and it is no difficult task to isolate a hundred different varieties of organisms and a large number of each breed. Septic and purulent material is formed in large quantities and is swallowed, causing serious disorders of the intestinal tract, and is said to be one of the causes of pernicious anaemia.

In addition to all this there is pain of a most wearing and aggravating character, and the breath is foul and infectious. Such an individual "pollutes the air that is breathed and contaminates the food that is swallowed." To carefully ventilate schools and to provide good wholesome food is a waste of money under such circumstances. The nutrition of such a child must be defective, and its growth is inevitably stunted. Among the more remote effects of bad teeth are the enlarged and suppurating glands in the neck, diseases of the jawbones and accessory cavities, and cancer of the tongue.

Causes of Decay.

The causes of decay of the teeth, like those of all diseases, are best classified into the predisposing and the determining. The predisposing causes include heredity, malnutrition, and acute illness. Heredity is important so far as it provides the child with a good or a poor material for its teeth. If the teeth are soft and friable, then when caries is established they will disappear rapidly. Also greater care will be necessary to prevent decay commencing in such teeth. As illustrating the effect of heredity it may be mentioned that Jewish children, as a rule, show less decay of teeth than the Gentiles. Dr. W. Hall, of Leeds, obtained the following figures :—

In good class Jewish school	11 per cent.	had defective teeth.
,, ,, ,, Gentile ,,	38 ,, ,,	
In poor class Jewish school	25 per cent.	
,, ,, ,, Gentile ,,	60 ,, ,,	

Probably the fact that nearly all the Jewish women suckle their children largely accounts for the differences.

Malnutrition is another important predisposing cause of caries. The improper feeding in infancy on patent foods, instead of milk, has a most injurious effect upon the teeth. The poorer the class of school, and the more neglected and underfed the children are, the greater is the percentage of children with bad teeth.

The nutrition of the teeth during development is arrested, for the time being, during an acute illness. The time of the illness will be marked on the teeth by a line, just as the nails become similarly marked.

The determining cause of decay of the teeth is composed of two factors—the presence of bacteria and the formation of an acid medium. Bacteria in the mouth have already been referred to. From our point of view there are three chief kinds—those which attack and destroy the teeth, those which produce disease, not only of the mouth, but of other organs, and those which produce fermentation. Those micro-organisms which attack the teeth can only do so when they are surrounded by an acid medium. Now the natural condition of the mouth is to be alkaline, but acid is produced when particles of food are left in the mouth and allowed to ferment. Fermentation produces an acid in the mouth just like it does in milk. If milk is kept too long without special precautions we say it has gone sour. Fermentation has gone on which has produced an acid, and this acid gives the sour taste. So in the mouth the food left between the teeth and round the gums will ferment and produce an acid, thereby affording the necessary opportunity for the bacteria to attack the teeth and cause decay.

Prevention.

The method of prevention now becomes almost obvious. If all particles of food are removed from the mouth there will be no acid produced and no decay. This simply amounts to regular and thorough cleaning of the teeth and mouth. The teeth should be cleaned every night. Just before bedtime is best because if any particles of food are left during the night the bacteria causing fermentation will have an undisturbed time of it, and a good deal of damage may be produced. A stiff brush should be used and the teeth and gums thoroughly scrubbed. Some simple tooth powder should be used ; one of the best is carbonate of soda, another good one is powdered borax, and if the use of this is combined with some mildly antiseptic mouth wash, such as a very dilute solution of carbolic acid, there will be produced not only an appearance but also such a sense of cleanliness of the mouth and throat as, once acquired, will be parted with very reluctantly.

Surely a good case has been made out for the introduction of the separate tooth-brush at school for each child, and the daily performance of what will probably be known as tooth-brush drill. I have no hesitation whatever in saying that it will be the very best and most beneficial drill that has ever been introduced into schools. The small expense that it would entail would prove an excellent investment, as it would undoubtedly have an immediate effect upon one of the most active causes of deterioration of physique. Since the above was written a notice has appeared in the daily press to the effect that Mr. Cadbury was about to introduce the use of the tooth-brush into the public elementary school at Bournville. It is impossible to overestimate the value of such an advance in school hygiene.

Of course a good deal can be done by proper direct practical instruction on the subject. The children should be taught the importance of saving their teeth, and the simple methods that will effect this. This instruction should be given in the infant schools and in every standard, so that there should be no danger of the subject being looked upon as limited to some special year's work and being subsequently forgotten. It is important to remember that the first teeth must be brushed and cleaned regularly. Many people fail to understand that a carious milk tooth will cause the permanent tooth to become carious also. There should also be regular inspection of the teeth of the children, and efforts made to get any defects remedied.

SLEEP.

Most town children suffer from an insufficient time for sleep. The results upon the organism of the child are most disastrous, both physically and mentally. To cut down a child's sleep is as cruel as to deprive him of food. Dr. Dukes gives the following amounts of sleep at different ages :—

Age.	Number of hours.	Time.
Under 6 years	13	6 p.m. to 7 a.m.
,, 7 ,,	12½	6.30 ,, ,, 7 ,,
,, 8 ,,	12	7 ,, ,, 7 ,,
,, 9 ,,	11½	7.30 ,, ,, 7 ,,
,, 10 ,,	11	8 ,, ,, 7 ,,
,, 13 ,,	10½	8.30 ,, ,, 7 ,,
,, 15 ,,	10	9 ,, ,, 7 ,,
,, 17 ,,	9½	9.30 ,, ,, 7 ,,
,, 19 ,,	9	10 ,, ,, 7 ,,

These amounts should certainly be taken as minima, and probably they should be increased so as to give the child of thirteen a rest of twelve hours.

Not only should the amount of sleep be graduated according to the age of the child, but also the hours of work. In practically all schools the younger children do far too much mental work, and get a totally inadequate amount of sleep, so that if it were not for the long holidays that succeed the terms of work most children would be seriously handicapped for life. The vacations save a complete breakdown. Dr. Dukes gives the following table:—

THE Hours of Work and Sleep adapted to the various ages of children.

	Ages.	Hours of Work.	Hours of Sleep.
Nursery	From 0 to ½	0	20
	,, ½ ,, 1	0	18
	,, 1 ,, 2	0	17
	,, 2 ,, 3	0	16
Infant School	From 3 to 4	0	15
	,, 4 ,, 5	0	14
Primary School	From 5 to 6	1	13½
	,, 6 ,, 7	1½	13
	,, 7 ,, 8	2	12½
	,, 8 ,, 9	2½	12
	,, 9 ,, 10	3	11½
	,, 10 ,, 12	4	11
	,, 12 ,, 14	5	10½
Secondary School and University	From 14 to 16	6	10
	,, 16 ,, 18	7	9½
	,, 18 ,, 19	8	9
	,, 19 ,, 21	8	8½
	,, 21 ,, 23	8	8

Many of the mental breakdowns that are so common among young students would not occur if during their childhood and boyhood an extra allowance of sleep had been given. At the recent meetings of the British

Association at York Dr. Acland exhibited a chart from which it seemed that, whereas in some schools small boys get ten hours sleep, in other schools boys of the same age get only $7\frac{3}{4}$ hours, and he quoted the testimony of the headmaster of a well-known preparatory school to the effect that more sleep for the boys had been attended by indubitable success, and all that had been done was to change the breakfast hour from 7 a.m. to 8 a.m. Then Dr. Acland gave his own experience of a boy who came under his notice, and he threw upon the screen specimens of the boy's writing when he entered the school. Soon, however, a change came over the boy's caligraphy. It was more careless and slipshod in style, words were written wrongly, and then corrected, and in some cases he had actually scored out words that were spelt correctly and had inserted the same spelling over again. On Dr. Acland's advice the boy was given more rest, and the result was at once seen in clear handwriting, which as nearly as possible resembled his "fist" when he entered the school.

Children as a rule require at least as long a period of rest as they have of work and play, for most of their growth takes place in bed, and therefore to stint them of sleep is to hinder their development. A common fallacy is that physical exercise acts as a compensation for long hours of mental application. Nothing could be more mischievous in its results. It is perfectly true that mental fatigue is prevented to some extent by intervals of physical recreation, but the only true rest to the body and mind is obtained by sleep. "There is no ground for supposing," says Dr. Acland, "that hard physical exercise is a sufficient compensation for hard brain work, but on the contrary it should be followed by an increased amount of rest." Children appear to need more sleep in winter than in summer. The most effective part of the night's sleep is during the first hours, and in order to get the best results it is important that the children should not have any hard mental work just before going to bed.

According to Dr. Clouston there is a decreasing degree of staying power manifest during the last thirty years, *i.e.* since the Education Act of 1870, on the part of the brain to the extent of about 40 per cent. It is a question for us all to consider what share, if any, schools have in this terrible fact, with their excessive hours of work in the early years of childhood, and the inadequate amount of sleep during the same period of life.

FOOD.

The uses of food for adults are (1) to keep up the heat of the body; (2) to supply the energy for internal work such as respiration, heart beat, brain work, and the work done by the different organs, and external work such as running, walking, and talking; (3) to make good any loss, and replace decayed tissues. In addition to these uses the food of children has to provide material for their growth.

Food can be regarded as composed of two chief materials: the one kind is used by the body in producing heat and energy, and the other kind goes to form the growing body of the child and to renew and repair the various tissues and organs. Fats, starches, and sugars are burned up in the body and heat and energy result, while such foods as the lean of meat, fish, the white of eggs, the greater part of cheese, and a considerable proportion of such foods as milk, oatmeal, bread, peas, beans, and lentils serves to produce actual body tissue and repair any worn out parts.

The food of children should contain some tissue-forming material, as well as fats, sugars or starches, and some vegetables or fruit. The following table will give some idea as to the relative quantities of these materials that common foods contain.

RELATIVE PROPORTIONS.

Food.	Tissue-forming.	Force-producing.	
		Fats.	Starch or Sugar.
Milk	37	29	34
Oatmeal ...	16	7	77
Bread... ...	13	2½	84½
Butter ...	2½	97½	—
Bacon ...	11	89	—
Meat	70	30	—
Cheese ...	50	49	1
Fish (herrings)	55	45	..
Lentils ...	29	2	69
Peas	24	2	74
Rice	6	..	94

Fats are particularly valuable foods for children, but the average child among the poor classes has far too little fat provided in the food. This lack of fat in the diet during early life undoubtedly predisposes to consumption and ill development. The great desire for sweet things, possessed by most children, is probably a manifestation of the physiological need of the body for sugar. Tissue-forming foods, on account of their expense, are often lacking, the result of which is deficient physical and mental development. If tissue-forming materials, fats, starches or sugars, and vegetables or fruits are not all represented in the diet, or are there in improper proportions, or are deficient in quantity, the child cannot develop as it should do. If the diet is deficient the nutrition of the body is more or less arrested; if the diet is ill-balanced but abundant the nutrition is perverted. Scurvy, rickets, and anaemia are all nutritional diseases.

To try to educate underfed children is not only wasteful of the teacher's energy, but is also cruel to the child because deterioration of physique is promoted by exhausting the enfeebled nervous system. Such a child's mental apparatus is not in a condition fit for work. If work is insisted upon, then the nervous system is speedily exhausted and all sorts of evils result. The limits of educational possibility are primarily determined by the food supply available. It is impossible to properly educate an ill-fed child, and if education is attempted the effect upon the physical and mental health of the child is disastrous.

In the report of the Royal Commission occur these sentences :—

"We consider that the question of the proper and sufficient feeding of children is one which has the closest possible connection with any scheme which may be adopted for their physical and equally for their mental work. It is evident that among the causes which tell against the physical welfare of the population, the lack of proper nourishment is one of the most serious. The subject demands special notice, not only as regards the existing state of affairs, but still more in view of any increase of physical training throughout the State-aided schools which may commend itself.

"We are aware of the danger of further encroaching upon the independence of parents, and of entering upon the wide question of how far the State should go in relieving them of their primary responsibility. But we are not on that account deterred from calling attention to the necessity for better feeding, which, in our opinion, has been fully demonstrated, nor from considering a practical remedy. We have no desire to give encouragement to any inclination of the parent to abandon any of his duties and responsibilities in regard to the feeding and clothing of his children; but it must be remembered that, with every desire to act up to their parental responsibility, and while quite ready to contribute in proportion to their power, there are often impediments in the way of the home provision of suitable food by the parents. The proper selection, cooking, and preparation may often be matters of serious difficulty to many parents. It would be in many cases an inestimable advantage could regular and sufficient meals—such as broth, porridge and milk, or bread and milk—be provided at a minimum cost. The preparation and cooking of these meals, where it is found necessary to provide them, ought to be regarded as one of the charges incident to school management.

"In like manner we think that an obligation for the proper supervision of the feeding of those who come for instruction should be regarded as one of the duties of school authorities, and that teachers should be instructed to take note of all children apparently ill fed. Unless children receive sufficient nourishment, they cannot be expected to profit by the mental or physical training provided for them."

As an initial effort the mere provision of a glass of good milk during the morning and also the afternoon school would produce a most gratifying effect upon the underfed scholars.

The report of the Inter-departmental Committee appointed on March 14th, 1905, contains a number of details with regard to schemes which have been instituted in various towns for the feeding of children attending public elementary schools, and concludes with a summary of recommendations for better organisation. The scope of these recommendations is limited by the statement that they are to be taken to apply only where arrangements are made for feeding school children. The Committee did not consider it within the terms of the reference to recommend that such arrangement should be made, nor to express any opinion as to the wisdom from an economic or social point of view of relieving children, apart from their families, by the provision of school meals.

The recommendations, distinguished mainly by the omission to touch upon the vital parts of the question or the points of most serious difficulty, are as follows :—

1. The local education authority, or some central body authorised for the purpose by them, should be kept regularly informed of any feeding of scholars which is in any way organised in connection with the schools maintained by the authority, and of all funds received by managers or teachers for that purpose.

2. The local education authority should cooperate as far as practicable with any feeding agency established in its area, and unless there is any good reason to the contrary, should be represented thereon, though such representation may not be feasible or even desirable in London and the county areas.

3. Any organisation for feeding school children should be of a permanent character—that is to say the framework of the organisation should be kept continuously in existence, notwithstanding that its operations may be in some cases properly intermittent.

4. Provision should be made for enabling meals to be given, where necessary, throughout the year, though summer needs will generally be small.

5. Where meals are provided it is desirable that they should be obtainable at least as often as every school day.

6. The object of the agency should be to feed the most destitute children regularly, rather than a large number irregularly.

7. The children of families in temporary distress should be made the first care of any feeding agency.

8. It is not desirable that teachers should be required to take part in serving or supervising children's meals.

9. While teachers may properly make the initial selection they should not be made responsible for the final choice of the children to receive meals.

10. A "relief committee" should be formed for each school or group of schools, and provision should be made for placing on such committee an adequate number of women.

11. In selecting children to receive meals (*a*) the information in the possession of the school attendance officers should be utilised; (*b*) the cooperation of Poor-law guardians and relieving officers should be invited; (*c*) as far as possible the cooperation of religious and philanthropic agencies in the district should be enlisted; (*d*) where there is a school medical officer or nurse, their advice and help should be obtained.

12. Care should be taken to give adequate notice beforehand to their parents when children are to receive meals; sufficient notice of the discontinuance of meals should similarly be given.

13. The parents should be told clearly that they are in receipt of charitable relief for their children where such is the case, and greater effort might be made to obtain payment from parents for the whole or part cost of meals supplied to their children.

14. Care should be taken to make the meals orderly, and to give them a civilising and educative effect upon the children.

15. Registers should be kept showing exactly what children have received food and on what days.

16. Schoolrooms and classrooms should not be used for meals, if other convenient rooms can be found.

17. Cookery centres may in some cases be usefully employed for the provision of children's meals. But a cookery centre can only provide for a few children, and it should be remembered that its essential purpose is the provision of cookery instruction.

The important questions involved in the discussion of nutrition, growth, and development of children are somewhat beyond the scope of this book, but the following table from the report by the Royal Commission on Physical Training may be useful:—

		Ages.	British Population (Roberts). Inches.	Boston School Children (Bowditch). Inches.	Edinburgh Schl. Children (Mackenzie). Inches.
Height,	Boys	6 to 9	45·67	46·15	44·52
,,	Girls	6 ,, 9	44·64	45·89	44·51
,,	Boys	9 ,, 12	51·68	52·10	50·20
,,	Girls	9 ,, 12	50·96	51·72	49·93
,,	Boys	12 ,, 15	57·07	58·34	55·26
,,	Girls	12 ,, 15	57·74	58·74	55·65
		Ages.	lbs.	lbs.	lbs.
Weight,	Boys	6 to 9	49·6	49·68	46·60
,,	Girls	6 ,, 9	47·1	48·25	45·62
,,	Boys	9 ,, 12	66·6	66·32	59·53
,,	Girls	9 ,, 12	61·8	63·95	57·76
,,	Boys	12 ,, 15	83·7	89·12	74·02
,,	Girls	12 ,, 15	86·7	90·95	78·36

There is no doubt that the rate of growth is greatly affected by the surroundings, by exercise, and by food. During the physical examination of school children many questions present themselves, involving issues of tremendous importance to the well-being of the race. Concerning every scholar it should be asked whether the child is fully grown for his age. If he is not it should be ascertained whether the arrested development is due to hereditary causes, congenital defects, or such causes as lack of food, improper food, use of drugs, bad sanitary conditions at home, &c.

All great reforms need a first step. There is urgent need of a total reform of the methods and surroundings of school life, and an excellent first step in the school education of the people is to ascertain the heights and weights of all the school children.

PART III.

MEDICAL SUPERVISION AND SCHOOL MEDICINE AND SURGERY.

CHAPTER I.

INTRODUCTION.

The School Medical Officer.

Many towns and urban districts have now appointed medical officers to the education authority, but the duties of these officials vary in different cases. There is no fixed standard either as to the nature or the scope of the work, and in many districts the remuneration is so nominal that the medical officer cannot afford to devote to the work the time that he recognises is necessary. In the near future it is likely that such appointments will be compulsory and their duties clearly defined.

It is desirable that in all cases the Medical Officer of Health should undertake the duty of inspecting, or supervising the inspection of, schools and school children. The work is so inseparably connected with the public health as to render this essential to the smooth working and efficiency of any scheme. When local authorities have the power and the desire to treat defective bodily conditions, then the services of specialists in eyes, ears, skin, teeth, etc., *may* be necessary for a few special cases, but the school buildings, the health of the school children, and the inspection of the children should be in charge of the local Medical Officer of Health.

MEDICAL INSPECTION AND SUPERVISION.

It is generally recognised that the organisation and direction of the medical inspection of schools should be assigned to the Medical Officer of Health, and the recent appointment of Dr. Newman as Chief Medical Adviser to the Board of Education seems to show that the Board intends to take this view. At the recent Congress the following considerations were urged in favour of such a course:—

(1) The Medical Officer of Health represents the preventive functions of the Sanitary Authority and the work of medical inspection is largely preventive.

(2) He controls the sanitation of the child's environment,—drainage, water, overcrowding, food, ventilation, housing, plans of buildings and the like.

(3) He has access to the school for the purpose of examining the children for infection, and he has control of all the apparatus for managing infectious diseases.

(4) He necessarily has a hygienic interest in the child before it begins to go to school, during its stay at school, and after its school days are over. The child cannot be divided up into abstractions,—the home-child,—the school-child,—the street-child,—the factory-child,—the work-child and so on. It is the same child right through its hygienic relationships and, as the school is the largest depot of children for the time being, the Medical Officer of Health should have the administrative advantage that direct personal examination can give to the preventive functions of the Sanitary Authority.

(5) The Medical Officer of Health knows that the physical condition of the child is an index to the sanitary condition of the home, and he wishes to have this new line

of entry into the home in order to improve the child's and the parents' environment.

Medical inspection should not mean merely dealing with epidemic and isolated cases, but should be a system whereby education will mean the development of body as well as mind. At present we neglect curable conditions in childhood and treat them later on in asylums and hospitals.

In Leipzig the children are systematically examined about three months after admission to school. The preliminary examination is made by teachers under medical superintendence. Then the detailed examination a little later by the doctor. Most of the parents attend this. The doctor delivers a short preliminary lecture on personal hygiene, then in the presence of mother and teacher each child is examined. A separate card is filled up for each child, and this passes with it through the school. If defects are found the parents are directed to seek treatment.

Of course in very large districts and towns the whole of the work cannot be personally done by the Medical Officer of Health, and part of it may be delegated to an Assistant Medical Officer. At present the duties consist usually in the examination of pupil teachers, the visiting of schools, and an occasional general inspection with a view to checking the spread of infectious disease. The aim of those directing education should be to arrange that every child should be medically examined soon after it comes to school, and this examination should be checked every year. Parents are compelled to send children to school, and so during the school age they may be said to be in charge of the State. But ordinary school conditions are undoubtedly useless or injurious to certain children, and it is the duty of the State either to weed out these children and to treat them separately, or to endeavour to bring them to the normal condition and educate them with the others. Moreover it is likely that with skilled medical supervision the methods of modern education may be modified so as to produce less physical harm and more mental good than is achieved at present. In connection with such work there is also a vast field of possible research with regard to the development and mental conditions of childhood. Such an examination as is recommended should include information under the following heads:—Name, date of birth, height, weight, chest measurement, personal appearance, general development of body, cleanliness, condition of teeth, eyes and eyesight, ears and hearing, nose and throat, deformities, diseases, etc. In cases of mental deficiency the head measurements should also be recorded.

Height and Weight.

The importance of this information has already been discussed and a table of standards is given on page 245.

Chest Measurements.

This is perhaps the best and most reliable indicator of physical capacity. It should invariably be recorded and carefully checked year by year. The results give a great deal of information as to the condition and development of the child. A well developed chest usually means sound lungs and heart, upon which the well-being of the body entirely depends.

Personal Appearance.

Under this head should be recorded the complexion, the appearance as to healthiness, carriage and general balance, and brightness and alertness.

General Development.

The general conditions of development and nutrition.

Cleanliness.

The condition of the body, the head, and the clothing should be carefully recorded, as affording, in the case of young children, an index of the character of the parent, and in older children a clue to the personal disposition of the child as well. Dirt always denotes ignorance and incapacity of the parent.

Condition of Teeth.

The importance of attention to the teeth has been explained elsewhere. Under this head the cleanliness, attention received at home in the form of daily brushing, the shape, regularity, number missing, number decayed, and the number of permanent teeth visible above the gums should be noted. The shape and development of the palate may well be added here.

Eyes and Eyesight.

Disease or deformity of eyes or eyelids, as well as the colour and the acuteness of vision should be recorded. From a school point of view it is sufficient if the child can manage to read ordinary type at the normal distance, and to see easily writing on blackboards or diagrams. It is occasionally pointed out that this may be done if one eye is normal, or by extra accommodation if the defect is slight, and a child may be suffering from an optical defect without having its school efficiency impaired. Later in life, however, after leaving school, such a defect may become very troublesome, and may prove to be a severe handicap. Consequently extremists advocate that conditions of short sight, long sight, and astigmatism should be accurately recorded. On the other hand it may be urged that if the routine examination is to include retinoscopic tests it will postpone, by its tedium and delay, the general adoption of urgently necessary medical inspection. If this is so, then the average child should be submitted to the general test of eyesight as already described and the more minute examination reserved for the cases weeded out by the general test, and also for cases where intellectual progress is unsatisfactory, and for special cases such as children suffering from persistent headaches, etc. In fact, the above plan represents all that is really necessary, and if generally adopted would prove of the greatest possible service.

Ears and Hearing.

The record here should show any deformity or disease of the ears, as well as the result of the test of hearing already described. If the general test shows hearing deficiency, then the ears should be tested separately. Avoid special minute examinations except where the general examination shows that the child has some defect and is therefore not capable of taking full advantage of the ordinary school instruction.

Nose and Throat.

It has already been pointed out that the condition of the nose and throat is an important index of the child's health. The condition of the tonsils, the cervical glands, the pharynx, as well as the habit of breathing should be recorded. The sense of smell may also be tested.

Deformities.

Congenital and acquired deformities should be separately noted. The congenital deformities include harelip, cleft palate, club foot, peculiarities of ears, indented nose, etc., all of which may be of great service in investigating the case of a mentally deficient child.

CHAPTER II.

THE DAY'S WORK.

FATIGUE.

There are two factors in fatigue, the muscular and the nervous. A muscle, as everyone knows, becomes fatigued after a longer or shorter period of activity. The cause of this fatigue is the production of poisonous waste materials in the muscle. These are produced, during the activity of the muscle, at a greater rate than they can be got rid of, and when they accumulate beyond a certain point the muscle becomes incapable of further useful work. By a period of rest the muscle can be restored to its original condition because the waste products are rapidly eliminated during repose. Probably in just the same way the brain becomes fatigued by prolonged mental work. Toxic bodies are produced in the brain during the period of activity, and when they accumulate beyond a certain point further useful mental work becomes an impossibility. In children the channels for the elimination of these waste materials are but poorly developed, so that mental fatigue comes on very rapidly.

The whole of the mental apparatus is most truly rested by sleep, but, unless the fatigue is so great as to amount to exhaustion, there are other means of removing the poisons that have been produced in the brain during a lesson of undue length. Within reasonable limits the muscular and the nervous activities may be regarded as complementary, the parts of the brain that have been used chiefly during the lesson being best rested by the activity of the muscles, *i.e.* by physical exercise or play. The effect of the exercise in increasing the rapidity of respiration and circulation still further tends to hasten the removal of the toxic bodies from the brain.

It should be remembered that the child becomes mentally fatigued rather by the length of the separate lesson than by the length of the day's work. For proper beneficial and useful work the child's lessons must be short and must be separated by intervals of play.

Many observers, as a result of investigations carried out by them, have pointed out that the length of time during which the attention can be fixed on a lesson is very short in early childhood and gradually increases with age. The results of their observations were as follows:—

At 6	years the attention can be fixed for	15 minutes.
From 7 to 10	,, ,, ,, ,,	20 ,,
,, 10 ,, 12	,, ,, ,, ,,	25 ,,
,, 12 ,, 16	,, ,, ,, ,,	30 ,,

These figures mean that if the attention of the child has been concentrated upon mental work for the above periods the limit of good work has been reached, and if the same lesson is continued it will tend to produce mental fatigue, and the children will gain no benefit from further instruction. The time of the teacher and the children is wasted by long lessons. At the end of one of the above proper periods of instruction there should be a minute devoted to simple physical movements or breathing exercises, and then a second lesson given of the same length, the subject being as great a mental change from the first as possible. After the second of these lessons there should be a period of physical exercise in the form of play.

It does not appear to be fully appreciated that the time during which the child is attending school is even more vitally important to its physical well-being than to its mental development. Any hindrance to the process of physical development during these years can never be compensated. The seeds of tuberculosis and diseases of the nervous, digestive, and circulatory systems are sown in many instances during school life. No wonder that children "outgrow their strength" when the demands that school life makes upon the body leave no balance for its proper development. All experts are agreed that the best work is got from the scholars by short and varied lessons. No lesson should exceed half an hour's duration, and after two such lessons there should be fifteen minutes' play. In this way there would be far more real working time in the school day than there is at present, and the results would more than justify the change.

There is a great deal of evidence that the school work of scholars is always best after intervals of rest, and steadily deteriorates after a certain period of constant work has elapsed. Usually the best work of the week is done on Monday and Tuesday, and on Tuesday afternoon the work begins to deteriorate. If there is a Wednesday half-holiday there will be an improvement on Thursday morning, and so on. For this reason it is an advantage to have a half-day's holiday on Wednesday and Saturday, instead of the whole day on Saturday.

The best work of the day is done during the first two hours, and the afternoon's work is always inferior. At all events this is the experience of most people who are actually engaged in educational work, although a certain amount of evidence has been brought forward against such a view. For this reason the afternoon is best occupied by those subjects which produce the least fatigue, such as history, literature, and languages. It cannot be too often repeated that gymnastics and drill produce so much physical and mental fatigue that the work done afterwards is almost useless. No mental work should be attempted for at least half an hour after a meal.

Fatigue comes on with increased rapidity if the surroundings are injurious. Bad ventilation, bad lighting, improper desks and injurious attitudes are common causes of rapid fatigue in schools. If, in addition, the child arrives at school suffering from want of sleep and insufficient food, it is wonderful how the teachers manage to get any real mental work done at all. If it is done, what a price does the child pay for its poor little stock of knowledge!

THE DAILY TIME-TABLE.

The arrangement of the time-table has been mentioned above in connection with the subject of fatigue. According as the subjects are arranged it may contribute towards the production of fatigue or help to obviate it. The daily programme should be so arranged as to engage successively different kinds of mental activity. The best work is done in the morning when the children are fresh, and so the most trying and fatiguing work should be taken then. During the first part of the day the children think better and quicker, their memory is better, and they more quickly recover when fatigued than at any other time. Arithmetic and mathematics are therefore justifiably attempted the first thing in the morning. The arrangement of the other subjects may be left to the judgment of the teacher, but care should be taken to make each subject as widely different as possible from the one before. The less fatiguing subjects should be reserved for afternoon.

The minimum times set apart for games should be twenty minutes in the middle of the morning, and the same interval in the afternoon. Better results would probably be obtained by having an interval of play after each hour or hour and a half of work. For young children under 9 years of age the ordinary school day of about $5\frac{1}{2}$ hours is simply cruelty and does an infinite amount of mental and physical harm. It has been proved over and over again that the best educational results are obtained by much shorter hours of school work, and much longer periods of outdoor exercise than are usual in most schools. The importance of the fact justifies its continued repetition, because education authorities at present appear to have quite failed to grasp this simple but fundamental truth. The experiment conducted by Mr. Charles Paget, M.P., is well known. Not being satisfied with the progress of the boys in the school on his estate he divided the school into two similar sections. One section continued the ordinary school work in the usual school hours, but the other devoted half the usual time to school work and the remainder to outdoor work in a garden. Those boys who were employed half their school time in the garden were found to excel the others in every respect.

Similar evidence is given by Sir E. Chadwick, who found that the children in half-time schools were ahead of those who attended the whole day.

For older children, of course, longer hours of work are necessary, and will do no harm, but many children arrive at the age of twelve or thirteen suffering mentally and physically from the effects of injudicious methods of education during their earlier years.

Dr. Clement Dukes gives the following table of the hours of school work suitable for each year:—

Ages.				Hours of work.
From	5	to	6 years	6 per week
„	6	„	7 „	9 „ „
„	7	„	8 „	12 „ „
„	8	„	9 „	15 „ „
„	9	„	10 „	18 „ „
„	10	„	11 „	21 „ „
„	11	„	12 „	25 „ „
„	12	„	13 „	30 „ „
„	13	„	14 „	35 „ „

The same writer very wisely advocates a reduction of these hours for boys between 13 and 16 years and girls about 12 and 13 years in those cases where growth is proceeding very rapidly.

Education of Girls.

The injury done to boys and girls during "preparation for examinations" is now beginning to be recognised, but the terrible risks in the case of girls is not yet appreciated. The "higher education of girls," consisting as it usually does of several years' cramming for examinations, often in subjects utterly uncongenial to the feminine mind, is an unmitigated evil, and often results in a complete breakdown. A few exceptional brains can manage to acquire the necessary examination tricks in a short time, and some of these cases appear to survive the ordeal unscathed, but for the more numerous class who find it necessary to grind away incessantly in order to get up to the examination standard the process is injurious and mind-warping. When, in addition to this direct mental injury, one remembers that these processes are at work usually just at the time when the body is finishing its physical development, and when it is being decided whether the body shall be normal and strong or abnormal and weak, there is little cause for surprise that education is at last making its first feeble efforts to dissociate itself from forced work for examinations.

"I would urge," says Dr. Clement Dukes, "that the education of growing girls should not be acquired at the expense of motherhood: we do not want crammed heads, but strong well-made bodies, fitted for Nature's requirements. There is no sphere for the girl which can excel that which comprises the virtues of motherhood; and if teachers and parents were more alive to their duties, and would see that education consisted more in training the girl for the beneficent occupation of home-maker, what a vast amount of happiness and usefulness would be engendered! Mental powers too highly developed in women involve a physiological cost, which her feminine organisation will not sustain without injury more or less profound.

"It is more essential for a nation to produce vigorous offspring, than to educate girls to the highest standard. By the highest *physical* education girls can be rendered strong, comely, and well proportioned; while by the highest *mental* culture (without this physical basis) they *may* be transformed into mere 'blue stockings' or neurotics, or a combination of both."

Such vital problems as physical degeneration, the decreasing birth rate, and the increase in lunacy and in neurotic conditions do not appear to have yet been popularly associated with the modern education of girls. Yet it is a possible association of cause and effect, and one that is well worth consideration by those who have at heart the well-being of the race, and who are seeking an explanation of these serious developments.

With reference to over-pressure in mental work it is impossible to improve upon the words of Sir Crichton Browne:—"It has often occurred to me that if educationalists could peep through a little hole in the skull, and see the living, throbbing brain, and realise that it is a pulpy organ of about the consistence of calf's-foot jelly; and if they could look at the minutest shred of it under the microscope and admire one little galaxy out of the millions of starry cells that it contains, lying scattered amongst the strands and sources of its fibres 'like a swarm of fireflies tangled in a silver braid,'—if they could, as physiologists can, picture to themselves the functional activity of the brain—now, as at times of ease and abandonment, *shimmering* over its surface from point to point; now, as at periods of calm and connected thought, localised into a steady *glow* in certain regions; and now, again, as in moments of intense mental application, concentrated on one spot into a *spark* of surpassing brightness—if our educators could do all this, and if they could become practically acquainted with the brain, they would, I think, be more careful in the handling of it than they sometimes are, and be a little less ready to deny that there is any danger of exerting overpressure on this delicate structure."

The brilliant boys at school are rarely successes in after life. The early mental overstrain either produces sufficient physical injury to handicap them heavily afterwards, or else causes them to rapidly reach their limit of mental development.

SIGNS AND SYMPTOMS OF OVEROWRK.

Overwork as a rule quickly produces easily recognised effects upon the young body and mind. Unfortunately such effects are only too commonly found in many of the secondary schools and colleges. In such cases the skin acquires an unhealthy appearance, dark rings appear round the eyes, and the scholar either becomes unnaturally restless and excitable, or unduly lethargic and dull.

Growth.

The growth is often arrested under such circumstances. Any child who fails to increase its weight regularly should be regarded as ailing. In fact, no stronger proof of its ill-health could be forthcoming. Occasionally the explanation is that the amount of food is insufficient in quantity, but more often it is the fact that the child is failing to digest the food supplied. Constipation, with its accompanying foul breath and loss of appetite, is a common result of overwork. By carefully noting the height and weight of every scholar three times a year it is possible to obtain a considerable amount of information as to their general well-being. The following table shows the average heights and weights at different ages :—

	Boys.		Girls.	
Age.	Height.	Weight.	Height.	Weight.
5	41·2 ins.	40·5 lbs.	41·0 ins.	39·6 lbs.
6	43·9 ,,	44·8 ,,	43·0 ,,	42·8 ,,
7	45·9 ,,	49·4 ,,	45·0 ,,	47·0 ,,
8	47·4 ,,	54·4 ,,	47·0 ,,	52·1 ,,
9	49·7 ,,	59·8 ,,	49·0 ,,	56·3 ,,
10	51·7 ,,	66·4 ,,	51·2 ,,	62·2 ,,
11	53·5 ,,	71·1 ,,	53·3 ,,	68·5 ,,
12	54·9 ,,	76·8 ,,	55·8 ,,	77·3 ,,
13	57·1 ,,	83·7 ,,	57·9 ,,	87·8 ,,
14	59·6 ,,	93·5 ,,	59·9 ,,	97·6 ,,
15	62·3 ,,	104·9 ,,	61·0 ,,	105·4 ,,
16	64·7 ,,	120·0 ,,	61·7 ,,	112·4 ,,

The above figures are averages of a large number of statistics. It should be remembered that there are variations in weight according to social conditions and surroundings. The following table shows such variations between 11 and 12 years of age:—

Class.		Age.		Average Height.
Public School	...	11 to 12	...	54·98
Agriculture ...	...	"	...	53·01
Factory ...	...	"	...	51·56
Industrial School	...	"	...	·50·02

The above table shows that roughly there is a growth of about two inches per year. Also that between 11 and 13 years in boys, and 9 and 10 in girls, there is a curious retardation in growth. At these ages the children do not appear to be doing so well as at other ages. In boys at 16 and girls at 13 growth is going on at its maximum rate, and at these ages it is well if the mental and physical activities are brought to a minimum.

Chest Development.

A systematic record of chest measurements is even more valuable. If a child's chest shows no increase in size in six months it should be medically examined. Probably no physical factor is under such control as the chest measurement. Every child's chest can be developed to a fair standard by proper breathing and physical exercises. Overwork usually causes shallow breathing and consequently an ill-developed chest.

Other Effects.

Among other effects of overwork may be mentioned the dull, lifeless appearance, the inelastic gait, the flabby and wasted muscles, and the various nervous conditions. The nervous evidences are very numerous, and include sleeplessness, bad dreams, somnambulism, headaches, starting and talking in sleep, hysteria, St. Vitus' dance, irritability, twitchings of muscles, and many other ill effects. Mental perversion is also common, and there is occasionally a total change in the moral nature of the child. Many of the above effects, unless quickly recognised and arrested, cause life-long misery and suffering.

EXAMINATIONS.

Much has been written on this subject. Most of the "experts on education," whose opinions are listened to with such reverence, have never had any real experience in teaching a large class of children. Periodical examinations are necessary and useful in order to test the progress of the scholar and the efficiency of the teacher. The examinations should be fairly conducted and the questions asked should be reasonable. The standard required also ought not to be excessive. Everyone who has had much experience in examinations has met that examiner whose idea of "examining" is to find out what the candidate does *not* know, instead of ascertaining how much he *does* know. Competitive examinations as at present conducted, whatever may be the necessity for them, are unmitigated evils both from an educational standpoint and also because of the enormous damage they do to the average candidate. One of the results of them is the evolution of the "examination expert," as he (or she) might be called. Such scholars early acquire the knack of absorbing knowledge from an examination point of view, and readily grasp the fact that the method of presenting the matter is of as much importance as the matter itself. These candidates are rarely injured by the cramming process, and they succeed brilliantly in school examinations, but, curiously enough, they are rarely heard of afterwards. On the other hand the examinations often severely and permanently injure great numbers of scholars in secondary schools. The fault is not with the system of examination, but because there is no proper control over the methods of preparing candidates for them. Competition of all kinds is healthy and desirable, but when candidates are crammed and overworked by attempting to do twelve months' work in six, or less, a certain number of disasters is inevitable. At all events there should be an invariable rule, from which no exception should be allowed under any circumstances whatever, that no boy should take part in any competitive examination during his sixteenth and no girl during her thirteenth or fourteenth year.

HOME WORK.

If good work has been done during the school day there should be no need for work in the evening in the case of children under eleven or twelve years old. After that age a certain small amount of home work may be required, but it should be always restricted in amount and of a definite character, such as working a few mathematical examples the methods for which have been thoroughly learned at school, or committing to memory a short piece of prose or poetry. The work set should not present any difficulty to the scholars. Nothing should be set which will involve more than an hour's work at most, and it must not need much reading. To use the already overtired and overstrained eye, in indifferent artificial light, in still further struggles with the type of the average school book is to convert a possible into a probable disaster. Constructive manual work has not such great disadvantages as home work.

Everyone who has had educational experience realises that the work in the average school is not so continuous in character as it might be. There are slack times which must be made up for by periods of overwork, and unfortunately the usual time for setting large amounts of home work is just when there is extra pressure being exerted during school hours. If the work in school is done thoroughly throughout the year there should be no need for any work out of school hours.

HOLIDAYS AND HOLIDAY TASKS.

The present average elementary school holidays are fairly well arranged and of the right length. The holidays of secondary schools are undoubtedly too long and are the chief cause of the cramming that may go on during the term. Any holiday of a greater length than four weeks should be considered too long. The aim of educationalists for the future should be to increase the number of working days in secondary schools and thus make it possible to abolish home work and holiday tasks. The holidays should be *real*. If holiday tasks are set the holiday is merely make-believe, and if the holidays are so long that they cannot be spared entirely for real cessation of study they should be curtailed and the proper school work begun earlier. On the other hand there is no objection to sensible encouragement of the scholars to devote themselves to some pursuit or hobby during the holidays. Nothing can be said against encouragement being given to the scholars to make collections of moths or insects, wild flowers, etc., and fossils or minerals. Among boys with a liking for wood work or metal work the idea of returning to school with specimens of such work should be fostered. All these tasks will do good, and the children will return to school all the better and fresher if they have failed to devote a moment of the holiday to ordinary school work.

Before leaving the subject of holidays it is important to mention the common form of holiday torture that is often inflicted upon children by well-meaning parents in the form of "musical education." Undoubtedly a great deal of harm is done to boys and girls by insisting upon set times of "practising" being observed when the child ought either to be resting the intellectual centres by means of sleep, or exercising its motor centres by physical activity.

CHAPTER III.

MENTAL DEVELOPMENT AND MENTAL DEFICIENCIES.

BEFORE considering the interesting and important matters concerning mental development and mental deficiencies of school children, it is necessary to give a brief description of the nervous system. The nervous system includes :—

1. The brain and spinal cord, called the central nervous system.
2. The nerves directly connected with the brain and spinal cord, called the peripheral nervous system.
3. Nerves only indirectly connected with the spinal cord, but connected with a series of small masses found at intervals in the body cavity, in front of the spinal column. This is called the sympathetic nervous system.

THE BRAIN.

The cavity of the skull contains a mass of nervous tissue called the brain, a large organ consisting of several parts. If it is examined it is found to have on the outside a layer of greyish material called "grey matter" which covers material of a lighter colour called "white matter." The grey matter consists of nerve cells which are formed into groups called "centres." These groups of cells are called centres because certain places on this grey matter have been proved to be associated with special parts, sensations, or acts. In other words, the grey matter is believed to be divided up, as it were, into pigeon-holes or compartments, each having special work to do. Thus special parts of the brain deal with sight, hearing, muscular movements of the face, arm, leg, etc.

The brain receives messages from the organs of sense, and transforms them into sensations such as sight, sound, or touch. Thus the eye can do no more than send messages to the brain. If these messages reach that part of the brain dealing with sight, and if that part of the brain is properly developed, is healthy, and is educated to interpret these messages, then, and only then, does the individual see. It is the same with the ears and the other organs of sense. The full possession of any one of the senses therefore is only possible when the three essential parts and their connections are perfect. These are

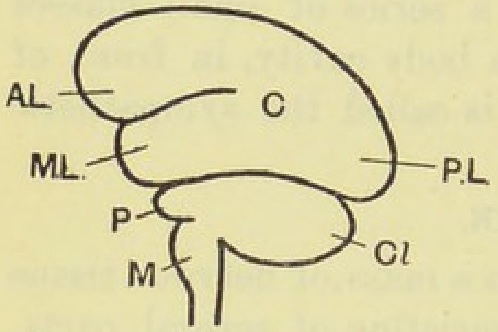

Fig. 96.

DIAGRAM OF THE GENERAL DIVISIONS OF THE BRAIN (left side).

C, cerebrum; AL, anterior lobe; ML, middle lobe; PL, posterior lobe; P, Pons; M, medulla; Cl, cerebellum.

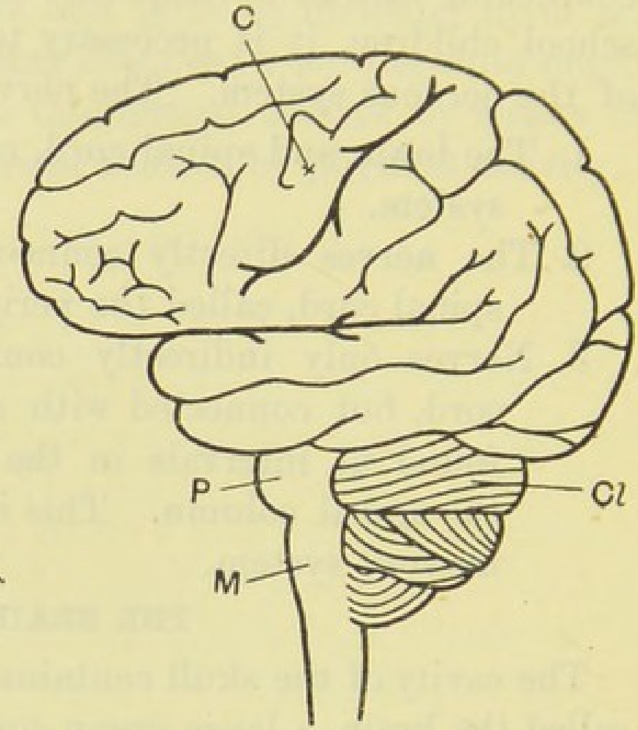

Fig. 97.

DIAGRAM OF BRAIN SHOWING CONVOLUTIONS AND FISSURES OF EXTERNAL SURFACE OF LEFT SIDE OF BRAIN.

The line from C leads to the place near which most of the motor areas of the brain are situated.

(1) the sense organ, such as the eye, (2) the connection of this organ with the brain, *i.e.* the sensory nerve, and (3) the centre of the brain, whose special function it is to deal with and properly interpret these messages. Of such sensory centres the positions of those concerned with smell, taste, hearing, sight, and ordinary sensation are known.

The brain also contains centres, called motor centres, concerned with movements. The positions of the centres concerned with movements of the face, tongue, lips, arms, legs, trunk, and head are known. Such centres are double, one on each side of the brain, and, curiously enough, centres on the right side of the brain govern movements on the left side of the body, and *vice versa*. Thus, in an ordinary right-handed individual, the arm centre on the left side of the brain would be more frequently used, and would become more highly developed than the corresponding centre on the right side. Such an act as writing would therefore have its centre on the left side of the brain.

Other functions of the brain include the process of thought and the phenomenon of memory.

THE SPINAL CORD.

The spinal cord occupies the cavity in the spinal column, and is continuous with the brain above. If it is cut across it is seen to be composed of the same two kinds of tissue as the brain, but the white matter here is arranged outside the grey. The white matter forms the paths of communication with the brain, while the cells of the grey matter can act as "centres" for what are called "reflex actions."

THE NERVES.

Connected with the brain there are twelve pairs of nerves, and from the spinal cord there pass thirty-one pairs. Nerves carry impulses either to the central nervous system or from it. If a nerve brings impulses from the skin or from the organs of special sense, such as the eye or the ear, to the brain or spinal cord it is called a sensory nerve. Those which convey impulses from the central nervous system to the muscles are called motor nerves. If a nerve contains both sensory fibres and motor fibres it is called a mixed nerve. All the spinal nerves are mixed,

REFLEX ACTS.

If the foot of a sleeping person is tickled it is jerked away. If the soles of the feet of a man whose spinal cord is injured anywhere above the sacral region be tickled, it often happens that his legs will be suddenly drawn up, although he can neither feel the tickling nor is able, of his own will, to draw up his legs. The explanation is that the sensation is conveyed from the foot along sensory nerve fibres to the spinal cord, the grey matter of which constitutes a "centre" for receiving such messages. These impulses so act upon the grey matter of the cord that they cause new impulses, motor impulses, to travel along the motor nerve fibres to the muscles of the leg and foot, with the result that the foot is jerked away. These movements are produced without the action of the will or brain, and take place perfectly when all connection with the brain has been destroyed. As long as there are the proper connections between the brain and the spinal cord, the brain exercises a controlling effect in limiting the violence of the movements caused by reflex acts. This is called inhibition. Also, when conscious, the will, or volition, comes into play, and the brain can limit or prevent the motor impulses being sent in response to a sensory stimulus. Thus, by an effort of the will, it is possible to prevent the foot being jerked away when the sole is tickled.

For a purely reflex act there are therefore three necessary parts: (1) a sensory nerve, (2) a nerve centre, and (3) a motor nerve. Many of the ordinary acts and movements of human beings are reflex acts. Some of them are involuntary or automatic, and take place with or without the will. Some acts that originally required considerable effort and a good deal of will control become more or less automatic afterwards. Thus we can go on walking without thinking about it. Among the purely automatic centres which require no stimulus from the outside are those concerned with circulation and respiration. These acts are continually performed during life, but the rate at which the work is done is constantly varied in response to impulse.

The start that one gives in response to a sudden noise; the jerking away of the hand if it touches a hot body; the closing of the eyes in response to a sudden flash of light; these are common reflex acts.

SYMPATHETIC NERVOUS SYSTEM.

Lying on each side of the front of the vertebral column is a row of small beads or ganglia connected together by a greyish-coloured cord. This is called the sympathetic chain, and extends from the base of the skull to the bottom of the spine. The ganglia are connected by fibres with the spinal nerves, and therefore with the spinal cord, and immense numbers of nerve fibres pass from the sympathetic chain to the various internal organs, such as the heart, lungs, stomach, intestines, and also to the walls of the blood vessels all over the body. These sympathetic nerves chiefly carry impulses which govern the muscular tissue of the internal organs and the muscular coat of the blood vessels.

THE NERVOUS SYSTEM OF THE INFANT.

The automatic centres, such as those concerned with circulation and respiration, are well formed in the infant at birth. Other centres that need no control from the brain are also in working order, such as the centre for sucking —a reflex act set going when the mucous membrane of the mouth encounters any foreign body. Other centres rapidly develop and acquire power and control, and the child reacts more readily to external stimuli, obviously noticing differences and alterations in its surroundings. Then the child begins to be able to possess muscular control, and coordinates its muscles in order to produce the coarser movements by an effort of will. The power for finer movements is acquired later on, and is part of the education of the brain.

Similarly the receptive centres have to be educated. Very early in life it is probable that neither light nor sound affects the child in any way. Afterwards a child will obviously notice a bright light or a sharp sound, but it is still unaffected by gradations of light or sound. Then light and shade become recognised, sight and touch teach each other, and gradations of light and shade are associated with special forms and shapes. Objects that are continually seen are sending the same impressions time after time, until at last these impressions become familiar and are remembered. The child is then able to recognise familiar faces and things. In a similar manner the centre for hearing is educated until it can differentiate and analyse sounds. Then the impressions produced by continually recurring sounds are stored up and are remembered.

So far we have traced the development of centres separately, as if each developed alone and independently of the others. This is not the case. As each centre develops so do its connections with other centres begin to be brought into being. Thus sounds begin to be associated with the pictures of certain objects that produce the sounds. Then an object begins to be coupled in the mind with sounds that are continually repeated while the attention is being called to the object, and the child eventually associates certain sounds with objects that are familiar. At this stage the repetition of a certain sound will call up in the child's mind the picture of the object connected with it, and the child learns to associate words with objects and ideas.

SPECIAL CENTRES.

From an educational point of view some centres are of special importance. These are the centres concerned with speech, of which there are four, viz.:—

1. The auditory word centre.
2. The motor speech centre.
3. The visual word centre.
4. The writing centre.

The first and third are sensory centres, *i.e.* they deal with impulses received, while the second and fourth are motor centres, and have control of speech and the act of writing.

These special centres are not on both sides of the brain, but on the left only. The auditory word centre, which develops as the child is showing signs of being able to distinguish special words and appreciate their meaning, is part of the hearing centre on the left side of the brain. Similarly the left visual word centre is part of the left centre for sight, and deals with the impulses caused by the images of written words. This centre is often developed entirely at school while the child is being taught to read words. From the above it will be understood that the left centres for sight and hearing each develop a special extra centre to deal particularly with words—written and spoken. Similarly the left centre which controls the movements of the lips and tongue develops a special centre for dealing with speech (the motor speech centre), and the centre controlling the movements of the right arm develops an additional one to control the particular act of writing.

All these centres have fibres connecting each with the others, *i.e.* the two sensory centres are connected together and also with the two motor centres, and *vice versâ*. By means of such connections we can immediately speak or write a word that we hear or see.

DEVELOPMENT OF SPECIAL CENTRES.

An infant learns, as we have already pointed out, to associate words with ideas, a process which is brought about by the development of the auditory word centre. This is followed by the development of the motor word, or speech, centre. Connections are then formed between the auditory word centre and the one for speech, and the child now attempts to imitate sounds that it hears, and educates its centre for speech by means of its auditory centre. Its first attempts are naturally wide of the mark, because not only are the muscles concerned with speech not properly under control, but also the child's hearing is not very acute, and it is unable to distinguish small differences between its own efforts and the sounds that it hears.

The connections of the centre for sight with the auditory word and the speech centre are also being developed, and the child now becomes capable of complicated mental processes. Thus an object is seen, the sound (or name) associated with it is remembered, and the motor speech centre reproduces the remembered sound more or less accurately, *i.e.* the child can give the name to an object that is in view. This is a tremendous advance upon any previous mental process. Similarly a name is heard, the visual centre reproduces the mental picture associated with the word, and the child is able to pick out the object bearing the name.

Associated with the development of these connections between centres is the increase in the capacity of each centre for storing up impressions, and so memory develops.

In this stage of mental development the ordinary child reaches the teacher. At school the above centres should continue their growth, and their connections with each other should be gradually improved and strengthened. Two new centres, the writing centre and the visual word centre, have to be developed entirely at school, and these in their turn have to establish connections with each other and with other centres before they can attain their full usefulness and play their proper part in the education of the child.

A proper appreciation of the above phenomena of development should be considered indispensable to all teachers and all people who profess to be interested in education. If this were so it would not be necessary for medical officers to have to spend so much time in trying to persuade teachers and well-meaning "experts in education" that it is quite hopeless to try to teach a child to read or write when there is no available visual word-centre; or to write when there is no working centre for writing; or to speak when there is no available speech centre, although such children may, in all other respects, possess good faculties.

DEFECTIVE CHILDREN.

Great lack of development of the various centres and connections that are used in education gives rise to idiot and imbecile children. Such children rarely reach school at all, as they are obviously incapable of being educated by the ordinary school methods. But there are children who, while suffering from lack of development of some centre or centres, are not obviously abnormal before their education is attempted. It is convenient to describe the lower type of such children as "feeble-minded," and the higher type as "defective." Such children reach the schools in large numbers, but gain little or no advantage from the ordinary school teaching, usually remaining year after year in the lower standards of the school, learning little or nothing, and eventually receiving no attention at all. The ordinary school methods are wasted upon such children, and they need practically individual instruction. Specially treated they often make considerable improvement, and in many cases become sufficiently normal, after a time, to go back to the ordinary schools. It is obvious that so long as defective children are being educated together with normal children they are subjected to severe strain and hopeless competition which can only result in making the defect worse. Such children placed among those of similar mental calibre occasionally show a wonderful improvement in quite a short time.

In 1895 a report was issued by the Committee, Parkes Museum, upon the result of examining a large number of children. About 100,000 children were reviewed, 9,777 showed certain developmental defects (abnormalities of skull, ears, eyelids, palate, nasal bones), abnormal nerve signs in 10,355 cases, and 7,391 were mentally dull. The "exceptional" children included 2 idiots, 51 imbeciles, 275 children feebly gifted mentally, 19 mentally exceptional, 110 epileptics, and 5 deaf mutes. About 1·26 per cent. of the total number of children were found to require special instruction, while 7 per cent. of the total number were mentally dull.

VARIETIES OF DEFECTIVES.

There are many varieties of defective children. If one or more of the special centres, *i.e.* the auditory word, motor speech, visual word, and writing centres, are affected, or if the communications between them have failed to become established, certain typical and easily understood results will follow. Thus if the auditory word centre is affected the condition known as "word deafness" results, and the child is unable to understand or remember what it is told. Such children do not recognise their own name when called, and are occasionally supposed to be deaf, or imbecile, which they are not. Instruction at a deaf school often does no good at all. Instruction by articulating and writing must be attempted, and is usually attended with excellent results. Many of these children are not mentally abnormal in any other direction.

If the connection between the auditory word centre and the writing centre has failed to develop the child is unable to write to dictation, while an affection of the writing centre itself will prevent writing altogether.

Affections of the visual word centre cause "word blindness," the child being unable to remember or recognise letters or words. These children can write from transcription, but not to dictation. They can draw and can recognise pictures, and can often do ordinary arithmetic, but it is quite hopeless to attempt to teach a word-blind child to read or write. They cannot read a word, and they write rubbish. Other imperfections in the visual centre result in inability to perceive colour, and to acquire notions of form, size, extent, distance, and relief.

In the same way any imperfection in the motor speech centre will affect the child's speech.

DETECTION.

The proper detection and classification of mentally defective children can only be done by medical men experienced in school inspection, and the necessity for the early recognition of such cases constitutes one of the many reasons why systematic medical inspection and supervision of all school children should be enforced. If the child is to be rescued from a life of utter uselessness and dependence it is of vital importance that the condition should be recognised early in childhood. It is then possible, by special methods of teaching, to bring about wonderful improvement in some of these children by slowly and carefully encouraging the development of the defective centres and their connections. Nevertheless it should be remembered that many children are backward and appear dull simply because the sight or hearing is defective, or because they have adenoid growths. When these physical defects are remedied the mental condition is found to become more nearly normal. Adenoid children in particular are liable to be looked upon as defective. They are often very dull and many cases have been found where it has been impossible to teach them even the simplest matters.

Although the actual diagnosis and classification of these mental conditions is essentially a matter for medical men, yet a good deal of the preliminary inspection, with a view to detecting abnormal conditions, may be carried out by a specially trained teacher. Simple tests, such as those known as Dr. Warner's methods, are as follows :—

1. The children are asked to hold out their hands in front of them. It is then easy to notice the balance of the hands, arms, spine, and shoulders, any peculiarities being noted.

2. By placing one's hand on the child's head the size, form, bosses, etc., can be noted. Then measurements of the head may be taken.

3. Another test is to hold in front of the child some small bright object which is held in the observer's hand. By telling the child to keep his eyes fixed on this, and by moving it to and fro, it is possible to obtain some idea as to the coordination of the eye muscles and the muscles of the face and neck, as well as a good view of the features and expression.

4. The shape of the hard palate is another important observation.

Special notes should always be made regarding the form and size of the head, general nutrition, abnormalities of feature, open mouth, nervous movements of the face, forehead or fingers, etc.

A good rule to bear in mind is that, in the majority of cases of marked deviation from the normal in formation or in development, or in the nervous system, such defects are accompanied by mental irregularity. As a result there should always be carefully noted the following conditions :—

Hare lip.	Open mouth.
Cleft or high palate.	Dull vacant expression.
Irregular and decayed teeth.	Twitchings and tremors.
Deficient ear lobes.	Signs of feeble circulation.
Abnormally placed earlobes.	Peculiarities of skull.
Indented nose.	Defective powers of attention.
Blue lips.	Irritability.
Peculiarities of skin.	

SCHOOLS FOR DEFECTIVE CHILDREN.

By the Elementary Education (Defective and Epileptic Children) Act 1899, the local education authority is empowered to provide special schools for these children. The Act is permissive only, but it enables school authorities to obtain grants towards the education of defective and epileptic children. In order to gain admission to such schools the children must be certified by the Education Medical Officer to be incapable, by reason of some mental or physical defect, of deriving benefit from the ordinary methods of teaching. It is not sufficient for the child to be merely backward or dull, nor are imbeciles to be admitted. The greatest care is necessary if any real good is hoped for. To fill such schools with obviously feeble-minded children is to waste public money and to effect very little improvement. The promising cases for such treatment are children with one or more defective centres, which by careful teaching may develop to almost a normal degree.

It is not advisable to admit children under seven years old to the special schools, because good infant school teaching is often very beneficial to such cases. They may be retained in the special school until the age of sixteen, unless they develop sufficiently to return to the ordinary schools before reaching that age. The instruction at the schools should be given by teachers who have special aptitude for the work, and for successful results it is necessary to give individual attention and instruction, so that only small classes are possible. All the work should be under constant medical supervision.

Great attention should be paid to articulation, and excellent results are obtainable even in bad cases. Speech of as normal a kind as possible is of the highest importance to such cases. Manual instruction is of special importance to them, the teaching being of the kindergarten type for younger scholars, and technical instruction for the older ones. Physical exercise also demands extra time and attention, breathing exercises and eye movements being particularly useful. Judicious open-air exercise should be encouraged in every possible way, and all special physical defects should be duly considered in the plan of exercise for each scholar. It is of vital importance to remember that the best results are obtained by finding out what powers these children already have, and educating them on these lines. A great deal of valuable time is often wasted in attempting impossibilities in the way of reading, writing, and spelling. In Copenhagen various grades of defectives are received either in day classes or in residential institutions. For the teachable cases there is usually one teacher for eight or ten scholars. The older boys learn farming, brush, broom, and basket making; the older girls being taught dairy and laundry work, or some form of weaving.

Special schools should be situated in as good a position as possible, on a gravelly soil, and with a good elevation. The diet of the children should be plain, but liberal. Milk, oatmeal porridge, cocoa, bread, eggs, vegetables, fruit, and a little meat (except in epileptic cases) should be the main articles of diet. Warm clothing is indispensable, and special attention to the hands and feet is necessary.

Parents' Position.

Parents very often offer objection to the attendance of their children at special schools, and under the Act the parent has the right to request the school authorities to examine from time to time (intervals not less than six months) any child attending such schools, in order to ascertain whether the child has improved sufficiently to be fit to attend the ordinary schools again. As a matter of fact every authority should arrange for all such children to be examined at far shorter intervals than six months. Medical examination is desirable at least every three months. Improved cases are sent back to the ordinary schools and degenerating cases are excluded as imbeciles. It is desirable that some special method of dealing with these degenerated cases should be devised.

EPILEPTIC CHILDREN.

It is estimated that 1 per 1,000 children is epileptic, and that one-sixth of these are severely afflicted. If the attacks are rare, and not violent, there is no reason why such children should not attend ordinary schools, provided that the intelligence is normal. Unfortunately the disease often causes rapid deterioration of intelligence, so that special teaching is frequently necessary. Severe cases should be treated in residential homes, and should receive constant medical attention. It is desirable that each house of residence should be of one storey only, and should contain not more than 20 cases.

CAUSES OF MENTAL DEFICIENCY.

Among the causes of mental deficiency in children one of the most important is undoubtedly heredity. A family history of mental weakness is traceable in about 21 per cent. of the cases, while the taint of consumptive tendency is found in nearly 30 per cent. Alcohol probably plays the greatest part of all, parental intemperance being found in about 24 per cent., and a much larger number probably suffering as the result of the effects of alcohol upon the offspring even when taken in moderation. The common habit of women, during the period of pregnancy, to partake somewhat freely of such alcoholic liquids as stout, etc., undoubtedly tends to cause deterioration of nerve tissue in the child.

Circumstances, surroundings, parental neglect, deficient and injudicious food, all play important parts in the production of the stunted, dull, and mentally feeble child—a fairly common type in town schools. Occasionally the condition is the result of injury, particularly injury at birth, while in others it is said to be caused by a fright or shock. Convulsions or epilepsy are well known forerunners of mental deficiency, and occasionally it follows as a result of a severe attack of scarlet fever, measles, or whooping cough.

It is difficult to give a satisfactory classification of the various causes and conditions associated with mental deficiency. A common method is to divide them into the congenital and the non-congenital.

CONGENITAL CONDITIONS.

1. **Microcephalus**, or the congenitally small head. In its extreme form it is characteristic of a low type of idiocy. Such heads are not only small in circumference (17 inches or less), but also have a characteristically narrowed and rapidly receding forehead. Above this type there are all grades of deficiency up to the ordinary mentally defective child. Between 18 and 19 inches in circumference is a common measurement in imbeciles. Nineteen or 20 inches is a common measurement in the feeble-minded.

2. **Hydrocephalus**, or the abnormally large head (sometimes of non-congenital origin). Associated with this condition are varying degrees of intelligence, from a low form of mental defectiveness up to an unusually high degree of intelligence.

3. **Tubercle.** Tubercle plays a very decided and important part in the causation of mental deficiency. Some hereditary taint of tuberculosis is commonly found, while in other cases there is actual personal infection, such as tuberculosis of joints, glands, or serous membranes.

4. **Cretinism** (absence or atrophy of the thyroid gland). This is another congenital taint or condition associated with mental defects. Some cases are normal at birth, but gradually develop the characteristic signs, viz.:—Coarse, dry, thin hair; low and narrow forehead; swollen eyelids, hands, and feet; full and flabby cheeks; large mouth; large and distended abdomen. Cretins remain almost stationary as far as physical and mental development are concerned, so that adult age is reached while the appearance and mental powers are those of an infant.

5. **Neurotic conditions.** Many of these are hereditary, and the mental deficiency dates from birth. Alcoholism in either or both parents is a common cause of these conditions.

NON-CONGENITAL CONDITIONS.

These are subdivided into the developmental and the accidental or acquired.

Developmental.

This term is applied to cases where actual mental deficiency supervenes upon a brain originally imperfect in development, although not noticeably so. These forms of mental weakness become evident at some crisis of development, such as dentition or puberty.

1. **Convulsions.** A history of convulsions during infancy, especially during dentition, is common in cases of mental weakness.

2. **Persistent epilepsy**. A gradual deterioration in mental power usually accompanies persistent epilepsy.

Accidental or Acquired.

1. **Injury**. Inflammation of the brain or its membranes may be set up by injury.

2. **Shock**. All kinds of events, such as the bite of a dog, likely to give a sudden fright or shock, have been said to commence the history of mental weakness in many cases.

3. **Poisons**. The administration of poisons, such as alcohol or opium, to children always produces deterioration of the mental powers.

CHAPTER IV.

COMMON AILMENTS AND CONDITIONS.

ANAEMIA.

A LARGE proportion of town children (boys and girls) are suffering from a deficient vitality that appears to be caused mainly by a diminution of the number of red corpuscles in the blood. Such a condition constitutes one of the forms of anaemia. It is brought about by badly ventilated rooms, by improper food, by insufficient sleep and exercise in the open air. The crimson colour of the lips diminishes in intensity and in the worse forms becomes pallid; the child becomes languid, drowsy, and disinclined for exertion, and is quickly fatigued; headaches and fainting attacks become common; the appetite diminishes and becomes morbid, indigestible messes being preferred to solid food, and occasionally a fondness for slate pencil, chalk, or coal is developed. Such children should receive medical attention, and all the teacher can do is to see that the rooms are well ventilated and that the child is excused part of the lessons and encouraged to take exercise in the open air.

BONE CONDITIONS.

1. Curved Spine.

The association of this condition with the badly constructed desks has already been discussed. A lateral curvature is not at all uncommon among children of over twelve years. All kinds of work or any desks that conduce to improper attitudes of standing or sitting are active causes of the deformity. Other causes include the habitual use of a high pillow in bed, so that the spine is bent when the child is lying asleep on its side, and the carrying of a heavy satchel. By keeping a vigilant eye on the children's attitudes a teacher can do much to prevent such deformities developing, and by careful physical exercises may help to remedy the defect when produced. More serious curvatures are those caused by rickets and by tuberculous disease of the bones. In the latter case the curve is usually more acute than in the former. There is also a tendency to special stiffness of the spine, particularly in the affected region.

2. Flat Foot.

This is another condition commonly caused by rickets. It is nearly always an acquired condition and is often found in weakly children about twelve years old. The muscles of the foot and the ligaments that support the bony arch of the instep become weakened by rickets or rheumatism, or by general conditions, such as acute fevers, with the result that the arch flattens down. The condition can be greatly improved, in many cases, by skipping exercises on the toes, and by exercises causing the body to be raised on tip-toe several times in succession. It should always receive attention, as it develops into a most painful condition and will be much more difficult to cure later on.

3. Affected Joints.

The commonest joint disease in schools is tuberculosis. The tuberculous joint exists in many varieties, and only a medical man can decide whether a joint is tuberculous or not. The hip and the knee are often affected. If a child is seen to be getting into a habit of standing with the weight of the body mainly on one leg, and rests one foot on the other, the medical officer's attention should be called to the fact. Limping, dragging, or rigidity of joints show that the disease is getting well advanced. There may be pain in the hip or knee.

The condition should receive immediate attention, and the child should be excluded from school altogether.

4. Rickets.

Rickets is a disease of very common occurrence in schools in poor districts. It particularly affects the children who suffer from the effects of bad feeding, incorrect feeding, and bad housing conditions. Special common causes include feeding upon condensed milk during infancy, deficiency of fresh milk, deficiency of fats, excess of starchy food, lack of fresh air, etc. The effects are probably caused by certain poisonous materials that are formed in the stomach or intestines by bacterial action. The rickety child is usually distinguished by certain signs that are the effects of the disease upon the body. These are the square head; the beaded ribs; the narrow and constricted chest; curved spine and bent legs; enlarged wrists, ankles, or knees; knock-knee or flat-foot; brittleness of bones, predisposing to fracture; general enfeeblement and pallor, and delayed development; and a marked liability to catch cold and acquire various diseases, particularly lung diseases.

The most important matter is to correct the general home conditions, and this is usually impossible. In school the child should receive extra consideration, should not be over-worked, and should be excused much standing. Careful physical exercises and plenty of play in the open air will do much to improve matters.

CHILLS AND COLDS.

Children improperly clothed, and especially those who are shut up in overheated and badly ventilated rooms, are liable to chills and colds. These may develop in their turn into severe illness. Severe "cold in the head" appears to be a highly infectious disorder, and any child with obvious symptoms of such should be sent home.

CHOREA OR ST. VITUS' DANCE.

Chorea is a severe nervous disorder which is common among school children over seven years old. It is probably caused by some special form of bacterial life and is usually associated with rheumatism. Sometimes it follows the acute fevers—scarlet fever, measles, whooping cough—and occasionally is said to follow a fright or shock. Badly decayed teeth are common among children suffering from chorea.

In mild cases the child may simply appear to be clumsy and awkward, but in the more marked and severe forms there are very obvious signs which vary according to the part of the body involved. The muscular twitchings may be limited to the face, or one limb, or one side of the body, or they may be general. If the face is affected the child appears to be continually "making faces," on account of the curious jerkings and twitchings of the muscles of the lips, nose, eyes, and cheeks. The speech is often affected. When asked to put out his tongue such a child usually jerks it out and in again and snaps together the teeth. All the movements of this disease are increased in intensity by excitement or by the knowledge that anyone is watching.

When the arms or legs are affected there is usually a constantly repeated, purposeless movement caused by the contraction of the same muscles over and over again. The child is never at rest. Mentally the child is in the same condition, being unable to concentrate his attention, besides being morbid, excitable, irritable, and quarrelsome.

The condition often lasts about ten or twelve weeks, and the child is unfit to attend school during the whole of the period. School work will only tend to intensify the ill effects, and no child should be allowed to return to school while the slightest trace of the signs is noticeable.

DIARRHOEA.

Diarrhoea among children commonly assumes an epidemic character during the later summer months. The disease is more prevalent during a hot dry summer than in cold and wet ones. Usually a marked connection can be traced between the temperature of the soil and the number of cases of the disease. It is practically limited to bottle-fed children, those fed entirely at the breast nearly always escaping. There seems to be no doubt that the disease is caused by pollution of the food by dirt and dust. Flies probably play a very important part in the spread of the disease.

Children suffering from diarrhoea should be sent home from school, and the parents should be advised to seek medical attention for them.

EYE DISEASES.

The matters connected with defects of vision have already been discussed. It now remains to mention some common conditions in the region of the eye.

1. "Red Eyes."

The commonest condition is the one in which the edges of the eyelids are inflamed and red. It usually indicates that the child is out of health and needs attention. Dirty and neglected children, particularly if of a tubercular tendency, are most liable. On the other hand it may be due to a defect of vision.

In the worse type of case the glutinous secretion from the inflamed edge sticks together the eyelashes in clumps. Scabs are formed, and the eyelashes are often removed with them.

The parents should be reminded that great care and cleanliness are necessary, and that the child requires medical attention.

2. Stye.

Styes are common amongst weakly, poorly fed, and neglected children, and they may occur as the result of defects of vision. They are caused by the obstruction of the ducts of small glands that open on the edge of the eyelid. The obstruction causes the gland to become inflamed and the stye results. It appears as a round, reddened swelling on the edge of the lid, and gives rise to a great deal of pain and inconvenience. In cases where they appear in crops the vision should be carefully tested.

3. Twitching.

The usual cause of twitching of the eyelids is some error of vision or, less frequently, some local condition of the eyelids.

4. Inflamed Eyeball.

Children suffering from a redness of the "white of the eye" or conjunctiva, together with "watering" and fear of the light, should be rigidly excluded from school. Many such conditions are of an infectious character and would spread through the school, while those conditions which give rise to the above signs, but are not infectious, render it desirable that the child should not be troubled with school work.

HEADACHES.

All teachers are familiar with children who are continually complaining of headache. In every case it should be regarded as a symptom caused by some disorder—possibly a very serious one.

(1) The commonest cause of all is probably eye strain. It has already been pointed out that children with defective vision often suffer from headache caused by the strain of the eyes. When the defect is remedied and the trying conditions are removed the headache disappears as if by magic.

(2) Another common cause of headache is an unhealthy condition of the throat and nose. Nasal catarrh and adenoids are particularly liable to cause headaches, and the child who frequently has a cold in the head is a continual sufferer in this way.

(3) Unhealthy conditions of the alimentary tract prove a fertile cause of headaches in children. Bad teeth and indigestion, singly or together, and constipation are commonly associated with headaches.

(4) General conditions, such as anaemia, rheumatism, debility, and malnutrition, in many cases are found to exist

in children who are continually complaining of headache when they have done some small amount of mental work.

(5) Highly nervous children, and particularly children about the critical age of fourteen, frequently suffer from headaches.

(6) A bad headache, especially in the case of a child not usually complaining, may indicate an approaching attack of some serious acute disorder, such as measles, scarlet fever, diphtheria, or pneumonia.

(7) Although the above lengthy list provides ample possibilities for explaining a headache in a child, yet the first thing that should occur to a teacher when members of the class are complaining is the possibility of the cause being the badly ventilated and overheated condition of the room. It is important for a teacher to bear in mind the fact that the room may have become excessively foul so gradually that the senses have failed to notice any special pollution. With this exception it should be definitely understood that healthy children never suffer from headache, and that they are always an indication that something is wrong.

HEART DISEASE.

A child may be suspected to be suffering from heart disease in the following instances:—

(1) Puny under-developed children with expanded finger ends (clubbing), and pale or livid skin.

(2) Dull children, with an obvious lack of energy and vitality associated with some lack of bodily development.

(3) Children who are rapidly exhausted by physical exercise, and become breathless after any unusual exertion.

(4) Attacks of faintness and fainting are often indications of heart disease.

(5) A bad circulation, evidenced by cold hands and feet, chilblains, etc., may indicate heart disease.

It is usual to recognise three kinds of affections of the heart, viz.:—

I. Congenital Affections.

Some children are born with the heart defective. If the defect is serious the child dies quickly, sometimes a few minutes after birth. The less serious cases may reach school age, but the children are always deficient in vitality, and the greatest possible laxity should be allowed. They rarely reach adult life.

II. Organic or Acquired Heart Disease.

Many of these cases are caused by rheumatism, although any history of a typical attack of rheumatic fever is rare. More usually it is possible to find the rheumatic association by a history of "growing pains," vague pains in the joints and limbs, attacks of tonsilitis and sore throat, or attacks of chorea (St. Vitus' dance). Other cases are caused by previous attacks of scarlet fever, measles, diphtheria, or other infectious disorders. In all cases the valves of the heart are injured in such a way as to prevent the heart working properly.

III. Functional Disorders.

This is the term applied to those cases where the heart appears to be sound and properly developed, but where the beat of the heart is too rapid, or too slow, or irregular, or where the child suffers from palpitation. Common causes of such conditions are anaemia and disturbances of the alimentary tract.

Children suffering from heart disease should receive extra indulgence wherever possible. Physical exercises should be very carefully graduated according to their capacity, and there should be no possibility of strain allowed. If the child is properly looked after at home and at school it is always possible that the heart may develop in such a way as to minimise the defect from which it suffers. This is called compensation.

INDIGESTION.

Faulty and improper digestion is common among school children. Among the better class children it is often due to excessive feeding or to rich and indigestible food. Among poor children the digestive system shares the general debility of the body, and the unhealthy condition is often intensified by improper food. Children should receive nothing but plain wholesome food, and any deviation from this rule usually inflicts its own penalty. Bad teeth will always upset digestion, not only by interfering with the proper mastication of the food, but also by the swallowing of poisonous matter from the decayed parts. Indigestion is the frequent cause of anaemia, headaches, constipation and diarrhoea, as well as many other common conditions of ill-health among children.

SKIN DISEASES.

The majority of skin diseases from which school children are likely to suffer are infectious, and the general rule of excluding such children from school should be adopted. In most cases the condition is the result of uncleanliness and overcrowding.

1. The commonest condition is the presence of sores and crusts on the scalp, especially of girls. Upon closer examination the presence of vermin is almost invariably detected. The worse forms, with great masses of crusts

and enlarged glands or even abscesses at the back of the neck, are disgusting to look at, and to the inexperienced eye appear to be dreadful cases to deal with. The observer will be astonished to notice how wonderfully these cases clear up directly the vermin have been entirely eliminated by the processes already described. The infection is caused and the acute condition is continually maintained by the scratching of the scalp by the child. This goes on continually while vermin are present, and poisoning of the skin is inevitable. Beyond the elimination of the vermin the only necessary treatment is the softening of the crusts by poulticing or bathing in hot water, and their removal. This condition should not be called eczema.

2. Impetigo.

This disease usually affects the skin at the angles of the mouth and on the chin. Small blisters appear in the middle of red patches. These afterwards become yellow, dry up, and form yellow crusts. It is extremely contagious and affected children must be excluded from school. It usually occurs among dirty and neglected children, and rapidly spreads from one member of the family to another If neglected it may spread through a whole school.

3. Eczema.

All skin diseases among children are popularly known as eczema. The real disease is quite common, especially in children about five years old, and the appearance varies from a simple scaliness to an angry-looking wet red patch that afterwards forms crusts. Although there is no reason to regard it as very contagious, yet it is advisable to exclude all affected children.

4. Ringworm.

This term includes a group of skin diseases produced by a kind of fungus. Occasionally schools are visited by an epidemic of ringworm, and teachers should be alive to the fact that a single case neglected may cause nearly all the other scholars to become infected. The disease is caused by a fungus, or vegetable parasite, which attacks the roots of the hairs, and the typical signs of the disease may be found on the scalp or scattered over the body.

The beginning is usually a small red scaly spot which gradually spreads evenly so as to produce circular patches. The hairs in the affected area become brittle and break off, leaving the patches bare. By the coalescence of two or more of the circular patches the affected areas may become irregular in shape. If neglected the condition may persist for years, and may result in permanent loss of hair over the affected area, but spontaneous cure often takes place after a long time.

In order to verify the diagnosis, and particularly in order to ascertain whether a cure has been effected, it is necessary for the medical officer to make a microscopical examination of hairs from the affected area.

The affected children should be removed from school. It is extremely contagious and spreads easily by means of hats, gloves, towels, hair brushes. The slightest particle of scale from the infected area is sufficient to infect another child or another part of the same child. If any child showing the slightest sign of the disease is at once dismissed and reported, there should be no difficulty in keeping the schools free from this infection. Unfortunately many teachers neglect to take this precaution, and as a result the disease is often spreading actively through schools.

5. Favus.

This is the name given to a more serious affection of the scalp. It is due to another vegetable parasite which attacks the roots of the hairs. The cure is extremely difficult.

Pale yellow cup-shaped patches form on the scalp, and afterwards fuse with each other to form greyish crusts. The hairs become brittle, and bald patches are formed as in ringworm. A characteristic and unmistakable mouse-like smell is emitted from the crusts. In every case immediate and total exclusion from school is urgently necessary.

6. Itch or Scabies.

The itch insect usually attacks the skin between the fingers, where the skin is thin. It is very minute, and the female burrows into the skin, unnoticed at first, but afterwards causing itching and redness. Under the skin she lays her eggs, which hatch in about fourteen days. The young ones then burrow afresh on their own account, and so the disease spreads. The intense itching causes vigorous scratching, and this results in considerable inflammation of the skin, with the formation of fairly typical crusts.

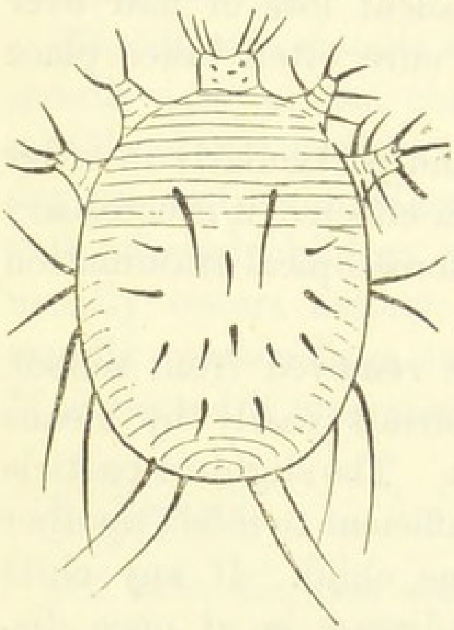

Fig. 98.
THE ITCH INSECT.

The itch is very contagious, the slightest contact being sufficient to cause infection. It is also conveyed by infected garments and bedclothes, all of which require disinfection before the disease can be stamped out. Infected children should be rigidly excluded from school.

THROAT CONDITIONS.

1. Adenoids.

Adenoids are soft growths attached to the mucous membrane of the nasopharynx or the cavity at the back of the nose. They are unfortunately very common among all classes of children. Heredity plays some part as a predisposing cause, but the actual cause is unknown. Enlarged tonsils are often associated with this condition. They may commence to grow after an attack of measles or whooping cough, and a probable predisposing cause is mouth breathing, which is acquired by many children merely as a bad habit. At the age of fourteen they tend to disappear spontaneously, but in many cases they have been the cause of irreparable mischief by that time. Their effects are numerous and are best discussed separately.

(*a*) **Depression and discomfort.** A child suffering from adenoids is continually feeling depressed and uncomfortable.

(*b*) **Mouth breathing.** Owing to the obstruction of the nasopharynx the child finds it difficult or impossible to breathe through the nose. The mouth is therefore always open, and this gives a dull and stupid appearance to the face, which gradually acquires a mask-like look that is incapable of expressing either joy or sorrow.

(*c*) **Dulness and stupidity.** Not only does the face look stupid and dull, but the mental condition quickly follows suit, and the child becomes backward and incapable of doing much mental work. Examples are common where such children have been regarded as mentally defective, but it is important to remember that their mental apparatus is quite normal in every respect except that the brain is clouded, as it were, by their complaint. The writer well remembers two extreme cases that were presented to him by their teachers as badly defective mentally. These children had each been at school about two years, and had not yet succeeded in learning the alphabet. Fortunately it was possible to get these cases properly treated, and on their return to school they rapidly became normal children and made good progress. It is very probable that large numbers of adenoid children are at the present time being "educated" at special centres for mentally defective children. Of course this is the result of inadequate medical supervision, and not only wastes public money, but also fails to educate at all a child who is capable of being educated in the ordinary way.

(*d*) **Fatigue.** Directly any mental work is attempted the child gets a headache and suffers from mental fatigue. This is due to the difficulty that there is in getting away the waste products from the brain. Such children are constantly complaining of headache.

(*e*) **Dead Speech.** Owing to the absence of resonance the speech acquires a characteristic dead quality, and there is difficulty with the letters *m* and *n*, *b* and *d* being substituted. Thus the child says "by" instead of "my," and "do" instead of "no."

(*f*) **Deafness.** In many cases the opening of the eustachian tube into the pharynx becomes blocked and deafness results.

(*g*) **Chest deformities.** The obstruction that prevents free and easy respiration causes extra strong action of the diaphragm in the effort to fill the chest. In young children this may result in serious deformity. The sternum is pushed out and often bent, while the lower and lateral parts of the chest are retracted, producing the condition known as "pigeon chest." If adenoids are present in a rickety child, a common combination, these effects are very pronounced. A long narrow chest is produced and the child is predisposed to consumption.

If the obstruction begins at about the age of ten the forced respiratory efforts produce a barrel-shaped condition of the chest.

(*h*) "**Veiled look.**" The eyes of adenoid children often have a characteristic appearance that has been called the "veiled look." This is caused by the lower lid covering more of the eye than it normally does. The explanation is that connecting the muscle of the lower lid with the ring of muscle surrounding the mouth there are small muscular bands which, when the mouth is kept closed, hold the lower eyelid down. If the mouth is perpetually open this tension is relaxed, and the lower lid creeps a little way up the eyeball.

The lot of the adenoid child is not a happy one. He is looked upon as stupid and dull; is often punished for not doing mental work that he is quite incapable of performing; and is disliked, ridiculed, and avoided by the other children. If he survives till the age of fourteen he loses the adenoids, but they have so crippled his development that he usually falls an early and easy prey to consumption a few years later.

Treatment.—Directly the condition is recognised the parents should be urged to seek medical aid. By the removal of these growths many of the children rapidly become normal in every way, and the author can recall several instances of adenoid children, previously regarded as being mentally defective, rapidly becoming bright and alert and active after the removal of the growths. The earlier that they are removed the better will be the result, because their presence hampers and hinders the proper development of the child. It is only by systematic physical examination of the scholars that the detection of early cases can be hoped for.

Probably much can be done to prevent the growth of adenoids by proper breathing exercises several times a day with the mouth closed. Children should be most definitely instructed to keep the mouth closed. By these means the membrane of the nose and pharynx is kept in a healthy condition.

It is very probable that mouth breathing, as a bad habit, is an important cause of adenoids by making the mucous membrane of those regions unhealthy. Systematic breathing exercises with the mouth closed, several times a day, in the open air or with widely open windows, would serve to keep the membrane healthy and check the tendency towards adenoids. Probably large numbers of adenoid children die of consumption during early adult life, and so by preventing the growth of adenoids, and by their prompt removal when they do occur, the great number of deaths from consumption may possibly be decreased. Teachers should remember that if they can persuade the parents of such children to obtain treatment for them they will not only be doing a public service, but will also help in wholly changing the lives of these miserable little unfortunates.

2. Enlarged Tonsils.

Enlarged tonsils are often associated with adenoids, and in some cases are the direct result of mouth breathing. The condition can be easily recognised by inspection of the throat. In some schools an astonishingly large percentage of the children (as many as 30 or 40 per cent.) show enlargement of the tonsils, and it is often an indication that the housing conditions of the locality are inferior. If the enlargement is considerable similar results to those produced by adenoids may be brought about. Mouth breathing and deafness are particularly common accompaniments. Also such children are particularly liable to throat affections, diphtheria, ulcerated throat, quinsy, etc., and also rheumatic fever. Teachers should suggest to the parents that such children require medical attention.

3. Sore Throats.

A child suffering from sore throat should always be at once placed in a desk to itself, because the condition is probably infectious. It is most important to remember that such cases may be suffering from diphtheria, and may set up a severe epidemic in the school. The fact that the child is liable to sore throat is not any reason why the above rule should not be observed. During epidemics of diphtheria and scarlet fever all children suffering from sore throat should be sent home and should be reported to the medical officer.

CHAPTER V.

CONSUMPTION.

Consumption may be described as essentially a disease of civilisation. It is in this country the most prominent cause of death. It is now known that the disease is actually set up by a special form of bacterial life called the tubercle bacillus. This germ may attack any part of the body. If it attacks the skin it produces a mild but extremely disfiguring disorder. When it attacks glands it becomes more serious, and tuberculous bones and joints are still more dangerous to life. The commonest site of attack is the lungs, where it causes phthisis or consumption. Among children the parts commonly affected include the intestines and the brain, resulting in an enormous mortality.

Children are liable to all forms of tuberculosis, but particularly to this affection of the glands, bones, and brain, forms of the disease that are not common in adults. Phthisis is probably the most infectious form, on account of the greater likelihood of the bacilli being scattered about by the sufferer. A single case of consumption in a school, among teachers or scholars, will be quite sufficient to cause dozens of cases of tuberculous glands, bones, brain, and lungs among the children, each child affected being attacked according to its personal susceptibility.

The havoc wrought by consumption is enormous. It is estimated that one-eleventh of the whole civilised world dies of consumption, and in Europe alone the deaths number at least one million a year. By rendering people incapable of work it increases the number of paupers by about ten per cent., and costs this country about a million pounds a year in maintaining them. It has been estimated that the working classes of this country lose ten million pounds a year in wages owing to consumption. The frequency with which the tubercle bacillus attacks children may be imagined from the following annual number of deaths among them :—

6000	die of	tuberculosis of	brain
5300	,,	,,	intestines
4000	,,	,,	(general)
1400	,,	,,	bones and joints.

The above figures tell only part of the tale. They give no information as to terrible damage done by the disease in the way of affected glands and skin, causing disfigurement and misery, as well as diseased bones and joints which cripple for life.

The death rate due to consumption is always greater in towns than in country districts. This difference is probably due almost entirely to the filthy and dusty workshops and the overcrowded and dirty condition of the schools.

CAUSES OF CONSUMPTION.

As in the case of all diseases the causes may be divided into the predisposing and the determining. The immediate or determining cause of consumption is the tubercle bacillus. This organism has considerable powers of vitality and can live a long time in the air and among dust and dirt, but is killed by five minutes' exposure to bright sunlight. It probably obtains access to the air from the sputum of consumptive patients, who often spit about in a most reckless fashion. This material gradually dries up, becomes powdered, and forms part of the dust of workshops, schools, public-houses, public buildings, tram-cars, etc. Such dust, when inhaled, may set up consumption in the person who has taken in the bacillus.

When such causes are considered there can no longer be any wonder that consumption is so common when a single case is able in this way to infect hundreds of other people. As a matter of fact many more people are actually attacked than is generally known. About twenty-five per cent. of the post-mortem examinations that are made upon all subjects reveal healed-up patches in the lungs, showing that some time during life the tubercle bacillus had made an attack upon the lung tissue and had done some damage, but had been eventually defeated and exterminated.

In spite of the omnipresence of the tubercle bacillus only a small proportion of people are actually attacked by it with success. Everyone inhales and swallows these germs from time to time and yet in the majority of cases no harm is done. The explanation is that the germ, in all probability, can do no damage unless some predisposing cause or causes have been doing their part previously in rendering the body susceptible to the attack of the tubercle bacillus. In fact it is at the present time customary to grossly exaggerate the importance of direct infection in cases of tuberculosis and to pay far too little attention to the predisposing causes.

PREDISPOSING CAUSES.

1. Heredity.

In about fifty per cent. of the cases there is a family history of the disease. It must, however, be understood definitely that heredity can convey a predisposition only, and that in many of the cases where heredity has appeared to be a cause the explanation is really that common conditions have produced the same effect upon different members of the family.

2. Decreased Vitality from Disease.

People suffering from chronic diseases that have slowly sapped their strength and vitality are particularly liable to consumption. Also children and adults who have passed through an attack of diseases—such as whooping cough, measles, influenza—that are liable to leave the lungs weak are specially susceptible.

3. Dust.

Exposure to dusty atmospheres not only has an irritating effect upon the lungs and predisposes them to a successful attack by the tubercle bacillus, but often actually supplies the bacillus at the same time. Dusty and dirty workshops, houses, public-houses, places, and conveyances predispose to consumption, in addition to providing the tubercle bacillus in many cases amongst the dust.

4. Bad Ventilation and Overcrowding.

This predisposing cause is most actively at work in overcrowded and badly ventilated workshops, public-houses, public buildings, and schools, and to a smaller extent in dwelling houses.

5. Injudicious or Deficient Food.

Perhaps this is the most important of all the predisposing causes of tuberculosis. A large proportion of town children are diseased, dwarfed, and undeveloped as a result of injudicious or deficient food. During infancy a considerable percentage of the children are artificially fed and as a direct result are more liable to die and are handicapped if they live. It has been shown that bottle-fed babies are thirty times more liable to die than those that are breast-fed, and those that survive usually have a decreased vitality and resisting power. The damage is further increased by the unsatisfactory milk supply of towns. In other cases the quantity and quality of the mother's milk is deficient.

To prevent the terrible sacrifice of life owing to the above causes public funds should be available. Money would be far more usefully spent upon the children than upon expensive sanatoria that can treat only a few adults and will leave the main cause of the disease quite untouched. The money should be spent upon feeding the children with wholesome food, improving the milk supply, and removing the causes of the enormous infantile mortality.

In towns a reliable milk supply is not obtainable by the poor, and in their present condition of ignorance they would not buy it if they could. Education upon such important subjects can only be successfully carried out in the schools, and meanwhile the dealer who tampers with the milk supply, in the way of diluting, adding preservatives, or removing cream, should be treated as a criminal. Either the whole trade must be revolutionised or there must be a municipal milk supply in every town. Pure milk in clean bottles at a fair price should be obtainable by everyone.

The subject of predisposition to consumption is closely connected with the question of infantile mortality. One sixth of the children die before they are one year old. Many are killed, but a greater number are wounded and continue an existence with lowered vitality and decreased developmental powers. Many of the survivors are maimed and stunted and remain as weaklings for a few years longer, being ultimately killed by consumption. The problem of infantile mortality is intimately associated with deficient and injudicious feeding.

6. Alcohol.

Alcoholic indulgence not only predisposes the individual to consumption, but also renders the offspring liable to be attacked by the disease.

7. Special School Conditions.

In schools there are special conditions that predispose to consumption.

(*a*) **Desks.** Unsuitable desks and the resulting bad postures hinder proper development.

(*b*) **Ventilation.** Bad ventilation and the continued breathing of warm foul air is an active predisposing cause.

(*c*) **Dust.** The dusty atmosphere of most schools is too well known to need pointing out. Infants by playing about on the floor are specially liable to suffer, and the bad habit of sucking pens and penholders not only increases the risk of direct infection but also conveys a large amount of dust into the child's mouth.

(*d*) **Direct Infection.** If a phthisical child or teacher or caretaker is in the school the bacilli are probably present in the air of the building. School conditions have been proved conclusively to be active causes of consumption and statistics regarding the mortality of teachers point the same way. Teachers occupy an enviable position with regard to relative total mortality, but consumption and lung diseases are relatively more commonly the cause of death than is the case in occupations with a much larger total mortality.

(e) There is at present no special weeding out of the weakly children. Such children have their brains over-worked and over-worried, while their bodies are under-fed and under-exercised. They grow up therefore with the weakness intensified.

PREVENTION.

The prevention of consumption involves a much wider issue than the mere extermination or circumvention of a bacillus. The most hopeful methods are those which aim at making the people in general, but the children in particular, strong and healthy and thereby eliminating the predisposition to the disease.

1. Improved Cleanliness.

The schools must be kept cleaner and more free from dust. Workshops must follow suit, and a great improvement should be brought about in the general conditions of houses and streets, and public buildings, public-houses, railway carriages, trams, etc.

2. Improved Food and Feeding.

More stringent regulations should be made with regard to the purity of the food supply, and more severe punishment should be meted out to those who tamper with it. Public milk supplies are greatly to be desired.

3. Care of the Children.

During the infancy of the child the food supply of poor mothers who are nursing their children should be supplemented. Such measures, combined with a pure milk supply, would give the infants a better start in life, and would probably result in a decrease of tuberculosis at all ages.

Children at school should receive food of a plain, nourishing, and substantial character.

Both for their own sakes and that of others children actually suffering from consumption should not be admitted into schools. At present many such children are attending most schools. No system of regular medical inspection is being carried out, and there are little or no available means of treating such cases when discovered. The home conditions of such children are often worse than the school.

In France there are special sanatoria for children over 2 years old. When tuberculosis is recognised or a predisposition is remarked the child is sent to one of these institutions. Here it leads a healthy open air life, is well fed, and gets plenty of sleep. In the great majority of cases a speedy and permanent cure results.

In Germany, Austria, and Switzerland there are holiday colonies for anaemic and predisposed children, where they get plenty of good food and breathe pure air.

In Denmark there is an interesting custom of exchange of children between town and country during the summer. Every summer 10,000 children from Copenhagen are received into the country districts, which in return send their children into the town.

In addition to increased general care of children such as is outlined above, there must be a total change in the educational system. The care of the young has been too long in the hands of the ignorant "educational expert." The methods of infant instruction, the time-table, the number of subjects taught, everything in connection with school life in fact must be considered afresh from a health point of view, and the most indispensable part of a child's education must be considered to be those matters which will enable it to lead a healthy and vigorous existence.

4. Education.

The education of the children in such subjects as cleanliness, the danger of dust and dirt, the danger of spitting, the importance of food and feeding, infant feeding, cooking, ventilation and the value of fresh air, etc., must have a wonderful effect upon the life of the poorer classes as soon as such teaching is done properly and occupies its proper position of supreme importance in the time-table, especially for girls. Such instruction, however, should not be limited to girls. Boys should be taught all such subjects thoroughly. The average girl may receive such instruction, but when she becomes a wife and mother she will order her home and bring up her children upon the same lines as her mother did. It is to this curious feminine characteristic that we may attribute the persistency of ancient superstitions and injurious practices connected with the subject of childhood. If boys receive careful instruction in these matters there is greater hope of enlightened ideas prevailing in the near future.

Before the children can be properly educated it is necessary for the teachers to be suitably trained. It is pathetic to listen to the instruction that is being given in most of the schools in what is called "the hygiene lesson." Teachers must be taught to properly appreciate such matters as the necessity for pure air, cleanliness, breathing exercises, and fatigue, and must be sufficiently trained in observation to notice children suffering from defects and diseases, or showing the preliminary signs of infection.

Properly trained teachers can do a vast amount of good and be of enormous help to the medical officer. Teachers as a class are more accustomed to dealing with children and are more intelligent than the average "trained nurse," and in many cases would do the work of simple physical examination of the children far more thoroughly and satisfactorily than any one else.

Sufferers from consumption must be educated to expectorate into vessels containing disinfectant, or into rags that can be burned; to hold a handkerchief before the mouth when coughing; to observe great personal and room cleanliness; and to sleep alone.

5. Notification.

Compulsory notification of the disease is greatly to be desired. Consumption should be added to the list of diseases that must be notified to the local medical officer of health. When this is done it will be possible to keep the house and patient under some observation, to obtain better ideas about workshop conditions, and to carry out proper disinfection.

6. Prevention of Infection.

In order to prevent broadcast infection taking place it is desirable that there should be proper provision for the care of advanced and hopeless cases of consumption. This is the most expensive and the least important of the preventive measures that have been reviewed above.

In conclusion it may be stated that the spread of consumption would probably be arrested by attention to the above matters. In particular the introduction of proper medical inspection of scholars, and the provision of institutions for the reception of children suffering from or predisposed to consumption would undoubtedly produce immediate and most gratifying results.

It should be distinctly understood that tuberculosis is by no means a common school condition, and that obvious evidence of consumption is, in the author's experience, a rather rare condition to meet among children attending school. The points to repeat and to particularly impress upon the public are that a single case of consumption is amply sufficient to infect a whole school, and also that predisposed and weakly children must receive special attention if they are to escape the disease *in after life.* It is not easy to diagnose the disease in children: they may appear to have phthisical symptoms when they are really suffering from adenoids or bronchitis. Clearly the only way to stamp out the disease is to send into the country all predisposed and weakly children, so that they may live an open air life, with plenty of sleep and nourishing food.

CHAPTER VI.

ACCIDENTS AND EMERGENCIES.

WOUNDS.

Minor wounds, such as a simple abrasion of the skin caused by a child falling on gravel, should always be carefully cleaned with cold water and then bandaged. Do not bandage too tightly, and remember that the essential condition for the successful treatment of wounds is absolute cleanliness. In cases where the wound is at all severe it is best to send at once for medical aid.

In cases of small clean cuts the best treatment is to carefully adjust the edges, place over the cut a strip of clean linen soaked in clean water (or, better, in a solution of carbolic acid, one part of acid to forty of water), and bandage carefully.

The bleeding from small wounds often stops under the above treatment, but if it continues after the bandage has been applied, or if it is severe from the beginning, it will be necessary to adopt special means to check it.

Bleeding.

If any kind of blood vessel is injured bleeding will be produced, and the process varies according as to whether a capillary vessel, a vein, or an artery has been broken.

Capillary bleeding is the commonest and simplest form of haemorrhage. The blood slowly oozes from the raw surface, and appears at many points. This bleeding is easily stopped by bathing the part with cold water, or by tying firmly over it a pad of lint soaked in cold water.

Bleeding from a vein is recognised by the fact that the blood is dark in colour, and wells up from the wound in a dark steady stream. The bleeding can be stopped by placing on the wound a pad of lint soaked in cold water, and kept in position by a bandage. The tightness of the

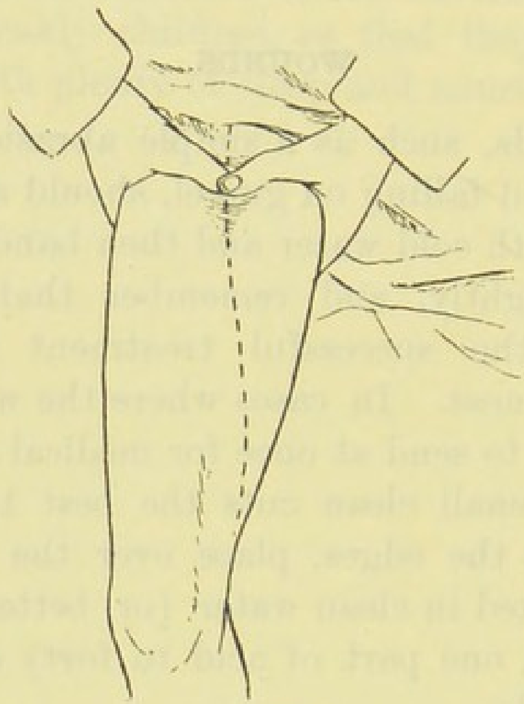

Fig. 99.
METHOD OF COMPRESSING ARTERY IN THIGH.

bandage should be gradually increased until the bleeding stops.

Arterial bleeding is the most serious form, and is the most difficult to stop. The blood is of a bright red colour, and is forced out in jets or spurts, if the artery is large, or in a continuous forcible stream from the smaller arteries. To stop the bleeding it is necessary to apply pressure over the wound itself. Press the thumb over the point in the wound from which the blood is seen to be spurting. If the pressure is sufficient and is maintained, the bleeding can be held in check until medical assistance is available. In less severe cases the bleeding may be stopped by tying a pad of linen firmly over the wound.

Where the artery is at all large and the bleeding is occurring from a limb, the most satisfactory method is to apply pressure to the main artery at a place higher up the limb than the wound. By thus closing the artery at a

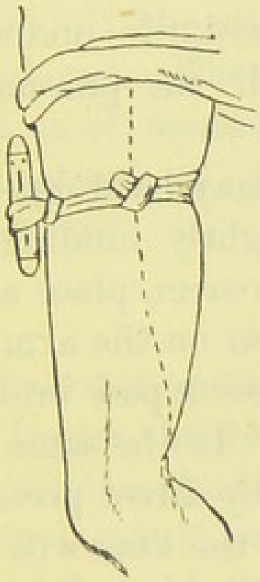

Fig. 100.
TOURNIQUET APPLIED TO THIGH.

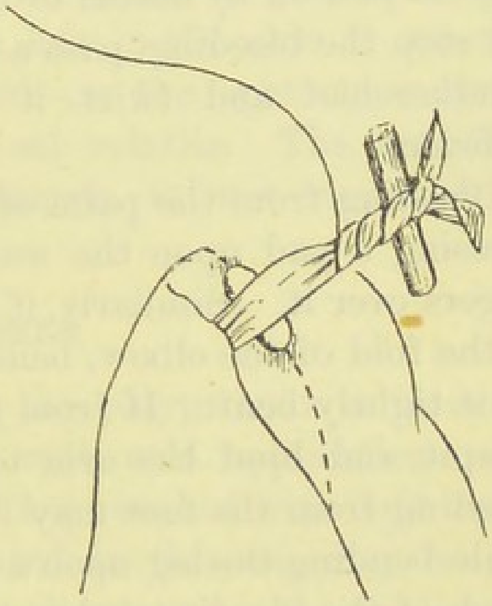

Fig. 101.
TOURNIQUET APPLIED TO ARM.

point between the heart and the wound, the bleeding will be arrested. This pressure is best exercised at a point in the course of the artery where it passes near to a bone. The artery can be easily identified by its pulsation, and it should be pressed against the bone by the two thumbs, one over the other. The points to be chosen for this pressure are easily learned by a few attendances at an ambulance class, but are difficult to describe in a few words.

Remember in cases of bleeding that sufficient pressure brought to bear upon the spot from which the blood is running will in the great majority of cases be all that is necessary in order that the bleeding should cease. For keeping up continuous pressure it may be necessary to employ some form of tourniquet. A good tourniquet may be made by tying a knot in the middle of a handkerchief, placing this on the spot where it is desired to produce compression, and tying the handkerchief tightly round the limb. Instead of the knot a piece of wood, or a flat stone, may be tied on by means of the handkerchief. If this does not stop the bleeding pass a stick or a penknife under the handkerchief and twist it round until the pressure is sufficient.

Bleeding from the palm of the hand may be stopped by pressing a pad upon the wound and tightly binding the fingers over it. Similarly, if from the forearm, place a pad in the fold of the elbow, bend the forearm on the arm and tie it tightly bent. If from the arm, press a pad into the armpit and bind the arm to the side. In the same way bleeding from the foot may be stopped by direct pressure, while bending the leg upon a pad behind the knee will stop much of the bleeding below the knee. Bleeding from the face and head can usually be checked by pressure against the bony surface beneath.

Nose Bleeding.

Bleeding from the nose is sometimes difficult to stop. The child should sit in a chair, with the head thrown back and the arms raised. If this is not sufficient to stop the bleeding, the head, face, and neck should be freely douched with cold water. Do not let the patient bend down over a basin, and frequent blowing and wiping the nose should be prevented. Another treatment is to syringe out the nose with a strong solution of alum in iced water.

BITES AND STINGS.

Bites of animals often cause irregular jagged wounds that are long in healing. The immediate treatment of all bites is thorough and vigorous sucking of the wound and spitting out the saliva and blood. It is best to encourage free bleeding for a time. Then the wound should be again sucked and cleaned carefully with hot water, and then some strong Condy's fluid applied.

Stings by insects are often the cause of great pain and shock. If the sting has been left in the skin it must be pulled out. Then quickly rub on the spot some strong solution of washing soda, or sal volatile. The continued application of these substances is not desirable or necessary.

BRUISES.

The commonest accident in the playground is bruising. The bruise should be treated with cold applications such as a handkerchief applied and kept soaked with cold water. Bruised eyes if promptly treated in this way may be prevented from blackening. The alternative is the application of very hot water for about fifteen minutes.

FRACTURES.

When a bone is broken the greatest possible care should be taken to prevent any movement. Sometimes the force producing the fracture is so great that one of the broken ends of bone gets forced through the flesh and skin to the outside, forming an open wound as well as a fracture. This is called a compound fracture. When the skin is not broken it is called a simple fracture. Simple fractures are often converted into compound by mismanagement, and the case is thereby rendered infinitely more serious, because the air can now get into the wound and may take with it some germs which may do serious injury and even cause death. A fracture is diagnosed by the loss of power of movement of the part involved, by the unnatural position, by local swelling and pain, or by the place of fracture being felt beneath the skin. Sometimes it is difficult to be quite sure whether a fracture has taken place or not, but the best rule is to treat every doubtful case as a fracture until medical help arrives.

When an individual has broken a bone, no movement whatever should be allowed until means have been taken to ensure immobility of the part. If the fracture is a compound one, the wound should be washed, if possible, with some clean water, or better, with a disinfecting lotion, such as a solution of carbolic acid (one in forty of water). Then place a pad of lint or a clean handkerchief over the wound, to prevent the entrance of more air.

In the case of a fractured skull very little can be done until the doctor arrives. The patient should be placed on a bed or couch with the head raised. Cloths soaked in cold water should be repeatedly applied to the head.

Fig. 102.

METHOD OF APPLYING BANDAGES TO BROKEN JAW.

A broken jaw is recognised by the patient being unable to speak, and also by feeling a depression at some point in the bone. If possible a bandage should be applied as shown in Fig. 102, after gently raising the jaw to its natural position. One handkerchief is fastened round the top of the head and below the jaw, and the other passes round the chin to the back of the neck.

A broken collarbone is a common result of a fall, especially among children. An irregularity will be detected by passing the fingers along the collarbone. Another sign is the inability of the patient to raise the arm above the shoulder. Place a pad, such as a rolled up handkerchief, in the armpit and, after placing the arm in a sling, tie it to the side by means of a broad bandage passed round the arm and chest, outside the sling.

Broken ribs are also of common occurrence. The patient complains of a sharp pain on drawing his breath, and a grating sensation at each breath may be detected by placing the hand over the spot. A broad bandage should be fastened tightly round the chest, and this is usually found to give great relief.

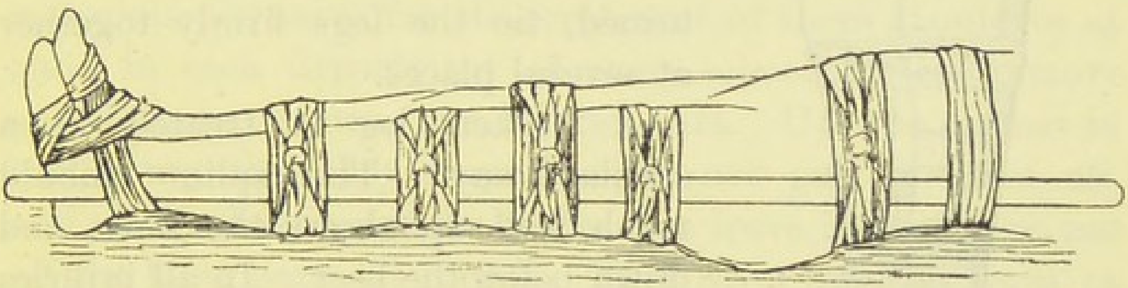

Fig. 103.
SPLINT APPLIED TO BROKEN THIGH.

In the case of a broken arm-bone temporary splints should be cut so as to reach from the armpit to the elbow. Roughly pad the splints by wrapping them round with handkerchiefs; and place one from the shoulder to the outside of the elbow, and the other from the armpit to the inside of the elbow. Bandage the splints firmly to the arm, and put the forearm in a sling.

Broken forearms are treated by fastening the arm to an angular splint. To make this, bind two pieces of wood at right angles to each other. Next, bend the arm to a right angle at the elbow, and fasten it to the splint with handkerchiefs; then put the arm in a sling. Broken bones of the hand or finger are best treated by fastening the whole hand flat against a broad splint, and then putting the arm in a sling.

A broken thigh requires very careful treatment. First take hold of the foot with both hands, and pull steadily until the injured limb is the same length as the other. Then tie the feet together. Next obtain, if possible, a long splint—a broom-stick or an umbrella will do—and tie it as shown in Fig. 103. The splint should go from the armpit to the foot. If no splint can be obtained, tie the legs firmly together at several places.

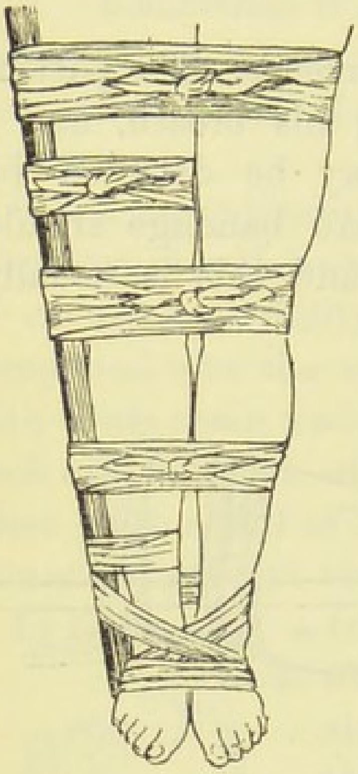

Fig. 104.

SPLINT APPLIED TO BROKEN LEG.

A broken leg is treated in a similar way. The splint should reach well up above the knee, and down below the foot. In all injuries to the knee, leg, foot, or ankle it is a good rule to tie the two legs together, so as to prevent any further injury being done by movement.

SPRAINS AND DISLOCATIONS.

When a joint is sprained there is usually a certain amount of damage done to the ligaments or membranes round the joint. The condition is usually very painful. The ankle joint is most often involved. A slight sprain is often relieved temporarily by a tight bandage round the joint. The treatment usually consists of cold applications, such as cold water dressings, but as a general rule it is easier and more satisfactory to bathe the joint with water as hot as can be borne. If this is persevered with there is usually great relief obtained.

A joint is dislocated when the bones forming the joint have lost their usual relative position. This unnatural position causes pain and deformity, and as a rule the joint cannot be used. In many cases of finger or thumb joints the dislocation can be readily reduced by simply pulling the bones into place, but in most cases it is wiser to leave the operation to a medical man, lest further damage should be done.

BURNS AND SCALDS.

These are not common accidents at day schools, but the materials necessary for the treatment of them should be at hand in each department of every school. First remove any clothing covering the injured part. Cut the clothes in such a way that they drop off. Do not pull them at all, and if any clothing sticks to the skin leave it there, but cut off the loose parts all round. Then cover up the burn or scald with pieces of cotton or linen soaked in a mixture of linseed oil and lime water, or olive oil and lime water, or either of these oils alone. Another good dressing is a solution of carbonate of soda or washing soda in water or milk. Now cover the dressing with a thick layer of cotton wool or flannel. Keep the patient warm, and give some strong tea or coffee if there is any sign of faintness or depression.

Children should be instructed that if their clothing should catch fire the best thing for them to do is to lie on the floor and roll rapidly over and over. Few children, however, would retain sufficient presence of mind under such alarming circumstances, and the duty of a bystander is to wrap round the burning child a rug, carpet, blanket, or coat, and then, laying it on the floor, roll it about rapidly until the flames are extinguished.

A common accident with children is the scalding of the mouth and throat by drinking out of teapots or kettles. In these cases the scalded parts swell up quickly and the child may suffocate. A doctor should be summoned at once, as an operation may be necessary to save the child's life. Meanwhile wrap up the child in a blanket, apply hot flannels to the outside of the throat, and give a little oil to drink.

In a school laboratory the skin is often burned by strong acids or alkalies, such as sulphuric acid or caustic soda. The best treatment is to immediately plunge the part into cold clean water, or hold it under the tap. When thorough washing has taken place it may be beneficial to wash the place with very weak acid (in the case of burning by alkalies) or alkali (for burns by acids), but such treatment should never be attempted until thorough washing has been carried out.

REMOVAL OF FOREIGN BODIES.

Substances, technically known as foreign bodies, may, as a result of some accident or mishap, have gained entrance to various parts of the body, such as the larynx, the stomach, the nose, eyes, ears, skin, etc.

Throat.

If a solid, such as a lump of food, a coin, a piece of bone, or even an orange pip, is sticking in the throat, or is drawn into the pharynx, it may cause most alarming symptoms: the face suddenly becomes purple, the eyes protrude, inarticulate sounds are made, and unconsciousness rapidly comes on. Pass the forefinger into the mouth, reach down the throat as far as possible, and try to hook out the obstruction. Even if you cannot reach the obstruction your efforts may cause vomiting, which will do good. Sometimes a sudden slap on the back is effectual. If the exciting cause is some small object such as a coin or orange pip the old way of holding the child up by the heels, head downwards, and giving the back a smart smack is often successful.

Stomach.

When a child has swallowed some solid object, such as a plum-stone, a pin, needle, or nail, the next few meals should be given as dry as possible, and plenty of bread and vegetables should be eaten. Do not give aperient medicines.

Eye.

Small objects in the eye give rise to a great deal of pain and irritation, and should be attended to at once. The pain can usually be located and that part of the eye examined by partly everting the upper or lower lid by holding the eyelashes with the thumb and finger. When the object is seen it can be easily removed by means of the moistened corner of a handkerchief. If the object is seen to be sticking in the cornea do not attempt to remove it, but wait for the doctor.

Nose.

Occasionally children push up the nose small objects, such as beads, and fail to recover them. By making the child sneeze the object is often dislodged, but if this is not successful it will be best to await the arrival of the doctor.

Ear.

If some small object has become lodged in the ear it is best to refrain from taking any steps to remove it. Such matters are best left to a doctor. As a general rule the teacher will find it best, as a matter of common caution, to refrain from applying active remedies except in the simplest possible cases. The parent of an injured child is often inclined to blame some innocent and well-meaning individual who has attempted to help.

Skin.

Foreign bodies such as thorns, splints, or needles are commonly lodged in the skin. If their removal is obvious and simple there is no reason why it should not be attempted, but it is important to remember here also that unsuccessful attempts of this kind are apt to render the ultimate removal of the object a much more serious matter.

VOMITING.

A child may vomit owing to the most trivial cause, but on the other hand it may be the first indication of a most dangerous condition. It is commonly the first noticeable happening in the preliminary stage of scarlet fever, diphtheria, and other infectious conditions, as well as such severe illnesses as pneumonia and brain fever, or such dangerous conditions as obstruction of the bowels or rupture. On account of the possibility of it being an indication of some serious condition vomiting should not be regarded lightly. To relieve the feeling of nausea an excellent remedy is good effervescing soda-water.

FAINTING.

In overcrowded and ill ventilated school-rooms fainting is by no means uncommon. It is usually caused by temporary feebleness of the heart's action, and is accompanied by paleness of face and some perspiration. Give the child fresh air and put the head as low as possible, either by laying full length on the floor or by bending the head and body forwards until the head is below the knees. Apply smelling salts to the nostrils, or sprinkle the face with cold water. When recovering it is beneficial to give some cold water to sip, but do not try to make the child drink during unconsciousness. Children should be taught that a most effectual remedy when feeling faint is to stoop down as if tying one's shoe-laces. This is usually quite sufficient to cause the feeling of faintness to pass away.

EPILEPSY.

An epileptic fit is a common cause of insensibility. In the severer type of disease the sufferer first screams, and falls down unconscious and rigid. Then the hands are clenched, the legs and arms are jerked to and fro, the face becomes purple, and foam often comes from the mouth. A common accident at this stage is the biting of the tongue if it happens to get between the teeth. The convulsive movements then gradually subside and finally cease, and the patient usually falls into a deep sleep. During the fit the eyes are usually turned sideways and they are quite insensitive to light and touch.

When a fit of this kind occurs the only thing to be done is to prevent the patient injuring himself. Loosen all the clothes about the neck, put something soft under the head, and if possible put a piece of wood or cork between the teeth to prevent the tongue being bitten. Do not try to restrain all movements, or give stimulants, or throw cold water on the face. Allow the patient to go to sleep as soon as possible.

Such fits usually recur at longer or shorter intervals, either regularly or irregularly. Children suffering frequently from severe fits should not be allowed to attend ordinary schools.

Much milder forms of epileptic attacks are common. Some are quite free from convulsive movements and are represented merely by loss of consciousness for a few seconds. The face becomes pallid, and there is usually perspiration during the attack. When consciousness returns the child may be liable to sudden eccentric behaviour or even acts of violence.

HYSTERIA.

As a rule attacks of hysteria are attended with laughing or crying, but occasionally there may be all the signs of an epileptic fit. There is, however, no real insensibility, and the condition may be distinguished by the patient resisting an attempt to raise the upper eyelid; also, when the eyelid is raised, the pupil will not be visible. The best treatment is either to leave the patient entirely alone or to dash a glass of cold water over the face.

POISONING.

In an ordinary school the possibility of poisoning is not very great, but if such an emergency should arise it is important to bear in mind the following rules:—

1. If the patient appears sleepy, keep him awake.
2. If there are stains about the mouth, with signs of blistering and destruction of the mucous membrane, do not give an emetic, but give raw eggs, milk, and then oils (linseed oil, olive oil, salad oil). Afterwards strong tea or coffee.

3. When there are no stains about the mouth give an emetic (large quantities of warm salt and water, or mustard and water, followed by tickling of the back of the throat by pushing the forefinger down as far as possible). Then give raw eggs, milk, and oils. Afterwards strong tea or coffee may be given. Do not give oils if there is a possibility of the poison being phosphorus.

DROWNING AND SUFFOCATION.

These are not common accidents of school life, but are possible ones. Instruction in the proper course to take in such emergencies should form a part of the teaching in all schools.

No matter how dead the person may seem to be it is the duty of those who are first on the spot to make every possible effort to restore life.

Send for medical assistance, and in drowning cases try to get some hot blankets if any house is near, but do not leave the spot yourself. At once proceed to loosen all clothing about the neck and chest, and clear out the mouth if there is any froth or dirt. Draw forwards the tongue, and fasten it out by means of an elastic band, or ribbon, or strip of linen, which must be passed over the tongue and tied under the chin.

Then turn the body over on one side, resting the head on the forearm. Then turn it on the back, and rub the chest vigorously, exciting the nostrils, when possible, with snuff or smelling salts.

If no attempt at breathing is made by the individual himself, lose no more time, but apply artificial respiration at once.

ARTIFICIAL RESPIRATION (Silvester's method).

(1) Put the patient on his back, with a pillow beneath the shoulders. Pull out the tongue, as directed in (2) above, and keep the mouth open all the while.

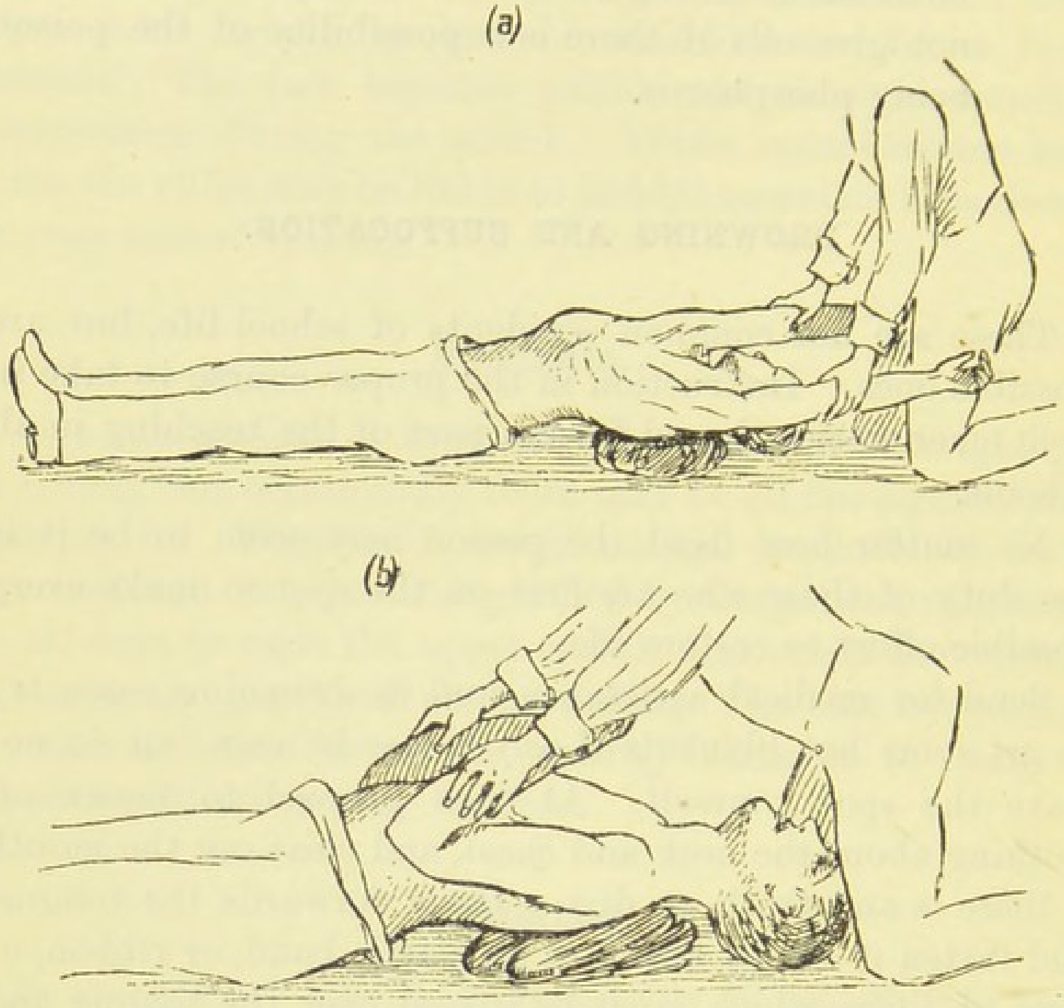

Fig. 105.

ARTIFICIAL RESPIRATION.

(*a*) Method of producing Inspiration. (*b*) Method of producing Expiration.

(2) To produce artificial inspiration, kneel at the patient's head, and grasp the arms just below the elbows. Then pull the arms slowly and steadily above the head. This raises the ribs and expands the chest, causing air to enter the lungs.

(3) In two or three seconds, produce artificial expiration, by bending the arms back again, and pressing them very forcibly against the chest. This forces the air out of the lungs. This double movement should be repeated about fifteen times a minute, and should be kept up for at least an hour, even when there is no apparent return to life.

(4) Directly any signs of breathing are shown by the patient, the movements may be stopped, and the limbs rubbed vigorously upwards towards the trunk, in order to promote the circulation of the blood. Hot bottles and hot blankets should be applied to the pit of the stomach, the legs, and the feet. Stimulants should be given such as brandy, or better hot coffee. If assistants are at hand, these efforts to promote circulation should be carried on simultaneously with the movements of artificial respiration.

CHAPTER VII.

EPIDEMIC DISEASES.

The epidemic diseases affecting schools include diphtheria, scarlet fever, measles, German measles, whooping cough, mumps, chicken pox, and small-pox, all of which have certain characteristics in common, viz.—

(1) They are all communicable from one person to another.

(2) Each disease has a definite duration.

(3) When infection has taken place no symptoms are produced at first. The interval of time, between the actual infection and the appearance of the first sign or symptom of the disease is called the period of incubation. When the incubation period has elapsed the typical symptoms of the disease appear, and last for a certain time, during which death may occur. If the active period of the disease is survived recovery usually takes place.

(4) A remarkable characteristic is that an attack of one of these diseases is rarely followed by a subsequent attack of the same disease in the same individual. In other words, an attack confers immunity from that disease. The chief exception to the above rule is diphtheria.

(5) In many cases the disease has been conclusively shown to be caused by some special form of bacterial life, and the same explanation is inferred in the case of the others on account of their common characteristics. From the obvious analogy that exists between the ordinary process of fermentation (*i.e.* a stage of quiescence or incubation followed by a period of activity and then by exhaustion of the process) and the course of these diseases the term zymotic has been applied to them.

SPREAD OF INFECTION.

1. By Air.

The germs of whooping cough, scarlet fever, measles, small-pox, chicken pox, mumps, diphtheria, influenza, and tubercle seem to be capable of being carried by the air. In most of them, however, the possible distance is only a small one, and it is likely that only in the case of tubercle, small-pox, and influenza can the infection be carried any considerable distance.

2. By Water and Food.

Typhoid fever and cholera are notoriously water-borne diseases. Infected milk may spread tubercle, scarlet fever, diphtheria, or measles.

3. By Clothes.

Scarlet fever and small-pox germs have a special proclivity of lying dormant for long periods in clothes and furniture of the sick room. Infected books and toys similarly help in the spread.

4. By Living Creatures.

Flies are probably active carriers of diphtheria and typhoid fever, and in towns probably play a conspicuous part in the spread of these diseases. Fleas may similarly carry infection. Cats undoubtedly suffer from and spread diphtheria.

PREVENTION OF INFECTION.

The spread of infectious diseases is prevented by carefully and thoroughly carrying out instructions and by the adoption of different precautions such as are grouped together as follows :—

1. Isolation.

The sick should be at once separated from the healthy.

2. Quarantine.

Those who have been exposed to infection should be isolated separately and kept under observation until the period of incubation of the disease in question has expired.

3. Disinfection.

The disease germs that may be present in the room, on walls, floors, desks, etc., or on pencils, books, or clothes, must be destroyed.

4. Immunity.

In the case of small-pox the disease can be checked in its spread and could eventually be stamped out by efficient vaccination, which confers immunity from the disease.

5. Notification.

When a case of infectious disease occurs it must be notified at once to the local medical officer of health.

6. Exclusion.

All children from an infected house must be excluded from school until the medical officer certifies that they can resume attendance.

SMALL-POX.

Owing to the effect of vaccination this disease is uncommon in schools. During epidemics, however, outbreaks may occur, and when this happens it usually serves as a most striking object-lesson upon the effects of vaccination. The circumstances of the outbreak of small-pox among school children at Ossett, near Wakefield, illustrate this. The following figures are taken from the report of Dr. Kaye, the County Medical Officer for the West Riding of Yorkshire. In the mixed department of this school were 169 scholars. On October 27, 1904, a child in one of the classes was found to be suffering from small-pox and was promptly removed to the hospital. In this class there were 27 scholars, 19 of whom had been vaccinated and 8 were unvaccinated. Every one of these 8 unvaccinated children took the disease, while the 19 vaccinated children all escaped. Similarly in two other classes every unvaccinated child contracted small-pox. Altogether there were 42 cases of small-pox among the scholars and only five of these had been vaccinated, and these five were in one class of older scholars in whom the effects of vaccination during infancy were wearing off. Throughout the whole school not a single re-vaccinated person took the disease.

There is abundant scientific and statistical evidence to prove that efficient vaccination, as shown by the production of four good scars, during infancy confers absolute immunity for at least ten years. Also if revaccination is properly performed at the age of twelve to fourteen years it will undoubtedly confer immunity for the remainder of life. In countries where revaccination is compulsory the disease is practically unknown.

The incubation period of small-pox is twelve days, during which period there are practically no symptoms. Then pain in the back, headache, vomiting, fever, and shivering show the commencement of the attack. In mild cases, such as occur in inefficiently vaccinated children, the eruption is the first sign. This begins on the third day of the illness. It is first noticed on the forehead, neck, face, and wrists. Afterwards it spreads over the trunk and limbs.

The rash appears first as red spots, slightly raised, and afterwards becoming more prominent. They are hard and "shotty." On the third day of their appearance the centre of each becomes clear and transparent, and they now look like blisters full of clear fluid. In two more days the middle becomes depressed and the clear appearance changes to dull yellow. After the eighth day the spots begin to dry and form scabs. A case should be regarded as infectious until all the scabs have quite disappeared.

During an epidemic of small-pox a teacher should send home any child with suspicious spots on the face or wrists, and report the case to the medical officer. No child from an infected house can be allowed to attend school.

CHICKEN POX.

This is very common among children, and spreads rapidly through schools in epidemics. It has a variable incubation period of from twelve to nineteen days, during which time there are no symptoms. The rash appears first as red spots on the chest, afterwards on the face and scalp, and then on the limbs. Fresh crops of the spots appear at intervals, and as each goes through the same development it follows that all stages of the process are noticeable on the same individual at the same time. In a few hours the red spots change into blisters, then they turn yellow, and in two or three days they burst, dry up, and form scabs. A child is free from infection when all traces of the scabs have disappeared. All children from infected houses must be excluded from school.

Any child showing a suspicious eruption should be sent home and reported to the medical officer.

SCARLET FEVER OR SCARLATINA.

The incubation period of scarlet fever is variable, being usually three or four days, and the disease is highly infectious from its commencement. In the earlier stages infection is spread mainly by the breath and the secretions of the nose, mouth, and throat, and later on a possible cause may be the scales of desquamated skin, that are particularly liable to adhere to clothing and to lie latent for an indefinite period. After the disease is apparently over a child may be sent to school with discharging ears or nose, or in very mild cases the disease may have been undetected and the child continue its attendance at school until this discharge commences. Such discharges are intensely infectious and will rapidly spread the disease. No child with discharging ears or nose should be allowed in school during a scarlet fever epidemic until the medical officer has made an examination.

A common event is the discharge of a child from the hospital apparently well, and with no discharge of ears or nose. Such a child is then sent to school, and is sent out to play in the playground with the others during recess. Although the weather may be very cold the child usually goes out of the warm schoolroom into the cold air without any additional clothing, and with no hat. A cold is contracted, and a discharge from the nose or ears is set up. This proves to be infectious and an epidemic is caused. With greater care exercised to prevent such children from taking cold there is reason to believe that they would not prove to be infectious to others, but if they contract a cold the infectivity appears to burst out afresh.

The usual premonitory signs of an approaching attack of scarlet fever are pallor, shivering, vomiting, headache, and sore throat. If scarlet fever is at all prevalent in the district any child showing two of the above signs should be sent home and reported.

The attack itself nearly always begins with shivering and vomiting, with more or less severe sore throat. The face then becomes flushed, and the rash appears on the side of the neck and on the chest. Afterwards the rash spreads to the abdomen and the limbs, but, curiously enough, does not appear on the face, the palms of the hands, or the soles of the feet. The rash appears as small deep red dots on a red skin. It disappears about the seventh day.

The sore throat is often a prominent symptom, and the glands about the jaw are swollen and painful, causing difficulty in mastication and swallowing. The tongue becomes brightly red, with swollen papillae, giving it the appearance of a strawberry.

Desquamation or peeling begins in severe cases on the third or fourth day; in milder cases from the sixth to the ninth day; occasionally it is postponed until much later. The peeling usually commences where the rash first appeared, *i.e.* on the sides of the neck and the chest. Then the trunk and the arms begin a few days after, then the palms of the hands, and finally the soles and the heels. From a school point of view a constant routine examination of the children's hands and fingers during an epidemic is most useful. Quite recently in the author's district an epidemic of scarlet fever was associated with a large public elementary school, and systematic examination of all the children in attendance was carried out. Three children were discovered in the peeling stage, and several others were sent home as suspicious cases. These afterwards developed the disease. By these means, combined with thorough disinfection of the rooms, etc., and the visitation of all suspicious cases of absence, the epidemic was suddenly and completely arrested. An examination of the registers showed that the children who were found to be peeling had stayed away from school, for one day only, about two weeks previously. This serves to illustrate the fact that mild cases escape ordinary observation and do not appear to be ill, but they continue the spread of the disease. In fact it is always more difficult to stamp out epidemics of a very mild character simply because some of the cases are not ill enough to be kept at home.

An ordinary case of scarlet fever is free from infection in about six weeks, but no child should be allowed to resume attendance while it shows any discharge of ears or nose. Of course all children from infected houses must be excluded from school.

MEASLES.

This disease causes a very high death rate among children, but it is not necessarily so fatal as it appears, most of the deaths being due to bronchitis or pneumonia, which so often complicate or follow an attack of measles and are frequently caused by neglect and exposure to cold. The incubation period is usually about twelve days.

The increase in the prevalence of measles during recent years is attributable to the crowding together of children in schools, the relative increase in town populations, and the impossibility of definitely recognising the disease before it becomes infective.

During an epidemic of measles the following precautions should be taken:—

1. Susceptible children from infected houses should be excluded from school altogether until the most recent case is certified as being free from infection.
2. Scholars who appear to be suffering from the slightest cold should be sent home.
3. All absentees should be visited by the attendance officers, and all suspicious cases visited by the medical officer. This is a most necessary and important step in order to properly enforce rule (1).
4. In severe epidemics it may be desirable to close infants' schools if the adoption of the above measures does not stop the spread. It is unnecessary to close the other departments.
5. During the closure the infants' school should be thoroughly disinfected. It is often advisable to disinfect the other departments on Saturdays, when they are not in use.

If an outbreak of measles occur in a boarding school the cases should be at once isolated, and all scholars who have been in the same dormitory during the previous week or sat next to them in class-rooms during that time should be placed in quarantine. All scholars who show any signs whatever of an ordinary cold should be separately isolated.

For four or five days before the typical rash appears the child begins to show evidence of being out of sorts. The commencement is usually shivering, hot dry skin, and headache. Then signs of a cold appear. The child sneezes, the eyes get red and watery, the nose runs, and the voice gets hoarse. A child showing any of these signs during an epidemic of measles should be at once sent home. In an infants' school it is advisable to send such a child home at once whether measles is prevalent or not. If teachers could only be persuaded to adopt this course, it is probable that most epidemics of measles would be avoided.

After about four days of these symptoms the typical rash appears, and it is only at this stage that the diagnosis of measles can be definitely made. But by this time the child, if it has continued to attend school, will have infected dozens of other children. The rash appears first on the face, which becomes flushed at first and then develops the characteristic appearance of raised, blotchy, dark red patches. This afterwards spreads to the rest of the body.

A child is infectious from the time of the first symptom until the end of the illness, usually a period of about four weeks.

GERMAN MEASLES.

This is a mild infectious disorder which has symptoms bearing some resemblance to both measles and scarlet fever. It is quite a distinct disease, having an incubation period of about sixteen days.

The preliminary symptoms are usually very mild. There may be headache, vomiting, and signs of a cold. The eruption appears first on the face, as in measles, and consists of slightly raised patches of a rose-red color. It then spreads to the body, where the rash is often like that of scarlet fever, but is more patchy. The glands at the back of the neck, in the armpit, and in the groin are enlarged, tender, and hard like peas. The disease itself is very mild, but it may be the forerunner of tuberculous infection of the glands.

WHOOPING COUGH.

People at any age may be attacked by this disease, though it is commoner and more fatal among infants than among older children and adults. Its incubation period is about eight days. It is highly infectious before the cough appears, and the infectiousness may continue for months. Although regarded by the average parent as a trivial complaint, yet it is actually the most fatal of all the infectious complaints of children under five years old. It causes twice as many deaths as scarlet fever.

The preliminary symptoms are those of a cold, viz. sneezing, running nose, watering eyes, and slight cough. These may persist for one or two weeks, during which time the infection is being spread broadcast if the child attends school. This is yet another reason why all children showing signs of a cold should in every instance and under all circumstances be excluded from school. By making this a routine practice it is impossible to exaggerate the important effects that would be achieved. Epidemics would be prevented in many instances, and a great number of fatalities avoided. The rule should be most rigidly observed in infants' schools.

The actual attack of typical whooping cough is unmistakable and painfully noticeable. A child who has had several attacks of the typical fits of coughing knows when one is coming on, and often appears frightened and begins to cry. A rapid series of short coughs are given until the chest is emptied of air, during which time the face becomes congested and livid. Then the breath is drawn in with a long crowing whoop. The fit of coughing may be followed by vomiting. Afterwards the child becomes bright and cheerful again. Infected children should be excluded for at least two months, or for a longer period if the paroxysms of cough, followed by vomiting, have not disappeared.

A distressing characteristic of whooping cough is the tendency that it seems to confer upon the lungs to acquire disease. It appears to weaken the resisting power of the lung tissue, and to predispose to attacks of pneumonia and to consumption.

MUMPS.

Epidemics of this disease are frequent in cold wet weather in spring and autumn. The incubation period is over a fortnight. Both children and young adults may be attacked and boys are more liable to be infected than girls. The outbreak is often associated with an epidemic of measles.

The first signs are pain, stiffness, and tenderness at the angle of the jaw, below the ear. This is followed by swelling. One side is affected first, usually the left, and the other side may or may not follow suit. The pain, stiffness, and tenderness may spread down the side of the neck and there may be great difficulty in opening the mouth. When both sides are affected with considerable swelling the appearance is very grotesque.

The condition is intensely infectious and it must be remembered that serious complications and sequelae are not uncommon. Cases should not be regarded as free from infection until the end of four weeks from the commencement of the disease.

Swellings at the angle of the jaw, closely resembling those caused by mumps, are occasionally seen in bad cases of scarlet fever and diphtheria.

DIPHTHERIA.

During the last twenty or thirty years there has been a progressive increase in the rate of mortality from diphtheria in England and Wales, and the increase is mainly in densely populated districts. The disease used to be regarded as one peculiar to country districts, but its character has now changed and it is practically always present in large towns. This is probably due to the fact that the diphtheria bacillus is extremely common in towns, and is present in many healthy throats without causing any disease. When, however, the bacilli gain access to an unhealthy throat they are able to set up the disease known as diphtheria.

After the attack is over and the throat is apparently healthy the bacilli may still persist in the throat and the child may be still able to give others the disease. Also healthy children may have the bacilli in the throat and may hand them on to other children without themselves suffering from the disease. Such cases are known as "carriers" and play an important part in the spread of the disease.

A consideration of the above facts shows plainly that in order to prevent the occurrence and spread of diphtheria we must devote ourselves to two objects, the exclusion of all children who have in their throats the bacilli of diphtheria and the removal of all conditions that are liable to produce a morbid condition of the throat, such as bad ventilation, over-heating, access of sewer gas or ground air into schools, bad drainage, and insanitary conveniences. It is most important to remember that the bacillus probably has no effect upon a healthy throat and that some predisposing cause must be at work before the disease diphtheria can be set up. In every school epidemic of diphtheria investigated by the author it has been possible to find some undesirable condition such as those enumerated above, and when these have been eliminated and those children possessing diphtheria bacilli in the throat have been excluded the disease has always disappeared. There is never any reason for school closure for diphtheria unless some structural alterations are urgently necessary.

By means of a bacteriological examination of the material from the throats of the children it is possible to know exactly which of the children are capable of giving the disease to others, and these children can be excluded until they are found to be quite free from the bacilli. If the school is closed for alterations or for holiday while cases of diphtheria are associated with it a good plan is for the medical officer to make this examination the first time that the scholars re-assemble.

If bacteriological examination cannot be obtained the best plan is to send home all children suffering from sore throat, but this plan cannot be relied upon to stamp out the disease, because many children who are acting as carriers may have no throat trouble at all.

The incubation period of diphtheria averages between two and five days. The greatest number of cases and the maximum mortality occur between the ages of three and twelve years. The first symptom is a sore throat. The glands round the jaw and throat often become inflamed, enlarged, and tender. Upon examination of the throat one or more patches of a greyish white membrane may be seen over the tonsils, the palate, or the back of the pharynx.

The disease may attack the trachea (causing "croup") or the membrane lining the nose, and it is by no means uncommon to trace mysterious recurrences of the disease in a school to an unrecognised and long standing case of nasal diphtheria. Wherever the germs may have taken hold they may persist there for long periods, and in many cases they can be still found after the lapse of twelve months. Usually, however, before the expiration of so long a time they have lost their virulence and are no longer able to set up the disease diphtheria.

The infection spreads rapidly through a school by the breath of those suffering from the disease (as well as the "carriers") and by infected pens, pencils, books, papers, modelling clay, towels, drinking cups, etc.

The use of diphtheria antitoxin in rendering the children temporarily immune to the disease has not been adopted in this country to any considerable extent, but it is a method full of promise for the future.

All cases of diphtheria and all children from infected houses should be excluded from school until a bacteriological examination proves them to be free from the diphtheria bacillus.

The following table gives a summary of some of the facts concerning the above diseases :—

TABLE OF INFECTIOUS DISEASES.

Disease.	Signs or Symptoms.	Incubation, from exposure to first sign of Disease. (Days.)	Day of definite illness on which Rash appears.	Mode of Infection.	Period of Exclusion from School.	Quarantine Period.
SCARLET FEVER	Headache, shivering, vomiting, sore throat and hot dry skin ; 2nd day, bright red rash ; skin peeling follows, and later on discharges often occur from the nose and ears. Face very pale in later stages.	1—7	1st or 2nd	Discharges from throat, nose, and ear. Peeling of skin?	Till peeling has quite finished, and discharges from nose or ears have ceased (generally not less than six weeks).	12 days.
MEASLES ..	Begins like a cold in the head ; with feverishness, shivering, running from the nose and eyes, and sneezing ; blotchy rash about 4th day on the face, which looks swollen and heavy.	7—14	4th or 5th	Discharges from lungs, throat, nose and ear. Peeling of skin.	Till cough and discharges have ceased, and the skin is smooth ; not less than four weeks.	18 days.
GERMAN MEASLES	Like both Measles and Scarlet Fever, but generally mild. Sneezing, blotchy rash, enlarged glands.	10—14	1st to 3rd	Breath (*i.e.* throat discharges).	Three weeks.	18 days.
DIPHTHERIA..	Sore throat, with lassitude and weakness as a rule ; white points or patches on the back and sides of the throat ; stiffness of neck ; pallor. Sometimes merely like a mild sore throat.	1—8	No rash	Discharges from throat, nose, and ear.	Till two successive examinations for diphtheria bacilli have given negative results.	Till bacilli are proved absent.
WHOOPING COUGH	Begins like a common cold, followed in a few days by fits of coughing, which gradually develop the charactersitic long-drawn whoop, and are often followed by vomiting.	7—14	No rash	Breath (*i.e.* discharges from lung).	Till cough and vomiting have ceased. Two months at least.	18 days.
MUMPS ..	Pain and stiffness in jaws, feverishness and limb pains ; swelling in front of ears and under the jaws. May be on one side only.	7—21	No rash	Breath (*i.e.* discharges from parotid glands)	Four weeks.	21 days.
CHICKEN POX	Scarcely any preliminary illness ; small red spots changing in about 24 hours to blisters (vesicles) containing clear fluid ; these burst and form scabs. Spots at different stages of development.	10—14	1st—3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	18 days.
SMALL-POX ..	More severe than last ; headache, backache, vomiting, with rash similar to last ; vesicles become pustules, then scabs on forehead, face, and hands.	12	3rd	Breath and scabs.	Till all scabs have fallen off and skin is clear.	14 days.

CHAPTER VIII.

SCHOOL CLOSURE AND DISINFECTION.

CLOSURE.

This is an exceedingly difficult problem at present because the public have a firmly fixed idea that the only way to combat a school epidemic is to close the schools. As a matter of fact the process is extremely clumsy, unscientific, and unsatisfactory, and the only purpose it serves is to mask the true state of affairs, and to confer upon the locality that state of bliss which is said to be the invariable accompaniment of ignorance. In towns especially it probably has no effect whatever in preventing the spread of the disease.

Article 101, which ceased to operate in March 1903, protected the school authorities against the pecuniary loss that they might suffer by the exclusion of infected children and also children from infected houses. The reason for its withdrawal is not obvious. The result is that only by obtaining an order for the schools to be closed can the education authority prevent its grant being seriously reduced. As a consequence the local medical officer of health is besieged by requests to close the school directly a few cases of infectious disease have occurred, and in many cases he thinks it wise to give way to the clamour. The

Board of Education have therefore taken the ill advised step of helping to perpetuate an antiquated and unscientific system. In country schools alone does the mere fact of closure influence the spread of an epidemic.

Occasionally it is necessary to close a school for the purpose of making alterations and remedying such defects as have been revealed by the systematic inspection and examination of the premises, or for the purpose of cleansing and disinfecting. If a school is closed for any reason it should be thoroughly cleaned and disinfected.

During epidemics of diphtheria the best procedure has already been discussed. Every infected child and every "carrier" of the disease can be detected by means of bacteriological examination. By the exclusion of all such cases, combined with the proper disinfection of the premises, and other steps that are discussed under the subject of disinfection, the spread of the disease can be arrested.

In the case of measles if the teachers received definite instructions to always send home all infants showing signs of a cold there would be fewer epidemics. When an epidemic does occur the carrying out of vigorous measures, and systematic medical inspection combined with the exclusion of all children from infected houses, is often successful in stamping it out. If these measures prove to be unsuccessful it is only necessary to close the infants' department. With regard to the other departments it may be advisable to exclude those children who have never had measles, but information of this kind is difficult to get exactly, and such a step should rarely be necessary.

Epidemics of scarlet fever can usually be arrested by taking such steps as have already been outlined.

It should be particularly borne in mind that school closure is often reduced to a farce by the continuance of the Sunday school and week-day meetings in the building in question. No school should be closed under any circumstances unless its complete closure for the period named can be arranged.

DISINFECTION.

By the term disinfection is meant the total destruction of all bacterial life. Substances or processes that are capable of effecting this are called disinfectants. It is probable that upon no subject in connection with disease is there denser ignorance than upon that of disinfection. It is still common, for instance, to hear in popular lectures, and to read in the lay press, the ancient advice about having saucers, filled with substances of more or less value as disinfectants, placed about a sick room. It is difficult to imagine what useful purpose such a process could possibly fulfil unless these well-meaning people consider that the microbes or germs of disease are willing and anxious to take the necessary suicidal plunge. Surely it should be unnecessary to state that no room can be disinfected while human beings are in it. It is much easier to kill human beings than to exterminate the microbes scattered about a room. So long as the room is inhabited it is only possible to keep things as clean as possible and to flush the room with fresh air.

Another common error is to use the term disinfectant to broadly denote deodorants and antiseptics as well as true disinfectants and germicides. A deodorant such as eau de Cologne, camphor, tobacco smoke, eucalyptus, etc., merely masks a bad smell and has no action upon germs. The term antiseptic should be applied to those substances which prevent the development and multiplication of germs without destroying them, *e.g.* Condy's fluid, iodoform, common salt, boracic acid.

Disinfectants may be classified into liquids and gases. Among the liquids are carbolic acid, solution of corrosive sublimate, formalin, and many patent substances. Any of these may be used for disinfecting pencils, desks, slates, or the walls and floor of rooms. Gaseous disinfectants include chlorine, formaldehyd, sulphur dioxide, hot air, and steam. If a gaseous disinfectant is desired for school disinfection, the best is probably formaldehyd.

Room Disinfection.

The choice of a disinfectant for school purposes is difficult, and the selection of the most suitable method of disinfection is still more so. It is customary to point out that bacteriological experiments have shown sulphur dioxide gas to be practically useless as an actual disinfectant, but it must not be forgotten that not only does the clinging odour of such gaseous disinfectants compel thorough flushing of the premises with fresh air afterwards, but also impresses upon the public mind the fact that such processes are being carried out. The use of formaldehyd has much more justification, and has been found by the author to be an extremely active germicide when diffused with steam into the air by means of some such apparatus as Lingner's. For good results, however, it is necessary to use large quantities of formalin. Formaldehyd also has the advantage of a penetrating and clinging odour, necessitating flushing with air and scrubbing after its use.

The use of disinfectant sprays is probably the method of the future. The liquid used can be applied in a known dilution, and is accordingly more trustworthy than gases or vapours. For dirty surfaces the spray will usually have a higher capacity to penetrate the dirt than will any gas.

Schoolrooms should be regarded as places that are bound to become infected from time to time, and so it should become the universal practice to disinfect the surfaces of schoolrooms regularly as a routine process. This has been done for some time in America. A considerable decrease in infectious diseases, particularly scarlet fever, measles, infectious colds, etc., has followed the systematic disinfection of school books and school premises.

The insanitary condition of many of the non-provided schools is notorious. Such buildings are usually overworked, and there is no time for proper cleaning. Unless ample time for cleaning, disinfecting, and flushing with fresh air can be arranged, no premises should be allowed to be used as a school. Moreover the average public elementary school is not clean. While the buildings are new they look bright and fresh, but the condition of the majority of schools leaves a great deal to be desired.

For the periodic routine disinfection of floors the best plan is to run over the floor with a mop soaked in a disinfectant solution, and leave the floor thus well moistened until the following morning. Of course the disinfecting liquid must be of the necessary strength.

Associated with school disinfection is the dust problem. It is impossible to estimate how many children acquire some form of tuberculosis, especially consumption, from school dust. The author's experiments show an enormous difference in the number of organisms in the air when the floor is covered with dust-preventing preparations.

Pens, Pencils, Slates, etc.

These can be easily disinfected by soaking in disinfectant solutions. In most schools these articles are used in common, and must be carefully attended to. Modelling clay that may have been infected should be disinfected by heat and thrown away.

Books, Papers, etc.

When these may have been infected the best plan is to burn them. If this is objected to on the score of economy they may be suspended on lines across the room when the premises are being disinfected by formaldehyd. Or they may be placed on end, with open pages, in an air-tight receptacle, and subjected to the action of formaldehyd for twenty-four hours.

Probably no ordinary system in use gives really satisfactory bacteriological results, and it is quite possible that a good dusting and exposure to sunlight in the open air would be quite as reliable. Steam disinfection is impossible on account of its disastrous effects upon leather and also upon the glutinous material used in the binding. The only really satisfactory solution of the problem is the provision of separate books to be reserved for the use of individual scholars.

Dr. Kaye suggests as an alternative that each scholar on using a book should write his name and the date therein. "This would tend to impart an idea of the value of books and the care necessary in handling them. It would also enable the books recently used by a sick scholar to be discovered and destroyed; and it might furnish valuable clues in tracing the course of a disease."

Desks, etc.

If gaseous disinfection is used for the rooms the desks are left in during the process. Afterwards they must be thoroughly scrubbed with disinfectant soap and water. If a spray is used the desks must be sprayed thoroughly and then washed.

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