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THE ELEMENTS OF HYGIENE AND PUBLIC HEALTH

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ELEMENTS OF HYGIENE AND PUBLIC HEALTH

A TEXTBOOK FOR STUDENTS AND PRACTITIONERS OF MEDICINE

BY

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WITH 98 ILLUSTRATIONS

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PREFACE

The medical practitioner has a place so very definite in the public health scheme of disease prevention and health preservation that it has for long been a matter of wonder to me that greater efforts have not been made by teachers and writers to help him to fill that place.

It was because I had these feelings, and because I thought that possibly it might be of some assistance if a book designed particularly for his use, both in his student days and after he began practice were provided, that I accepted the invitation of the publishers to undertake the preparation of this volume.

Except that its plan differs to some extent from that generally adopted in other textbooks on public health, and the view-point is not quite the same as that taken by the authors of the majority of the well-known books on the subject, there is nothing particularly original in the contents of that now submitted.

That the information may be somewhat more up-to-date is merely accidental. That many of the illustrations are unfamiliar is due to the generosity of the publishers, who prefer to use fresh drawings rather than follow the fairly common practice of showing pictures appearing in other publications.

In the course of preparing the book I have consulted a large number of works on preventive medicine, hygiene, and public health, and wherever in these I have found information I desired to use I have taken it. If I here express my indebtedness to the authors as a whole it is only because it would have occupied too much space to mention them by name, and to give full references in the text.

As no textbook on public health could be written without reference to official publications, it is probably unnecessary to say that I have availed myself fully of the valuable information given in the reports of the Local Government Board and other Government departments; of the American and Colonial Boards of Health; and of Medical Officers of Health in this and other countries.

Several of my colleagues in the public health service have helped me with criticisms, suggestions, and illustrations, and I wish particularly to thank my friends, Dr. Angus of Leeds, Dr. Cates of St. Helens, Dr. Howarth of the City of London, and Dr. Orr of Ealing for their kindness in these connections.

CHARLES PORTER.

LONDON,
February 1917.

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THE ELEMENTS OF HYGIENE AND PUBLIC HEALTH

CHAPTER I

INTRODUCTORY

Relation of Hygiene to Medicine.—Hygiene is the science that deals with the preservation of health and prevention of disease. Being so, it is very closely related to, is indeed a branch of, the science of medicine. The fact that there is so close a relationship between hygiene and medicine, occasionally overlooked by practitioners of curative medicine, is always insisted upon by hygienists, who hold the view that unless colleagues engaged in the practice of other branches of medicine are willing to co-operate, works of hygiene designed to preserve health and prevent disease are unlikely to be successful.

Divisions of Hygiene.—There are two main divisions of hygiene, viz. Personal Hygiene and Public Hygiene, or, as it is more commonly called, Public Health. The former, broadly speaking, is the branch of hygiene in which the individual as an individual, as master of his own body and master of his own health, is dealt with. The science of personal hygiene, if it may be regarded as a separate science, attempts to discover and to teach how mastership of the body may be obtained and practised.

In Public Health the individual as a member of a group of individuals living what is practically an artificial life in a community is considered. The science endeavours to find how the unnatural conditions affect the health of the individual and how they may be treated, rendered if possible less unnatural, so that they shall exert a less or no deleterious influence upon health.

Apart from these, other divisions of hygiene, *e.g.* school hygiene, factory and workshop hygiene, military hygiene, tropical hygiene, are recognised. These divisions are more or less artificial and the titles have been coined for convenience, and with the intention of indicating that in the school and the factory, for instance, health is threatened by special conditions, and that special methods have to be or have been adopted for the prevention of damage by these conditions.

The Medical Curriculum and Hygiene.—Though hygiene is generally regarded as work for the specialist, commonly known as the Medical Officer of Health, in connection with *personal hygiene* particularly there is no one better fitted to spread the teachings of the science than the medical practitioner. The foundations of personal hygiene are those of curative medicine, viz. a practical knowledge of the structure of the human body and of the functions of its component parts and organs. Its teaching is how to regulate the organs so that they shall act normally and healthily, and be ready to resist influences from within or without the body that may tend to interfere with the normal activities.

For the person who has passed through the medical curriculum little extra study is required for the understanding of this teaching. Practically it only means learning how to apply the knowledge already acquired.

In respect of *public hygiene* again, though certain of the subjects may have to be more fully studied than would ordinarily be the case, the medical curriculum supplies much of the information required. Certain new subjects and sciences may and do call for attention, but to these the preliminary medical education serves as an admirable introduction.

The Subject-matter of Hygiene.—(*a*) *Diseases*, and the study of disease, of course form a very large part of hygiene. Mainly though not exclusively, however, diseases due to a specific cause, such as the infectious or communicable or possibly communicable diseases, and diseases of occupation, are considered. The viewpoint from which they are regarded is somewhat different from that in the case of general medicine, the research being mainly into etiology, causation, and mode of spread; any matter indeed that can be regarded as coming under the head of epidemiology. Possible methods of prevention are, of necessity, very carefully studied.

(*b*) *The natural requirements of the human being*, the air he breathes, the water he drinks, and the food he consumes, call for careful study also, since it is important to know how these essentials may be altered so as to give rise to injury to health, as well as the conditions to which they may give rise.

(*c*) A great deal of importance is attached to the study of *Statistics and Statistical methods.* It is held that it is only by an analysis of the figures relating to diseases, and the deaths due to certain diseases, that a proper appreciation of the necessity for the application of preventive methods can be reached and a true understanding of the effects produced by these methods arrived at.

(*d*) *Law* is a subject for constant study by the hygienist who works at the administrative side of hygiene, though the laws to be studied and enforced are of a special character and relate mainly to his own subject.

(*e*) Many of the other subjects calling for study are grouped under the title *Sanitary Science*, which is made up of pickings from a number of widely divergent scientific and professional fields of work. A knowledge of *geology*, for example, is helpful in connection with the choice of sites for houses and buildings and of water supplies suitable and safe for human consumption. *Chemistry* assists when questions relating to air, water, and food supply are under consideration, and it is useful to know something of *architecture* and *engineering* in relation to housing and the sanitation of houses.

The Medical Practitioner and Hygiene.—The field to be traversed, it will be noted, is very wide, and many subjects are included. Many as they are, however, they are not so numerous as to discourage those who look to the medical practitioner for assistance in applying their teaching in the interests of hygiene. Many of them fall within the medical curriculum; many of them are such as should be applied by the medical man in the exercise of his profession.

It is mainly these subjects that the hygienist desires to see applied, and it is asked of the medical practitioner that while thinking no less of the treatment of disease he will consider also the causation of disease and the influence of surroundings and external conditions on causation; will regard a diseased individual not entirely as a person to be rendered healthy, but to some extent as a being to be kept healthy.

Treatment of the Subject.—What follows is designed to help the medical practitioner to comply with this request. That a certain amount of knowledge is already possessed, with regard particularly to the more medical side of the various subjects considered, is presupposed. It is asked only that there be a recognition of the importance of this knowledge, and in dealing with personal hygiene it is indicated that this must be properly applied in relation to the influences capable of affecting the ordinary healthy physiological activity of the body.

Because the textbook is to be regarded more or less as a medical textbook, the purely medical side is, of necessity, considered, and necessarily the consideration of disease is early taken up. In considering this, as in the case of personal hygiene, the fact that the student is already possessed of some knowledge is taken into account, and a certain amount of detail is omitted. Chiefly, attention is concentrated on causation, the individual causes, and prevention.

Sanitary science is treated of in somewhat fuller detail, statistics and sanitary law more shortly, and with the object only of providing such knowledge as will enable the medical practitioner to perform his duty as part of the public health service.

CHAPTER II

PERSONAL HYGIENE

The health of the individual is very definitely something personal to himself, and almost inevitably the main part of the responsibility for safeguarding and maintaining it must be his.

Personal hygiene recognises this, and by laying down rules, sometimes called the *laws of health*, for the guidance of the individual with regard to living generally and all the intimate personal conditions that may affect life and health, endeavours to show him how to preserve the former and maintain the latter.

The Laws of Health.—*Eating.*—In the chapter on food some consideration is given to the subject of diet and dietaries, and reference is made to the importance of choosing and preparing foods properly. Here attention is directed to the necessity of bearing in mind the construction of the digestive system and the functions that each part, from the mouth downwards, is capable of performing: of remembering further that the organs entering into the composition of this system work best when they are worked regularly and methodically. The exact part played by each segment of this system should be remembered, and that the ultimate aim of digestion is to transform the food taken into substances fit for absorption by the tissues and of value to them in the performance of their functions.

It is probably unnecessary to state that the digestive or alimentary system includes the mouth and that digestion begins there with the breaking up of the food and its incorporation with certain fluids and ferments. When it is recognised that the more completely the food is broken up the more easily the stomach, intestines, and other portions of the system can do their work, insistence upon the importance of mastication and the thorough use of the teeth becomes unnecessary.

The *chewing* of every particle of food thirty-two times is commonly recommended, and the objectionableness of bolting unchewed morsels frequently pointed out. The strain of chewing is slight: the strain that is thrown on the more important organs of digestion as a result of its neglect may be serious.

That the organs and juices concerned with digestion have certain selective functions, that they can and will only act upon such materials as are to be of use to the tissues generally, rejecting everything else as waste, is a further point of importance. These waste materials may cause interference, and to obviate it they should be discharged from the digestive system at least once in the twenty-four hours, preferably in the morning.

Regularity in this connection is important, but in connection with the taking of food into the body it is also necessary. For the reason that the digestive system cannot be continually at work, and that periods of rest are essential, the *taking of food regularly*, at fixed times, is an important part of the hygiene of this system. Food should not be passed into the stomach more frequently than three or four times in the day. The morning meal, the midday meal, and the evening meal should be so arranged that there is an interval of at least three or four hours between them. This allows of a certain amount of rest for the stomach and other organs of digestion; and if they are habituated to such a periodicity of work and rest, their health will be maintained, and they in turn will assist in securing the maintenance of the health of the remainder of the body.

Drinking.—Water is the one fluid that can be taken with absolute impunity. Provided it is pure, it may be drunk without fear by any human being of any age, and does good by assisting the organs concerned with elimination and the discharge of waste products.

Water may be taken at any time, but it is particularly a good practice to begin and end the day with a draught of cold water, and while abstaining from drinking at meals to drink freely in the intervals between meals.

Water given to infants—who, it should be borne in mind, suffer from thirst as well as adults and require, and indeed often improve as a result of having, water to drink—should first be boiled and given warm and slightly sweetened.

Reference is made to alcohol, tea, coffee, and other beverages in discussing the question of diet. In the meantime it may be said with regard to those mentioned, but particularly alcohol, that the more sparingly they are taken the better, and that if they are used it should only be at mealtimes and by adults. For the young, they are both unnecessary and harmful. Of the conditions traceable to the use of alcohol in excess the best known are perhaps interference with the functions of the kidneys and liver. That metabolism is hindered and that it may injure the brain and nervous system is generally recognised.

Hygiene of the Mouth.—*Care of the Teeth.*—The chief matter calling for attention in regard to the teeth is *cleanliness.* Cleansing is necessary in order to remove the particles of food which, lodging about the teeth, are acted upon by bacteria, and undergo decomposition with the production of acids capable of leading to the disintegration of the tooth enamel. The cleansing also aids in the removal of the bacteria, not only those that act upon the food, but those much more important organisms that produce caries of the teeth.

These organisms are found chiefly in situations into which the tongue, nature's tooth cleanser, finds it difficult to make its way. It is mainly because of this that the toothpick, the toothbrush, and the silk thread are necessary as cleansers.

The toothpick should be used regularly after each meal, as indeed should also the toothbrush ; the silk thread should be used once or twice a week.

The best type of toothbrush is that in which the bristles are of medium hardness and not too long. They should be firmly fixed and arranged in ridges in order that the spaces between the teeth may be properly cleaned out when the brush is moved, as it ought to be, upwards and downwards as well as from side to side (fig. 1).

For a child a short brush is best. The toothbrush should occasionally be well washed with soap and water.

Tooth powders are used mainly for imparting a polish to the enamel, and should not be too coarse. Carbolic tooth powders containing too much of the acid, as the cheaper forms are apt to do, are to be avoided, since they may irritate the gums and cause bleeding.

Since even with the greatest amount of care and cleanliness caries is very apt to appear, the dentist should be visited from time to time and teeth found to be defective should be dealt with at once.

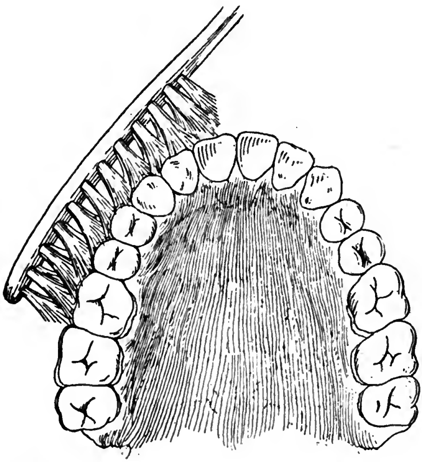

FIG. 1.—To show the advantage of a tooth-brush with ribbed bristles in connection with the cleansing of spaces between the teeth.

The *choice of food* has a very important relation to the preservation of the teeth. For the present marked tendency to caries amongst children the soft foods generally consumed are commonly blamed. That harder or rather tougher foods, foods that require chewing, not only clean the teeth, but strengthen them by exercising the jaw muscles, stimulating the gums, and increasing the flow of blood in these parts, should be impressed both upon children and adults. Soft or sweet foods are to be avoided, particularly just before retiring to rest.

Hygiene of the Skin.—*Cleanliness.*—That the chief functions of the skin are in connection with the regulation of body temperature and the excretion of waste products; that the former, and to some extent the latter, depend upon variations in the amount of heat radiation, in the amount of blood and size of the blood-vessels, and the activity of the sweat-glands and the secretion and excretion of perspiration, are facts that need only be mentioned. All these functions are better performed if the skin is kept clean.

Though, even at the present time, when the importance of hygiene is more widely grasped than ever before, the great bulk of the people limit their efforts at cleanliness to a washing of the face and hands and sometimes the neck, there is every necessity for giving attention to the whole body surface. Dirt of the skin, consisting of dust particles from the air, dead cells of the epidermis, dried products of perspiration, particles of clothing and organisms, all held together by the secretion of the sebaceous glands, is found all over the body. Because it constitutes a mechanical obstruction to the sweat-ducts and is otherwise objectionable and even dangerous, its removal by means of *soap* and *water* is called for.

In the preparation of soap, fatty matters and alkalis are mixed together, and as a result of the mixing saponification occurs. The fat is broken up into glycerine and fatty acids, and the alkali uniting with the acids, soap is formed. If the alkali used is potash, *soft soap* results: if soda, *hard soap*. Soap is soluble in water, and gives an alkaline mixture which, when applied to the skin, renders some of the oil in the dirt soluble, and by emulsifying some other part renders it more easy to be got rid of by means of the water.

For the solution of the soap and the removal of the emulsified and dissolved oil, *hot water* is to be preferred, and in the case of the exposed skin surfaces, the face and neck, should be used at least twice a day.

The hands should be washed at these times also, and, in addition, before meals and after exposure to contamination of any kind. For the removal of the dirt from the remainder of the body a *daily bath* with warm water is necessary. Cold water, if naturally soft, or softened by the addition of ammonia, may, however, be used by those who follow clean occupations and bathe regularly every day. *Warm baths* are best taken at night and the *cold bath* in the morning. The temperature of the water for the former should be between 94° and 104° F., and for the latter between 55° and 65° F. The chief advantage of the cold over the warm bath is that it is more stimulating to the skin, toning up the muscular walls of the blood-vessels and increasing the power of reacting to variations in the temperature. Only those who react to the cold water, and feel warm and comfortable after leaving the bath, should use it. For those who shiver and go blue, the cold bath is unsuitable, and should not be taken. The *hot bath* has a temperature of between 104° and 110° F. and should be taken at night. Water at this temperature more thoroughly cleanses than water at a lower temperature, and even those who bathe daily should take a hot bath occasionally. Those who do not bathe every day should have a hot bath once if not twice a week. *Russian* and *Turkish baths* encourage the activity of the skin and should be followed by a shampoo.

For infants and young children a daily warm bath at bedtime is essential, with occasionally a hot bath. The greatest care must be exercised in connection with the choice of soap and drying the skin, particularly at the flexures. Children should not have a cold bath before the fifth year, and then only in the summer and if they react properly. The cold bath all the year round should not be taken until after the age of ten.

The skin appendages, the *hair* and *nails*, especially in children, should receive attention no less than the skin itself. The extent to which girls in elementary schools in this country suffer from verminous heads suggests that their hair is not combed and brushed daily and washed weekly as it should be.

Clothing.—The amount of heat lost by radiation from the body surface depends chiefly upon the amount of skin exposed, upon the atmospheric temperature, upon the amount of moisture in the air, and upon the wind, and it is in order to reduce radiation that in cold and temperate climates clothing is worn.

Almost universally the *materials used for the purpose* are cotton, linen, wool, and silk. In choosing between these it is usual to consider (1) whether the material is a good or bad conductor of heat; (2) whether or not it retains odours and organic matter; (3) its absorptive power in relation to moisture; (4) its permeability to air.

So far as these points are concerned, *Cotton* is found to be a good conductor of heat, to be greedy of moisture, to retain odours strongly, though it does not to any extent attract or hold organic matter. It is fairly permeable to air. *Linen* resembles cotton, but does not absorb moisture so readily, and is a little less permeable. *Wool* is a bad conductor. It is greedy of moisture, and is permeable. It does not retain odours. *Silk*, like wool, is a bad conductor; it differs from it in absorbing less moisture.

In every respect wool is the best material, either for garments to be worn next the skin or for those for outward wear, especially in the colder climates. Silk, though expensive and not durable, is also suitable for under-garments. It is light and cleanly and a bad conductor of heat. Cotton and linen are less suitable for garments to be worn next the skin, because they absorb moisture and readily get wet. Being good conductors of heat the fluid evaporates rather quickly, and the body temperature is too rapidly reduced, chills in this way being produced. For underwear cotton is more used than linen, and has advantages, especially in the form of the so-called "cellular underwear." In this spaces are left between the strands of the cotton during manufacture, and radiation is discouraged, since the air imprisoned in the meshes is a bad conductor.

No matter what materials are chosen for *under-garments*,

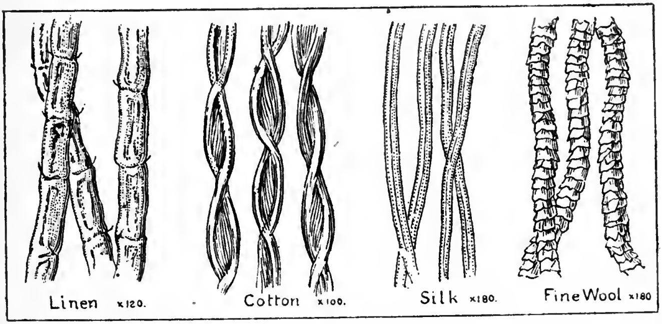

Fig. 2.—Microscopical appearance of certain fibres.

these should never fit the body too closely. Tight under or other clothing interferes with circulation, and limits the freedom of the movements of the muscles and limbs. *Woollen garments* are soft, warm, elastic, and permeable. They readily take up moisture, but as they do not readily part with it they require to be washed frequently.

The *outer garments* in cold and temperate climates are best made of wool. In connection with these articles the points to be borne in mind are *permeability* to moisture and their *behaviour in relation to heat*, since variations in weather conditions have frequently to be encountered. Though it is advisable to make garments of material impermeable to moisture, however, it is undesirable to interfere with the permeability to air, since the layer of air next the skin must be changed frequently. *Waterproof clothing* is unsatisfactory and uncomfortable, because it is impermeable to air as well as moisture. The so-called "rainproof" cloths are rather better, since the salts with which they are treated to make them rainproof do not interfere with the passage of air.

The question of *colour of outer garments* comes in particularly in regard to heat absorption. White and light-coloured garments absorb much less heat than those of a darker colour, and display less affinity for organic matter and germs. It is because of their behaviour towards heat that white and light-coloured materials are worn in warm climates and in summer, and dark-coloured in winter.

Outer, like under garments, particularly those for children, should not fit the body too closely. The *garments of an infant* should fit loosely, and those placed next the skin should be bad conductors of heat. All should be light and easily removable.

In young children the chief desiderata are that the garments should be warm and easy fitting. The practice of leaving a large part of the legs and arms uncovered is bad because of the risks of chilling from excessive heat radiation.

Over clothing which is so frequently found amongst the poorer classes, and particularly with girls and children who are weakly, is no less objectionable than this form of *under* clothing. In this country a multiplicity of garments under or over is really not called for. A suit of woollen underclothing, covering the whole body, but not too tightly, and varying in thickness with the season, and a suit of outer garments, are all that is necessary. In the colder months, if too much heat is lost, additional outer garments may be worn. Chest protectors and mufflers are to be avoided.

The clothing of girls is in general too complicated, and over clothing and tight lacing are too common. The wearing of woollen garments next the skin and of making the shoulders, rather than the waist and hips, the main supporters of the outer garments are, on the other hand, not common enough. The importance of these two last considerations cannot too strongly be insisted upon.

Boots and Shoes.—Except in very wet weather the shoe is preferable to the boot, since it gives greater freedom to the ankle. Whichever is worn, it should be light, strong, and flexible, and adapted to the natural outline of the foot.

Many common malformations of the foot are traceable to badly fitting boots, and particularly in the case of children the choice of footwear is a matter to which careful attention should be given.

Exercise.—In connection with exercise the chief organ to be considered is the heart, and the main thing that must be seen to is that the exercising is not overdone.

The need for exercise is felt chiefly in childhood, when growth and development are going on. These processes are, of course, encouraged by increased activity of the heart and more rapid circulation of the blood, with consequent increased carriage of food to the various tissues, increased consumption or burning up of food in the muscles, and increased demand for food by improvement in the appetite.

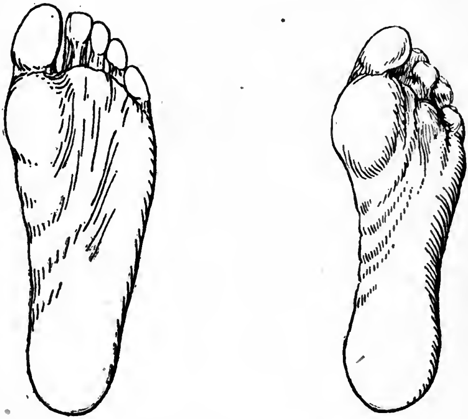

Fig. 3.—Showing the normal foot and the foot deformed by the use of improper boots or shoes.

Increase in the rate of respiration leads to a greater intake of oxygen; and increased elimination of water and waste materials through the skin leads to a demand for more water.

In exercise such as the child takes, little strain, if any, is thrown on the heart, and the increase in the size of the organ which results is of value because it leads to improved circulation and nourishment.

In the adult the increase in the rapidity of the heart's beat, the freer and more rapid flow of blood, the increase in burning up of foods and in elimination which result from exercise play a part in leading to the production of what is known as "fitness."

The great thing is to choose the exercise carefully and to know when to stop. The *best exercise* is that in which the whole body is fully catered for, which is not too strenuous, and which is suited to the age and constitution of the individual.

The fault of so many of the athletic games and pastimes to which persons resort for the sake of exercise and amusement is that they make a call upon one set of muscles or one part of the body only. Cycling, rowing, hammer throwing, weight lifting and throwing are all examples of exercises in which there is specialisation.

In all of them, if indulged in to excess, in addition to the strain thrown upon the special muscles, there is strain thrown too on the heart, with hypertrophy of the muscle of that organ as a result. Over-indulgence in any of these exercises is bad at any age; in early youth and during and after middle age it is particularly bad.

It is not only those games that call into activity special groups of muscles that lead to hypertrophy of the heart: over-athleticism of any kind is capable of bringing it about. For the person to whom exercise is merely part of the scheme for the maintenance of health, the less strenuous it is, the more regularly it is taken, and the more uniformly it affects the whole body the better.

It is the game with too much spurting in it, that is indulged in hard by fits and starts, without proper light and continuous training, which does harm. The person who walks regularly, or swims regularly, and plays an occasional game of golf is doing himself more permanent good than he who plays football or lawn tennis hard now and then and slacks between whiles. Probably also he is benefiting more at the time and even in the long run than the person who plays hard all the time.

Because it is taken in the open air, *walking* is the finest health exercise of all, but any open-air exercise is to be preferred to one taken indoors.

Fatigue.—No matter how the exercise is taken, it should always be stopped before *fatigue* is experienced. Nothing is gained by fatiguing the body, and more good is obtained from just enough than from too much.

That the feeling of fatigue is to a great extent a species of auto-intoxication and produced by the formation of waste products resulting from muscular metabolism is nowadays well known; unfortunately, however, it is too frequently forgotten.

Bathing and rubbing after exercise to some extent mitigates these effects and they should not be omitted. The great thing, however, is to avoid exercising up to the point where fatigue is experienced. It is important, too, to have in mind the necessity for *rest* after exercise. But rest is not only necessary for the muscles, and fatigue is not always merely muscular fatigue. *Nervous fatigue* also occurs, and over-exercise of the brain and nervous system and overstrain of the functions performed by them are to be avoided. In the interests of health they should not be worked to the point of fatigue any more than the muscles should, and they should be rested also.

It is true that this may be brought about by throwing into activity some other system such as the muscular system, but it is not always the case that rest of the brain accompanies transference of activity to the muscles.

Quietness of the whole body and abstinence from all activity often does more good, and while the brain worker does well usually to drop his books and his thinking for a time, and devote his attention to the movement of his limbs and muscles, there are many occasions on which it would be better for him to abstain from both forms of activity and rest completely.

Sleep.—Absolute and complete rest is only obtained during sleep. In this the muscular system of course participates. The muscles, in fact, are the parts of the body first to fall asleep, but it is the brain and nervous system that chiefly benefit. Not only are the brain cells and centres relieved from the necessity of reacting to stimuli conveyed to them by the nerves, but the heart beating more slowly and the blood-vessels being diminished somewhat in size, the rate of blood-flow and the quantity of blood are both diminished. In this way the cells and centres are subjected to less stimulation also.

Both for adults and children the time to be allowed for sleep in proportion to the work done is of the utmost importance. No rigid rules can be laid down as to the number of hours of sleep necessary for various types of persons. Some people require more sleep than others, and children certainly require more than adults generally. The infant should spend most of its time in sleep; the child of four at least half its time. The child of seven should have at least eleven hours; the child of nine, ten hours or more. From the twelfth to the fourteenth year nine or ten hours may be sufficient. In adult life, at least eight or nine hours should be spent in sleep. Most people require more sleep in winter than in summer. The best kind of sleep is obtained in the first few hours after going to bed. Children, especially, should retire early to bed; and since the brain benefits from regularity in work and rest, the habit of going early should be forced upon children.

A certain amount of *preparation for sleep* is necessary. Neither work nor play should be continued up to the last moment before going to bed. The taking of food within two or three hours of retiring to rest is also bad, since, though digestion and absorption go on actively in the intestine during sleep, in the stomach the process of digestion is practically suspended.

The *hygiene of the bedroom* is a matter of some importance and will be more fully considered later. In the meantime it may be mentioned that good, pure air is as necessary for the brain during sleep as during activity. The bedroom should be airy and should be well ventilated. The body will not suffer if it is well and properly clothed. If contaminated or bad air is breathed during sleep, assimilation being active during sleep and resistance to some extent lowered, effects more serious than those produced by breathing such air during the waking hours may result. The sleep is likely to be disturbed, and to the poisonous effects will be added those produced by insufficient sleep.

The *signs of insufficient sleep* are mainly mental, but largely also physical. They are most marked in the case of the child, and children who habitually get too little sleep are anæmic, languid, dull, drowsy, and stupid-looking. The appetite is poor, the growth is stunted. The face is pale; the eyelids are heavy; the eyes sunken and dark-ringed. The children are disinclined for muscular activity and are incapable of learning. A diminution in the amount of study or increase in the amount of recreation and of sleep will often work wonders in such cases.

The Hygiene of Infancy.—At no period of life is there more need for the practice of the laws of personal hygiene than in infancy. At no period is greater benefit likely to be obtained from the application of these laws.

The penalty of neglect is either death or continued ill-health throughout life.

Up till a comparatively short time ago the importance of properly taking care of the baby's health was not generally recognised. Three sets of people, mothers, doctors, and nurses, were supposed to know all about it, and it was left to them.

The mother was supposed to know by instinct what were the right things to do; the doctor was supposed to have learned all about babies during his course of study, and the nurse was supposed to have obtained instruction from the doctor.

All these suppositions were erroneous. A woman does not necessarily, simply because she bears a child, know everything about it; as a fact, the vast majority of mothers, young as well as old, unless specially taught, know little of the subject.

In the medical curriculum instruction with regard to babies found no place. Even now it is only exceptionally that the medical student is taught anything whatever with regard to infant feeding and infant hygiene generally. Naturally if he was taught nothing, the nurse also was taught nothing.

The effects of this ignorance were felt entirely by the baby. The extent of the effect was measured by what is known as the *Infantile Mortality Rate*, which in any one year is the number of deaths of infants under one year of age per 1,000 births during that year.

In England and Wales in 1901 this rate was 151; and in 1912, 95. In 1901, 151 babies out of every 1,000 died, and a number which it is impossible to estimate were temporarily or permanently injured mainly because of ignorance: ignorance of the mother, ignorance of the doctor, and ignorance of the nurse. In 1912 there was a reduction of the rate to 95, because a section of the medical profession and the public awoke to the fact that mothers as a rule, and particularly young mothers amongst the less-favoured classes, were without knowledge of feeding methods, and of such elementary matters as the importance of cleanliness, of proper clothing, of fresh air, and such-like for infants.

Following the recognition of the existence of the ignorance came the attempt to remove it. Every one who was capable of teaching the mothers was set to work; people who were considered capable of learning and afterwards teaching were made to undergo training; the authorities charged with the care of public health were convinced that it was their responsibility to see that the ignorance was dispelled, and advised that the best way to meet it was by employing persons to get into touch with the mothers and to teach them.

In the interval between 1901 and 1912 the work done reduced the infantile mortality rate from 151 to 95 per 1,000 births, but greater improvement must be made. Very little of the infantile mortality is "essentially inevitable." Most of it is to be avoided by the spread of knowledge and the dispelling of ignorance. To this end in most districts *leaflets of advice* are distributed and explained to women in their

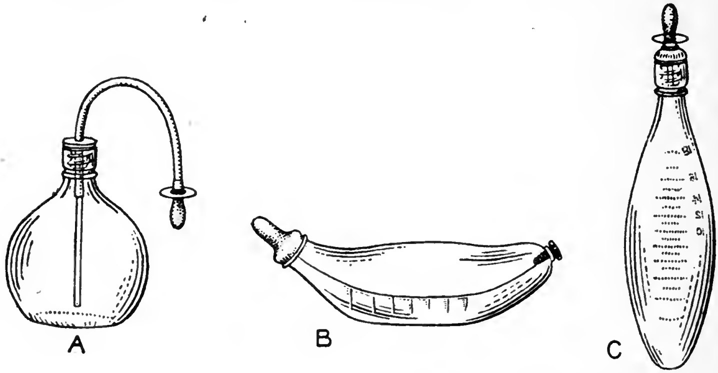

FIG. 4.—Types of Feeding Bottle: A, the "Tube Bottle," is difficult to clean and is always condemned in favour of B or C, which are good type bottles.

own homes by Health Visitors and also at institutions known as "Schools of Mothercraft" and "Infant Consultations," to which mothers come, usually with their babies, and receive instruction and are given demonstrations on infant care and rearing and allied subjects by teachers qualified medically or otherwise to teach. The consultations are always under medical supervision, and at them the babies are weighed and their mothers advised fully as to feeding and so on.

In a textbook of this kind it is impossible to enter at any great length into a consideration of the subjects which may be regarded as forming part of the larger subject of infant hygiene. It is undoubtedly a medical practitioner's subject, and one that should be taught to medical students.

The old idea that the doctor has nothing more to do with the baby after it is born, unless it should fall ill, is wrong. He should not rest satisfied with advising what is to be done with the mother: he should be in a position to advise, and should advise, with regard to the baby also, how it should be fed and cared for, so that it shall be contented and happy and healthy and protected from diseases and conditions due to want of cleanliness and neglect.

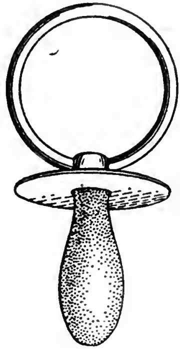

FIG. 5.—The Dummy Teat. This is condemned as it is liable to carry bacteria and to produce adenoids and deformities of the upper jaw.

Ante-natal Hygiene.—So much of infantile mortality is found to be due to conditions arising before or at birth, *e.g.* congenital syphilis, prematurity, deformities, injuries at birth, marasmus, inanition, and so on, that it is clear that more attention should be given to the *hygiene of pregnancy* and of the unborn child than has been the case in the past.

If the mother could be properly cared for and advised during the late months of pregnancy, placed more or less under medical supervision, and shown how she should order her life during this particular period, there would probably be a reduction in the number of premature births and both mothers and infants would benefit. Probably, also, if greater care were exercised during the puerperium; if working-class women were not compelled to hasten back to work either in the house or in the factory, there would be some reduction. Certainly the health of the woman would benefit, and clearly the health of the mother is no less important than that of the child.

Such measures as are suggested above would probably exercise a beneficial influence on infants. The baby who dies in the early days of life of *marasmus* or *inanition* is very commonly a puny infant when born. By caring for the mother many of these cases might be prevented. *Ante-natal deformities* might also, to some extent, be prevented by care during pregnancy. For the prevention of *injuries at birth* attention at the time of confinement is necessary. Fairly generally and wisely the *eyes* of newly born babies are attended to nowadays, and probably many cases of *ophthalmia neonatorum* and blindness are prevented in this way.

For the prevention of *congenital syphilis*, which, if it does not cause death, certainly leads to enfeeblement of health, and not infrequently to serious nervous disorders, no proper means are available at present. Practically the syphilitic should be prohibited from having children, even from marrying, until a medical certificate stating that it is safe to do so has been obtained.

So far as the medical profession is concerned it is almost universally agreed that preventive measures in respect of syphilis and other venereal diseases are necessary. Education respecting the nature, consequences, etc., of these diseases is considered to be eminently desirable, and doubtless would be advantageous if combined with more active preventive measures.

Heredity and Eugenics.—In considering the question of personal hygiene it is necessary that reference should be made to the subject of heredity and eugenics. If it is the case that disease and a tendency to ill-health can be inherited, then the possibility of the inheritance of health and a tendency to good health must be admitted.

That disease in the shape of syphilis can be inherited has already been pointed out. That many other equally definite conditions come from inheritance also there can be no doubt.

As to the inheritance of a tendency to ill-health or to certain diseases there are grounds for difference of opinion. In relation to tuberculosis, for example, the common view is that the part played by inheritance is the endowing of the offspring with a tendency to the disease in the shape of a weakened resistance. From this very moderate view there are some who dissent, alleging that tuberculosis is acquired quite independently of tendency; that the offspring of the consumptive is not of necessity more liable to the infection than any other individual. Statistics supporting either of these theories are readily obtainable, but the former is the view generally accepted.

Practically, however, the important thing to remember is—and this is the aim of hygiene—that there is a possibility of preventing infection; and if in the case of the offspring of tuberculous parents special precautions are taken, nothing will be lost. That there is inherited a tendency or predisposition to such diseases as gout, rheumatism, insanity, cancer, and a number of others is admitted.

The possibility of the inheritance of the *alcoholic tendency* or of the weakness of will power that permits of the indulgence in alcohol is also recognised. The giving of attention to hygiene and the laws of personal hygiene undoubtedly results in a weakening and even the overcoming of any tendency, that to alcoholism as well as the others. It is imperative, therefore, that the individual with an inherited alcoholic tendency should, by obeying these laws, keeping himself fit and living a healthy life, strengthen his resistance and counteract his hereditary weakness.

Though much is said as to the possibility of overcoming inherited diseases and tendencies by care and attention to hygiene, in the view of the eugenist the results likely to be obtained by these methods are far from satisfactory. They are not thorough enough and come into operation too late.

The object should be to ensure that *only* health and a tendency to health are inherited, and that the aims of eugenics, the only aims worthy of attention, are carried out, viz. "to increase the probability of the men of the future being hereditarily endowed with noble qualities."

In addition to being endowed with such qualities the men will be endowed with good health and resistance to disease, and will be free from hereditary diseases or taints of any kind. In order to obtain offspring so endowed the eugenist urges that parents should be selected. Only the fit should marry. Marriage should be a union of noble qualities and of health.

By means of statistics it is possible to prove that the result of such a union would be offspring endowed with qualities similar or even in some instances superior to those possessed by the parents.

Amongst the qualities inherited it is probably hoped there would be immunity, complete or partial, to certain diseases. With regard to this, however, it may be stated that, so far as the infectious diseases are concerned, the amount of immunity inherited, if any, is small. Immunity acquired, *e.g.* by means of vaccination or an attack of the disease, is generally recognised as being non-transmissible. To say that natural immunity is transferable is exceedingly difficult. In any case it is doubtful if it could be depended upon to any extent and to the exclusion of other methods of prevention of spread of infectious disease and protection of the individual therefrom.

This remark is made, since it would almost seem that the eugenists believe that if their system were generally adopted there would be no further necessity for the practice of any form of hygiene either personal or public.

That there is much in the views of those who urge so strongly the claims of eugenics cannot be doubted, but the feeling that there is a tendency on their part to claim too much cannot be avoided. Admitting, however, that they are justified and that, by proper selection and mating, offspring in every respect practically perfect will be obtained, the difficulty that appears is as to how it is to be brought about.

One tendency of the individual, in this country at least, which must be eliminated first is that of choosing his or her own mate. That, it would seem, is the first tendency to be dealt with, and it is a problem of some magnitude. In isolated instances the eugenists and others may induce the proper type of individuals to marry, but it will only be in isolated instances, so isolated that they cannot be regarded as much more than experiments.

That the generality of persons, even if compelled, would mate or refuse to mate at the dictates of some person or body of persons is unbelievable. Even a rule that no one should marry without a medical certificate of health and freedom from disease, desirable as it undoubtedly is, has not, where it has been tried, been conspicuously successful.

With regard to it, indeed, it is alleged that it has operated in restraint of marriage, and in these days, when marriage is commonly either postponed till adult life is fairly well advanced or is avoided completely, this is a serious matter.

One great advantage of the making of the provision undoubtedly has been in drawing attention to the importance of health of the contracting parties in relation to marriage. A very great deal of educating will have to be done before this lesson is driven home, and a very great deal more before the claims of eugenics are thoroughly grasped. Till then, and perhaps even after the rule of eugenics is established, care of the body and of health both from the private and public point of view will have to be practised with the object of preserving those "hereditarily endowed with noble qualities" to perpetuate the breed of men and women so endowed.

Sex Hygiene.—This has already been mentioned and an indication given that it will be found more fully dealt with in the section relating to syphilis and the venereal diseases.

CHAPTER III

PUBLIC HEALTH AND DISEASE

Origin and Spread of Infectious Diseases

Of the diseases to which public health is expected to give attention, the most important are those which, because they have as a characteristic that they may be acquired from persons suffering from them, are known as *communicable or infectious.*

Nature and Origin of Infection.—All of them are considered to be due to a specific organism, in some cases definitely recognised, in others not. In relation to the spread of infection with these organisms it is believed to be essential that they should come directly or indirectly from some body, either that of a human being or in some instances of an animal suffering from the disease.

In other words, the belief is that *there cannot be a case of infectious disease without a pre-existing case of the same disease, no matter how remote.* Nowadays there is no belief in the possibility of diseases arising *de novo.*

Whether they occur *sporadically* as isolated cases, or as *pandemics*, affecting large numbers amongst separate populations in one or more countries; or as *epidemics*, affecting a number of persons in a population within a limited period; or are *endemic*, and are more or less constantly present in one particular area, the view held is always the same: the infection came from a pre-existing case.

The number of isolated cases and even of epidemics which it is found impossible to trace back to the point at which infection occurred is exceedingly large. This is not because there has been no source of infection, but rather because the knowledge of the behaviour of organisms is still incomplete and the methods of investigation still too imperfect to carry the investigator right back to the original case of the infection, to the spot where the causative organism lay hidden, or to enable him to recognise the change in conditions that caused it to renew its activities and to discover the manner in which it is spread.

Organisms may be able to lie dormant and to pass into an inactive phase; they may require special circumstances or conditions to reawaken them, may require special vehicles for their carriage. All these are probabilities, even certainties, just as it appears to be an equal certainty that they cannot originate *de novo*.

For practical purposes the *pre-existing case* is the important factor. The individual or, in the case of such diseases as are transmissible from animals to man, the animal already infected is the source of infection. From the preventive point of view this is important; more important still, however, is the *mode of the spread* of infection from the original source.

Spread of Infection.—To a considerable extent the mode differs in different diseases. Normally, however, what seems to happen is that the infected person gives off the infection, *i.e.* the germs of the disease, in the breath and the discharges from the body, and the uninfected person takes such infection into his body either as a result of coming in contact with the infected person or the discharges, or by inhaling air or swallowing material contaminated with the infection.

The *breath* or expired air is generally believed to be capable of carrying infection. The risks of germs being given off in this way are naturally very much increased if the air is forcibly expelled, *e.g.* in talking, shouting, coughing, and sneezing.

Diseases in which there is affection of the throat and air passages—scarlet fever, diphtheria, pneumonia, measles, and whooping cough—are amongst the conditions in which infection is commonly spread by the breath.

Discharges from the body, both normal and abnormal, are capable of carrying infection. *Normal secretions* frequently responsible are *mucus* from the mouth and throat (scarlet fever and diphtheria); *saliva* (mumps and rabies); and *sputum* (tuberculosis, pneumonia, and other lung conditions). *Milk*, that of the cow certainly, is capable of conveying the infection of tuberculosis. *Fæces and urine* are both liable to convey infection, in the case of enteric fever, cholera, and epidemic diarrhœa. *Abnormal discharges* in certain diseases, *e.g.* in syphilis, gonorrhœa, ophthalmia, puerperal fever, may all give rise to infection.

Exhalations from the skin are sometimes considered to be responsible for carrying infection in such a disease as typhus fever; it is more likely, however, that the carrying in this disease is done by a biting insect, viz. the louse. Amongst the host of other *insects* which are known or supposed to act as carriers of infection may be mentioned, mosquitoes (malaria and yellow fever), fleas (plague), and biting flies (sleeping sickness).

Carriers of Infection.—The question of carriage of infection raised by this mention of insects in relation to disease is exceedingly important.

During the last few years, knowledge with regard to the subject has markedly increased. Originally to account for cases which could not definitely be shown to be due to contact, particularly in diseases, such as enteric fever, which were believed never to be spread in this way, it was the custom to throw the responsibility upon *air*, or *water*, or *food*.

These, in fact, were regarded as the three main carrying agencies, and diseases were generally stated to be capable of transmission by one or another, or sometimes by more than one of them, and to be taken into the body by inhalation or ingestion.

Nowadays, however, there is very much less belief in air-borne infection, and though epidemics of many diseases are still quite frequently traced to water supplies and articles of diet, there is a distinct tendency to think of the possibility of an *animate*, or living, rather than an *inanimate carrier* in relation to outbreaks as well as sporadic cases of infectious disease.

Living Carriers.—Human beings and even animals may act as carriers when actually suffering from the disease in a mild, unrecognised form, or after apparent recovery. Further, they may act as mere *intermediaries* carrying the infection of a disease from which they themselves are not suffering, and have not suffered. Very commonly the name "carrier," as in the case of enteric fever, is limited to the person who has suffered and apparently recovered from the disease, but still harbours and from time to time excretes the organism.

The *mild unrecognised case* is believed to be intimately associated with the occurrence of outbreaks of such diseases as scarlet fever and diphtheria. It is in relation to diphtheria mainly, indeed, that the carrier who is not himself the subject of the disease is believed to act, and many instances are recorded of the discovery of the *B. diphtheriæ* in the throat and nose of perfectly normal, healthy persons. Such carriers as these are naturally important, but great importance is attached also to the *insect type of living carrier.*

Possibly the discovery of the relation of the mosquito to the spread of malaria first directed attention to this matter. Certainly since then insects have been very much under suspicion, and in addition to a host of tropical diseases several of the diseases more commonly found, in this and other countries in the temperate zone, are believed to have insect carriers associated with them. The spread of typhus fever and relapsing fever, for example, is alleged to be brought about by the louse, and the germs of enteric fever and possibly also epidemic diarrhœa are continually stated to be carried by the *Musca domestica*, the ordinary house-fly. In this case, the part played by the insect is merely a *mechanical* one : it acts, that is to say, merely as a porter.

In other cases, the rôle of the insect is more important, since the parasite actually passes through a phase of its life-cycle in the insect, and is not transferred to its new host until it has completed part of its life-history therein. The transmission here is said to be *biological*, and the organisms which require the services of an insect as an intermediate host are usually animal parasites. The vegetable parasites being much less complex organisms do not probably require anything more than a mere vehicle for their transportation. That insects act as porters is accidental and due to the fact that they occur so numerously and have so many opportunities of coming in contact with infected materials and with individuals both infected and healthy.

Probably the best example of the insect which acts as an intermediate host for a parasite is the anopheles mosquito associated with malaria, and the following facts with regard to this and other insects may be noted.

Mosquitoes.—The mosquitoes are true insects, and belong to the order Diptera, being two-winged. They make up the family of Culicidæ, which is further divided into two sub-families, the Anophelines and the Culicines.

To the former belongs the anopheles already referred to as the intermediary in the case of malaria, and to the latter the species carrying yellow fever (*Stegomyia*), as well as that carrying the parasite of filariasis—a culex.

Unless very closely examined all mosquitoes appear very much alike; those mentioned, however, have certain characteristics that help to distinguish them from one another. Not only so, but in the adult form the two sexes present certain differences, particularly as regards the appearances of the head; and since it is only the female which acts as a disease carrier, she being a blood-sucker whereas the male is entirely vegetarian, it is important to note these differences.

In the case of the anopheles one of the characteristics is that the palpi are of the same length as the proboscis; in the male, however, they are somewhat thicker at the end and are generally more bulbous than in the female, which also has less luxuriant whiskers or plumes.

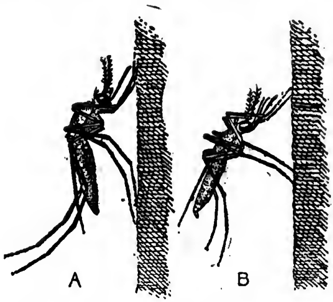

Fig. 6.—To show resting position of Culex (A) and Anopheles (B).

The culex male carries palpi that are longer than the proboscis and are feathered, the palpi of the female being very short. The anopheles and the culex may to some extent be distinguished by the differences in the length of the palpi. The wings also differ, those of the anopheles being variously marked, spotted, or barred, while those of the culex are clear and usually without spots. Further, the culex presents a humpbacked appearance, whereas the anopheles is straight; and in resting on a wall the anopheles usually forms an angle between its body and the vertical, the head pointing inwards, while the culex tends to rest its body parallel with the wall.

Mosquitoes, though mainly found in warm climates, are occasionally to be met with in these islands and most commonly in the south. Having regard to the fact that the eggs of mosquitoes are deposited in water and that they are to some extent aquatic as well as aerial, it will be readily understood that they prefer neighbourhoods where stagnant water is commonly found. They are not, however, too particular in their choice, and the female will use any collection of water, whether it is in a gully or a cart track, a waterbutt or a cesspool. In warm countries, indeed, the greatest care must always be exercised in connection with the covering up of stagnant waters.

Except in the case of the stegomyia, which carries yellow fever, the chief resting period of mosquitoes is during the day. They usually hibernate during the cold wet seasons, concealing themselves in dark places till the warmer weather comes.

The distance covered by these insects is very small, and all betray a marked tendency to remain in the neighbourhood in which they were born. They may, of course, be transported by the wind or by means of vehicles, such as trains or ships, as in the case of the stegomyia of yellow fever. The eggs are very resistant, and can hatch out even after having been dried for some time.

Mosquito Prevention.—The methods to be adopted in connection with the destruction of mosquitoes are based upon the knowledge possessed with regard to their habits and life-history.

Amongst the earliest steps to be recommended are those directed to the destruction of breeding-places. In marshy districts great diminution in the number of the insects has followed *drainage* of the land. Drainage of stagnant pools and cleansing, filling in, or covering over of open ditches have had a similar effect. *Wells* particularly should be covered, and improperly covered cesspools should also be attended to.

Fountains, ornamental waters, and expanses of water that cannot be drained may be stocked with fish—goldfish, for example, or, as in Barbados, the " millions " which have a liking for the larvæ.

If drainage, filling in, or covering is impossible, the surface of the water may be treated with kerosene or other oil. This proves effective because it floats on the surface and cuts off the air supply of the larvæ. The oiling must be properly carried out and the thin layer applied must cover the whole surface of the water. It is usual to repeat the process at intervals of not less than one week.

The adult mosquito may to some extent be destroyed in houses by means of *fumigants* such as sulphur, burning 2½ lb. to the 1,000 cubic feet, though this is likely to produce less permanent good than the methods for dealing with the places in which the breeding of the pests takes place.

Midges.—Midges, which in many respects resemble mosquitoes, have been mentioned in connection with *pellagra* and other diseases. Since the majority lay their eggs in water and pass through the same stages as the mosquito, similar precautions may be taken against them.

Flies.—Flies, so far as disease-carrying is concerned, may be considered as divided into two groups, *biting or blood-sucking flies*, and *non-biting flies*.

Of the blood-suckers, probably the *tsetse fly* (*Glossina palpalis*), which is so closely associated with the spread of sleeping sickness, is the most important; but the *stable fly* (*Stomoxys calcitrans*), which occasionally bites human beings, is regarded, particularly in America, as playing a considerable part in the transmission of polio-myelitis, anthrax, etc.

The tsetse is found only in Africa, affecting certain areas and forming there what are known as "fly belts." It is a greyish-brown fly about the size of the ordinary house-fly, exceedingly vivacious and very persistent in its attacks on men and on cattle. Both the male and the female bite, and the former is to be distinguished by the presence beneath the end of the abdomen of a distinct protuberance formed by the external genitalia. The proboscis in both sexes is long, and the wings when at rest overlap one another across the back.

Most commonly the tsetse is found haunting the banks of rivers, lakes, and pools, biting only in the daytime. Large areas have been cleared of human beings by this insect, and rendered quite uninhabitable. In relation to sleeping sickness it probably acts mainly as a mechanical carrier, withdrawing the *trypanosome*, the organism of the disease, along with the blood from an infected person and inoculating it, unchanged, into the individual next attacked.

Attempts at extermination have not met with any great amount of success. Apparently the female carries her eggs with her, dropping the young only when the larval stage has been reached. For the development of the larvæ moisture is necessary, and this they obtain by burrowing into the damp soil upon which they drop and where they develop into the adult fly. As a means of getting rid of the tsetse, removal of vegetation, in order to allow of access of the sun and drying of the ground has been tried with some success.

Since the fly requires a supply of blood every two or three days, it is suggested that by removing crocodiles, and other large vertebrates from which this can be obtained, from any district destruction might be brought about. The segregation of all individuals suffering from trypanosome infection has also been suggested.

The *Stomoxys calcitrans* (stable-fly), except that the proboscis is longer and sharper, resembles the house-fly very closely. It feeds exclusively on mammalian blood. Its eggs, which it lays in horse manure, cow dung, and collections of moist fermenting materials, generally develop more slowly than those of the house-fly, a period of something like a month being necessary for the completion of its life-cycle.

The House-Fly.—Of the *non-biting flies* the *Musca domestica*, the common house-fly, is the most important. It is found practically universally from the sub-polar to the tropical regions.

Its association with disease is very strongly insisted upon, and so firm is the belief that it is one of the chief carriers of enteric fever that the suggestion has been offered that it should be named the *typhoid fly* rather than "house-fly."

Since the earlier stages in its development are passed in filth, and the adult is attracted by and haunts excremental material, it is certainly possible that it may be a carrier, if not the main carrier, in some outbreaks.

It is not, however, entirely because of its relation to enteric fever that it is regarded as important from a public-health point of view. It is because the presence of flies indicates the existence of filth; because they develop so rapidly and are so numerous; and, foul as they are, come so closely in contact with man and his food, that their destruction is called for. As in the case of the mosquito, methods of extermination are based upon a knowledge of the life-history and habits of the insect.

The *adult fly* is greyish in colour and from 5 to 7 millimetres long. It has a very mobile head, the upper part and sides of which have a number of compound eyes; and a proboscis through which it sucks up its food. The wings are clear and transparent and the legs blackish brown and hairy. The female particularly does not tend to wander far from the neighbourhood in which she lives, and the male even, unless carried by the wind or provided with some sort of vehicle, does not fly either high or wide. The male being the wanderer, it is he who picks up germs from the filth and excrement in which he is bred and on which he feeds, to carry

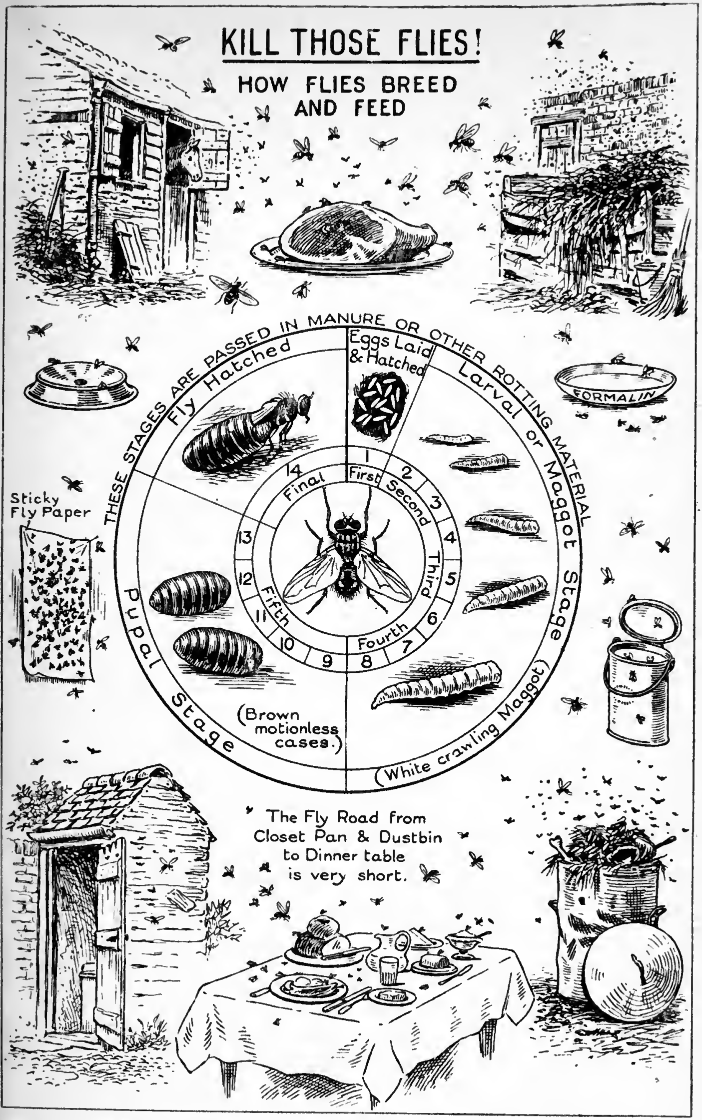

FIG. 7.—Posters similar to this and showing the breeding-places of the fly, the stages in its development, and the manner in which it may spread disease are widely used by health authorities in this and other countries.

them on his feet and in and on his body to articles of human food in the larder or on the table.

In this country the breeding season of the fly is almost entirely limited to the warm weather, and during the summer months there may be as many as four layings by the same fly. The eggs, which are oval in shape and about one millimetre in length, are laid in clusters of about 150 to 200 in manure or other material containing moisture and organic matter. In temperate climates the period taken for the formation of a fly, from the time the egg is laid, is from ten days to a fortnight, hatching occupying about twelve hours and the intermediate stages, larval and pupal, each about a week. The fly, it may be noted, is full grown when it leaves the pupal case, and what are commonly called "young flies" really belong to another variety.

Food of Flies.—At all stages, the larval and pupal as well as the adult, a more or less liquid food is preferred. In the case of the adult if the food of which it desires to partake is, like sugar, for example, solid, the insect regurgitates a certain amount of fluid in order to dissolve or soften it.

Experiments having shown that micro-organisms undergo no change in the digestive apparatus of the fly, it follows that if it has fed upon substances containing infective organisms, *e.g.* typhoid, cholera, or tubercle bacilli, prior to attacking such an article of food, in addition to depositing germs that may have lodged on its feet it will probably add others as a result of regurgitation and defæcation.

The life of the fly is comparatively short, at midsummer rarely longer than from two to three weeks. In the autumn, under natural conditions, large numbers die as a result of cold or following an attack by the *fly fungus* (*Empusa muscæ*).

Diseases carried by Flies.—The diseases with which the fly is alleged to be associated as a carrier include enteric fever, cholera, epidemic diarrhœa, dysentery, diphtheria, poliomyelitis, ophthalmia, and a number of others, amongst them certain parasitic diseases such as tape worm and miners or hookworm disease (*ankylostoma duodenalis*).

The carriage is done mainly on the exterior of the fly, but as it deposits vomit and fæces, both of which may contain organisms, on the surface of the materials which it visits or desires to consume, it can easily be believed that the amount of infective material is at least relatively large.

Fly Prevention.—In connection with fly destruction the chief aim must be to deal with breeding- and feeding-grounds. Manure and garbage must not be stored for longer than seven days, since though eggs may have been deposited, the adult fly cannot develop in so short a time. At the time of removal the larvæ or pupæ also will be removed if their formation has not been prevented by the use of some such material as carbolic acid, borax, or paraffin.

The household dustbin undoubtedly is a very common breeding-place for flies, and if they are to be kept down *house refuse* must be removed once a week or oftener, and the bins thoroughly cleansed after removal of the material. Cleansing in and around houses and cleansing of streets are equally necessary.

For dealing with flies which find their way into houses, the old-fashioned *fly paper* is very useful. Water or milk slightly sweetened, to which a trace of *formalin* has been added, is also good. In bad cases *fumigation* of the rooms with sulphur dioxide may be resorted to. Flies dislike draughts, and usually rooms in which good through ventilation is obtained are avoided by them. The application of paraffin to window-panes, etc., may also be tried.

For keeping flies out of larders the windows may be covered with gauze, and various *traps* made of this material are highly recommended. Milk and other foods should always be kept covered. Apart from the house-fly, the *bluebottle* and the *latrine-fly* may be associated with the carriage of intestinal disorders. The breeding-place of the latter being largely similar to that of the housefly, it may be dealt with in much the same way.

Fleas.—The flea which most commonly attacks man is the *Pulex irritans*; others, however, which are found inhabiting certain animals, *e.g.* the rat flea (*Ceratophyllus fasciatus* and *Laemopsylla cheopis*) and the fleas infesting cats and dogs, occasionally also attack man.

That the rat flea will bite man is important, since it is in this way that plague is spread from rats to human beings. In addition to being associated with this disease the flea is alleged to be concerned in the spread of typhus and other fevers. The carriage of infection is entirely mechanical, the organisms obtained from an infected person or animal being inoculated into a healthy person.

Extermination of fleas :—*Cleanliness* is essential. Domestic animals being largely the source of infection of houses or rooms in houses, they should be kept clean. For clearing rooms of fleas, *sulphur dioxide* may be used. *Kerosene* is also good, and floors may be treated with this substance. Some persons are more liable to attack by these insects than others, and to some extent may protect themselves by the application round the wrists and ankles of strong-smelling

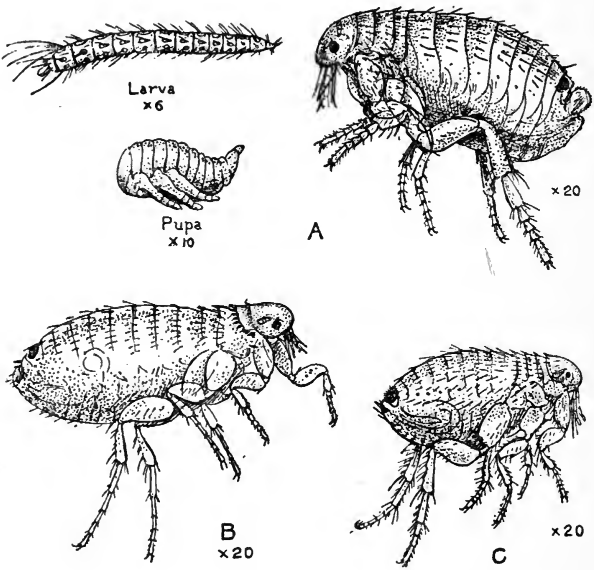

FIG. 8.—Fleas: A, Pulex irritans, showing pupa and larva; B Ceratophyllus fasciatus; C, Laemopsylla cheopis, the common flea of rats in India. B and C are plague fleas.

essential oils, most insects having a strong objection to perfumes.

Bed Bugs and Lice.—The bed bug is regarded as the carrier of spleno-megaly and leprosy; the louse of typhus and relapsing fever. Houses infested with bugs are difficult to cleanse.

Fumigation with sulphur dioxide sometimes gives good results, and kerosene is also recommended. After fumigation the *walls* should be stripped and distempered or repapered. *Corners* and *cornices* and *woodwork* generally, including picture frames, are common harbours for bugs, and require careful attention and cleansing.

The body louse (*Pediculus corporis*) is frequently found in bed and other clothes, particularly about seams and hems. The eggs are attached to fibres in the material, and take about three weeks to hatch. Boiling and washing or thorough and prolonged steam disinfection or the application of a hot iron along the seams are necessary. For the head louse (*Pediculus capitis*), combing and cleansing are required. The nit, since it is fixed to the hair by a cement-like material, is generally more difficult to eliminate than the adult, and treatment of the hair with warm vinegar to dissolve the

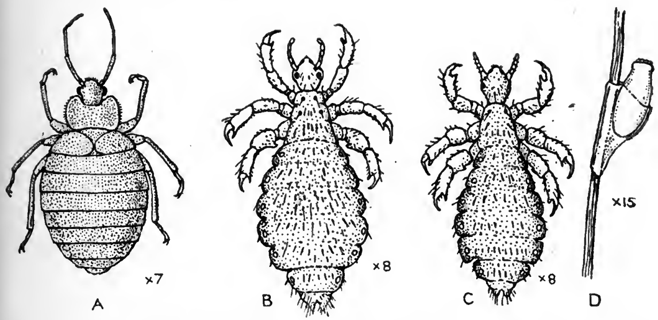

FIG. 9.—A, Bed bug ; B, Pediculus corporis ; C, Pediculus capitis ; D, Nit attached to a hair.

cement, with paraffin, preferably liquid paraffin (Paraffinum molle, B.P.), or carbolic oil is recommended. In elementary schools in poorer districts where risks of infestation are great, the hair should be cut short and kept short. Boys are less frequently affected than girls.

Ticks are blood-sucking parasites and are now recognised as responsible for the carriage of a number of diseases both of man and animals, particularly in warm climates. *Relapsing fever*, *Rocky Mountain spotted fever*, which closely resembles typhus fever, and South African *tick fever* are examples. Cattle, sheep, horses, dogs, and fowls also suffer from diseases spread by ticks.

Ticks in some respects resemble the bed bug. They are mainly nocturnal in their habits and obtain nourishment by burrowing deeply into the skin of the host. In Africa, in order to protect themselves from attack, travellers and others are recommended to raise their beds well above the ground, and to use mosquito nets of a small mesh.

Rats.—The rat besides being destructive is the main source of plague, and harbours the flea which carries the disease.

The two main varieties are the black rat (*Mus rattus*) and the brown rat (*Mus decumanus*). The latter is most commonly seen, and is known under the name of *sewer rat*. It is essentially a wild animal and only haunts dwelling-houses and other buildings, particularly in the winter months, with the object of obtaining food supplies. So far as food is concerned it will eat and thrive on any kind of food-stuff.

Though found in large numbers in sewers, rats do not live there, but usually under hedgerows or cornstacks in the country and under houses or elsewhere in towns. The nest is an excellent breeding-place for fleas, and most rats swarm with them.

The tendency of the female rat is to remain near her nest, leaving the foraging for food to the male, who, particularly in a house where there are carelessness and wastefulness, finds a full supply in the dustbin and even the larder. Rats found in houses quite probably come from sewers, finding their way through untrapped drains or defects in the sewer or the drain.

In this country epidemics of rat plague are rare, and the infection is believed usually to come from abroad, and to be brought by infected rats from plague-infected ports. When a ship is moored at a wharf, interchange, unless precautions are observed, takes place, the wharf rats making their way on board and the ship rats seeking the shore.

Precautions against Rats.—Particularly in ports to which ships come from foreign parts, suppressive measures should be adopted as a routine both as regards the ship and the shore rats.

In the case of ships, all the rats must as far as possible be destroyed. This is generally done by pumping large quantities of sulphurous acid gas into the holds after all cargo has been removed. During unloading care must be taken that rats do not escape and get ashore, and that the vermin are not landed in the cargo.

Especially at night the ship should be kept as far from the quay as possible, and all gangways should be removed. It is generally recommended also that guards consisting of large circular discs of wood or metal should be placed upon mooring chains or cables, the rope or chain passing through an opening in the centre. The rats generally find these difficult to negotiate, particularly if they are made concave and placed so that the concavity faces the quay.

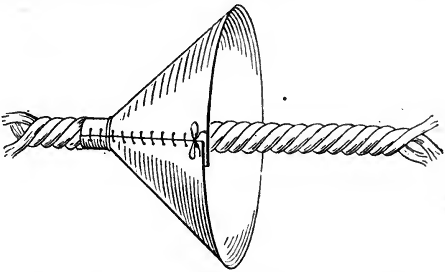

FIG. 10.—Rat shield on ships hawser.

In dealing with rats on shore, cleanliness is necessary. *Refuse and garbage* that may provide food for rats, and *empty boxes or rubbish* that may give shelter, should be removed. *Rat runs* should be found and stopped with broken glass and tar or cement, and *drains* in houses in which there are rat runs, as well as sewers and cesspools, should be attended to. Ventilation openings at spaces under floors should also be guarded.

Rat-proofing of buildings by means of concrete over the site and well up round the lower end of the walls is very important. For the rats themselves *traps* of the spring variety may be used. *Poisons* containing phosphorus or arsenic are good, but should not be laid where poultry or other domestic animals may be poisoned. Various *bacterial viruses, e.g.* the Danysz, though stated to be uncertain in their action, are sometimes recommended. *Hunting* with dogs and ferrets is very effective. But in connection with all such measures it is to be remembered that the fleas leave the rat when it is cold, and that it should not be handled without precautions such as the wearing of gloves and puttees and the use of some of the oils that fleas dislike.

Other Carriers. *The Human Carrier* may be (*a*) a person suffering from a mild, unrecognised attack of the disease; (*b*) a person who has apparently quite recovered; and (*c*) a person who is not suffering and never has suffered, but acts merely as an intermediary or carriage for the infection.

The individual who suffers from an infectious disease in so mild a form that the fact that he is suffering is not detected is usually referred to as a *missed case*, and many outbreaks of scarlet fever, diphtheria, and other diseases have been traced to cases of this kind.

The carrier in relation to *enteric fever* has received a great deal of attention. The disease being difficult of diagnosis, cases are often missed and may give rise to considerable outbreaks. Common as missed cases may be, however, the real difficulty in enteric is with the carrier who has apparently recovered from the disease but still harbours the bacillus and discharges it for a shorter or longer period in his fæces or urine. The person whose discharges only show the bacillus for a short time is known as a "transitory carrier"; if the condition lasts for a considerable time he is named a "chronic carrier."

Quite an appreciable proportion of patients who have suffered from typhoid fever become carriers. The proportions as a matter of fact vary from 2·3 up to as high as 32 per cent. of the total number of cases of the fever. The proportion of carriers in an ordinary population is stated to be about 3 or 4 per 1,000.

The chronic-carrier condition is more frequent in adult life than in youth, and is more apt to arise if the patient has not been under supervision throughout the duration of the fever. Most of the carriers recognised have been females, and many have been connected with the milk trade, or with the preparation or cooking of food. There seems to be a well-marked relationship between the carrier state and gall-stone disease.

Even when found the chronic carrier is difficult to deal with. *Isolation* is practically hopeless and *treatment*, of the intestinal carrier especially, useless. The only thing to be done is to keep the sufferer under observation to ensure that proper rules are observed with regard to hygiene and, most important of all, the abstinence from such occupations as involve contact with the food of others.

As a preventive measure it has been recommended that before a typhoid patient is discharged as cured, the fæces and urine should be examined for and found to be free from the bacilli characteristic of the disease. The examination is, however, difficult, and the suggestion has not been adopted to any extent. The Widal reaction, since it may persist for years after an attack, is useless in this connection.

Apart from enteric fever, carriers are recognised in relation to cholera, dysentery, and malaria.

Animal Carriers.—Quite a number of diseases are recognised as being common to man and animals. Tuberculosis in the bovine is undoubtedly transmissible to man, and outbreaks of scarlet fever and diphtheria have been traced back to milk obtained from cows suffering from eruption or ulceration on the teats and udders.

Diphtheria may be contracted from cats, and diphtheria bacilli have been isolated from the nasal or throat secretion of cats in households in which cases of diphtheria have occurred.

The association of animals with *parasitic diseases* of man, particularly those due to intestinal parasites, is well known. The infection in these cases may be of the nature of a direct infection, the animal passing the eggs into food or water taken by the individual; or the animal may act as the intermediate host, development of the parasite being delayed until the flesh of the animal itself has been consumed by man.

As an example of direct infection, the condition known as *hydatid* may be quoted. This affects the liver and other parts of the human body, and is produced by the cysticercus of the *Taenia echinococcus*, a parasitic worm of dogs.

Infection with the *Taenia solium* (of which the pig is the intermediate host) may be given as an instance of the second type of infection. Pork containing the cysticercus of this worm—*Cysticercus cellulosæ*—is known as *measly pork*. Development of the cysticerci into the full-grown worms takes place in the human intestine.

Modes of Infection and Immunity.—No matter how the disease organisms are carried, entry into the body appears to occur by way of (1) Inhalation, (2) Ingestion, or (3) Inoculation.

The infections that may be *inhaled* are those given off by the breath of the infected person, or such as have found their way into the air indirectly, *e.g.* from the dried sputum or other excretions and secretions of the infected person.

In most instances in which the disease germ is inhaled it is caught probably on the fauces or in the nose, and though it may be carried straight to the lungs along with the air, entry into the system is made more probably through the lymphatics and blood-vessels, which have been reached as a result of absorption from the tonsils or nasal mucous membrane.

Germs that are *ingested* pass in with water and liquid and solid foods, particularly such as are taken uncooked, or cold after cooking. Outbreaks of typhoid or enteric fever and cholera are commonly traced to water, and infection with scarlet fever, tuberculosis, and diphtheria to the ingestion of raw cow's milk. Malta or Mediterranean fever is associated with the taking of raw goat's milk in which the *micrococcus melitensis*, the germ of the disease, has been found to flourish.

Amongst the diseases acquired as a result of *inoculation* may be mentioned puerperal fever and those following an attack by stinging or biting insects, *e.g.* malaria, yellow fever, sleeping sickness, plague, typhus fever, and relapsing fever. In diseases regarded as infectious by direct contact, to which the name *contagious* is sometimes applied, the infection is probably very often inoculated.

Signs of Infection.—After their entrance into the body, organisms may or may not be successful in giving rise to the diseases for which they are responsible. In the event of success, certain signs appear, and the disease passes through a number of stages each more or less distinct from the others. The first of these is known as the *stage of incubation* or *incubation period*, which runs from the time the infection enters the body until recognisable signs or symptoms of infection appear and the *stage of onset or invasion* is entered. The signs and symptoms established in this stage persist, unless death results, until the *stage of decline or convalescence* is arrived at. The time occupied in the passage through these various stages differs with each of the diseases. In scarlet fever, diphtheria, and measles, it is a matter of weeks; in tuberculosis, syphilis, and leprosy it may occupy years.

In connection with prevention, the period of incubation is perhaps the most important, as from it information may be obtained with regard to the source of infection and the length of time contacts with infected persons should be kept under observation. When dealing with the individual diseases further reference will be made to this. In the meantime the following table, which contains a list of the commoner infectious diseases, and shows the incubation period usually noted in each, may be found useful:

Disease.	Incubation Period.
Scarlet Fever	1–7 days
Diphtheria	2–4 ,,
Measles	10–14 ,,
Smallpox	12–14 ,,
Chickenpox	12–21 ,,
Typhus fever	5–12 ,,
Enteric Fever	10–15 ,,
Cerebro-spinal Fever	2–5 ,,
Erysipelas	1–4 ,,
Cholera	1–10 ,,
Plague	1–5 ,,

Disease.	Incubation Period.
German Measles	15–18 days
Whooping Cough	5–14 ,,
Mumps	17–19 ,,
Influenza	1–3 ,,
Syphilis	3–5 weeks
Tuberculosis	1–12 months (?)

Immunity and Resistance to Disease.—Amongst those attacked the *intensity of the infection* varies, and, speaking broadly, it is mainly upon the size and quality of the dose of the germs and the resistance of the individual that the variations depend. The extent to which each operates is incapable of measurement, and practically also of explanation. The same may indeed be said of most of the observed facts in connection with infection, such as the occurrence of variations in the character of epidemics, the preference of most of the diseases for a certain period of life, a certain sex, and a certain time of the year. The fact that the first cases in an epidemic are generally the most severe is also inexplicable.

So far as intensity of infection is concerned, it seems likely that it is mainly because the individual possesses the power of resisting and to some extent of overcoming the infection that variations occur. This power of resisting infection is generally named *Immunity*, and with regard to it, it may be stated broadly that it may be complete or partial, and may be displayed to one disease or to more than one.

Immunity is regarded as being of two types, (1) *Natural* and (2) *Acquired.*

Natural Immunity.—In the case of natural immunity an individual is born with an insusceptibility to some disease and does not, or does not tend to, contract it. Examples of this form of immunity are found in man, *e.g.* the natives of some countries are immune to yellow fever, typhoid, and malaria, though strangers in such parts acquire them readily. To this form the name *Racial Immunity* is given, and in all probability it is due to heredity and selection, the weaker, less-resistant members of the race being weeded out.

In addition to racial immunity there is *Individual Immunity*, in which certain individuals, it may be in the same family, never contract certain common infectious diseases, *e.g.* scarlet fever. The practical immunity to this disease which exists amongst adults is more or less of this type.

Acquired Immunity.—Two types of acquired immunity are recognised, viz. (*a*) Active and (*b*) Passive.

Active Acquired Immunity results either from an attack of the disease or from vaccination with the modified virus of the disease, as in the case of smallpox, enteric fever, and cholera for example. This form of immunity may be short-lived or very enduring, but is entirely personal, and is not transmissible to the offspring of the immunised individual.

Passive Acquired Immunity results from inoculation with the serum of an animal that has been actively immunised by inoculation of organisms or the toxins produced by them. As an example of this may be quoted the practice frequently adopted in this country in connection with diphtheria, in which immunity is conferred or sought to be conferred upon contacts with persons suffering from the disease by injecting small doses of anti-toxin. The passive immunity that results probably does not last longer than three or four weeks.

Immunity passively induced, while it lasts, is transmissible to the offspring. As already indicated, immunity may be conferred either against organisms or their products, or *toxins*. The two types are quite distinct and are not interchangeable.

Immunity and Preventive Medicine.—Most of the statements made above are matters of fact, and are readily understood. It is when attempts to explain them are made that difficulties are encountered. It is necessary not only to try to find the factors concerned in immunity, but to try to show if possible that they are the same in natural as in acquired immunity. Up to the present, although a vast amount of patient and brilliant work has been done with regard to the subject, very little that is definitely helpful has been made out. Interesting and important as the investigations have been, and useful as some of the information obtained has proved to be in connection with the prevention of some of the infectious diseases, it is not proposed to enter into any description of the researches or any analysis of the theories evolved.

One point of practical importance may, however, be made, viz. that though most of the results obtained seem to suggest that for a person to be immune some substance must be injected into the body or some mysterious power conferred by an attack of the disease or otherwise, such conclusions must not be too readily accepted as final.

In time it may come that there will be placed within the reach of every one materials capable of protecting against each one of the diseases, in the same way as calf lymph properly administered by way of vaccination is capable of protecting against smallpox. Already, as will be shown later, man may be protected against diphtheria, against enteric fever, against cholera, and against plague, by the injection of antisera or vaccines. There is no reason to suppose that in time he may not be protected, when necessary, against scarlet fever, measles, rheumatic fever, and influenza.

In the meantime hygiene can help him, and he can do a very great deal for himself. He can attend to *personal hygiene* and look after his health and adopt such special precautions as a close study of the diseases has shown it is advisable to adopt.

Most of these precautions will be referred to when considering the diseases ; here stress is laid on the importance of having regard to health and the laws of personal hygiene. It is not, it is true, always the weak and unhealthy, the poorly fed and the badly housed who are attacked by disease, but in this connection there are advantages in health, strength, good housing, and good feeding. Health as a protective is worth preserving, but the strong should remember that though bodily strength may not seem to be reduced, resistance may be by neglect or indiscretions in diet or over-indulgence in alcohol. Resistance, it should be noted, is always reduced by fatigue, and over-exertion of the body is to be avoided. Exposure to cold and wet, insufficient and unsuitable food, and bad housing conditions, particularly if there is over-crowding, also tend in many cases to lead to lowering of resistance.

Preventive inoculation, like vaccination in the case of smallpox, is a precaution additional to others that the individual may exercise on his own behalf or under advice.

In smallpox, vaccination is universally recommended because smallpox is universal, is continually threatening, and is, when acquired, always dangerous. This additional precaution is known to be effective, and if at all unpleasant is merely transiently so and only to a trifling extent. Antityphoid, anti-cholera, and anti-plague inoculations are recommended under special circumstances and have proved of value on many occasions to those exposed to special risks.

CHAPTER IV

PUBLIC HEALTH AND DISEASE (*Continued*)

THE NOTIFIABLE DISEASES

THE diseases to be dealt with in this chapter are those to which in this country the law as regards *notification* applies, viz. :—

- Smallpox
- Typhus Fever
- Scarlet Fever
- Diphtheria and Membranous Croup
- Enteric Fever
- Continued Fever
- Relapsing Fever
- Puerperal fever
- Erysipelas
- Cerebro-spinal Fever
- Tuberculosis
- Cholera
- Plague
- Ophthalmia Neonatorum
- Polio-myelitis
- Measles
- German Measles

In regard to these it is the duty of medical practitioners to inform the medical officer of health of the district of the occurrence of any one of them in any patient upon whom he is attending or whom he has been called in to visit, " forthwith on becoming aware that the patient is suffering" from the disease. The object of notification is to ensure that preventive measures shall be put in force, and the diseases named have been made notifiable because they are particularly dangerous or occur very numerously or because preventive measures are applicable in respect of them.

Smallpox.—In the early eighteenth century, in this country, the death-rate from smallpox was something like 3 per 1,000 of the population. Between 1902 and 1912 the deaths totalled 4,963, and of this number 2,464 occurred in 1902, the last year in which the disease showed anything like a marked tendency to prevalence. During the last eleven years nothing in the nature of a widespread epidemic has occurred : in 1914 in

England and Wales there were 59 cases, as against 88 in 1913, 109 in 1912, and 265 in 1911. In the middle of 1914 a small outbreak occurred in Milnrow near Rochdale, and in 1912 there was a small epidemic in Kirkcaldy in Fifeshire.

Etiology and Epidemology.—Smallpox occurs in all parts of the world, and affects the white as well as the coloured races. Because they are less well vaccinated, coloured peoples are more liable to attack than the whites.

In pre-vaccination days children under five years of age suffered most; nowadays, provided vaccination is taken advantage of, the young children escape. Males appear to suffer more than females, although at certain age-groups under fifteen the death returns show some preponderance of females over males.

In temperate climates smallpox is a disease of winter and spring mainly. The period of maximum prevalence occurs between January and June, after which it falls, to rise again about the beginning of November. In the East, cases occur most numerously in the October–December quarter.

Transmission.—Smallpox is spread mainly as a result of direct contact, but the virus, whatever it may be, is exceedingly tenacious, and can be carried by clothing and other fomites. Water, milk, and articles of diet play no part in the transmission of the infective agent. Opinion as to the possibility of conveyance of smallpox by air currents—*aerial convection or diffusion*—is divided.

The *incubation period* may vary from eleven to fourteen days, but generally extends to twelve days. Almost invariably the eruption appears on the third day of the fever (the fifteenth day after exposure); the rash begins to be vesicular on the fifth day of the fever (seventeenth after exposure), becomes pustular on the seventh to the ninth (nineteenth to twenty-first after exposure), and scabs form about four days later.

The *quarantine period*, or period during which contacts with a case of smallpox must be kept under observation, is generally put at fourteen days, though some prefer to make it longer, seventeen to eighteen. During this period contacts should most certainly be vaccinated, unless only recently done.

Prevention.—Smallpox is highly infectious, and *isolation* should be very strict and in hospital, and disinfection most thoroughly carried out. The contacts should, if possible, be provided with accommodation and kept under close observa-

Country and Date of Census.	Population.	1891.	1892.	1893.	1894.	1895.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	Total
Germany (1900) . .	56,367,178	49	108	157	88	27	10	5	15	28	49	56	15	607
England and Wales (1901) . . .	32,526,075	49	1,431	1,457	820	223	541	25	253	174	85	242	2,461	6,761

tion, or else should be seen daily at their own homes and moved into isolation the moment the slightest sign of illness appears.

Vaccination.—In face of an outbreak, these measures with, in addition, *vaccination of contacts* and of the inhabitants of the infected district generally, are usually successful in limiting the spread of the disease and eventually stamping out the epidemic. For the prevention of the occurrence of epidemics there is no measure to compare with vaccination.

In European countries in which vaccination has been fully practised and statistics are available, the reduction which has occurred in the death-rate from smallpox and in the total number of cases is most remarkable.

In Germany the law requires that all infants must be vaccinated before the end of the calendar year following the year of birth; and all school children must be revaccinated in their twelfth year.

The effect of this procedure on the German mortality statistics is shown in the table in which the deaths in the years 1891 to 1902 are given alongside those for England and Wales.

The effect on incidence has been no less marked. In Germany in 1912, for example, only 275 cases in all were notified and in 1913 just over 80. In both these years the majority of these cases occurred either amongst foreigners or *in towns or districts bordering upon foreign countries and especially Russia.*

That the effect of vaccination has been less marked here than in Germany is due to the fact that there always has been evasion or disobedience of the law, even when vaccination was compulsory, and that revaccination is not and never has been compulsory.

In countries in which there are no laws with regard to vaccination conditions are much worse. In Russia the yearly average is 125,000 cases, and in Italy in non-epidemic years about 4,000. These figures give some idea of the power of vaccination to prevent smallpox, and in the statistics of individual outbreaks there is proof of its power to limit the spread of the disease and to protect individuals.

In an epidemic which occurred in 1913 in Sydney, New South Wales, for example, of fifty-two persons, nurses and members of the staff of the smallpox hospital, all of whom were vaccinated or revaccinated, none were infected. Of a staff of fifty in the public-health department engaged in the removal of patients and disinfection, all with one exception were vaccinaated or revaccinated, and only the unvaccinated individual contracted the disease. In this outbreak the disease occurred in a mild form, but the total number of cases notified up to the end of 1913 was 1,070. Of this number 69 or 6·4 per cent. had *probably* been vaccinated in infancy or over 13 years before being attacked; 999 or 93·3 per cent. had never been successfully vaccinated before contracting the infection of smallpox. Because of the difficulty of diagnosis at the beginning of this epidemic (many of the earlier cases, as so often happens, were mistakenly diagnosed as chickenpox) the outbreak was well started and the disease widely diffused before steps to limit the spread could be taken. When measures were adopted, however, that upon which the greatest reliance was placed was vaccination. The total number of contacts vaccinated, most of them previously unvaccinated, as Sydney is or was very badly vaccinated, was 6,000, with the result that all who were so dealt with, *within two days of exposure to infection*, were protected against smallpox.

The figures published by the Medical Officer of Health of Stepney with regard to a small outbreak of 37 cases are interesting in this connection also. Dividing the 37 cases into groups according to age, he found that of those attacked 7 were children under 8 years of age; of these 2 were vaccinated and had the disease in a mild form, 5 were unvaccinated and 4 died. Patients aged between 8 and 30 numbered 14; 3 were unvaccinated and 1 died; the remainder had been vaccinated in infancy, none were revaccinated, and all recovered. The age group 30 to 60 gave 13 cases. All had been vaccinated in infancy, none were revaccinated, and two died.

Further in an epidemic in Liverpool in 1902–3, out of 943 cases in persons vaccinated in infancy the deaths were 2·9 per cent., and among 220 unvaccinated cases the deaths were 27·2 per cent. Many other figures could be quoted, but those given are sufficient to show :—

(1) That in a well-vaccinated and revaccinated community smallpox outbreaks are rare and small in extent.

(2) That recent vaccination if successful invariably protects from attack.

(3) That amongst the vaccinated the disease is generally less severe and always less fatal.

(4) That in vaccinated communities it is always the children who escape.

In the opinion of the anti-vaccinators, all the improvements in relation to smallpox are the result of improved sanitation. The risk of spread of infection is, it must be admitted, greater in an insanitary than in a sanitary district. Most outbreaks as a matter of fact are almost entirely limited to those areas in which the poor congregate, and where such conditions as overcrowding and bad housing are found. This seems to support the views of the anti-vaccinators, but it must be borne in mind that it is in these situations that the neglect of vaccination and particularly of revaccination is most evident. The well-to-do who live in sanitary surroundings almost invariably at once resort to revaccination in the face of an epidemic and so secure additional protection. It should be noted too that smallpox is not the only disease that is favoured by bad hygienic conditions, but with the possible exception of typhus fever none of them have diminished to anything like the same extent.

Further, if improved sanitation really is responsible, England, which is without doubt in this respect the most advanced of all countries, should certainly show better results than Germany. The figures quoted above, however, prove that the latter Empire is far ahead of this country.

Vaccination in this country is generally performed during the first few weeks of life, and every person registering a birth is handed a form to be given to the public vaccinator or a medical practitioner when he arranges for vaccination to be done. According to the Vaccination Acts it must be performed before the age of six months, unless an exemption certificate is given by a medical man that on health grounds it is undesirable, or exemption is obtained as a result of the parent making a statutory declaration before the child reaches the age of four months that he conscientiously objects to vaccination. The statutory declaration is made before a commissioner of oaths, and must be sent to the vaccination officer (a lay officer) within seven days after it has been made. In many cases, in maternity hospitals or wards especially, infants are vaccinated before the end of the first fortnight. Calf lymph is exclusively used. When vaccination has been successfully performed, the person carrying it out must sign a certificate to this effect.

Revaccination is performed in the same way as primary vaccination, and with the same precautions. The practice in Germany is to carry it out at the age of twelve, and, though it is difficult to say how long the protection conferred by vaccination in infancy may last, probably this is not too soon.

Since the immunity obtainable from revaccination disappears, equally with that acquired in infancy, it is advisable that the process should be repeated at intervals; in the event of the occurrence of an outbreak revaccination is advisable.

The Law as to Vaccination.—Acts relating to vaccination were passed in 1867, 1871, 1898, and 1907.

By the Act of 1867 all children must be vaccinated by a Public Vaccinator or a general practitioner within three months of birth, otherwise liability to a penalty is incurred.

The Act of 1898 extends this period to six months after birth, and the Public Vaccinator is bound to visit the child's home if the parent requires it. In the event of a child not having been vaccinated at the end of four months, the Public Vaccinator is bound to give twenty-four hours' notice to the parent, and to call and offer vaccination with calf or such lymph as is issued by the Local Government Board.

If the officer is of opinion that it would be dangerous to vaccinate on account of the insanitary condition of the house, or the prevalence of infectious disease, vaccination is to be postponed, and notice sent to the Medical Officer of Health.

The exemption clause of this Act provided that if the parent or guardian of a child satisfied two justices or a stipendiary magistrate that he conscientiously believed that vaccination would be prejudicial to the health of the child, and obtained a certificate to that effect. he escaped liability to a penalty for non-vaccination. According to this Act a second order for vaccination cannot be made until the child is four years of age. Guardians are empowered to provide additional vaccination stations during epidemics.

By the Vaccination Act of 1907 a Statutory Declaration before a commissioner of oaths, a justice, or other officer empowered to take statutory declarations is substituted for the certificate required by the Act of 1898. This declaration must be sent to the Vaccination Officer within seven days after it is made.

In the case of Scotland the law of vaccination up to the beginning of 1908 was contained in an Act passed in 1863, and it was not till 1908 when the Vaccination (Scotland) Act, 1907, came into operation that conscientious objection was recognised. Under this act the fact of objection may be declared and exemption from vaccination obtained. Parents and guardians neglecting to declare and failing to provide for vaccination are liable to a penalty.

The Practitioner and Prevention.—To all intents and purposes the practitioner is the first line of defence against smallpox, and the extent of any outbreak depends almost entirely upon his readiness in diagnosis, and the rapidity with which he gets into touch with the Medical Officer of Health of the district.

Diagnosis of smallpox, from chickenpox particularly, is not easy, and in recognition of the difficulty it is a common practice to make chickenpox a notifiable disease whenever an outbreak of smallpox occurs. Generally this is too late, having regard to the fact that when the outbreak has occurred every one is on the look-out and missed cases are comparatively rare. It is the first case of smallpox mistaken for chickenpox or a non-variolous eruption that gives rise to the trouble.

It is by detecting the first cases that the medical practitioner can help most, and if he cannot without reservation absolutely assure himself that any doubtful case is *not* smallpox he should at once communicate with the Medical Officer of Health of the district, and ask him to see the patient.[1]

Apart from assisting in the prevention of smallpox by being on the look-out for cases and never hesitating to communicate with the Medical Officer of Health with regard to doubtful

[1] It is no part of the duty of the Medical Officer of Health either to act as a consultant or to visit a patient after receipt of a notification with a view to confirming the diagnosis or otherwise. Though generally willing to be of assistance, he will not examine a patient without the consent or at the request of the medical attendant. The Medical Officer of Health who acts otherwise is the exception.

cases, the practitioner can help by pointing out the necessity for vaccination and revaccination, particularly to the contacts with any cases which he may have seen. He should also impress upon the parents of newly born children the importance of having vaccination performed and take every opportunity of recommending vaccination and revaccination as a preventive. Under no circumstances should he consent to "oblige" parents by vaccinating only in one place. He should insist upon performing the operation properly and making three or four insertions.

Typhus Fever.—As a result of sanitary improvements, particularly in relation to housing, typhus fever, so far as this country is concerned, is rapidly becoming extinct.

In 1914, 14 cases occurred in England; and in 1913, 11. Of the 11, the majority occurred in Liverpool; and of 31 notified in 1912, 8 were in Sunderland and 6 in Liverpool.

Outside Great Britain, the countries which have suffered and still suffer most are Russia and certain parts of Southern Europe. In Mexico epidemics are stated to be of common occurrence. Under the name of Brill's disease, typhus in a mild form has existed for a great many years in New York. The *incubation period* of typhus fever is twelve days. The causative organism is not known, but is supposed to reside in the blood throughout the febrile period, and possibly for some time after. It is a disease of winter, and even in warm climates chooses the coolest time of the year for its prevalence. This preference for winter is supposed to be due to the fact that at that season the poor huddle more closely together, and so give the disease greater opportunities for spreading. This view lends support to the opinion now rapidly gaining ground, that the louse (*Pediculus vestimenti* or *humanus* and *P. capitis*) is the chief carrier of the disease, sucking the virus with the blood from its victim and acting merely as a porter of infection from the sick to the healthy.

As a result of the discovery with regard to the part played by lice, the necessity for retaining the old theories as to spread of infection by means of exhalations from infected patients, food, or water or from soil disappears. Overcrowding, bad housing, poverty, and dirt are important in relation to typhus fever, because where they are found there also are vermin found.

Prevention.—Prevention of typhus fever has always been regarded as a matter of sanitation and housing, and the discovery of the relationship of the louse to it makes it no less urgent to prevent overcrowding, and to attend to the housing of the poor, in addition to attacking the vermin themselves.

In this connection *cleanliness* both domestic and personal must be insisted upon, though as the law now stands it is easier to compel the former than the latter. The getting rid of vermin is no easy matter. In most large towns baths and disinfectors are provided for the cleansing of verminous persons, and they should be induced to use them. At the same time their bedding should be removed and disinfected by means of steam, and the home and the contents fumigated with sulphur.

When an outbreak of typhus fever occurs there is usually an increase in the amount of activity in connection with *housing*. In addition more strenuous action should be taken against the louse. The patient himself should at once be isolated. All contacts should be found, and if possible isolated for two or three weeks, and they themselves and their clothing should be thoroughly disinfected and freed from vermin. Houses in which the fever has occurred must be thoroughly cleansed and disinfected, bedclothes and other articles being steamed or, if of little value, burned.

Persons who are concerned in the removal or nursing of patients must be careful to avoid collecting lice on their clothing or elsewhere. Some of the materials recommended as useful for keeping off fleas may be employed ; baths should be taken regularly and frequently, and garments fitting tightly at the wrists and ankles worn.

The Practitioner and Prevention.—A great deal of the responsibility for preventing the occurrence of outbreaks of any size rests upon medical men whose practice, hospital or private, lies amongst the inhabitants of the poorest districts of towns. Typhus fever is not easy to diagnose, and as few people have seen cases it is apt to be missed and mistaken for influenza or pneumonia or typhoid fever. If the practitioner has any doubt with regard to a case, the best course to adopt is to communicate with the Medical Officer of Health, and throw the responsibility on him.

The practitioner who urges the importance of attention to personal cleanliness and hygiene generally, and the avoidance of overcrowding, will do much to prevent spread of infection.

Diphtheria.—Diphtheria occurs practically all over the world either in an epidemic or an endemic form. In this country it is one of the commonest infectious diseases, and few districts escape. In many it is practically endemic, becoming epidemic at longer or shorter intervals. Epidemics seem to occur more or less in waves over a number of years. In addition variations occur in each year as well, and usually about the middle of September the numbers begin to increase, remaining high till March is reached, when a fall takes place. With the coming of autumn the numbers again increase, and so on year after year.

Both as regards treatment and prevalence, diphtheria is much more under control than formerly. The number of deaths per 100 cases (fatality-rate or case-mortality) in England and Wales in 1912 was 9·34: the death-rate per 1,000 of the population, which has greatly diminished, in that year was nearly 60 per cent. lower than in 1901. This marked improvement is undoubtedly due to improved diagnosis, and improved methods of preventing, treating, and dealing with the disease.

Diphtheria is a disease of childhood, the vast majority of cases and of deaths occurring amongst children under ten. Girls suffer much more frequently than boys, and the death-rate is higher amongst females. To some extent the greater prevalence of the disease amongst children is due to the fact that they are brought closely together in school.

The cause of diphtheria is the bacillus known as the *B. diphtheriæ* or the Klebs-Löffler bacillus. This organism is easily found in the surfaces, usually though not exclusively mucous surfaces, affected by the disease and in the secretions of the affected mucous membranes.

The *incubation period* of diphtheria is generally something under one week. The protection conferred by an attack of the disease is slight and short-lived, and second attacks are not uncommon.

Origin and Spread.—Infection occurs most commonly as a result of direct contact with an infected person by *kissing* or by employing *utensils* which he has used. In schools *pencils*, *slates*, *books*, and *drinking cups* probably all play a part in the spread of the disease.

Unrecognised carrier cases are frequent sources of outbreaks in schools. The carrier case is peculiarly apt to arise because of the tendency of the bacillus to remain in the mucous membranes after the patient has apparently recovered. Because of this it is the custom in many fever hospitals to isolate convalescents from diphtheria until a negative result has been obtained from two successive swabbings from the nose and throat.

Apart from carriers, outbreaks of diphtheria have in some cases been traced to *cats* and other animals, and to *food*, particularly milk. So far as is known, infection is not spread by water; and though *defective drains*, *damp houses*, and *sewer gas* may lower resistance and thus more or less predispose to attack, they cannot be regarded as causes of the disease.

In the case of milk outbreaks the diphtheria bacilli may come from sores on the udder of the cow or from the milker or some other person concerned with the distribution of the milk.

Prevention.—The preventive measures generally adopted are directed mainly to keeping the disease in check and preventing and limiting outbreaks, and include, in addition to notification of cases, efficient *isolation* of the patient, preferably in hospital; full *investigation* as to the source of infection; detection and following up of *contacts* in the home, the school, and elsewhere; the provision of facilities to practitioners for having *bacteriological examinations* of swabs carried out free of charge; *disinfection* of infected premises and articles; *inspection* of infected premises for defects and remedying of these defects.

Antitoxic serum also is generally provided free of charge either for curative or prophylactic purposes.

In relation to *contacts*, swabbing with the object of discovering the existence of any harbouring the bacilli in the throat or nose is widely practised, particularly in school outbreaks. In these cases also it is usual to keep the homes of infected children under careful observation, and to exclude family contacts attending school for two weeks if the patient has gone to hospital or if the patient is kept at home for so long as he is infectious and for two or three weeks afterwards. *Closure of schools* is not so popular now as formerly, as it is apt to lead to a scattering of the children and possibly the formation of several foci of infection.

When an outbreak of diphtheria has been traced to a *milk supply* the first step to be taken is *stoppage of the milk*, and the machinery for bringing this about is at the disposal of the Medical Officer of Health.

With regard to *isolation of diphtheria* it may be said that, except in houses of a fair size, it is difficult to carry out in the home. The patient must have a room set aside for his own use; the various utensils which he requires must be used by no one but himself; friends must be rigorously excluded, and those who are engaged in attending upon him should keep as much by themselves as possible. The hanging up of a sheet soaked in disinfectant outside the patient's room, or between his quarters and the remainder of the premises, serves as a danger signal if in no other way. The *disinfection* to be carried out after the recovery of the patient will be described later.

The Practitioner and Prevention.—Here as before it is in connection with detection of cases that the practitioner can help most. The sooner he recognises the nature of the disease, and the more rapidly he notifies it, the better.

As already noted, most local authorities assist practitioners by placing facilities at their disposal for having swabs examined bacteriologically, free of charge. Swabs are provided free also, as well as envelopes ready addressed either to the Medical Officer of Health or bacteriologist. Reports are sent to the practitioner immediately the examination has been completed.[1]

On public-health grounds it is the duty of the practitioner, in addition to examining the patient, to examine all the members of the household also, and to take swabs from all of them, or from such as he considers suspicious.

Should the patient be isolated at home, instructions should be given as to the precautions to be adopted with a view to the prevention of spread of infection. In about six weeks from the commencement of the disease, swabs should be taken, and the examination of these will usually be carried out free of charge. No request for disinfection should be made to the Medical Officer of Health until the examination has proved negative as regards the diphtheria bacillus. In some districts special forms are supplied to practitioners to be used when requesting disinfection.

In many, also, leaflets of instructions as to isolation are left at houses in which diphtheria has occurred.

Enteric or Typhoid Fever.—The *incubation period* of this disease is twelve to fourteen days, and the onset gradual. Broadly speaking, it occurs universally, the countries in which cases are fewest being those that are most advanced as regards

[1] Many practitioners make a practice of administering antitoxin even before the report is received, if the clinical signs are in favour of a diagnosis of diphtheria. This is a good practice.

sanitation. Taken as a whole, Great Britain probably sees less of it than any other country, but even here the districts to suffer most are those in which sanitary advance has been slowest, and in which particularly a *pure water supply* has not been provided and a good system of collection, removal, and disposal of *excreta and refuse* adopted.

As showing the improvement that has occurred it may be noted that whereas in the ten years 1871 to 1880 the deaths numbered 33 per 100,000, between 1901 and 1910 the rate was 9 per 100,000. Between 1901 and 1910 there was a reduction of 68 per cent. in the rate.

During the last few years the average number of cases notified per annum has been about 8,000, or about 0·2 per 1,000 of the population, as against 2·0 per 1,000 in the years 1869–75. The *case mortality rate* (the number of deaths per 100 persons attacked) is generally in the neighbourhood of 20 per cent. In 1912 it was 19·1 per cent. in England and Wales. In most years the period of greatest prevalence is the *autumn*. For this reason it is sometimes known in America as "Fall fever." Males and females seem to suffer equally, and, though no age is exempt, it is calculated that about 70 per cent. of the total cases occur at ages between fifteen and fifty-five.

Modes of Infection.—The organism associated with the disease is the ***Bacillus typhosus***, and practically always it finds its way into the body through the mouth, usually with water and food, or as a result of kissing a person suffering from the disease or using utensils employed by him. Fingers soiled by excreta containing the germ may also convey the germ to the mouth. Nurses and others attending upon patients under treatment for enteric fever may be infected in this way.

Spread of Infection.—The vehicles regarded as most important are *water* and *food*, particularly *milk* and other articles eaten raw or only slightly cooked, *e.g. water cress* and other vegetables used in salads, *fruit*, *shellfish*, *ice cream* and *ice*. *Cooked* (fried) *fish*, especially such as are sold in the cheaper fish restaurants, since they are often not properly gutted and cleaned, and *air currents* or *dust* may also act as vehicles.

Contamination of the materials with the organism takes place either *directly* from one who is a sufferer or a "carrier," or *indirectly* and through an intermediary, the *fly* being at the moment believed to be one of the most important.

Each of the vehicles may now be considered in connection with these generalisations.

Water.—The *B. typhosus* is rarely found in water and attempts at isolation of the organism usually fail, but as purification of the water and stoppage of the entrance of contaminating substances are generally followed by a cessation of the outbreak or a reduction in the number of the cases, in districts in which enteric fever is endemic and in most epidemics it is generally the water supply that is blamed.

In the vast majority of instances the water is *directly* contaminated by discharges, fæces and urine, containing the organism, passing into it with sewage, or as a result of an infected person defæcating or urinating into it.

Any source of supply, river, stream, lake, or well, may be polluted in these ways.

Food.—Articles of food may be contaminated directly or indirectly.

In the case of *milk*, though the organisms may find their way in directly from the hands of a milker suffering from the disease or more probably from those of a carrier, they usually do so indirectly as a result of diluting the milk or placing it in a pail or other vessel which has been washed or rinsed with contaminated water. So far as is known, the cow does not suffer from enteric fever. During storage, germs may be blown into the milk with dust or be introduced by flies which have obtained access to it after having picked up the infection from excreta or in other ways.

Ice cream may be infected by flies also. Water ices may contain the bacilli if made with contaminated water, or like cream ices may become contaminated during storage. The ices sold in streets and shops in poorer localities are made from boiled custard or thin corn flour, and since the material is boiled and partially cooled before it is placed in the freezer it must receive the organisms from flies, dust, or dirty vessels or hands, or from glasses that have been rinsed in contaminated water.

Block ice, if made from grossly polluted water, or if carelessly handled, may be a means of causing infection. If there is any doubt as to its purity it should not be added to drinks.

Vegetables eaten raw, *e.g.* lettuce, may be polluted by the hands of a "carrier"; by the water with which they are watered, or in which they are washed, or from the manured soil in which they are grown. When *watercress*, which is a not uncommon vehicle, is contaminated, it is generally as a result of having been grown in water polluted by sewage or otherwise.

Shellfish, such as oysters, mussels, and cockles, if infected, generally are so because the situation in which they have been grown, the so-called "layings," are exposed to contamination by sewage. The cooking to which mussels and cockles are subjected is usually insufficient to destroy any contained germs.

Human Carriers.—In discussing the carrier question in a previous chapter, note was made of some of the ways in which persons in this condition may participate in the spread of infection in this and other diseases. Probably therefore it is unnecessary to say much now, though it may be noted that in most of the carrier epidemics recorded here and in America and elsewhere the carrier has been a woman and concerned with the production, preparation, or distribution of articles of food (see p. 38).

Insect Carriers.—That flies may act as the vehicles for the carriage of typhoid bacilli from infected filth to milk and other materials has already perhaps been sufficiently noted. In America certain observers have expressed the fear that the amount of prominence given to the fly in this connection may lead to a belittling of other influences, and it is probable that in the list of carriers, so far at least as this country is concerned, this insect does not stand very high. In towns particularly it seems unlikely that, if the only source is the excreta of infected patients or carriers, its opportunities of collecting bacilli are many, though they may be greater in rural and other districts where pail closets and other primitive methods of dealing with excreta prevail. In warm and tropical countries where sanitation is neglected the importance of the fly is probably considerable.

Drains.—Though defective drains are commonly held to play a great part in the spread of this infection, the importance of this relationship is undoubtedly greatly exaggerated. Practically the only way in which they can act is by polluting sources of water supply, and in towns where proper water mains are laid it is difficult to see how this can occur. In districts in which the water is derived from wells there is perhaps greater risk. The soil pipe, and other portions of the drainage system situated overground and in exposed positions, if defective may possibly be a danger, provided some vehicle in the shape of flies appears to carry the infective materials that escape from the pipes.

Prevention.—All the improvements in connection with enteric fever in this country are due to the attention given to sanitation and particularly to water supplies.

Districts in which cases occur year after year, with an increase each autumn or at other times, can largely remedy this by introducing a *sound drainage, sewage, and scavenging system*, and by *providing a good water supply* and *protecting the water from contamination.*

If thereafter outbreaks traceable to water occur, they will be due to accidental contamination occurring in one or other of the ways already mentioned or perhaps after floods. The behaviour of an outbreak due to water-borne infection is always more or less the same: at first a few cases, widely distributed, then a sharp and sudden increase of attacks, and finally an explosive outburst of a large number of cases. In the historical outbreak in Lincoln in 1904–5, and in others reported from time to time since, these characteristics were well shown.

In a case such as this it is generally advised that, in order to limit the outbreak, a disinfectant, *e.g.* hypochlorite of soda, should be added to the water before distributing it. In addition, posters and handbills indicating that the water is suspected and that it should be boiled before use may be distributed. At the same time, since these are only temporary measures, steps should be taken to guard against further pollution and if need be to provide a safe and proper supply.

In addition to these special measures and others that may be taken in respect of risks from imported cases and from cases that may come from the consumption of polluted milk brought into the district, or from shellfish, vegetables, and so on, the routine methods of prevention, *notification*, *isolation*, and *disinfection* are practised in all districts.

In connection with these there are investigation of the notified cases; following up possible sources of infection and of contacts; warning of contacts of risks run and of precautions to be exercised.

With regard to notification and disinfection, something will be said later. As to *isolation* it should be pointed out that unless this is carried out in an isolation hospital there is serious risk of spread of infection. Even in hospital there are risks, and it is no unusual thing for nurses to acquire the disease from patients or from handling soiled linen and utensils.

Investigation of cases is carried out mainly with the object of discovering the source of infection; and though quite often it is without result, it may reveal itself as a missed case which has been under treatment for "influenza" or "pneumonia," or which has not been treated at all; or as an *imported* case, infection having taken place abroad or in the country, or at the seaside. Sometimes the source is definitely found to be milk or shellfish, vegetables, ice cream, or more rarely fried fish.

When it is shown to be milk, more than one case has usually occurred, all or most of them associated with one milk supply. In such a case the source may be at the milk shop or the farm, and if so it should be dealt with. In the interval the supply of milk should be stopped, or if the suspicions do not quite amount to certainty, *pasteurisation* or *boiling* recommended.

Cases due to *shellfish* are comparatively common, and many of the layings from which oysters, cockles, and particularly mussels are derived are exposed to contamination by the sewage of quite large districts. Oysters taken from contaminated layings before being sold should be placed for about ten days in clean running water to cleanse themselves. Mussels and cockles, which are less commonly eaten raw than oysters, rarely undergo a sufficient amount of cooking to kill the contained germs if they have not had an opportunity to cleanse themselves. In certain districts the authorities have established municipal cooking places for use by vendors of shellfish. In the majority of seaside places notices warning against the practice of eating shellfish picked up on the shore are commonly exhibited, and in the case of adults may have some effect.

Should *ice cream* be suspected, it is usually because a number of cases have occurred with nothing in common between them but the fact of having consumed ice cream from a certain source. The modes in which this material may be contaminated have been described, and indicate the preventive methods to be adopted. Practically the same may be said with regard to *watercress* and *vegetables*.

In districts in which enteric fever is endemic and the methods noted above cannot be carried out completely, several prophylactic measures are recommended. These include *anti-typhoid inoculation*. Those who have experience of this method as practised amongst the troops regard the results obtained as most highly satisfactory, the number of cases amongst the inoculated being trivial, having regard to the conditions to which the men were exposed.

In districts where *flies* are numerous and there are opportunities for these pests to pick up infection, *covering of food* should be carefully attended to and *muslin screens* should also be placed over doors and windows.

The Practitioner and Prevention.—His duty is mainly in relation to diagnosis and notification. The danger from "missed cases" is very real; and since most local authorities provide facilities for having the *Widal test* applied to any blood free of charge, and there is no difficulty in taking the blood, there should be no hesitation about taking advantage of the provision made. If the practitioner desires it and the patient is poor, the Medical Officer of Health is usually willing to act as consultant.

The practitioner can help greatly in prevention, by encouraging patients who cannot safely be isolated at home to go to hospital. If the patient is isolated at home, he can and should, because of the ease with which spread takes place, assist also by seeing that proper precautions are taken in respect of nursing and isolation.[1]

Further, if his inquiries into a case have given him any suspicions as to source of infection, he should communicate these to the Medical Officer of Health.

Scarlet Fever.—This is more or less a disease of temperate climates, though, with the exception of tropical Africa and Asia, it occurs all over the world. In this country it is practically endemic, but tends to become epidemic at certain more or less fixed periods, generally every five or six years. Each year also there are variations, the minimum incidence occurring generally in the spring, about March, and the maximum in the autumn, usually in October. The disease varies considerably

[1] Leaflets indicating the precautions to be taken are generally issued by the Medical Officer of Health, but the practitioner should impress the necessity for cleanliness on persons attending on the patient. He should advise that fæces and urine be received in and mixed with corrosive sublimate 1–1000, carbolic acid 1–20, or other disinfectant and left in contact for at least thirty minutes before being disposed of in the water closet, or if there is no such convenience, by burial or burning. In military field hospitals typhoid excreta after disinfection are frequently mixed with sawdust and burned.

in virulence in different epidemics, though it is generally stated that the type of disease is much milder nowadays.

Age Incidence.—Children of from one to five years are particularly susceptible to scarlet fever. Babies under one are less so, and after five the susceptibility seems to diminish gradually up to ten or fifteen years of age and thereafter more rapidly. Adults present a distinct insusceptibility, but when attacked may suffer severely. In epidemics it is the youngest children who suffer most, and, on the whole, females are more susceptible than males. The *case mortality*, which varies from 2 to 5 per cent., is generally higher in the earlier stages of an outbreak than towards the end and amongst children under five. In England and Wales in 1914 the number of cases per 1,000 of the population was 4·47. The death-rate is generally about 0·1 per 1,000.

Causation.—The organism most commonly found in scarlet fever is a streptococcus, but definite proof of its relationship is lacking.

Transmission of Infection.—Infection is usually obtained as a result of direct contact with a person in an infectious condition. In all probability the most infectious stages are the pre-eruptive and eruptive. The desquamated skin, until recently regarded as very important, is now generally held to be practically blameless. Convalescents suffering from *otitis* and *rhinitis* and showing discharges from the ear or nose are looked upon as particularly dangerous, and in the majority of the so-called "return cases" of scarlet fever, *i.e.* cases occurring amongst contacts with a patient after return from hospital, the infection is obtained from a nasal or aural discharge. It may, however, be obtained from the secretion of the not quite normal throat or nose of a convalescent, and in hospital practice in order to protect the mucous membranes from the effect of chill it is usual to give the disinfecting baths not on the day of discharge, but the day before. It is advised also that the discharged patient should sleep apart from others for at least a fortnight, or so long as there is any suspicion of nasal or aural discharge.

Outbreaks of scarlet fever in schools commonly originate from convalescent cases presenting a discharge from the ear or nose. Not infrequently the children with these discharges have attended school right through the attack ("missed cases") or have been absent for a day or two only with a "sore throat" or a "cold." In such cases detection often does not come until other children have been infected and an investigation is made. In these days of mild scarlet fever the missed case is generally regarded as the cause of the continued prevalence of this disease.

Though direct contact is by far the most important method, scarlet fever may be spread also by means of *food*, particularly *milk*, and by clothing and other *fomites*. *Fleas* and other biting insects may play a part, but it is unlikely that either water or soil or defective sanitation operates at all.

Many outbreaks are traced to *milk*, and in investigating cases inquiries as to the source of milk supply are always made. If several cases are associated with one milk supply, a thorough examination must be undertaken and may reveal that the milk-carrier, the milker, or some other individual on the farm is in an infectious condition. In some instances the cows giving the milk are found to be suffering from a form of *ulceration of the teats*, and it has been suggested that the organism causing this condition, a streptococcus, is the same as that producing scarlet fever in human beings.

Outbreaks associated with milk present certain characteristic features that may be noted, viz. (1) they are generally sudden, (2) children, being milk drinkers, are the chief sufferers, (3) the outbreak, at first at least and until contact infection begins to operate, is localised, cases occurring mainly amongst the users of one supply, (4) the type of disease is generally mild, (5) the outbreak commonly subsides rapidly, particularly if the milk is dealt with.

The infection in the case of milk is of course *swallowed*. In other cases, however, it may be inhaled or enter at a wound or a burn. Parturient women are supposed to be particularly liable to attack because the genital tract is in a more or less wounded condition.

Prevention.—The methods adopted resemble those applicable in the case of diphtheria. Patients discovered to be suffering from the disease must be isolated in hospital or at home. Rooms, clothing, etc., must be disinfected. The source of infection must be discovered if possible and dealt with.

In school outbreaks "missed cases" must be sought for and excluded. The regulations laid down by the Board of Education are that infected children should be excluded during the period of isolation in hospital or at home, plus two weeks after return home in the former case, and after disinfection has been carried out in the latter. Children living in infected houses when the patient has been removed to hospital should be excluded for two full weeks after disinfection. When the patient is treated at home the period of exclusion of the other children from the same house should be the same as for the patient himself.

When the school outbreak is at all considerable the question of *school closure* may have to be considered, though many regard it as more or less useless, especially in towns, where children may come as closely in contact outside as inside the school.

In *milk* outbreaks stoppage or pasteurization of the milk is necessary.

Routine methods—notification, isolation, and disinfection, and the others noted—have not proved particularly successful in scarlet fever. The disease is, if anything, more common than ever. A great diminution was hoped for as a result of the establishment of hospitals, and disappointment has been great that no fall has resulted. At the root of the trouble is the missed case, the patient with the disease in such a mild form that until desquamation occurs no one can diagnose it.

The Practitioner and Prevention.—As in diphtheria the practitioner should look to other members of the family as well as the patient: examine throats, look for desquamation, and so on. When his diagnosis is made he must notify without delay. If the patient is isolated at home, he must see that isolation is properly carried out and that none of the other members of the family expose themselves to risks of infection. As a further precaution he may adopt the method suggested by Dr. Milne of Dr. Barnardo's Homes, which consists in anointing the body of the patient with eucalyptus oil and syringing the throat with a weak antiseptic solution. The object of this procedure is of course to prevent the diffusion of the virus from the surfaces from which it seems mainly to escape. If he suspects the milk to be the source of infection, he may give instructions as to boiling, etc., but he should certainly report his suspicions to the Medical Officer of Health.

Continued Fever, though in the list of notifiable diseases, was probably only included in order to ensure that cases of enteric or other fevers running a prolonged course should not be overlooked. The average number of cases notified in England each year is about one hundred, and a number of these are probably either typhoid or paratyphoid fever. In cases definitely diagnosed as paratyphoid fever, which is non-notifiable, if it is desired to bring their existence to the notice of the Medical Officer of Health by way of notification, they might conceivably be certified as "Continued Fever (Paratyphoid)."

Relapsing Fever.—Though this disease was sometimes called "famine fever," and was supposed to be due, like typhus, to privation, its chief association is with insanitary conditions, its decline and practical disappearance being coincident with improved sanitation and housing.

Cases are sometimes met with in Ireland; and epidemics occur occasionally in India, in Russia, and Northern Europe. It is a highly infectious disease and is due to a spirillum (*spirochæta*) first described by Obermeier (*Spirillum Obermeieri*), who found it in the blood of patients suffering from the disease. Insects (fleas, bugs, and ticks) appear to be the principal carriers of infection.

The *incubation period* of relapsing fever is from five to ten days. *Prevention* is the same as in the case of typhus fever.

Tuberculosis occurs all over the world. Climate and season, race, age, and sex exert no influence whatever. Roughly, in England and Wales alone phthisis kills something like ten or twelve persons annually out of every 10,000, and the other tuberculous diseases eight or nine per 10,000.

During the year 1913 there were notified in England and Wales 96,533 cases of pulmonary tuberculosis and 38,190 cases of other forms of the disease, equal respectively to 2·64 and 1·14 per 1,000 persons living.

In addition to being the most fatal of diseases, tuberculosis, the pulmonary form particularly, causes a great deal of disablement and suffering. It shows a distinct preference for males, something like four more males than females dying annually per 10,000.

There is no greater drain on the manhood of a nation than this disease; and when the sums spent upon it in poor relief and in hospital and sanatorium treatment are added to the loss resulting from the diminished productiveness of the adult male victims, the seriousness of the position is made all the more apparent.

Though much is made above of the fact that male adults are so largely affected, it must not be supposed that either females or children escape lightly. So far as females are concerned, the figures, though smaller than for males, are still considerable, and just as in males it is the adults who suffer mainly. In childhood the mortality is highest between ten and fifteen, and lowest between five and ten years.

To account for the relatively greater prevalence of the disease amongst males a suggestion sometimes offered is that the lungs in the female are less liable to injury; the explanation generally accepted, however, is that it is largely a matter of occupation. Women, though no doubt just as much exposed to infection, owe their escape to the fact that their surroundings at home, no matter how insanitary they may be, are less trying than those of the males, their life generally more sheltered, and their work, no matter how hard, less strenuous.

Causation and Sources of Infection.—Tuberculosis is due to the *B. tuberculosis* of Koch. It is generally regarded as an infectious disease, the infection arising in most instances from an existing case, either human or bovine. In the case of infection from the bovine, entry to the human body occurs as a result of ingestion of milk or of meat containing the germ, particularly the former. The seat of infection is then mainly the abdominal glands and organs, the bacillus having passed through the intestinal mucous membrane into the lymphatics. Other organs, the lungs, meninges, etc., are reached by way of the lymph or blood stream.

The material conveying the bacillus from the infected human subject to the uninfected is generally believed to be the *sputum*. In advanced cases particularly, large numbers of bacilli are given off in this way, to escape when the material dries and is ground into dust. Picked up by air currents and wafted here and there, the infected dust finds its way into a human body where, if the conditions are suitable, it sets up the tuberculous process in the lungs or elsewhere. The method of reaching the spot where it eventually settles, it should be noted, is not necessarily through the air passages, nor is inhalation the common method of infection.

Pure inhalation infection is probably rare, and dried sputum, having regard to the considerable length of time which it takes to dry and the shortness of the life of the bacillus in the presence of light and air, of comparatively little importance. In relation to sputum, the greatest risk of infection arises from *droplets of material* discharged by the consumptive during coughing, sneezing, and loud speaking, when considerable numbers of bacilli are expelled.

As a matter of fact it makes little difference whether the bacillus escapes with it or from it after it has dried; the sputum of a patient suffering from phthisis is always dangerous material, particularly if carelessly discharged or exposed. No doubt it often goes in particles of moist sputum; equally it probably also goes with dust. The *house-fly* may also act as a carrier, bearing bacilli from the sputum to food. The greatest risk of infection is run by those most intimately associated with the consumptive person, and having regard to the fact that the methods and opportunities of spread are so numerous it is practically never possible to say exactly how it has occurred. Inhalation infection in such cases and in general probably plays little part, and it is safe to say that if spread of infection were limited to inhalation there would be far fewer cases than at present exist. Further, if it were at all active as a method, the precautions taken by consumptive employees in factories and workshops would be much less effective than they undoubtedly are, and employment with a consumptive almost as dangerous as many, unfortunately for the consumptive workman, desire it to be regarded.

Tuberculosis in Animals.—Both cattle and pigs suffer to a considerable extent from tuberculosis. In the case of the former there is danger to man both through milk and flesh. From *pigs* the risk is from the flesh only. *Sheep*, possibly because they lead a much more open-air life than cattle or pigs, comparatively rarely suffer from tuberculosis.

Amongst cattle the percentage suffering from tuberculosis is very high; somewhere between 15 and 30 per cent. of carcases examined after slaughter have been found to be tuberculous. Cows appear to be particularly susceptible, and in some districts as many as 13 per cent. of the milks examined have been found to contain tubercle bacilli. In large towns and districts where supervision is strict, tuberculous cows are only exceptionally found in the herds, though in some instances over 50 per cent. of the cows of certain breeds have given a positive reaction when tested with tuberculin.

The bacillus associated with bovine tuberculosis differs in certain minor respects from the human variety. Nevertheless, *infection of man from bovines* can take place, usually by way of the digestive system, milk being by far the most common vehicle for transmission of the bacillus. The milk containing the organism in the vast majority of cases comes from a cow with tuberculosis of the udder, but bacilli may find their way in as a result of contamination of the fluid with excreta.

With regard to infection from *tuberculous beef and pork*, the view that all organisms are destroyed as a result of the cooking of the flesh is not generally accepted, and so long ago as 1898 recommendations were issued by the Tuberculosis Commission that carcases or parts of carcases showing signs of this disease should be regarded as unfit for food.

Predisposing Conditions.—The chief factors predisposing to tuberculosis are *social* and *sanitary*: *poverty, bad housing, overcrowding, poor ventilation and foul air, insufficient daylight,* and *insufficient nourishment and clothing*. For the occurrence of infection *exposure to the organism* and *diminished resistance* are all that appear to be necessary. Both may result in the home, or the diminished resistance may come from the bad conditions in the home and the exposure to infection occur elsewhere. In the case of children the diminished resistance may come from home conditions or heredity. In the case of adults either the exposure or the production of lowered resistance may come from the employment.

The *trades* which are commonly held to be those increasing liability to attack are such as are carried out in badly lighted and ventilated places; such as are associated with the production of irritating dust and particles, and such as cause the workers to lead a hard and exposed life.

The part played by *poverty* is very great. Much of the fall in the death-rate from this disease that has taken place in late years is traced to improvements in the social conditions of the people. Generally speaking, the poor have been better fed, and to some extent also they have been given better houses. With regard to *housing*, it should be pointed out that in a great degree defective housing operates because it deprives the individual of proper and sufficient light and air.

Tuberculosis is an urban disease, because housing in towns is frequently bad, and light and air unequally distributed. In this connection it may be noted that the type of dwelling known as the "*back to back*" house, in which a house is built with its back against that of another, or otherwise so that through ventilation is interfered with, is particularly bad.

As regards *overcrowding*, the difficulty is that the amount of fresh air per head is reduced and the air breathed is mainly such as has been fouled by use because it is impossible to obtain sufficient ventilation and air supply. In overcrowded places there is also greater risk of infection, because of the more intimate association of the occupants. The *dirty and badly* *kept house* is no less dangerous than that in which there is overcrowding.

Amongst other conditions regarded as predisposing to infection with the tubercle bacillus may be mentioned *alcoholism, insanity, syphilis*, attacks of *acute febrile diseases* such as enteric fever, measles, whooping-cough, and influenza. *Pneumonia* and *pleurisy* are often, as is well known, forerunners of phthisis.

Damp soil is said to favour the disease, and in a number of districts in which the soil was markedly damp great reduction was said to follow soil drainage. In certain districts also *rain-bearing winds* have been held to exert an influence, and in Exeter, for example, areas or streets which are exposed to S.W., W. and N.W. winds have been shown to have a much higher tuberculosis death-rate than any others.

Prevention.—Broadly speaking, the two main directions taken by prevention are towards *improving sanitation* and *educating the people*, particularly the poor and ignorant and those who are infected.

In regard to sanitation, every effort is made to abate overcrowding; to obtain remedies for defective conditions in existing houses; to prevent the occupation of unsuitable houses and parts of houses; to get rid of houses that are beyond repair; and to provide new and better housing, open spaces, and suchlike improvements.

Supervision of the food supply, of milk and meat particularly, is also attempted. Close watch for the detection of tuberculous meat is kept on slaughter houses and at ports to which carcases come from abroad. Butcher shops are visited regularly, and any meat regarded as suspicious is seized and destroyed. *Cowsheds* in towns are regularly visited and the cows examined. As already hinted, however, it is not milk produced in the town that is the danger, but that coming from country districts. In these, though there are signs of improvement, the supervision is less strict, and milk from tuberculous animals is sold, probably in considerable quantities, in most districts. Generally speaking, therefore, it is wise to pasteurise or boil all milk that is to be consumed by young children.

Education takes the form of spreading information as to the causation of the disease, its mode of spread, and the possibility of preventing it and even curing it by giving attention to the rules of personal hygiene. The fact that cases are now compulsorily notifiable is important and helpful. Notification not only reveals the places in which environmental conditions require attention; it brings forward also the infected, who can be instructed as to how he may help himself and at the same time protect others, and generally helps in connection with methods of prevention.

The *advice* given in infected households is general and special: general with regard to the advantages of cleanliness, fresh air and sunlight or daylight; special as to the necessity for providing the patient with a separate bed, and if possible a separate sleeping-room, and as to the danger from sputum. The consumptive is recommended not to *cough* without first protecting his mouth with a handkerchief and not to *spit* indiscriminately, but always into a spittoon or a spit bottle containing a quantity of a disinfectant. In many districts *spittoons or spit bottles* as well as disinfectants are distributed free of charge to poor patients. Instructions are given as to the *cleansing of spittoons*, and it is advised that if there is a water closet the contents should be emptied into this, or if not, that they should be buried fairly deeply. Handkerchiefs used for shielding the mouth in coughing should be handled carefully and should not be unnecessarily exposed. They should be placed in a disinfectant before they are washed.

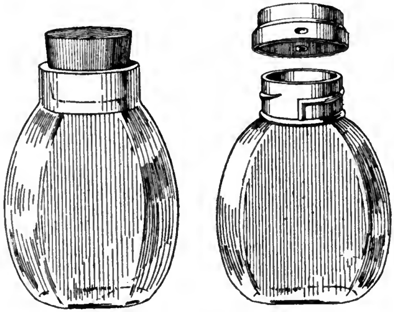

FIG. 11.—Sputum bottles. Apparatus of this kind is recommended for use by consumptive patients, and even distributed free by many health authorities.

Disinfection of the premises and clothing of a patient on removal to hospital or elsewhere, or after his death, is generally carried out and possesses a certain amount of educational value if nothing else.

Particularly since the passing of the National Insurance Act, many authorities have established special departments and prepared *special schemes* of working, and have appointed *special officers*, medical and nursing. Tuberculosis Dispensaries, Sanatoria, and Hospitals for Advanced Cases have also been established.

Considerable importance is attached to the institution of *Dispensaries*. Broadly speaking, the dispensary is a clearing house for tuberculosis in the district which it serves. It is staffed by one or more medical officers and one or more nurses, and at it patients, and as many as possible or all of the contacts with a person found to be tuberculous, are examined, and if found in need of treatment in a sanatorium or hospital are sent on. Visits are paid to the home by the dispensary officers; treatment is given; attempts are made to obtain improvements in environmental and sanitary conditions, educational work is done, and so on. That part of the insurance benefit known as *Domiciliary Treatment*, which is intended for such patients as are unsuitable for admission to an institution, is also frequently carried out from the dispensary.

The *Sanatorium* is intended mainly for the treatment of early cases. The *hospital for advanced cases*, which is not uncommonly at the Poor Law Infirmary, is really an isolation hospital; and from the preventive point of view, isolation of cases in the later stages, when the danger of spread of infection is greatest, is most important.

In the case of tuberculosis, however, there is no general power to compel patients to submit to isolation; and having regard to the fact that it is chiefly the careless patient who is the danger (a fact that should be impressed), there is probably no need for wide powers in this connection.

After care of patients discharged from sanatoria is an important matter and one to which many authorities, with the assistance of philanthropic bodies, are giving attention. Further, in order to diminish risk of infection from sputum in public places and conveyances, it is quite a common practice for authorities to arrange for the exhibition of "Do not spit" notices. By-laws with regard to spitting have also been passed, and occasionally persons are punished for disobedience of these.

In connection with preventive work, especially on the educational side, reference should be made to the importance of *school medical inspection* and the *teaching of hygiene* in schools. The benefit resulting from these is certain, as time goes on, to become more evident even than it is now.

From the administration of the National Insurance Act, 1911, particularly that portion dealing with *Sanatorium benefit*, assistance in regard to prevention is to be hoped for also. Indirectly, much of the advance recently made is traceable to this measure, and it was to provide properly for the treatment of the insured consumptive that thoroughly organised schemes became necessary. The practically universal establishment of dispensaries and the speeding up of sanatorium provision was the result.

Practitioners and Prevention.—By attending to his duty in respect of notification of cases the practitioner can certainly assist in prevention. Chiefly, however, he will do so if he regards himself as the hygienic as well as the medical adviser of the family to which the patient belongs.

Having regard to the importance of fresh air in the treatment of tuberculosis, he will impress the importance of the *open window* and will do his best to see that it is kept open. He will press for *cleanliness* also, and for the carrying out of the various measures already noted, including separate beds for consumptives, the use of spit bottles, and so on.

He should try to get into touch with all the members of the family and try to arrange for their examination. In carrying out this work he can receive assistance from the Tuberculosis Dispensary. There also the practitioner in charge of insured as well as uninsured patients will find some one ready to consult with him in regard to any difficult case. In connection with prevention the Medical Officer of Health and his department are always at the service of any practitioner.

Puerperal Fever.—The operation of the Midwives Act is largely responsible for the improvement which has taken place in connection with this disease. This Act, which at first applied only in England and Wales, and, though asked for, was not extended to Scotland till 1915, concerns itself largely with laying down rules as to the qualifications and conduct of midwives. Orders made under it compel the midwife to attend to asepsis and to give notice and call in medical aid on the occurrence of certain symptoms. Infection is spread mainly by dirty fingers and dirty instruments, enema syringes, etc.

In England and Wales in 1914 the number of cases of puerperal fever notified was 2,337 as against 1,989 in 1913. In 1909 the death-rate from puerperal sepsis per thousand births was 30 per cent. lower than that of 1901, and since then the reduction has continued.

Prevention.—The lines of prevention are obvious. With improvements in sanitation and increase in the amount of attention given to the parturient woman, a steady reduction in the numbers of cases may be expected.

Practitioners and Prevention.—In the majority of instances the cases of puerperal fever are amongst women attended by midwives and not by doctors. So much regard is now given by the practitioner to asepsis, that it is not to be wondered at that his cases escape.

Erysipelas.—The number of cases notified annually in England and Wales as "erysipelas" is about 20,000. The deaths average about 800, infants under one and adults over twenty-five contributing most of the deaths.

Nowadays erysipelas is regarded as comparatively unimportant, and there are many who doubt the necessity of retaining it on the list of notifiable diseases. In most districts no special *preventive measures* are adopted in respect of it.

Polio-myelitis.—One of the reasons for making this disease notifiable in 1912 was that it had been found to show a tendency to occur in the form of outbreaks here and there throughout the country. So far most of these have been small, but in America outbreaks of considerable size have occurred since 1907, and there a quite serious view is taken of the disease.

Generally known as infantile paralysis or "acute anterior polio-myelitis," the disease has been defined as one "resulting from an acute, self-limiting, general infection, occurring sporadically and in epidemic form, its most marked symptoms being sudden paralysis emanating from lesions in the spinal cord and brain."

The incubation period is on an average four to five days, and the *onset*, though it may be sudden, is more commonly gradual, showing all the signs of a slight feverish attack before the characteristic pareses appear. The disease is most prevalent in summer and seems to have first attracted attention about 1880, since when epidemics in increasing numbers have been noted. In 1913 the total number of cases notified was 728.

Age and Sex.—Children mainly are attacked, about 75 per cent. of the cases occurring at ages under five. The case mortality is from 10 to 15 per cent., and in about half of the cases that recover there is permanent paralysis of one or more groups of muscles.

The *virus* responsible for the causation of the disease is not as yet made out, though it is believed to be present in the mucous membrane of the nose, pharynx and gastro-intestinal canal, the spinal cord and brain.

Transmission.—The disease varies somewhat in *infectivity*, transmission occurring largely as a result of direct and probably fairly close and intimate contact. Though quite frequently the bedfellows of persons attacked escape, occasionally two or more cases occur in the same house.

Social and *sanitary* conditions seem to exert little or no influence. *Schools* are believed to play some part, and there are some who trace the spread of infection to dust. Food, especially *milk*, is also blamed. Abortive cases and healthy human *carriers* and insects have been blamed. In America particularly, the stable-fly (*Stomoxys calcitrans*) is regarded as a carrier of importance, and biting insects such as fleas are also under suspicion.

Prevention.—Practically no routine preventive measures have so far been adopted by local authorities. After receipt of a notification, visits are paid to the addresses given, with the object of obtaining information as to the source of infection.

The suggestions offered by the Local Government Board are that (1) an antiseptic solution (1 per cent. hydrogen peroxide or 1 in 500 permanganate of potassium) should be applied in the form of a spray to the throat and nasal passage of patients and of persons brought in contact with them. (2) All discharges from the patient, as well as all articles which may be soiled by such discharges, should be immediately disinfected. (3) The sick should be isolated from the healthy, either at home or in a hospital. (4) The sick-room and its contents should be disinfected at the end of the illness. (5) No child should be allowed to attend school from an infected family.

Practitioners and Prevention.—The medical practitioner can assist in the prevention of the disease by notifying every case encountered in the acute stage and seeing that the precautions recommended above are properly carried out.

Cerebro-spinal Fever.—*Cerebro-spinal Fever*, known also as *Epidemic Cerebro-spinal Meningitis* or *Spotted Fever*, was made compulsorily notifiable at the same time as polio-myelitis, which, in the early stages particularly, it somewhat resembles. From the fatality point of view, however, the disease is much more serious, and if death does not result, recovery without some such sequela as deafness or blindness is rare.

Quite a number of outbreaks of the disease have occurred in this country and in Europe and America in recent years.

In 1913 the number of cases notified in England and Wales was 304. During the course of the war soldiers in this country and elsewhere developed the disease, and a considerable proportion of those attacked died. As the Canadian Contingent suffered markedly, it was alleged that they had brought the infection with them from Canada. It should be pointed out, however, that spotted fever has always been known more or less as a disease of war time, and in the campaigns of the past epidemics were fairly common in the armies engaged.

The *organism* associated with cerebro-spinal meningitis is the *meningococcus* (*Diplococcus meningitidis intracellularis* of Weichselbaum), which is found in every true case in the spinal fluid, and commonly also in the mucous secretion of the nose and pharynx.

In arriving at a diagnosis bacteriological examination of the spinal fluid, obtained usually by means of lumbar puncture, is of the utmost importance, and in most districts facilities for having it carried out are provided by the local authority.

Transmission.—As to the spread of the disease, little is known. In large towns it is usually the poorer classes who suffer, and dirt, insanitation, bad housing and overcrowding, all probably play a part. Direct and fairly intimate contact with the infected and with "contacts" and "carriers" who harbour the organism in the nasal secretion is probably necessary. A great deal of importance, it may be noted, is attached to carriers in relation to transmission, and it is the practice to take and examine swabs from the pharynx of all contacts with notified cases. The fact that the organism is found in the blood lends support to the view that possibly biting insects may act as carriers.

Prevention.—The measures described in connection with polio-myelitis would seem to be appropriate in the case of cerebro-spinal meningitis. Hospital isolation is particularly important and is commonly practised. Gargling of the throat and spraying of the nose and throat and plenty of fresh air are recommended in the case of contacts and carriers found to be harbouring meningococci. In America prophylactic injections of dead cultures of the meningococcus are recommended.

The Practitioner and Prevention.—No special note need be made of the procedure necessary on the part of the practitioner. Cases of basal meningitis not obviously due to the pneumococcus or the *B. tuberculosis* should be notified.

Cholera.—This disease, though included in the list of conditions notifiable in this country, is nowadays almost entirely limited to tropical countries, India particularly.

This country escapes because of the system in vogue at the ports which ensures the exclusion of cases, and because, even if a chance case did escape detection, the water supply and the sanitary arrangements, generally speaking, are so good that no epidemic of any size could possibly occur.

The best-known epidemics in Great Britain are those of 1831–2, 1848–9, 1853–4, and 1865–6. In 1893, the last occasion upon which the country was invaded, Grimsby and Hull being the points attacked, the number of cases was comparatively small and the death-rate 45 per million of the population. In India, between 1896 and 1912, over seven million deaths were certified as due to cholera, the death-rate being nearly two per thousand.

The *case mortality* is usually about 50 per cent. The *incubation period* is short, rarely longer than five days.

Causation.—The causative organism is the *Vibrio choleræ* or comma bacillus of Koch. It is found in the characteristic "rice water" stools of cholera patients and is fairly easily isolated from them.

In its *mode of spread*, cholera resembles enteric fever to a considerable extent. Infection, though it may be inhaled, takes place mainly through the digestive tract. It is primarily and typically a *water-borne disease*, but infection may occur as a result of direct contact with a person suffering from the disease or with his infected excreta. The water which contains the vibrios has acquired them either as a result of direct contamination with infective discharges, the infected persons having passed the excreta into the water; or indirectly, rain falling upon the surface carrying the pollution from the soil into wells, and so on.

The fact that the bacillus can live in soil, provided it is kept nourished and warm, is regarded as of considerable importance, and the relation of rainfall and the level of the underground water and temperature to epidemics in India and Germany is explained elsewhere. Cholera shows a preference for the warm periods of the year and usually dies out in the cold season.

Infection may be *spread* by means of *food—milk* especially —*fruit* and *vegetables*, or *aerated waters. Human and insect carriers* probably play a great part, and the spread of cholera from India to other countries, sometimes throughout the civilised world in the form of a pandemic, is accounted for mainly by the movements of human beings. some of them infected, some of them "carriers," some of them perhaps carrying infected articles.

Prevention is almost entirely a matter of attention to sanitation and water supply. In these respects no doubt great advances are taking place in India, and as ignorance and religious prejudices become less marked still greater advances will be made. In order to prevent the entry of cases into other countries dependence is placed upon quarantine or watchfulness at the various ports and other entrances.

In this country, as there is no quarantine, entire dependence is placed upon watchfulness. This is carried out in accordance with certain instructions laid down in *Regulations as to Cholera, Yellow Fever, and Plague,* issued in 1907. Under these regulations, it is the duty of the Medical Officer of Health, amongst other matters, to board any ship from or touching at an infected port and to examine all persons on board. Every person suffering from cholera is to be certified and removed to hospital, and none of the others may leave until he has given his name and the address to which he proposes to proceed. Having certified a ship infected, it is the duty of the Medical Officer of Health to take steps to have infected bedding and clothing and other articles, as well as the interior of the ship, disinfected. The bilge water, in both infected and suspected ships, must be disinfected and pumped out and the water tanks emptied.

These measures, which have been successful in this country, have the advantage that they interfere less with shipping than quarantine. Quite a number of other countries have agreed to adopt somewhat similar arrangements, and it seems probable that in time the older quarantine methods will more or less disappear.

Personal Prophylaxis.—Europeans taking up residence in infected districts are advised to exercise the greatest care in relation to eating and drinking, and are particularly warned against consuming food or drink prepared or sold in the bazaars. Vegetables and such fruits as grow near the ground and do not have to be peeled should not be eaten raw. Tomatoes, melons, etc., should be dipped for a few seconds in briskly boiling water; in the case of strawberries boiling sugar syrup may be used. Avoidance of alcohol is also advised, particularly in the hot weather. Tea is the safest of all drinks in the tropics. The greater attention which is now and has for some considerable time been paid to the water supplied to the troops in India has led to a great diminution in the number of cases amongst them. Inoculation with Haffkine's anti-cholera vaccine, giving first 1 c.c. of an attenuated culture and following it in three to five days with a similar dose of an exalted culture appears to have given good results.

Ophthalmia Neonatorum.—Though ophthalmia of the newly born may not add anything to the general death-rate, it is nevertheless a serious condition, leading in many cases to total or partial blindness. It was because of this that regulations making the condition compulsorily notifiable were brought into force. In these regulations ophthalmia neonatorum is defined as "a purulent discharge from the eyes of an infant, *commencing within twenty-one days from the date of birth*," and every practitioner is required to notify forthwith on becoming aware that a child upon whom he is in professional attendance is suffering from the disease. A midwife in attendance must also notify unless notification has already been made by a doctor.

Notifications must give the name and address of the patient and the date of birth and of onset of the disease, and are to be sent to the Medical Officer of Health. The fee payable is now 1*s.* to medical men and midwives alike. Midwives, it may be noted, are required by the Rules of the Central Midwives Board to send for medical assistance and to give notice of the fact of having done so to the local supervising authority under the Midwives Act in any case where she finds any inflammation of the eyes, however slight.

The prevention of ophthalmia neonatorum is really in the hands of the person in attendance on the mother when the child is born. If the infant's eyes are properly cleansed, if a drop of a solution of silver nitrate (1 or 2 per cent.) is instilled into them immediately, and proper precautions are taken to see that they are properly washed during the first few weeks of life, little harm is likely to come to them.

If ophthalmia does unfortunately occur, energetic treatment is indicated. The object of notification is to see that such treatment is obtained. In most districts, on receipt of a notification a lady inspector visits and makes arrangements as to treatment. In large centres there is commonly little difficulty in obtaining medical practitioners or nurses to apply the treatment, privately or in hospital, but in rural districts it is generally necessary for the authority to supply the nurses who are to carry it out.

The Practitioner and Prevention.—His duty has already been described, and it is safe to say that the majority of cases that occur are not amongst the confinements attended by doctors. Medical men usually see that the eyes receive attention, and in cases which they notify personally they have usually taken care to commence treatment before the notification is sent to the Medical Officer of Health.

Plague is notifiable under an order issued by the Local Government Board in 1900. In the East cases of plague occur in large numbers, and in India, in the seventeen years 1896–1912, over eight million deaths resulted from it, the years 1904, 1905, and 1907 contributing over a million each. Within the last few years there seems to be some tendency to decrease.

The *case mortality* in the East from plague is generally very high, 60 to 80 per cent. or over. In an outbreak that occurred in Glasgow in 1900 the rate was about 50 per cent. The *incubation period* is from three to five days and the *onset* sudden with marked feverish symptoms. The forms in which the disease may occur are known as *Pneumonic*, *Gastric*, and *Septicæmic* plague, and there is, in addition, an "ambulant" form. The first three are the most fatal, the ambulant cases rarely being serious enough to call for treatment. From the point of view of spread of infection they are highly important.

The organism associated with the condition is the *Bacillus pestis*, which can be isolated from the characteristic buboes, the spleen, and the blood, and in pneumonic plague from the sputum.

In the majority of instances infection enters through the skin, almost invariably by means of a flea-bite. It may result from *direct contact*, but this is exceptional and limited probably to the pneumonic form. Infection is apparently never carried by food. Plague as a matter of fact may be regarded as "a disease of rats which incidentally and occasionally attacks man" (Newsholme). The carrier of infection from the rat to man is the *flea*.

Since the discovery of the organism several attempts have been made to produce immunity against it by inoculation of dead cultures. The best known of these is *Haffkine's Prophylactic Fluid*, which is made from a six-weeks-old broth culture of the bacillus, sterilised at 65° to 70° C. for an hour. It is given in doses of 5 to 10 c.c. and is largely used in India, where it has been successful both in reducing the number of attacks and the mortality.

Prevention.—Since the discovery of the facts referred to above in relation to the causation of plague, great advances have been made as regards prevention.

In India the measures adopted include (1) temporary evacuation of quarters in which plague is prevalent, in this way removing man from danger of attack by infected fleas; (2) inoculation with Haffkine's prophylactic fluid; and (3) the systematic destruction of rats, along with measures to prevent these rodents obtaining food in human dwellings, and the rendering of dwellings as far as possible rat-proof. In effect these are the measures to be adopted in this or any other country.

Primarily watch must be kept on the rats, and as, as was shown in a recent outbreak in Suffolk, hares and other rodents seem also to be liable to plague, they too must be watched.

Rats must be prevented from landing at our ports from ships "coming foreign." How this is to be done has already been described and the methods of dealing with rats in relation to plague indicated.

In order to prevent the entry of human cases into the country, special rules have been laid down in the Cholera, Plague, and Yellow Fever Order. These relate mainly to rat destruction, and the taking of steps to prevent the landing of these vermin. Isolation of infected persons and the taking of addresses is to be carried out as in the case of cholera.

In the event of plague appearing in any district, *notification* being in force, the attention of the Medical Officer of Health would be directed to the cases; then would follow *isolation* of the patient and of contacts, *i.e.* evacuation of the house as in India; *disinfection* of rooms and of articles; and in addition, attacks on rats. Officers engaged in carrying out the preventive work, and possibly also contacts, would be given Haffkine's prophylactic, and the former especially would be protected in every way possible against attack by fleas and other biting insects.

In these times, provision is usually made by the local authority for the bacteriological examination of fluid from buboes, etc., and all medical men would be advised of this and probably at the same time warned that a case or cases of plague had occurred.

The Practitioner and Prevention.—Having been so warned, the practitioner would naturally be on the look-out, and would be chary about arriving at a diagnosis independently in any case which might possibly prove to be plague. Suspicious circumstances are the occurrence at or about the same time or in succession of more than one case of pneumonia in a house, or the unusual prevalence of disease of a dubious character in a neighbourhood. Fluid for diagnostic purposes can easily be obtained by means of a syringe from a bubo. If the bubo is discharging, some of the discharge may be collected in a sterile tube. Sputum in pneumonic cases is to be collected as in phthisis. When dead rats are to be sent for examination they should first be placed in corrosive sublimate or other strong disinfectant. Care must be taken against infection with fleas from the rat in these cases.

Measles is practically endemic in this country, occurring year after year, and showing epidemic tendencies each spring and autumn. Every second or third year the epidemic tendency becomes more marked, and the number of cases is greatly increased. Occasionally, even regularly every third or fourth epidemic, the disease appears to increase in virulence, and to show a very high mortality.

Children mainly are attacked, and particularly those under five years of age. In epidemics in places in which the disease only occurs as a result of spread from an imported case, *e.g.* Shetland and Fiji, age is no protection.

The number of *deaths* certified as due to measles each year is very large, much larger than that from the majority of other infectious diseases. Since 1881 the death-rate has varied from 18 to 45 per 100,000 living under five years of age. About 93 per cent. of the total deaths occur in the age period one to five.

Besides the deaths certified as due to measles, there are numerous others attributed to such causes as bronchitis, pneumonia, diarrhœa, and convulsions, but more or less the direct result of measles. The disease is particularly fatal to rickety children. Second attacks of measles are rare. The *incubation period* is generally about fourteen days, and the prodromal stage lasts two or three days.

The *causal organism* has not been discovered.

Infection is acquired mainly as a result of direct contact or from the discharge from the air passages. It is doubtful if it is carried by fomites. Amongst children, the schools, particularly the infant departments, are responsible, the infection in the majority of cases being the result of direct contact with a case in the early stage when the disease is highly infectious and practically unrecognisable.

Prevention.—Notification of measles was made compulsory under The Public Health (Measles and German Measles) Regulations, 1915, issued by the Local Government Board. Under these regulations the duty of notifying is placed not on the medical practitioner alone, but also upon parents or guardians of the patients.

In addition to calling for notification, the Local Government Board have given local authorities directions with regard to prevention and power to make provisions for carrying it out.

The measures to which it is considered special attention should be given are (1) following up of notified cases with a view to the discovery of unreported cases; (2) verification of diagnosis in cases notified by parents and guardians if no doctor is in attendance; (3) supervision of domestic isolation and treatment; (4) provision of hospital isolation and treatment for certain of the cases; (5) the making of arrangements for the exclusion from school of affected children and of certain of the family contacts.

In order to assist in carrying out visitation and the supervision of domestic isolation and treatment, local authorities are empowered to make arrangements for the provision of medical assistance, including nursing, for the poorest inhabitants of their districts.

Schools and Measles.—Considerable importance is attached to preventive measures against measles in schools for the reason chiefly that they play such a great part in its spread. In the past, schools were continually liable to be closed and school work to be upset on account of outbreaks of measles. Recently this has been to a great extent prevented by the introduction of a system of *exclusion of infected children*, and with them all family contacts under five years of age and such other contacts over this age who have not already suffered from the disease.

Actual school closure is limited to infant departments, and is done only when the exclusions are numerous. The fact that measles is more or less limited to the age group under five is a very usual reason for suggesting that the lowest age limit of school attendance should be fixed at five years.

The *period of exclusion* for infected children is four weeks, and for contacts attending the infant school, as well as those attending the senior school, who have not had the disease fourteen days. Seniors who have already had measles need not be excluded.

Disinfection, though no reference is made to it in the measures noted above, is sometimes practised, and probably will continue to be so. It may have some advantages, but since clothing, hair, etc., seem to have little to do with spread of infection, it is difficult to see that, apart from impressing the public, it does much good.

The Practitioner and Prevention.—Now that measles is notifiable, it is possible that the practitioner will have greater opportunities of taking a share in its prevention than he had in the past. He should be on the look-out to impress the seriousness of the disease, and the necessity for isolating the infected person and protecting the contacts from infection. Particularly he will try to break down the old beliefs with regard to measles : that it is trivial ; that anybody can treat a case ; and that every child must catch it sooner or later.

With regard to the *broncho-pneumonia of measles* he should remember that it is exceedingly infectious, and should try to ensure, as far as practicable, isolation of all children suffering from this sequela.

As to notification of cases, the following points are important from the practitioner's point of view : (1) The notification must be made as soon as he becomes aware that a person upon whom he is in professional attendance is suffering from measles (or German measles) to the Medical Officer of Health for the district. (2) He need not notify, and shall not be paid a fee for so doing, if he has reasonable grounds for supposing that the case has already been notified, or if a case has to his knowledge occurred in the same house or institution within the preceding two months and has been notified. No notification need be sent regarding an inmate of a building, ship, vessel, boat, tent, van, shed or similar structure belonging to the King. (3) The fees for notifications are the same as those paid in respect of cases of the other notifiable diseases.

Apart from the duties imposed upon medical practitioners, certain others are given to Medical Officers of Health and local authorities with a view to bringing about prevention. In respect of all cases notified it is the duty of the Medical Officer of Health to make "such inquiries and take such steps as are necessary or desirable for investigating the source of infection, for preventing spread of infection, and for removing conditions favourable to infection." If a medical practitioner is not in attendance on a patient, the Medical Officer of Health must take "such steps as are necessary or desirable for ascertaining the nature of the case."

Apart from providing forms upon which notifications are to be made, and supplying them on request to medical practitioners, the local authority may provide or contract for the provision of medical assistance for the poorer inhabitants of the district when suffering from measles (or German measles). Medical assistance is held to include nursing. As isolation in hospital of any considerable numbers of measles cases is likely to prove a very difficult matter on account of the extent of the ordinary epidemics and the limited amount of accommodation, it seems probable that at times there will be great calls upon the services of the nurses. What they will be able to do apart from recommending that a doctor should be called, and that in the meantime the patient should be kept warm in bed and apart from all other children, it is difficult to say.

German Measles.—Epidemics of this disease occasionally occur, and it is probably because it may be mistaken for measles or for scarlet fever, and causes some interference with school work, that it was made notifiable at the same time as measles. German measles, it should be noted, is a quite distinct disease; it always "breeds true" and affords no protection against either of the other two fevers. The case mortality is very low, and it exerts little or no influence on the general death-rate. The *cause* is unknown. It spreads mainly as the result of direct contact. In camps and barracks it may do so, and incapacitate considerable numbers of the men.

The *incubation period* is from fourteen to twenty-one days. Second attacks are rare.

Prevention.—The Public Health (Measles and German Measles) Regulations contemplate that measures similar to those suggested in the case of measles will be adopted in relation to German measles. Care should be taken that cases are not mistaken for scarlet fever, and sent into the scarlet-fever wards of a hospital, there to develop and possibly die of the more serious infection.

Amongst troops isolation of the infected for at least three weeks and disinfection of clothing and quarters are generally practised during an epidemic.

CHAPTER V

PUBLIC HEALTH AND DISEASE (*Continued*)

Prevention of Infectious Disease

In addition to the system of notification which has for its object the localising of cases of infectious disease, the methods of prevention applied to the majority of the commoner infectious diseases at least, are *isolation of the sick* and *disinfection of his dwelling, clothing, etc.*, with, in the case of smallpox and others of the more dreaded diseases, *quarantine* and careful *supervision of all contacts, i.e.* persons who have been associated with the infected person.

The routine of this system runs somewhat as follows: *notification* of the patient by his medical attendant; *isolation* of the notified person either at home or in hospital; *disinfection* of premises, bedding, etc.; *investigation* of circumstances in relation to the attack; *quarantine* of contacts if considered necessary; application of special measures, if any are indicated or applicable; removal or remedy of any defective sanitary conditions in the patient's home.

All of these measures are most closely linked together; none of them alone is really of much use without the others, though in many instances, as a result of want of knowledge as to causation, some of the steps in the procedure are perforce omitted. For the reason that each of them is important, it is necessary that they should be discussed.

Notification.—The diseases to which the provisions of the Infectious Disease (Notification) Acts, the measures under which notification is called for, refer are *smallpox, cholera, diphtheria, membranous croup, erysipelas, scarlatina* or *scarlet fever, typhus fever, typhoid* or *enteric fever, continued fever, relapsing fever*, and *puerperal fever*.

These are usually known as the *notifiable diseases*, and the list may be added to by a sanitary authority, either of its own accord or on the suggestion or by order of the Local Government Board. Quite a number of diseases have been added in this way, the reasons being either that the disease threatened, *e.g.* in the case of plague and cerebro-spinal meningitis; or that the necessity for actively interfering with it was urgently called for; or (as for example, when, smallpox being epidemic, chickenpox is made notifiable) that mistakes in diagnosis should not lead to difficulties in obtaining control over the main disease.

As instances of diseases added to the list apart from plague, cerebro-spinal meningitis, and chickenpox quoted above, there may be noted *anterior polio-myelitis*, *ophthalmia neonatorum*, *measles*, *anthrax*, *glanders*, and *hydrophobia*. In some districts whooping-cough and epidemic diarrhœa have also been included, either permanently or for a limited period, and many of the diseases now made generally notifiable by the Local Government Board, *e.g.* tuberculosis and measles, were notifiable in a number of areas before the orders affecting them came into force.

In regard to the diseases named in the Acts or added under the powers granted by them or otherwise, the persons primarily responsible for making the notification are the head of the patient's family and "every medical practitioner attending or called in to visit the patient."

In default of the head of the family, relations and others in charge of the patient, and even the occupier of the premises, are required to notify. The notification is to be sent to the Medical Officer of Health of the district by the practitioner "forthwith on becoming aware that the patient is suffering from an infectious disease," and by the head of the family, etc., "as soon as he becomes aware that the patient is suffering."

Except in the case of measles, where the requirement is definite that parents and guardians shall notify, in practice it is usually only the medical attendant who makes a notification, using generally a form provided by the local authority, and receiving a payment of 1*s.* in respect of each case.[1]

Every person who fails to notify as required by the Act is liable on conviction to a penalty of 40*s.*

Isolation and Isolation Hospitals.—From all points of view,

[1] Prior to the passing of the Local Government (Emergency Provisions) Act, 1916, the fee paid to the practitioner was 2*s.* 6*d.* if the case occurred in his private practice, and 1*s.* if it occurred in his practice as medical officer of a public body or institution.

but more especially the preventive, which seeks to protect healthy individuals from the possibility of infection, isolation in hospital is the more satisfactory.

In the home, no matter of what class, it is apt to be inconvenient and to interfere with the social and business relations of the other occupants of the house. The precautions usually recommended to be taken—*e.g.* the plentiful use of disinfectants and particularly the hanging of a sheet soaked in a disinfecting fluid outside the sick-room door; the provision of separate utensils of all kinds for the use of the patient and his attendants; the burning of the remains of food; the disinfection of bed and other linen before sending it to the laundry—are all troublesome to carry out, and quite frequently are neglected.

Practically, it is only in a hospital that anything like complete and thorough isolation can be practised, but sometimes even hospital isolation fails. Particularly in regard to scarlet fever has this failure been detected, and many examples of persons discharged from isolation, apparently free from infection, giving rise to the disease in others have been reported.

On account of the occurrence of these so-called "return cases" many authorities have ceased to believe that hospital isolation is any better than home isolation in this disease; nevertheless, where the circumstances of the people and the available accommodation in the house suggest that isolation at home cannot be properly applied, removal to hospital is recommended or even insisted upon. This advice is generally accepted, but if it is not—provided he can show that the patient is in an infective condition and without proper accommodation—the Medical Officer of Health can obtain an order from a magistrate under which removal can be carried out.

Hospitals.—In districts in which hospitals are provided the amount of accommodation usually bears some relation to the size of the population and the number of diseases to be isolated. In the larger districts provision is made for all the notifiable diseases with the exception of smallpox, for which separate accommodation is generally set aside. Roughly, in these places one bed is provided for every thousand of the population. In smaller districts it is not uncommon to find that the proportion is one for two thousand of the population, and that only one or two of the diseases are dealt with. In villages frequently a small cottage is used, and accommodation provided for four cases.

A great deal of care is called for in connection with the construction of hospitals. The site must be carefully chosen, must be of sufficient size, and readily supplied with water and easily drained. It should be isolated from neighbouring buildings, but should not be more than four or five miles from the district it is to serve.

The size of the site should be sufficient to provide a space of one acre for every twenty to thirty patients.

No part of the building in which patients are to be accommodated should be nearer to the boundary wall than 40 feet. The wards are most conveniently constructed in blocks of two, one for male and the other for female patients suffering from one specific disease. In some places all the wards are on one floor, but if a large number of beds are required, in order to economise space, the blocks may be two stories high; but in any case they should be separated by a space of at least 40 feet. Preferably the wards should be rectangular in shape, and should not contain more than twelve or fourteen beds, allowing 150 or 200 square feet of floor space and at least 12 feet of wall space per bed, and 2,000 cubic feet of air space per patient. There should be windows on both sides, the total glass area providing at least 1 square foot to every 70 cubic feet of ward space.

In height the wards should be from 12 to 15 feet. The walls should be smooth and impervious, so that they may be easily washed down.

Since windows are numerous, ventilation should be easily carried out, but additional air inlets and outlets may be provided. Even though steam or hot-water radiators are used, fireplaces are absolutely essential.

For artificial lighting electricity is best and most convenient. Water-closet, bath, and lavatory accommodation should be provided in connection with each ward, but should be entered through a lobby with a window to the open air, and not directly from the wards.

In each ward block there should be a room for the use of nurses from which a view of the wards can be obtained. This is usually spoken of as the *duty room*.

The accompanying plan of a ward block indicates a number of the arrangements referred to. Occasionally a suite of three rooms is placed near the entrance to the block, all communicating one with the other, and used in connection with the discharge of patients. Of these rooms, one is that in which a patient about to be discharged leaves the clothing he has worn while in the ward; another contains a bath of water to which a certain amount of disinfectant is generally added, and the third a dressing-room in which he puts on fresh disinfected clothing preparatory to leaving the hospital. Very often, instead of providing these rooms in connection with the ward, they are placed in a separate building, known as the *discharge block.*

Apart from the ward blocks, it is necessary to provide: an administration block; small wards for the isolation of doubtful cases; a laundry; a mortuary; a boiler house; a building to contain disinfecting apparatus; and so on. Of these, the *administration block* is the only one to which

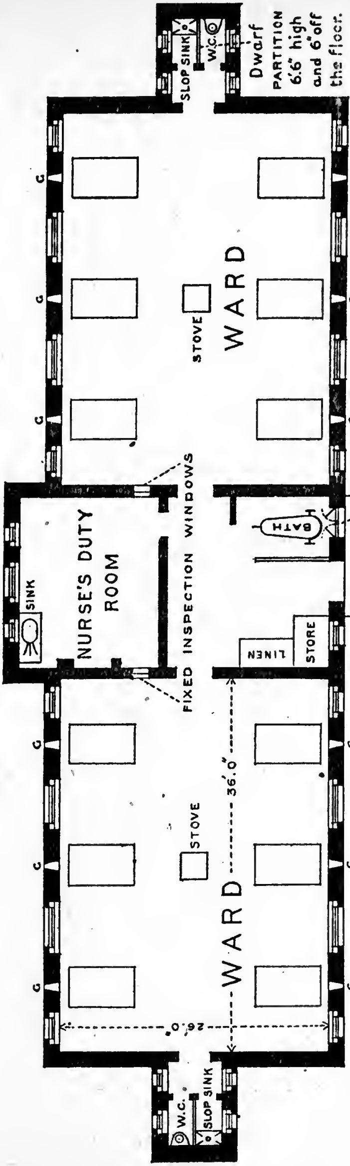

FIG. 12.—Plan of wards in ward block of an isolation hospital.

reference need be made. In it are placed the various offices in which the business of the hospital is transacted, as well as apartments for the medical and other officers. In the case of smaller hospitals it usually contains the sleeping-quarters for the nurses and others, and commonly also the hospital kitchen. In larger hospitals a separate nurses' home is not uncommonly provided.

The administration block need not be 40 feet from the boundary wall, but should be at least this distance from the ward blocks.

In the *administration of isolation hospitals*, of the many details that call for attention the *nursing arrangements* are perhaps the most important. Each ward block has its own fittings, utensils, and so on, and efforts are made to keep each disease as far as possible by itself. Sometimes an attempt is made to keep the nurses attending to patients suffering from one infection apart from those in charge of others, but if the nurses are careful as regards washing of hands, use of cloaks, and so on, there is little risk of infection passing from one patient to another through them, and separation is unnecessary. The great difficulty in keeping patients apart comes when convalescence is reached, and, to prevent mixing, a separate exercise ground should be provided for each disease.

Temporary Hospitals.—The arrangements described are such as should be provided in a more or less permanent hospital, but sometimes in epidemics temporary structures of wood, corrugated iron, or canvas are hurriedly run up, and if used in connection with an existing hospital, and placed on land near it, these are very convenient. Occasionally, because they are cheap, temporary buildings are erected in place of a permanent hospital. The material of which they are constructed is cheaper than ordinary building materials, and they can be put up with little labour; but sanitary conveniences and drainage, heating, lighting, and water supply are required for them as for the permanent building, and cost no less, and as repairs are continually required they rarely work out so cheap as it was hoped they should.

Smallpox Hospitals.—For the isolation of cases of smallpox special accommodation is necessary, but because the disease occurs so comparatively rarely quite a number of authorities object to making the provision. If it is made, all the points referred to above should receive attention, and in addition, in order to avoid all possible risk from "aerial convection" of infection, the building should be erected from a quarter to half a mile from populations of any size.

Within the last few years quite a number of such hospitals have been used as sanatoria for tuberculous cases, and the Local Government Board is generally prepared to permit of such use, provided arrangements are made whereby, if small-pox cases occur, the hospital can be used as originally intended.

Cubicles and Barriers.—Before leaving the subject of hospitals reference should be made to a special type of ward sometimes erected and a special method of use of wards sometimes adopted.

The object of both of these is to guard against *cross infection*, *i.e.* the infection of patients isolated on account of one disease with another. In what is known as the *cubicle system* the ward is divided into a number of separate apartments by means of partitions consisting mainly of glass. Each apartment is entered from an open verandah, and contains a bed and other necessary furniture, and is large enough to allow the patient between 2,000 and 3,000 cubic feet of air space. The nurse is provided with a room near the centre of the block, from which she can see into each of the cubicles. On the verandah, lavatory basins are provided in which the nurse is supposed to wash her hands after leaving a patient. Bathing of the patients may be carried out in portable baths, or a common bathroom may be used if proper precautions are taken. The same remarks apply in the case of water-closets.

The special method sometimes adopted is that called the "barrier method," in which more than one disease is nursed in the same ward, each patient being separated by a barrier, more or less imaginary, through which no one except the nurse is allowed to pass. Each patient is provided with separate and distinct utensils, and particularly with such appliances as thermometers, syringes, etc. Those who favour the method state that the secret of success is that the nurse should thoroughly understand and practise asepsis. She must wash her hands before and after touching a patient, she must wear an overall, and so on.

Disinfection.—The object sought in disinfection is to kill the organisms which, given off by the patient, may have found their way into the apartments which he has occupied, the bed and bedclothes he has slept in, the clothing he has worn, and the articles which he has used. The time to apply it is after the patient has been removed to hospital or, if he has been treated at home, when he has recovered or has died.

For the purpose of bringing about disinfection, disinfectants or agents having a germicidal power are employed.

In ordinary practice use is made both of chemical and physical means, the former for everything except clothing and bedding, which can be disinfected by heat.

The *chemical agents* employed are applied either in a gaseous or a liquid form. Of the gaseous disinfectants those now mainly used are *sulphur dioxide*, obtained by burning sulphur in air, and *formalin gas* or vapour, obtained by exposing formaldehyde to the action of heat or some chemical substance.

If a liquid disinfectant is used, formalin is generally chosen, though in some places corrosive sublimate, or a liquid containing chlorine, or one or other of the coal-tar disinfectants is employed.

With both the gaseous and liquid agents what is mainly sought to be carried out is surface disinfection of the walls, floor, furniture, etc. A certain amount of aerial disinfection is also brought about, but in all probability sunlight and fresh air are equally effective in this connection. The procedure in relation to the application of the two forms of chemical agents differs slightly.

Gaseous Disinfectants.—When sulphur dioxide is to be depended upon, either crude sulphur or specially prepared "sulphur candles" or cylinders of the compressed gas, which are more convenient, may be used. The gas produced by the burning of 3 to 4 lb. of sulphur is taken to be the amount required for 1,000 cubic feet of space, and this weight of sulphur, or candles equal to this weight, should be ignited, or cylinders containing the requisite amount of gas should be employed.

Crude sulphur is not so much used now as formerly, candles or cylinders, though more expensive, being more certain and quicker. To obviate risks of fire the vessel containing the crude sulphur or the candle should be placed in a vessel containing water. To assist in setting the sulphur alight it is usual to apply a little methylated spirit, but before the process begins the room must be prepared. All furniture should be pulled out from the walls, and the drawers opened, so that the gas may get freely at all surfaces. Windows should then be closed, and all the cracks covered over with gummed paper or other suitable material. The chimney should be stopped with paper or wet cloths, and the fireplace and ventilating openings covered over with paper. Since the gas acts best in the presence of moisture, water may be sprinkled on any convenient surface. When all is ready a match is applied to the crude sulphur or the candles, or if cylinders are used these are opened. Since the gas is heavy it is well to place the sulphur at some height above the floor. When the evolution of gas is seen to have commenced, the person carrying out the disinfection leaves the room, shuts the door, and from the outside covers over all cracks or openings in it, *e.g.* the keyhole, through which the gas might escape.

The room should not be entered again for at least *six hours*,

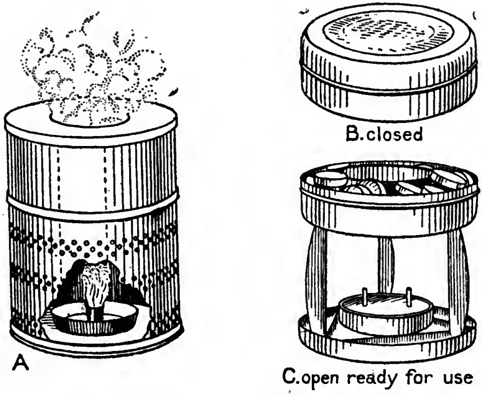

Fig. 13.—Apparatus used in connection with disinfection with formalin vapour obtained by heating tablets of formaldehyde. The form shown in B and C, being collapsible, is particularly convenient.

but preferably not within eighteen hours. When entry is made the windows should at once be thrown open in order to allow the gas to disperse. When the atmosphere is quite free the room should be thoroughly cleansed. Carpets and rugs should be taken up and beaten and shaken in the open air. Chairs and cushions should be taken out and dealt with in the same way, and everything that can be scrubbed and washed with soap and water should be so treated.

In some places wall-papers are rubbed down with bread or even stripped off before disinfection is carried out; and though this is hardly necessary, if a disinfected room can conveniently be redecorated so much the better.

The preliminaries to the use of *formalin gas or vapour* are the same as in the case of sulphur dioxide. The vapour is obtained either by heating *paraform tablets* or by allowing interaction to take place between liquid formalin, which is a 40-per-cent. solution of formaldehyde or formic aldehyde (CH_2O), and potassium permanganate.

The tablets are obtainable in such a size that twenty-five, when heated in a vessel over the flame of a spirit lamp or a small candle, give off a sufficient amount of the gas to disinfect 1,000 cubic feet of space. Various firms sell special outfits consisting of a tin containing the exact number of tablets and a small candle which, when lighted, burns sufficiently long to vaporise the tablets. Special lamps—Alformant lamps—are obtainable, and are sometimes employed.

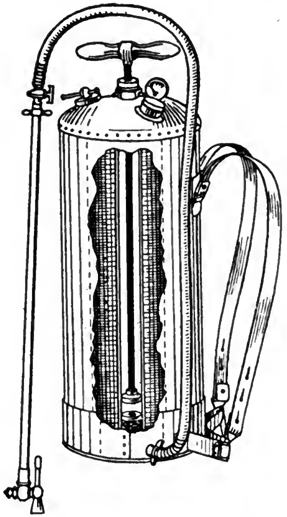

Fig. 14.—Formalin Spray Apparatus. The cylinder is carried knap-sack fashion by the person performing the disinfection after the cylinder has been filled with formalin and air has been pumped in.

When permanganate is used, specially made blocks in tins into which the formalin in sufficient amount may be poured will be found convenient. Various firms make a speciality of these blocks. In contact with the potassium permanganate the formalin rapidly vaporises, forming a thick white cloud. The exposure in the case of formalin should be the same as with sulphur dioxide, and following its use there should be, as before, a thorough cleaning of the room. One of the great advantages of formalin is that it has no tendency to cause damage to any of the articles or materials exposed to it. Sulphur dioxide, on the other hand, may cause a little discoloration and certainly tarnishes metal work, brass particularly.

Liquid Disinfectants are preferred by many to the gaseous forms, and very generally it is formalin that is favoured. Solutions of the hypochlorites and of coal-tar preparations are, however, sometimes used. For their application special apparatus is required, and various forms, one of which is illustrated, are on the market.

Formalin for spraying purposes is used in a solution of a strength of 6 ozs. to the gallon of water. When a room is to be sprayed all the pictures must be removed from the walls and furniture pulled into the centre of the room; then walls, ceiling, etc., are thoroughly sprayed from below upwards, in order to avoid streaking. The length of the process depends on the size of the room to be disinfected, but for an ordinary-sized apartment ten to fifteen minutes is about the average. The saving of time is one of the advantages of this method. Formalin has the special advantage that it does not damage wall-papers, etc. When the disinfection is completed cleansing should be carried out with the windows open.

Steam Disinfection and Disinfectors.—In practice the methods and agents referred to above are usually reserved for the disinfection of such materials as cannot conveniently be dealt with by physical agents, particularly heat.

For some time the form in which this was applied was as hot dry air, a special apparatus, more or less in the shape of an oven, heated by means of gas, being used. This proved unsatisfactory, not only because articles were not infrequently scorched or even burned, but because it was found that for anything but a mere surface disinfection it was quite inadequate. Resort was therefore had to moist heat derived from steam, and experiments that were made showed that even with bulky articles the heat penetrated well, and, provided a certain amount of care were exercised in connection with the exposure, even in the deepest layers sufficient heat would be obtained to ensure the killing of the most resistant germs and spores.

As in the case of dry air, it is necessary to use a special apparatus, but whereas at first it was generally believed that steam at a temperature of over boiling point (212° F.) was necessary, a considerable amount of work is now done in what are called "current steam disinfectors," with the steam just as it comes off from the boiling water and at the temperature of boiling water.

Steam with a higher temperature is usually obtained in practice by the use of pressure in the boiler and the disinfecting apparatus. The pressure ordinarily used is 20 lb. to the square inch, and though the boiler and the apparatus are constructed to withstand a higher pressure than this, matters are so arranged that there will be a blow off as soon as there is any tendency to pass the point named. The temperature obtained with this pressure is 220° F. and the steam is usually known as pressure steam, and the disinfectors in which it is employed as "high-pressure disinfectors" to distinguish them from the others referred to above, which are called "current or low-pressure disinfectors."

The articles commonly disinfected by means of steam are chiefly bed and personal clothing, mattresses, pillows, and such-like.

A certain amount of care is required in carrying out the process, but if trouble is taken no damage whatever need be caused to any article. Since stains of any kind on sheets, etc., are apt to be permanently fixed as a result of exposure to the steam, they should be removed before the disinfecting process is carried out.

Blankets, unless very carefully handled, are apt to be hardened by exposure to steam, and in many places it is the practice to disinfect these by soaking them in a liquid disinfectant. Gloves and furs, and articles made of leather, such as boots and belts, cannot be treated in a steam disinfector. For these, chemical disinfectants—liquid or gaseous—should be used.

Great difficulties are experienced with books. Generally, if they are of little value, it is recommended that they should be destroyed; if valuable, they may be placed in a box with the leaves as much separated as possible, and be exposed to formalin or other vapour.

Articles treated in a steam disinfector are usually exposed to the steam for at least twenty minutes. When the disinfection is completed the articles should be allowed to remain for a time in the apparatus to dry, but in connection with the majority of the machines there is usually some contrivance to assist the drying process by sucking out the steam and moisture or drawing in heated air.

With regard to removal from the apparatus, it may be noted that disinfectors are generally constructed to open at both ends, and disinfecting stations are built in two parts. The machine is built into the partition between the two apartments, one of which is used as a receiving room for infected articles, and the other for disinfected articles. When the door to the disinfector on the infected side is open the other

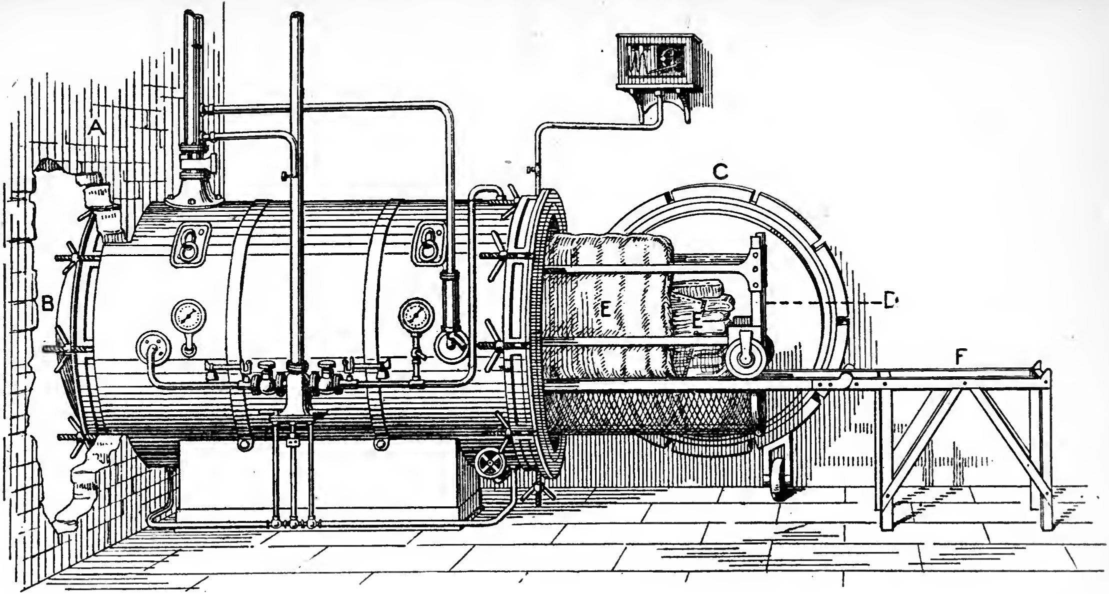

FIG. 15.—High Pressure Steam Disinfector (Equifex): (A) Partition between the apartment in which articles are received for disinfection and that in which they are removed from the apparatus after the process; (B) door on disinfected and (C) door on infected side; (D) cradle containing (E) articles to be disinfected; (F) detachable rails to carry the cradle.

is automatically closed, and *vice versa*, the only way of getting from the one room to the other being through the open air.

In relation to disinfection and its performance by local authorities it may be noted that, so far at least as the notifiable diseases are concerned, the process is performed free of charge and as a routine. The various articles to be disinfected by steam are collected and placed in a special vehicle; the room or rooms are prepared for disinfection and disinfected; the clothing is conveyed to the disinfecting station, and after having been dealt with there is returned.

In the poorer parts of towns where the tenements are small quite commonly the members of the family are provided with accommodation in special shelters until the process is completed. The local authorities have power to make this provision as well as to provide the staff and the materials and apparatus for carrying out the disinfection.

In other than the notifiable diseases, and when disinfection is performed on account of vermin, it is the practice in some districts to make a small charge if the parties concerned are in a position to pay. The requests for disinfection are usually directed to the Medical Officer of Health of the district and not uncommonly by the medical man to the family concerned.

CHAPTER VI

PUBLIC HEALTH AND DISEASE (*Continued*)

Non-notifiable Diseases

The diseases with which it is proposed to deal here include: Mumps, Whooping-cough, Chickenpox (Varicella), Pneumonia, Epidemic (Summer) Diarrhœa, Cancer, Influenza, Rabies, Glanders, Anthrax, Tetanus, Actinomycosis, Venereal Diseases, and Paratyphoid Fever.

Mumps (Epidemic Parotitis).—This highly infectious disease mainly affects children, boys particularly, but, as shown by the fact that epidemics occur in barracks, adults are not exempt.

Its distribution is world-wide, and in this country it appears most often in cold, damp weather, spring and autumn being its favourite seasons. So far no causative organism has been found. The *incubation period* is fourteen to fifteen days. The infection usually spreads by direct contact; the striking distance, however, is short, and several instances of spread in schools having been stopped short by a door are described. On an average about three deaths per million are registered annually as due to mumps. The fatal cases occur most commonly amongst children under five. It is least fatal between fifteen and twenty-five.

Amongst those who die, death usually results from cerebral complications, the other complications, orchitis, ovaritis, and pancreatitis, though painful, being rarely fatal.

Prevention.—Local authorities rarely pay any attention to mumps and, except in special cases, do not isolate or even disinfect. In boarding schools or barracks the infected should be isolated and disinfection of rooms and clothing carried out. As regards exclusion from school, the practice is to exclude the infected child and possibly also such family contacts as belong to the infant's department for a period of three or four weeks.

The Practitioner and Prevention.—The practitioner must guard against mistaking diphtheria with enlarged glands for mumps, and avoid sending cases of mumps diagnosed as some other disease associated with glandular enlargement, scarlet fever, diphtheria, or plague even, into hospital, since it is apt to spread rapidly, and may cause considerable administrative difficulties to the hospital authorities. The fact that the disease is sometimes fatal is to be borne in mind.

Whooping-cough affects children under five mostly, and causes a great many deaths amongst infants. Under one, females appear to die more readily from whooping-cough than males. Since 1891 the death-rate has been steadily declining, that for 1910 being lower than in that year by between 20 and 30 per cent. In 1911 there were 7,648 deaths, and in 1913, 5,327.

The fatality-rate is probably between 5 and 10 per cent., but varies with age: under the age of one it may be as high as 20 per cent. The majority of the deaths occur as a result of complications or association with such conditions as rickets and infantile diarrhœa. Cases occurring amongst children compelled to live under unhygienic conditions, where there is overcrowding, and so on, are most liable to end fatally.

The *incubation period* is about fourteen days.

Whooping-cough is most common in the spring and autumn, and epidemics occur more or less every two or three years.

The causative organism is probably the *B. Pertussis* (Bordet & Gengou) present in the bronchial secretions early in the paroxysmal stage. Infection may be obtained as a result of inhalation. Fomites seem to be capable of carrying infection also.

The patient is most highly infective in the early stages of the disease, and risks of infection largely disappear when the spasmodic stage has been reached. In New York all cases that come to the knowledge of the health department are kept under supervision, and parents are warned to keep infected children indoors until one week after the appearance of the whoop.

The rule as to the exclusion from school in this country is that this should be maintained for six weeks or as long as the cough continues.

Prevention.—Except that the disease is not notifiable, the measures adopted are usually the same as those followed in the case of measles. The improvement which has taken place in regard to the disease is commonly traced to improved hygienic conditions and the greater amount of care given to infants both as regards rearing and during an attack of the disease.

Preventive inoculation with vaccines of B. Pertussis has been tried and is recommended in America.

Chickenpox (Varicella) is only important because it may be confused with smallpox. Very occasionally a patient dies of chickenpox in a severe form, the so-called *Varicella gangrenosa*, or as a result of affection of the larynx, but generally speaking the death-rate is unaffected by chickenpox.

The *incubation period* is usually about twelve to fourteen days. Chickenpox is highly infectious from the onset, and infection results mainly from direct contact. The virus has not been discovered; and though it is supposed to be given off in the breath of the patient and to be contained in the scabs, nothing is known for certain.

The disease occurs in the form of epidemics, sometimes at the same time as outbreaks of smallpox, sometimes in the wake of scarlet fever and other infectious diseases. It seems to be independent of season. It affects children most commonly, but adults are not exempt.

That it is a distinct disease from smallpox is certain: vaccination against smallpox affords no protection from chickenpox and occasionally a patient suffers from the two infections at the same time. As a general rule chickenpox is not notifiable, but during epidemics of smallpox, or when it is threatened, local authorities, in order to avoid the risk of cases of the latter disease escaping detection, make notification of varicella compulsory for a period.

In the case of children attending school the rule is to exclude the infected child until all the scabs have disappeared. Only in the case of those attending the infant department is exclusion of family contacts necessary.

Prevention.—No special routine measures of prevention are adopted in connection with this disease. Very generally information with regard to cases in schools is sent to the Medical Officer of Health, and in these instances visits of inquiry are paid to the home of the patient. Advice is given as to isolation, and sometimes, if desired, disinfection is carried out after the child has recovered. When the disease is notifiable all notified cases are investigated.

The Practitioner and Prevention.—His part is to see that he does not diagnose chickenpox as smallpox or *vice versa.* Diagnosis to a large extent depends upon the appearance of the rash and its distribution, but in any case of chickenpox in which he feels the slightest doubt the practitioner should not hesitate to refer to the Medical Officer of Health.

Pneumonia.—In England and Wales the deaths from pneumonia average annually between 50,000 and 60,000, the majority being credited to the lobar form. This form there is at present a fairly marked tendency to regard as possessed of a considerable amount of infectivity, and instances are quite common in which two or more persons in a family are affected, simultaneously or consecutively. In institutions and in places, particularly if they have been occupied for some years, where many persons work or live together, a number of cases sufficiently large to justify the use of the term "outbreak" may occur at or about the same time.

In some instances, as at Middlesbrough in 1888 and more recently at Tranent near Edinburgh for example, such outbreaks are known as outbreaks of "epidemic pneumonia."

The organism most commonly found in lobar pneumonia and in the epidemic form and in broncho-pneumonia is the so-called *pneumococcus of Fränkel*, which occurs as an encapsuled streptococcus—usually a diplococcus—and is found in the expectoration. This organism, in addition to being capable of producing pneumonia, has frequently been found alone and has been regarded as the causative germ in cases of peritonitis, pleurisy, meningitis, middle ear disease, etc.

Another organism sometimes found associated with pneumonia, particularly in such cases as are classed as "epidemic pneumonia," is a bacillus called the *Bacillus pneumoniæ* of Friedländer. The *B. coli communis* and the *B. influenzæ* may also give rise to signs and symptoms of pneumonia.

Pneumonia, it is well known, frequently occurs as a sequela or a complication of enteric fever, and other infectious diseases are also quite often followed by an attack of this disease.

The infection in these cases has probably been predisposed to by the weakness following the earlier illness, the germ of pneumonia finding its way in from some outside source; or, since the pneumococcus is not uncommonly found in the normal secretions of the respiratory passages, it is not impossible that the cases are examples of auto-infection.[1]

[1] According to an American observer one pneumonia patient in five acquires infection from the organism present in the throat; four patients in five acquire infection through direct contact with a pneumonia case or carrier and with a pneumococcus only associated with disease conditions.

As the virus is contained in the expectoration, it is possible that infection is obtained in much the same way as in the case of tuberculosis, by inhalation or swallowing. As was shown in two outbreaks recently reported from Glasgow and Bermondsey, persons engaged in nursing pneumonia patients and therefore coming most closely in contact with them show considerable liability to become infected. Clothing and other fomites seem to be capable of harbouring the organism and spreading the infection.

The *incubation period* may be as short as twenty-four hours, but generally lasts about two to five days. The onset is sudden; and while the disease is mainly infectious when the expectoration begins to be discharged, it may be so from the commencement. Affection of the apex of the lung is supposed to be characteristic of the infectious variety of pneumonia.

Pneumonia is not limited to any *climate.* Great difficulty has been experienced with it amongst the workmen in Panama and in South Africa, and negroes are stated to be particularly liable to infection. Its favourite seasons are winter and spring. In this country it is more or less an urban disease and affects chiefly, though not exclusively, the poorer districts where there are overcrowding and insanitation generally. The case mortality is generally high.

"Chills" probably have little or nothing to do with pneumonia, though by lowering resistance prolonged exposure to cold may predispose to an attack. One attack of pneumonia does not confer any particular immunity, and second attacks are not uncommon. Some amount of immunity may be obtained by the injection of antipneumococcic serum or vaccine.

Prevention.—In some places, particularly in America, it has been made notifiable. If notification were adopted here, and the notified cases properly followed up and instructions similar to those issued in consumptive cases given, probably a great deal of good could be done and notification justified. *Isolation* might also be carried out and would undoubtedly be a valuable preventive. *Education* of the public is necessary in order that the knowledge that the disease is infectious may be spread and the importance of *fresh air*, *sunlight*, and proper *ventilation* and the dangers of *overcrowding*, *alcohol*, and *exposure* impressed.

Because of the association between pneumonia and insanitary conditions, improvements in *sanitation* and *housing* must as far as possible be obtained. That *vaccines* have a value in relation to prophylaxis must not be forgotten in connection with outbreaks in institutions and where large bodies of men are employed and housed. Disinfection of bedding and of rooms is resorted to in some districts as soon as possible after information has been received with regard to the occurrence of a case of or death from pneumonia, and, if for no other reason than that it directs attention to the belief that the disease is infectious, is probably useful.

The Practitioner and Prevention.—In cases which he is called upon to attend he should insist upon isolation and the adoption of general preventive measures. He should make it clear that the disease is infectious and warn contacts that it is possible to acquire the disease as a result of contact, or from the sputa. After the recovery or death of a patient he may recommend disinfection. In the majority of districts the local authority will carry this out free of charge.

Epidemic (Summer) Diarrhœa is mainly a disease of the early years of life and plays a large part in keeping up the death-rate amongst infants (Infantile Mortality Rate), a fact that has led to the application of the name *infantile diarrhœa* to it.

In summers characterised by a small rainfall and a continuous high temperature cases are more numerous, and the number of deaths very large. In cold wet summers there is a considerable fall in numbers. Why the type of weather should exercise so much influence is not quite clear, though the fact that variations in the number of cases correspond with the *earth temperature* and not with that of the air suggests that the soil has something, so far not explained, to do with it.

Diarrhœa is a disease of dirt and filth, and in towns cases are always most numerous where the houses and their surroundings, particularly the yards, are unclean and badly kept. It is rife in districts where privies exist, where the household refuse is neglected and the sanitary arrangements are primitive. The causative organism is not definitely known, but is probably intestinal in origin.

Multiple cases in households are not uncommon, and in all probability infection is acquired in much the same way as in enteric fever from the *discharges of the patient*. In diarrhœa the danger is greater even than in enteric, having regard to the difficulty of dealing with the excreta of infants in poorer-class houses. The *unwashed hands* of persons who have attended a child or an infant suffering from diarrhœa doubtless very often convey the infection either directly or indirectly through food.

Flies may carry the infection, having obtained it from the excreta of an infected person or from filth and filthy surfaces, privies, and manure and refuse heaps. The material picked up by these insects usually reaches the human subject through food, milk, etc., contaminated by them.

Cows' milk is generally regarded as a common vehicle, because it is mainly infants who are bottle-fed on cows' milk who are attacked. Breast-fed babies are least commonly affected, and next to them those who are partly on the breast and partly on the bottle. Cows' milk is probably contaminated chiefly by flies and dust.

Other foods may also carry the infection, and outbreaks in hospitals and institutions are commonly traceable to infected food. *Water* may act as a vehicle if exposed to contamination with filth.

Prevention.—The description given above practically indicates the lines to be taken; the following summary of suggestions offered to local authorities by the Local Government Board may, however, be found useful:

(1) Systematic visitation of the houses of infants with a view to the removal of injurious conditions in or about their homes.

(2) Special visits to mothers during the season in which infantile diarrhœa is likely to prevail.

(3) Advice should be given as to the domestic precautions to be taken, laying stress upon the necessity for boiling the milk when received, properly cleansing and scalding the milk vessels, and keeping the milk cool by placing the vessel in cold water and covering it with muslin.

(4) Warn mothers that any domestic uncleanliness and the preparation of an infant's food with unwashed hands may lead to serious consequences.

(5) Advice should be given as to the method to be adopted for dealing with flies.

(6) Local authorities should see to removal of refuse and scavenging generally, and street watering. In districts in which the privy system prevails they should make every effort and give every assistance to get rid of them. They should see to it also that yards are paved and kept clean, ashpits as far as possible demolished and proper covered bins provided.

Notification of diarrhœa has not yet been attempted generally, but would undoubtedly be useful. *Isolation*, though rarely practised, is almost as essential as in the case of enteric fever.

The Practitioner and Prevention.—His line should be that laid down in connection with enteric fever. He can assist in the education of the people, pressing for breast instead of bottle feeding and insisting upon cleanliness in feeding; warning mothers of patients that the disease is infectious, and pointing out how spread of infection is to be avoided.

Cancer.—Though the number of deaths due to cancer is very large and is, apparently at least, steadily increasing, remarkably little is known about the condition.

At one time thought to be *possibly infectious*, it is now declared not to be.

All kinds of irritants and irritations are blamed as causes of cancer, but exactly why they should act is not definitely understood or explained. The theory that *heredity* plays a part is not now accepted. The evidence that *cancer districts* and *cancer houses* exist is almost entirely statistical, and quite frequently, particularly in the case of cancer houses, it has been shown to be quite inadequate to support the belief.

Occupation, though the sweep and the worker amongst pitch seem to run some risks in connection with their work, plays a very limited part in the production of cancer. *Insanitation*, overcrowding, defective housing, and poverty exert no direct influence.

The death-rate from cancer in 1913 was 1,055 per million, having gone up steadily since 1860. The increase is now generally alleged to be more apparent than real, and due to improved methods of diagnosis particularly as regards cancer of inaccessible organs.

The frequency with which the breast and generative organs are affected is supposed to account for the fact that females always show a higher rate than males. In 1913 the figure for males was 947 per million and for females 1,155. In males the alimentary system and particularly the stomach and liver are most liable to attack. The majority of deaths from cancer occur after the age of thirty-five.

Prevention.—Apart from drawing attention to the disease and the relation which chronic irritation seems to bear to it, little or nothing has been done in connection with cancer prevention. In some districts leaflets are issued setting forth what is known as to the cause of the disease and urging the importance of obtaining medical advice early.

On account of the acceptance of the "cancer house" theory by the general public, local authorities occasionally carry out *disinfection* on request.

Influenza is typically pandemic, but epidemics have occurred in all parts of the world and at all seasons of the year. In this country in most years a considerable number of cases are detected, the average mortality being about three per million.

Season and weather seem to exercise very little influence and sex affords no protection, the rates being always about equal for males and females.

Persons of any age are liable to attack. The case mortality is probably not high except amongst persons of advanced age and those weakened by respiratory or other diseases.

Very often the term "influenza" is very loosely used, and probably large numbers of cases of catarrh and so-called "influenza colds" are not the result of infection with the specific organism at all. Cases of enteric fever and pneumonia are quite commonly stated at first to be examples of influenza.

In any outbreak the majority of the persons attacked suffer from symptoms affecting the respiratory, the alimentary, or the nervous system. The disease is highly infectious, and infection is usually acquired as a result of direct contact. The *incubation period* is short and the onset sudden. So far as can be judged from statistics, rural districts seem to suffer more than urban districts. In weakly persons particularly, pulmonary tuberculosis is not an uncommon sequela.

The causal organism is the *B. influenzæ* of Pfeiffer. As to the mode of spread of infection nothing definite is known, though it may be mentioned that in the respiratory form the bronchial mucus usually contains a number of the bacilli.

During epidemics, it is stated, domesticated animals, cats and dogs as well as horses, sometimes suffer from attacks of this disease. "Pink eye," a severe and fatal disorder to which horses are liable, at one time described as a form of influenza, is now believed to be a distinct infection.

Prevention.—Influenza spreads so quickly, lasts such a comparatively short time, and is so rapidly infectious that preventive measures, if any could be adopted, would almost inevitably prove of no avail. Notification has practically never been tried, and in all probability would be useless.

The Practitioner and Prevention.—By advising isolation the practitioner can do something towards limiting the spread.

Home isolation should be as complete as possible, since it is practically unknown how spread takes place.

Rabies (**Hydrophobia**), rare amongst the human inhabitants of this country, occurs to some extent in France, Belgium, and Russia. In the United States of America a certain number of deaths from rabies are reported annually.

The *animal* from which rabies is acquired, in most instances, is the dog, though bites by wolves, foxes, and, more rarely, cats have also given rise to infection. Penetration of the skin is essential, and the risk of infection is said to be less when the bite is on a part of the body covered by clothing than when on an exposed part. Bites on the face are the most dangerous of all. Those that do not break the skin are least serious. About 15 or 16 per cent. of all persons bitten by an animal suffering from rabies take the disease.

The *incubation period* is ordinarily from six to seven weeks.

The *organism of rabies* has not as yet been isolated, though it is now known that the virus is present in the saliva, the central nervous system, the spinal fluid, the milk, and urine of infected animals. It is stated to be present in the saliva for from three to eight days before the symptoms appear, and this is the principal reason for advising that when a person has been bitten, the animal, if suspected of rabies, should not be shot, but kept under observation for a period of at least ten days. Symptoms should develop within that time.

In untreated cases the *case mortality* is 100 per cent.

Rabies is most common in *summer and autumn*. The mortality is highest amongst children, possibly because, in ordinary households, they are more closely associated with the domestic pets than are the adult members of the family.

Prevention.—On the occurrence of cases or suspected cases in any district a muzzling order should be issued at once, and stray dogs should be destroyed.

When a person is bitten the wound should be dealt with at once by means of strong nitric acid or the actual cautery. Disinfectants, *e.g.* carbolic acid, though recommended, are held to be unreliable. Silver nitrate is useless. Cauterisation with acid may result in the warding off of danger, but no risks should be taken, and it is preferable that the Pasteur treatment also should be applied.

The object of the treatment is to habituate the patient to the virus by inoculation of stronger and stronger doses until eventually he is capable of withstanding the dose acquired directly from an infected animal.

The Practitioner and Prevention.—The main part of the practitioner is in relation to treatment rather than prevention. He should never agree to the destruction of the suspected animal, but should recommend that it be kept for observation. The dread of rabies is so great that almost always advice is sought as soon as the bite has been inflicted. The practitioner may have to decide whether or not the patient should undergo treatment, and may safely advise it, since, though there may be risks of sequelæ such as paralysis, in the majority of cases there are none.

Glanders or Farcy.—This disease, though not unknown amongst human beings, in this country at least is rare. The persons affected are usually those who work among horses, and in them infection has been obtained as a result of direct contact or inoculation from an animal suffering from either acute or chronic glanders.

In the acute as well as the chronic form the chief sign is affection of the nasal mucous membrane accompanied by a muco-purulent or purulent discharge. In both also, more commonly perhaps in the acute, the skin is apt to be involved with the formation of nodules which break down and discharge a blood-stained fluid. Ulceration of the nasal mucous membrane and the skin is a common feature, and glandular enlargements are usually present in the angles of the jaw.

The skin nodules are frequently named "farcy buds," and "farcy" is used as an alternative name to glanders in those cases in which skin lesions and enlargement of the lymphatic glands are marked.

The *causative organism* is the *B. mallei*. From it a vaccine named "mallein" is produced and used mainly for diagnostic purposes amongst horses.

The disease is exceedingly infectious amongst animals and also to man unless particular care is taken to prevent the entry of infective pus into abrasions or through the mucous membranes or conjunctivæ. Though animals may apparently acquire infection in this way, it is unlikely that man can be infected by eating meat from a glanderous animal.

The *incubation period* is from two to seven days. The death-rate amongst animals is very high, and in the case of man recovery rarely takes place.

Prevention.—The main efforts at prevention are made on behalf of animals (horses, asses, and mules) and the Board of Agriculture have issued an order (*The Glanders and Farcy Order*, 1907) giving instructions as to the slaughtering of infected animals and the methods to be adopted in connection with the disposal of the carcases. Stalls and premises in which a case has occurred are to be thoroughly disinfected, cleansed, and limewashed. Prevention of infection in man depends largely on the exercise of care by the individual. In London an order calling for notification came into operation in 1910. In 1913 the condition was notifiable in thirty-six other districts.

Anthrax in man usually results from infection from wool, hair, hides, or skins, particularly such as have come from abroad. Because it is most common in persons employed amongst wool it has been called "wool-sorters' disease." Next to these, tanners and others who work with hides and skins are most liable to infection, generally the result of inoculation leading to malignant pustule on the face or back of the neck. Amongst persons employed in sorting wool and hair, especially horsehair from the East,[1] the infection is commonly inhaled or swallowed, and the respiratory or digestive system affected (internal anthrax). In both external (malignant pustule) and internal anthrax there is always a risk of general symptoms developing, but the internal form is much the more dangerous.

The causative organism is the *B. anthracis*, which when exposed to air rapidly forms spores provided with a thick capsule and exceedingly resistant to heat and disinfectants.

Animals—cattle, sheep, pigs, etc.—are very liable to attack by anthrax, and after death, which generally results in a comparatively short time, the blood and the spleen teem with bacilli. In an animal dead of the disease the spleen is commonly found to be greatly enlarged and very soft. Infection in animals is generally swallowed and comes usually from food contaminated by the bowel and other discharges of infected animals. In order to prevent the risk of infection of grass-fed animals it is recommended that carcases should not be buried in fields without special precautions, since anthrax spores may be brought to the surface by worms and otherwise.

The *incubation period* of anthrax is two to five days.

[1] A number of shaving-brushes recently shown to be infected with *B. anthracis* were found to consist largely of horsehair from China and Manchuria.

Amongst cattle the case mortality is difficult to estimate, since infected or suspected animals are usually slaughtered and not uncommonly the carcases find their way into meat markets.

In man the chances of recovery from external anthrax are considerable, provided the pustule is completely removed without delay. Internal anthrax is generally fatal.

The deaths from anthrax in this country are not numerous, though the disease is not uncommon in Bradford and other Yorkshire towns where cloth making and wool working are the important industries. In 1913 the disease was notifiable in thirty-eight districts. In London it was made notifiable in 1909.

Under the Factory and Workshop Act 1901, *notification* of anthrax cases is called for from medical practitioners *if the disease is believed to have been contracted in a factory or workshop*. The notification, in respect of which a fee of 2*s*. 6*d*. is payable, is to be sent to the Chief Inspector of Factories, Home Office, London.

Prevention.—With a view to preventing spread amongst animals, the Board of Agriculture issued an order—the *Anthrax Order* 1910—imposing certain duties in relation to the disease upon farmers and others.

In connection with the prevention of anthrax amongst wool-sorters, great importance is attached to the presence of *blood clots* in the raw material as the hiding places of anthrax spores, and it is recommended that they should be carefully sought for in the process of sorting, and destroyed or treated with a disinfectant.

For the protection of the workmen from dust, the use of extraction fans and the wearing of respirators and overalls are insisted upon. All dust abstracted by fans should be burned.

The necessity for absolute cleanliness, abstention from taking food in workrooms, and the washing of hands before food should be impressed upon the workers, who should also be forbidden to work unless properly protected if they have any cut, sore, or abrasion of the skin. Having regard to the importance of early treatment, suspicious symptoms should at once be reported. An obvious precaution is, of course, thorough disinfection of the material before it is to be handled, and horsehair imported from China, Siberia, and Russia is required to be so treated. In the case of wool, however, though boiling, steaming, or treatment with certain liquid and gaseous disinfectants would destroy the organism, the possibility of damage to the raw material unfortunately restricts their use.

In the prevention of risk of *infection from food* the enforcement of the Anthrax Order is probably of considerable assistance. In addition, careful inspection of carcases of meat is necessary.

The Practitioner and Prevention.—The practitioner will have few opportunities of preventing the occurrence of cases of anthrax, though by insisting upon early and thorough treatment he may be able to ensure the recovery of his patient.

Tetanus.—Though this disease is largely one of hot countries, each year a number of deaths in England and Wales are certified as due to this cause. A considerable proportion of these occur amongst infants and children under five, and at all ages the number amongst males is always higher than amongst females.

The organism responsible for the disease is the *B. tetani.*

Infection occurs almost invariably as a result of inoculation at a wound.

Horses and other animals are liable to attack, and in the majority of instances persons infected have obtained the infection in stables or from manure, the normal habitat of the bacillus being apparently the intestines of the horse and other animals. The bacilli or their spores, which are very resistant, can live for a considerable time in soil, dust, and manure, and in some instances, probably, infection has followed inoculation of a wound with one or other of these materials. The large number of cases that appeared amongst the men who fought in France and were wounded there in the early part of the war resulted from inoculation with soil that had been enriched for vine growing, year after year, by the liberal application of manure.

Jute brought into this country from India is capable of carrying the spores, and several cases have occurred from time to time in jute mills. The case mortality is very high.

Prevention.—Stablemen, gardeners, and jute workers particularly should give immediate attention to wounds, and should not allow them to go untreated or to remain unprotected during work. Jagged wounds are the most dangerous, and the tiniest scratch may form the starting-point of the disease.

Actinomycosis.—The parasite of this disease is the *actino-*

myces or Ray Fungus, a name given to it on account of the arrangement of the filaments of which it consists. In nature it is found fairly commonly on the spikelets of certain grasses—Timothy grass, wild barley, etc.

Actinomycosis is primarily a disease of cattle, and in them it is generally found in the alimentary canal. The parts about the head, the jaw, tongue, mouth, and glands of the throat are commonly affected, but cases in which the udder is involved are sometimes seen.

The organism enters usually with hay, straw, or other dry food through an abrasion or a small wound. Infection of the jaw may take place through a decayed tooth. The term "lumpy jaw" is used to describe the appearance when the jaw is affected. When the tongue is attacked so much fibrous tissue is formed and the organ becomes so firm that sometimes it is referred to as "wooden tongue."

Amongst human beings the disease is not of frequent occurrence in this country, and, though infection may occur as a result of a bite from an infected animal, in the majority of cases the fungus probably finds its way into the body in a manner similar to that seen in the case of cattle.

The possibility of man suffering infection from the consumption of meat from diseased carcases seems to be slight, nevertheless it is generally held that infected tongues and flesh, being diseased, are unfit for human consumption and should be condemned.

Prevention.—Except as regards meat inspection it is doubtful if any general measures of prevention can be adopted. Since there may be danger from wild barley and grasses, the practice of chewing straw indulged in by farm workers and others should be discouraged. That there is risk of infection from bites of infected animals is a fact to be borne in mind.

Venereal Diseases.—The absolute extent to which these diseases occur is practically unknown.

According to one estimate there are every year 122,500 fresh cases of venereal disease in London and 800,000 fresh cases in the United Kingdom. Of the latter number, 114,000, it is computed, are syphilis and the remaining 686,000 cases of gonorrhœa and chancroid. This means that about one person in fifteen or about 7 per cent. of the people are syphilitic. With the exception of measles, gonorrhœa is stated to be the most frequent infection, and in New York as high as 75 per cent. of the male population are believed to be infected.

The only figures which give any real indication of improvement are those relating to the army and navy, but these relate to the pre-war period, and the opinion generally now held is that after the war both service and civil figures will be found to have increased tremendously.

As to deaths from syphilis, a steady slow decrease in the number has occurred, but that this indicates anything but that it is not given as a cause in death certificates is unlikely. Neither general practitioners nor hospital physicians and surgeons find any falling off in the number of cases encountered, and there has been no decrease in deaths from post-syphilitic conditions. Some indeed, particularly those connected with disease of the blood-vessels, have shown a tendency to increase. As regards sex in relation to deaths from syphilis, it may be taken that the figures for males are at least one-third higher than for females.

As to *age*, the death returns in the main relate to infants and children under five. From five to fifteen the numbers are at their lowest, beginning to rise at the age of twenty and to fall somewhat at sixty, more markedly at seventy and on to eighty.

Syphilis and the other so-called venereal or enthetic diseases are of world-wide distribution. In this connection it may be noted that there seems little doubt that a good deal of infection in this country is imported by sailors and others whose duties call them to foreign countries, and that cases are more numerous in ports and in districts including a port than elsewhere.

The organism of syphilis is the *Spirocheta pallida* (*Treponema or Spironema pallidum*) and of gonorrhœa the *Gonococcus*, a small coccus occurring usually in pairs, the adjacent surfaces being flattened or concave.

The *incubation period* of syphilis is three weeks, and of gonorrhœa two or three days. The infection, in the majority of cases, both of syphilis and gonorrhœa is obtained as a result of direct contact during coitus. In the case of syphilis accidental infections of fingers amongst surgeons and nurses are fairly common, and spread as a result of kissing or using cups and other utensils employed by patients in the primary and secondary stages of the disease is not unknown.

Syphilis may be transmitted by the parents to the offspring in the primary and secondary stages of the disease.

Gonorrhœa is almost always obtained during sexual intercourse, though accidental infections may occasionally occur. Some reference has already been made to the danger to health and to the public health from the venereal diseases. Apart from insanity, general paralysis and other nervous sequelæ, syphilis is responsible also for many of the numerous cases of, and deaths due to, disease of the heart and blood-vessels. It is held also to predispose to tuberculosis. It is the cause of a large percentage of the miscarriages that occur year by year, and if there were no syphilis very many infants would be saved much suffering and there would be a great fall in the number of deaths amongst babies and young children.

Many deaths and much ill-health amongst women are traceable to infection with gonorrhœa often innocently acquired.

Prevention.—Though in certain parts of the United States of America some attempt is made to deal with these diseases, and in parts of Australia Acts have been passed making notification compulsory, forbidding quacks to treat patients with venereal disease, empowering the taking of action in respect of prostitution, and the provision of free treatment, at the moment little or nothing is done here.

The official view is that venereal diseases can best be controlled and those free from infection best protected by providing means for early and accurate diagnosis, and making skilled advice and adequate treatment easily available for all infected persons. Local authorities have been directed to make arrangements in accordance with this view, and will receive financial assistance provided the arrangements are approved by the Local Government Board.

Officially *notification* of cases is not favoured, on account of the fear that the dread of publicity would drive still more of those who have acquired infection into the hands of the quack.

Education of the public is a necessary part of prevention, and in the case of the venereal diseases education, because it brings in matters that it has not been customary to discuss publicly, viz. prostitution, sex, and sex-hygiene, is not considered to be easy. In Queensland, in order to ensure wider publicity with regard to the diseases, special leaflets are distributed and probably have a value. With care such leaflets could be made quite inoffensive.

Prostitution, since prostitutes are the main spreaders, is a matter to be seriously dealt with; unfortunately, however, the proper method of dealing with it has not yet been found.

Examination and more or less the certification of prostitutes as practised in some continental countries are unsuitable for this country, and as a matter of fact have absolutely failed wherever they have been tried.

Teaching with regard to *sex* and *sex hygiene*—as to the facts of life and of birth, the practices to be avoided, and the risks run by those who are unclean sexually—is counted as essential. If it is attempted, however, it must be done by some one who has the confidence of the child, and who has authority and tact. Probably the parents are the best, and after them the teacher. The period chosen should be about puberty, and the teaching should be individual.

Prophylaxis.—In most countries, but particularly in Germany and America, a great deal is done with a view to prevention amongst soldiers and sailors. In these countries chief reliance is placed upon calomel ointment (30 to 50 per cent.), and on request a quantity of this is provided to any man, with instructions to rub it well into the glans penis.

In the American army the men are encouraged to report to the medical officer for the application of preventive as well as curative treatment at the earliest possible moment after exposure to or the appearance of signs of infection. The results obtained are stated to be excellent. From the use of the Wassermann test, which need not be described here, in diagnosis, and of salvarsan or its alternatives in treatment, a great deal is expected, and any scheme of prevention must include facilities for obtaining these by the sufferer. No serum for use in the treatment of syphilis or gonorrhœa has as yet been discovered.

Syphilis and Marriage.—As the danger of transference of infection to the offspring of syphilitics is limited to the primary and secondary stages, it is usually stated that such persons should not marry until they have undergone at least three years' continuous treatment and have been free from symptoms for at least a year. Unfortunately there is no means of compelling the subject of syphilis to follow this advice. Attempts have been made in America to make the production of a clean tree of health by both parties to a marriage compulsory, but only with doubtful success.

The fact that in many cases the syphilis which infects the offspring is acquired after marriage only needs to be mentioned.

Paratyphoid Fever.—Clinically this disease and enteric fever are one; bacteriologically they are quite different, the organism associated with paratyphoid and known as the *Bacillus paratyphosus* presenting certain features that distinguish it from the *B. typhosus* of Eberth. Generally two classes of the bacillus are recognised, viz. *paratyphoid* A and *paratyphoid* B, according to the effect produced in certain culture media and on certain animals. In the human subject the two types produce similar effects, though type A is more commonly found than type B.

The paratyphoid bacillus is more pathogenic for the lower animals than is the *B. typhosus*. In infected individuals it is found in the blood, the fæces, and the urine, and can generally be isolated from these. *Paratyphoid carriers* are no less common or dangerous than enteric-fever carriers.

Like enteric fever, paratyphoid occurs all over the world. In this country probably a certain proportion of the cases regarded and treated as enteric are cases of paratyphoid. In warm climates, particularly India, the disease is more or less endemic, though epidemic proportions are rarely reached. During the war quite a number of cases occurred amongst the forces fighting in the Dardanelles and elsewhere.

Paratyphoid seems to be a lighter infection than enteric, the case mortality rate being 3 to 5 per cent. as against 10 to 30 per cent. for the other.

The one distinctive feature between the two diseases, as regards etiology, relates to the causative organism, and what has been said with regard to incubation, source of infection, and mode of spread in the case of enteric fever may be taken to apply to paratyphoid also.

Prevention also should proceed along the same lines, except that, if the desire is to protect against paratyphoid, inoculation must be made not with *B. typhosus*, but with the *B. paratyphosus*. For absolute safety probably the best course of all is to inoculate with a mixture of the three organisms, *B. typhosus* and *B. paratyphosus* A and B.

Paratyphoid fever is *not notifiable* as such in this country, though many Medical Officers of Health will accept the notification in this form, "Continued (paratyphoid) fever." In all probability the disease will in time be placed upon the list of notifiable diseases.

In India a careful record is kept of all cases; and after the diagnosis has been made on a culture from the blood or discharges, a full investigation is made in respect of each case.

Search is always made for possible *carriers*. It is suggested that, having regard to the fact that the natives seem to suffer from the disease to some extent, all followers and servants employed with British troops should be examined, and those found to be carriers should be dismissed.

In order to provide a convenient means of including both enteric fever and paratyphoid fever under one head and of facilitating comparison with the figures for the years prior to the recognition of paratyphoid, it has been suggested that the name "Enterica" should be used.

CHAPTER VII

TROPICAL DISEASES

No branch of preventive medicine probably has received more attention within recent years than that concerned with the diseases which are peculiar to or occur most commonly in the tropics, and in this chapter it is proposed to deal with a few of them, and to give an outline of the preventive methods adopted.

Malaria occurs largely in tropical countries and to a considerable extent also in Europe, *e.g.* in Italy and southern Russia, and in many parts of America. Wherever it occurs to a marked extent it causes annually many deaths and much suffering and economic loss. Women as well as men suffer, and children are readily infected.

Causation.—The organism associated with the disease is the so-called *Plasmodium malariæ*, an animal parasite, which attacks the red blood corpuscles, and developing in them eventually leads to their destruction.

With each type of malaria there is a special type of plasmodium associated, and the several stages in each type of fever mark definite stages in the development of the parasite.

The parasite has the power of reproducing itself both asexually and sexually, the former occurring completely inside the human body, sexual reproduction only being fully carried out within the body of a female anopheles mosquito, the main carrier of the disease.

Apart from acting as a carrier this insect serves as a biological factor also, union between the male and female elements (gametocytes) withdrawn from the malarious individual taking place within her body. The sporozoites which result from the union are discharged by the mosquito into any person attacked, to settle down in the red blood cells and set up the disease.

Prevention. Mosquito Destruction.—In relation to the

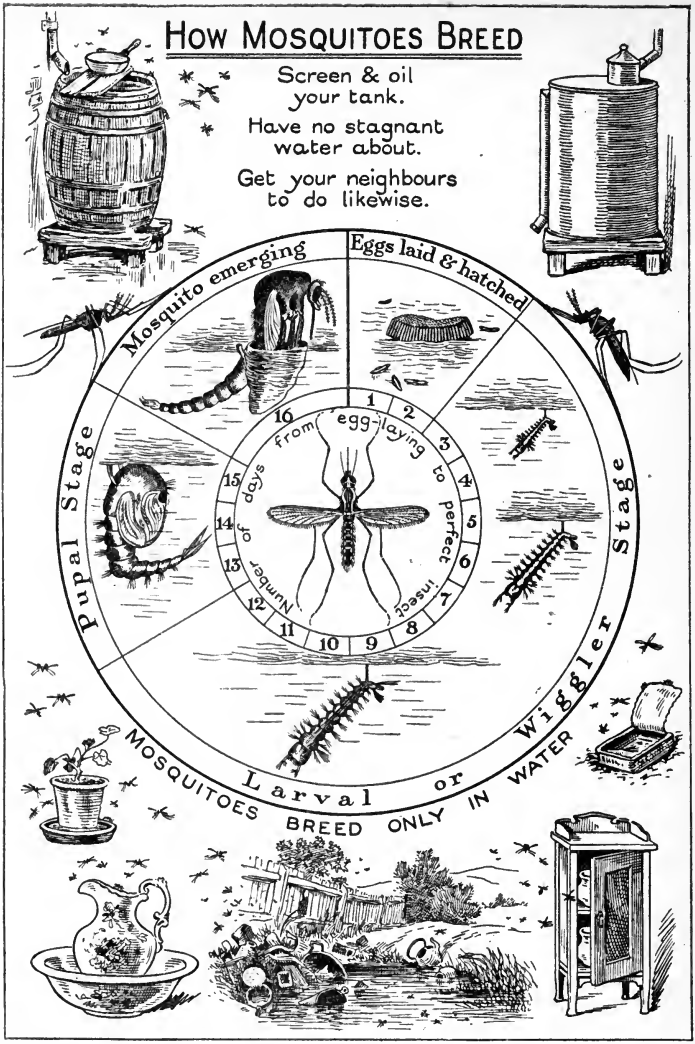

FIG. 16.—Shows the development of the mosquito and some of the situations in which it may breed out. Posters somewhat on these lines are used by the health authorities in Brisbane and elsewhere. Note the mosquito-proof water-butt in the top right-hand corner.

prevalence of malaria the anopheles mosquito is an absolutely essential element, and if it can be blotted out of a district there will be no more malaria. Measures having this as an object are widely adopted, and consist mainly of attacks upon the collections of water that form the breeding-places of the mosquito. They include *drainage* of land and abolition or covering of drains, ditches, pools, and cesspools. The surface of collections of water that cannot be so dealt with is generally covered with a layer of *petroleum or kerozene.*

In Khartoum, where as a result of active anti-mosquito work malaria has become very rare, creosote and other disinfectants are regularly added to stagnant water. Penalising of persons who allow mosquitoes to breed out on their premises is a most excellent preventive.

Fish of various breeds, *e.g.* the minnow-like fish known as

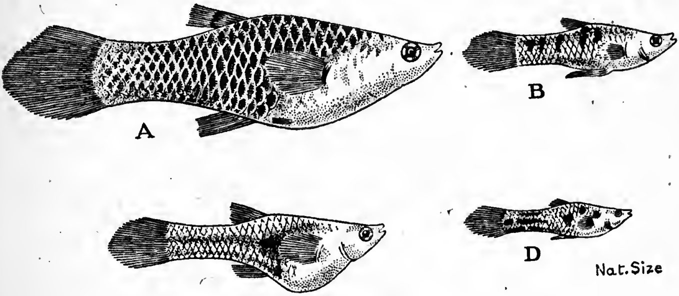

FIG. 17.—The "millions" fish.

"millions," which are known to have an appetite for mosquito larvæ are very largely employed for stocking ponds known or likely to act as breeding places.

Prophylaxis.—With the object of protecting himself from attack the individual may adopt certain precautions. If he must be out-of-doors in the evening, when the anopheles is most active, he may protect his face, hands, and wrists and any other exposed parts of his body, or apply strong-smelling oils.

To protect himself during sleep he may use *mosquito net curtains* over the bed and place *netting over doors and windows.* In constructing houses in the tropics a wide verandah should be formed and completely closed by means of small mesh wire gauze.

Quinine in five-grain doses daily is very widely used as a prophylactic in most malarious districts, and in many places is distributed free to the natives and those who cannot afford to purchase it.

Black-water Fever is probably a form of malaria and occurs in a number of districts where the latter disease is common. The case mortality is high, about 25 per cent. or more of the cases terminating fatally. Natives are much less liable to attack than Europeans, and amongst the latter new-comers commonly escape, those who have been in residence for some time providing most of the cases.

The *causation* of the condition is somewhat obscure; the view more or less widely held at present, however, is that it is a malarial infection and associated with improper use of or idiosyncrasies in relation to quinine. One attack of the disease predisposes to others, and relapses are not uncommon.

Yellow Fever is spread by a mosquito, the *Stegomyia calopus or fasciata*. It occurs in the West Indies and West Africa, with occasional spreads to other areas where conditions more or less tropical and suitable to the Stegomyia exist. As the Stegomyia lives and breeds in collections of water in the neighbourhood of houses, the disease shows a marked tendency to localisation, largely in the neighbourhood of the sea coast and navigable rivers. Spread of epidemics by land are comparatively rare, but carriage of infection by means of shipping frequently occurs, and outbreaks on ship-board are sometimes reported, the infection having been carried by mosquitoes which have made a home on board.

The disease generally disappears when the ship passes into colder latitudes as a result of the death of the mosquitoes, which, though markedly long lived under suitable conditions, soon die off in the cold. In this connection it may be noted that, since the flight of the Stegomyia is short, provided members of the crew exercise care on shore and avoid entering houses and so on, if the vessel is moored from 1,000 to 1,200 feet from the land cases are unlikely to occur. The Stegomyia prefers *low country*; yellow fever is comparatively rare in elevated situations.

Both *sexes* are liable to infection, men possibly more than women. No *age* is exempt. *Insanitation*, particularly such as allows of the existence of conditions favouring the development of the Stegomyia, is favourable to the spread of the disease. Infection is not spread by means of *fomites*, The *case mortality* varies from 30 to 40 in mild, to 70 to 80 per cent. in severe epidemics.

The average *incubation period* is three to five days. The organism associated with the disease is at the moment not definitely known. Formerly the *B. icteroides* of Sanarelli was blamed; now, however, the opinion is that the cause is an ultra-microscopical virus and possibly a protozoon parasite. It is regarded as possible that some of the lower animals, *e.g.* monkeys, serve as reservoirs of infection.

The Stegomyia is not merely a carrier of infection. Germs present in the blood drawn from an infected person by the mosquito apparently pass through certain stages within its body, and apparently a period of thirteen days at least is required before the organisms are sufficiently developed to give rise to infection.

Prevention.—To stamp out the disease it is necessary to stamp out the Stegomyia, particularly the female, which is a blood-sucker. For the destruction of the living mosquitoes various *disinfectants*, particularly *sulphur dioxide*, are found useful in houses in which the disease has occurred or the insects are numerous. The stagnant pools and other collections of water in which the mosquito breeds should be thoroughly dealt with. *Attention to sanitation* is essential.

Isolation of cases of yellow fever and *screening of the patient* during at least the first three days of the disease, when the organism is still in the peripheral blood and accessible to the mosquito, is most important.

Personal Prophylaxis.—The individual who has any choice in the matter of residence should avoid districts where there is infection and where mosquitoes are numerous. An open, elevated situation away from the coast and rivers is the safest. The dangerous mosquito is that found in the neighbourhood of infected houses, and it is worth remembering that the favourite feeding-time is during the day. In the case of yellow fever there is no drug prophylaxis.

Though yellow fever is one of the dangerous epidemic diseases dealt with in the Cholera, Plague, and Yellow Fever regulations, conditions here are not at all favourable to the Stegomyia, and without this mosquito spread apparently cannot take place. Ships leaving infected ports should be fumigated with the object of killing any mosquitoes which may possibly have found their way on board in baggage or otherwise.

Malta Fever mainly favours the neighbourhood of the Mediterranean, but cases occur also in India, Hong-Kong, and the West Indies, and even in Central Africa. In Malta and Gibraltar at one time it was a very common cause of invaliding of the soldiers.

Persons between the ages of fifteen and forty are most liable to attack, and women are more susceptible than men. Though it lasts a long time and leads to considerable disablement, the average *mortality* is generally about 2 per cent.

One attack confers a certain amount of temporary immunity.

At first generally taken to be an *air-borne* disease dependent upon insanitary conditions, it is now accepted that Malta fever is due to the *Micrococcus melitensis* and that the organism enters the body by *ingestion* or by *inoculation* or through the *mucous membranes*, but mainly as the result of consumption of *contaminated food.* The article chiefly concerned is *milk derived from goats* which suffer from the disease and excrete the germs in the milk as well as other secretions and excretions of the body.

Infection does not seem to spread readily by *personal contact*; but as the urine of infected persons contains the germ, infection may be and sometimes is obtained from it.

The *source of infection* of the goat is probably food, young goats getting it from the infected mothers, and older goats from food contaminated possibly by urine. The excretion of the micrococcus in the milk of the goat may continue for long periods, and it has been found in that of apparently quite healthy animals.

Prevention is on similar lines to those adopted in enteric fever, with action directed to the elimination of the organism from the milk of the goat. In Gibraltar stamping out of the disease followed a reduction in the total number of goats.

Malta-fever patients should be isolated until the urine has been shown to be free from the specific germ.

Leprosy is a common complaint throughout all tropical countries, but is very prevalent in China, Japan, India, and other Eastern countries. Of the three million lepers in the world, two-thirds of the number are Chinese. In India alone there are upwards of 200,000. In Africa and the West Indies it is common, and there are endemic centres in Florida, Louisiana, and California. In Queensland cases occur from time to time, and special laws have been passed with regard to it and special provision made for the patients. In Europe, Norway, Russia, France, Greece, and Italy have a few cases, and in the British Isles there are some imported cases.

Climate and season seem to have little to do with the origin of the disease. The *incubation period* is stated to be as short as a few months and as long as forty years.

Causation.—Food, particularly decomposing *fish*, is said to play a part in causation, but in many districts where leprosy is endemic fish is practically never eaten. Persons of any age are liable, young children and quite old people possibly less so than others. Members of either sex may be attacked. Negroes and Chinese seem to be more liable to infection than members of the white races.

Insanitary conditions, overcrowding, poverty, bad food, and dirt may have a predisposing influence.

The *causative organism* is the *B. lepræ* of Hansen, which is found in the various lesions characteristic of the disease, in the internal organs, and in certain secretions and excretions.

As to the *mode of spread* there is considerable uncertainty. It is less infectious than tuberculosis by way of direct contact, and the view at present is that the intervention of some insect is necessary. Mosquitoes, flies, lice, bed-bugs, cockroaches, and ants are or have been named as possible carriers.

Prevention means mainly *isolation* of the infected with immediate and thorough *disinfection* of his dwelling and destruction of possibly infected vermin. At present, in addition to isolation in special asylums or *lazarets*, the authorities of districts in which cases have to be dealt with place reliance upon *improvements in sanitation*. In America, though the number of cases is not large, many authorities desire to see asylums, or *leprosaria* or lazarets, established, *segregation* in addition to *cleanliness* being essential as regards prevention.

In this country no special precautions are taken.

The indication in relation to *personal prophylaxis* is avoidance of leprous districts and particularly of houses, especially such as are verminous, occupied by lepers.

Dysentery.—Cases of this disease are now generally classified according to causation as (*a*) Protozoal, (*b*) Bacillary, or (*c*) Doubtful.

The organism associated with the *protozoal* variety is mainly the *Amœba coli* (*Entamœba histolytica*). The bacillary form of dysentery is caused by a bacillus called the *B. dysenteriæ*. Cases classed as doubtful are probably bacillary in origin and may be caused by organisms other than the *B. dysenteriæ*, *e.g.* cocci and possibly the *B. pyocyaneus*.

The *protozoal variety* of dysentery is almost entirely a disorder of the tropics. It is endemic in many tropical countries, particularly in damp, low-lying districts. It runs a chronic course with relapses and recurrences, and such sequelæ as tropical or liver abscesses are common. Europeans as well as natives of endemic areas are very liable to infection, especially if sanitation is neglected. Epidemics of this form of dysentery are rare. In the British Army in India an appreciable number of cases, many of which end fatally, occur year by year.

In *bacillary dysentery* the disease is acute with a sudden onset. Its distribution is practically universal, and even in this country, though it is rare amongst the general population, epidemics appear in asylums and other institutions from time to time, particularly if there is overcrowding or neglect of sanitation. In camps, and especially in war time, dysentery of this type is not at all uncommon. The British Mediterranean Expeditionary Force of 1915, as is well known, suffered severely from this condition. The mortality in the bacillary form varies from 5 to 30 per cent.

The mode of infection in all forms of dysentery is in all probability through the mouth by *food* and *water* contaminated from the fæces of the person suffering from the disease by means similar to those met with in the case of enteric fever. *Chronic cases* are a frequent cause of infection, as are also *carriers*.

The *preventive measures* to be adopted are much the same as for cholera and enteric fever. The person who desires to avoid infection must be careful, especially with regard to food and drink. Fruit and vegetables eaten raw are particularly dangerous. Water for drinking purposes should be boiled or submitted to treatment before it is drunk.

Outbreaks in institutions are to be dealt with by isolation of the sick and the giving of attention to overcrowding, sanitation, water supply, and so on.

Sleeping Sickness occurs in tropical Africa, mainly in the neighbourhood of the Victoria Nyanza.

The causative organism is an animal parasite, the *Trypanosoma gambiense*, which is found in the cerebro-spinal fluid, the lymphatic glands, and the blood of persons suffering from the disease.

The infection is carried from the sick to the healthy by a biting fly, the *tsetse* or *Glossina palpalis*, the characteristics of which have already been noted.

Preventive Measures.—Both the infected person and the tsetse-fly require attention. The former should be isolated as soon as the disease is diagnosed, and *isolation* should as far as possible be carried out in a place where there are no tsetse-flies and the patient in any case should be protected from flies. Protection of persons attending upon him as well as of others is also necessary.

In areas in which the disease occurs attempts should be made to *exterminate the flies.* Clearing of the land in tsetse areas tends to a certain amount of diminution in the number of flies, but complete extermination is regarded as almost hopeless.

White as well as coloured people suffer from this disease, and it is necessary for Europeans to protect themselves from flies in regions in which sleeping sickness occurs.

Kala Azar.—This disease was first noted in Assam, but occurs in various parts of India. The outstanding features are fever, enlargement of the spleen, anæmia, and emaciation.

The *causative* organism is the *Leishmania or Leishman-Donovan body*, a species of *trypanosome* or *herpetomonas.* Though the spleen seems to be its favourite habitat, it has been found in the bone marrow and lymphatic glands and elsewhere in the human body.

How the parasite is spread is not as yet definitely settled, although quite a number of insects have been suggested, particularly the bed-bug.

Prevention.—Isolation of the sick and *disinfection* of his room, bedding, and clothing, and particularly the killing off of bugs, seem to be indicated.

Pellagra, known in Italy as "mal del sole," where it was at one time supposed to be due to exposure to the sun, is an endemic and epidemic disease characterised by symptoms involving the digestive, cutaneous, and nervous systems. Mainly tropical, it occurs also, however, in many European countries and in America, and is not unknown here.

The *causation* is obscure, but food has been blamed; and even in America where pellagra is believed to be organismal in origin and spread by insects, particularly the stable-fly (*Stomoxys calcitrans*), it is thought that a dietary consisting largely of maize may act as a predisposing cause in relation to infection, and sunlight as an aggravation of such of the symptoms as involve the skin.

Water and *air* do not carry infection, and direct contact does not operate.

Pellagra is rare amongst children under five, affecting mainly persons between twenty and forty. The *incubation period* is short, and most cases arise in spring and summer, when also remissions take place in chronic cases.

About 50 per cent. of the cases die during the first attack.

Prevention.—When maize was first suspected the sale or use of *diseased maize* was forbidden, but with little effect. Improvements in *sanitation* have also done little good. If the *Stomoxys* or other insects are really concerned in the spread of infection, good results may be obtained from attacks upon them.

Beri-beri is a form of peripheral neuritis, occurring especially in the East and in certain parts of Africa, Australasia, and South America. On ship-board and in various parts of the world epidemics of neuritis indistinguishable from beri-beri are seen from time to time.

The main theory with regard to causation is that it results from improper feeding and is associated with the consumption of *polished rice*, *i.e.* rice which has had all its outer coatings removed by the processes through which it has passed. With these outer coatings the rice loses a considerable number of its constituents, including some rich in fat and others rich in phosphorus and the so-called Vitamine.

Beri-beri is a disease mainly of the poorer classes, but no class, no age, and no race is exempt. In some outbreaks, in addition to causing a vast amount of suffering, ill-health, and interference with labour, the mortality rate may go from an average of 3 up to 50 per cent.

Prevention is to be brought about by attention to *food and feeding*, and particularly by the taking of action to prevent the practice of polishing rice. In some districts it has been suggested that a law should be passed imposing a tax upon rice polished to such an extent that it contains less than 0·4 per cent. of phosphorus pentoxide. In addition to improvements in this direction, sanitation, housing, and water supply, which appear to exert some influence, should be improved also.

Sand-fly, Pappataci, or Phlebotomous Fever.—This disease, which runs its course in about three days and is sometimes called, for this reason, "three-day fever," has a fairly wide geographical range. In India a number of cases occur every year amongst the European troops, causing some degree of ineffectiveness among them. The disease exists to a very considerable extent in Egypt and the Sudan.

The causative organism is unknown, but *infection* is carried by the sand-fly, *Phlebotomus pappatasii.*

Prevention on a large scale means the discovery and treatment of the breeding-places of the fly. Personal *prophylaxis* involves the use of netting during the night.

Dengue.—This disease, although generally accompanied by more or less of an erythematous rash, in many respects resembles influenza. On account of the severity of the pains in the bones and joints it is occasionally known as "break-bone fever." It is common in most tropical and sub-tropical countries, particularly near the coast, and on low-lying land near rivers and creeks. The *incubation period* is from two to four days and the onset sudden. During convalescence depression may be intense, and dengue epidemics are usually marked by an increase in the number of suicides.

The *mortality* is low, death seldom occurring except amongst old or feeble persons.

The infective agent, whatever it may be, is apparently conveyed by a mosquito, the *Culex fatigans*, the distribution of the disease corresponding very closely with that of this insect.

If this mosquito is the carrier of infection, the lines of *prevention* must be mainly those indicated in the case of malaria and yellow fever.

CHAPTER VIII

ANIMAL PARASITES

Many of the animal parasites associated with disease are protozoal in type, *e.g.* the amœba of dysentery and the *Trypanosoma gambiense* of sleeping sickness already described. Others are more highly organised, *e.g.* various worms and insects.

Worms.—The worms that may be met with are either round or flat. The best known of the flat worms are the cestodes or tape worms and the flukes or trematodes, and of the round or nematode worms the *Ascaris lumbricoides* and the *Oxyuris vermicularis*, the *Trichinella spiralis*, and the *Ankylostoma duodenalis*.

Tape Worms.—Infection with these worms is usually the result of eating meat containing the living larvæ or *cysticerci* as they are generally named, the *cysticercus* or bladder worm escaping from among the fibres of the meat when the alimentary canal is reached. Thereafter the bladder gradually disappears and the young worm fixes itself by the head or *scolex* to the intestinal wall and proceeds to develop, steadily producing segments, each sexually complete and capable of producing a large number of eggs. When the segments are broken off and discharged from the human intestinal canal, the eggs find their way through grass or water or otherwise into the intestinal canal of another animal. Here the embryo escapes and makes its way into the muscles, where it forms a *scolex and cyst* and waits to be carried to its final host, to complete its existence.

The most important cestodes which make man their final host are the *Taenia solium*, the *Taenia mediocanellata*, or as it is sometimes called *T. saginata*, and the *Bothriocephalus latus*. A description of the two first-named worms and of their cysticerci will be found in the section on food.

In the case of the *Bothriocephalus latus* the intermediate host is commonly the pike, the perch, or the turbot. The adult worm is common in Russia, Switzerland, and Japan, but is only rarely seen in this country.

The *T. echinococcus*, which has the dog as final host, has man as intermediate host, passing the larval stage in the human liver. The cysts formed are named *echinococcus cysts or hydatids*, and hydatid disease is the most serious condition due to tape worms from which man suffers.

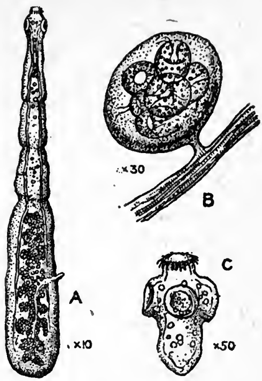

FIG. 18.—A, Tænia echinococcus. B, Hydatid cyst containing scolices. C, Scolex, with head extruded to show hooklets.

Prevention of infection with tape worms means care in relation to *food*. *Pork* particularly requires careful examination, and in addition should always be well cooked; *vegetables*, particularly those eaten raw, should be carefully washed and cleaned before use.

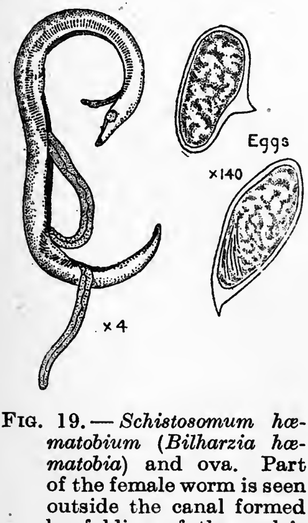

FIG. 19.—*Schistosomum hæmatobium* (*Bilharzia hæmatobia*) and ova. Part of the female worm is seen outside the canal formed by folding of the male's body.

Trematoda or Fluke Worms.—The worms of this type which may affect man are the *Schistosomum hæmatobium*, or *Bilharzia hæmatobia* as it was formerly and is still commonly called, and the *Distomum hepaticum* or liver fluke.

Schistosomum hæmatobium.—This worm, unlike the majority of worms, is not hermaphrodite. The male worm, though really flat, is so folded as to form a canal in which the female lies. Cases of bilharziasis occur mainly in hot and tropical countries and very commonly in Egypt, Arabia, India, and the Transvaal.

The adult worms are found in the blood of the portal vein and other large intestinal vessels. When impregnated with ova the female migrates to and deposits her eggs in the small veins in the wall of the bladder or rectum. These eggs present a very characteristic appearance, being oval in shape and provided with a spine fixed usually terminally, but sometimes, particularly in the case of eggs deposited in the rectal wall, laterally.

By means of the spines the ova bore their way through the tissues of the bladder or rectum, to be voided with the urine or fæces. Because hæmaturia is one of the signs of infection, and cases occur in large numbers in certain parts, the disease produced by the Bilharzia has been named *Endemic Hæmaturia.*

Escaped from the body, the ova in water and elsewhere hatch out an embryo : this enters the first host, one of certain molluscs, and there undergoes further development. Man, the final host, is reached through the medium of drinking water containing the mollusc, and in him, in due course, the adult stage is reached.

Prevention in the main means protection of water from contamination and treatment by filtration, or preferably boiling. All doubtful waters should certainly be boiled. Draining of canals and other collections of water containing the molluscan host has been recommended.

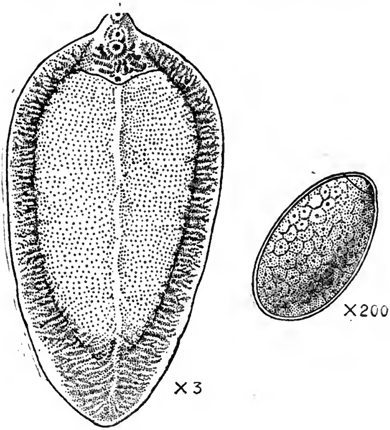

Fig. 20.—*Distomum hepaticum*, or Fluke Worm and ovum.

Distomum hepaticum obtains the name of fluke worm on account of its resemblance to the fluke or flounder. It measures about an inch in length and is found very commonly in the liver of the sheep, giving rise to the condition known as "liver rot." Man may be infected as a result of consuming infected liver, when the worm will be found in the portal system.

In China a worm of this kind known as the *Fasciolopsis buski* is commonly found in pigs, and cases of infection of the human subject with this parasite have been described.

Nematodes or Round Worms.—The *Ascaris lumbricoides* (common round worm) affects the ox and the pig as well as man. In man it occurs as a pinkish worm tapering at both ends; the male measures about 6 inches in length, the female about 12 inches. The worms inhabit the small intestines, and the female discharges large numbers of eggs which escape from the body with the fæces. The ova are very resistant to cold, heat, and drying, but under suitable conditions the embryo develops inside the egg, to escape when the body of a suitable host is reached.

Cases of infection with this worm are known all over the world, especially where sanitation is neglected and the water supply is open to fæcal pollution. In this country rural districts suffer most. In addition to being conveyed by water the eggs may reach the human subject by way of fruit and raw or imperfectly cleansed and cooked vegetables. Children are more liable to infection than adults. It is rare to find the worm in large numbers in the infected person. The lines to be adopted in regard to *prevention* are indicated in what has been said above.

The *Oxyuris vermicularis* or thread worm attacks the human subject, particularly children, but also dogs and other animals. The infected person may harbour enormous numbers, which are to be found usually in the cæcum and rectum. The females which measure about half an inch in length occupy the cæcum until impregnated, descending to the rectum to discharge their eggs. Quite often they leave the gut and give rise to irritation about the anus and perineum, especially in the night.

The male, which is the shorter of the two and has a long twisted tail, dies after impregnating the female. Infection usually results from ingestion of the eggs with food or water. Amongst children personal reinfection through fingers soiled by scratching the anus is not uncommon.

Prevention depends upon cleanliness and care of food and water supply. Infection frequently passes from child to child, and it is advisable to provide a separate bed for the child who is infected.

The *Ankylostoma duodenalis*, also named *Dochmius duodenalis*, *Sclerostoma duodenale*, *tunnel worm*, and *hook worm*, causes a disease which is known as *Ankylostomiasis* or hook-worm disease (in America) and miners'-worm disease or miners' anæmia.

It is very common in the tropics, where it plays tremendous havoc with life and health, and consequently also with labour. In some regions anything up to 70 or 80 per cent. of the inhabitants may be infected with the parasite. In Europe cases have occurred in mines and other underground works where conditions suitable for the development of the ova are found. Some years ago cases were detected amongst the Cornish tin miners, and in America *hook-worm disease* due to a species of ankylostoma called the *Necator Americanus* is now attracting a great deal of attention.

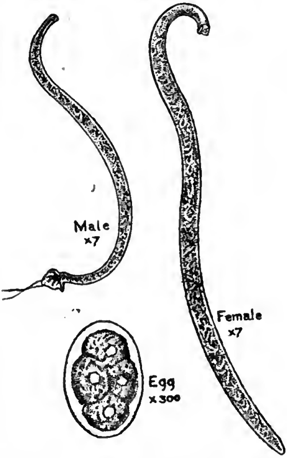

Fig. 21.—*Ankylostoma duodenalis.*

The infection in the Cornish mines at least was almost certainly introduced by foreign labourers or by men who had spent some time in foreign countries. The adult ankylostoma measures about half an inch in length and inhabits the upper part of the jejunum, attaching itself to the mucous membrane by means of suckers and hooks with which its head is armed.

The chief symptom produced by the worm is *anæmia*, the result partly of the abstraction of blood and partly of poisoning by means of a toxic substance secreted by the parasite.

The female worm lays a large number of eggs which escape with the fæces. In a suitable position, where there is a free supply of oxygen, warmth, and moisture, an embryo develops inside the egg in from six to eight hours, escaping when mature to become a larva at the end of twenty-four hours. In the presence of moisture and organic matter the larva passes through a number of stages till at the end of a week it has reached the stage when it is capable of giving rise to infection and of developing into the adult worm in the body of man. The egg, the embryo, and the larva in the early stages are incapable of so developing, and are stated therefore to be not infective.

Entry into the human subject takes place with food or water or through the skin. In the latter case the larva finds its way through a hair follicle, and eventually reaches the jejunum by way of the blood stream to the lungs, the air passages, and the throat. In its passage through the skin the larva frequently produces an inflammatory reaction, sometimes called "ground itch."

Though the number of worms in individual cases may reach four or five thousand, the intensity of the symptoms has no relation to the amount of infection, and many persons who harbour the worms present no symptoms whatever, and, acting as "carriers," may give rise to a number of cases before they are detected. Though the larval worm can live for five or six months in damp and polluted soil, in the neighbourhood of privies for example, their resistance to heat and drying and low temperatures is not very great.

Apparently the resistance of the larva of the *Necator Americanus*, the American or New World variety, is less than that of the *Ankylostoma duodenalis*, or Old World form.

In addition to man, dogs, horses, sheep, and some other animals are liable to become the hosts of the ankylostoma, the forms being quite distinct for each animal and all of them different from that infecting man.

Prevention.—Ankylostomiasis occurs chiefly in places in which sanitation is neglected and amongst people who are dirty in their habits. In mines and tunnels the disease obtains a footing because the workers relieve themselves in the workings, and because the places where the excreta are deposited are never cleaned. In the tropics ankylostomiasis is endemic for similar reasons, the larvæ developing in the soil, and when mature entering the body through the skin or by way of contaminated food or water.

Attention to sanitation, including the provision of proper conveniences and a clean uncontaminated water supply, is necessary. In addition, however, it is essential that there should be education in the elements of personal hygiene and the value of cleanliness.

In many mines shower and other *baths* have been fitted, and an attempt has been made to induce the miners to refrain from attending to the calls of nature in the workings. Deep mines are less frequently affected, possibly because conditions as regards heat and moisture are unsuitable.

The carrier case is always a serious problem, and in some mining districts attempts have been made, by examining the fæces of the workers, to find those discharging ova and to exclude them until treatment has been applied and ova are no longer found.

Isolation and treatment of the sick are very important, and should not be omitted.

Trichinella (Trichina) spiralis.—The animals liable to attack by this worm, in addition to man, are the rat and the pig. In each of these the whole life-cycle is passed, partly in the intestinal canal and partly in the muscles. In the former, in the course of a few days, the larval worms, which have reached it as a result of having been swallowed with a piece of muscle taken as food, develop into full-grown worms, the female measuring about an eighth and the male about an eighteenth of an inch in length.

The source of infection in the case of man is undoubtedly the pig, which gets its infection from the *rat*, either by eating it or more probably by eating food fouled with its excreta. The rat is probably infected chiefly in slaughterhouses and butcher shops by eating pig excreta, offal, etc. In animals diagnosis during life is practically impossible; and probably the most satisfactory means of *prevention* is proper cooking of pork.

Filaridæ.—Quite a number of nematode worms having the name *filaria* are known to affect man, passing the adult stage in one tissue, for example the lymphatics or connective tissue, in an earlier stage choosing another tissue, namely the blood. An intermediate stage in many cases is passed in another animal, generally a *mosquito*. The fact that the blood is the common haunt of the young filaria gives the reason for the use of the title *Filaria sanquinis hominis*, at first more or less indiscriminately applied to the several types of filaria found. *Filariasis* is another more or less general term used in relation to infection with filaria without reference to type.

The adult filariæ which are recognised as associated with definite conditions are (1) the *F. bancrofti*, which, affecting the lymphatic system, is taken to be the cause of *elephantiasis and chyluria*; (2) the *F. or Dracunculus medinensis*, or *Guinea worm*, which affects the connective tissues, particularly those of the legs, and gives rise to ulceration or abscess formation;

(3) the *F. loa*, which affects the connective tissues in the orbit and elsewhere; and (4) the *F. perstans*, which is found in the mesentery.

Amongst the filariæ demonstrable in the blood, those that are important because they are the larval forms of recognised adult worms are (1) the *F. nocturna*, so called because it is found only in the evening; it is the larval form of the *F. bancrofti*; (2) the *F. duvina*, found only during the daytime, is the larval form of the *F. loa*; and (3) the *F. perstans*, found at all times, the adult worm bearing the same name. The embryo stage of *F. medinensis* is passed outside the human body. In order to distinguish the larval from the adult form it has been suggested that the term *micro-filaria* should be used for the former, and this is now commonly done.

The *F. bancrofti* and the *F. medinensis* being the only really important members of the class, from a preventive point of view, it is only to them that attention need be directed.

F. bancrofti has its normal habitat in the lymphatics of the trunk and extremities. It is thin, of a whitish colour, and is about 3 or 4 inches long. The female produces a large number of eggs which develop inside her body into embryos, which, when they escape, find their way into the blood, forming the *F. nocturna*. This larval filaria is enclosed in a sheath and is about $\frac{1}{50}$ of an inch long, has a sharp tail, and is highly motile. As the name indicates, it is found in the blood only at night, the largest number about midnight. During the day they are believed to lie hidden in the lungs and other internal organs.

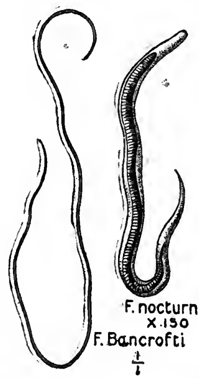

Fig. 22.—*F. bancrofti* and its larva *F. nocturna.*

The *intermediate host* of this filaria is the mosquito *Culex fatigans*, which it reaches by being withdrawn with the blood sucked from the infected person.

Soon after reaching the stomach of the mosquito the embryo loses its sheath and proceeds to bore its way through the stomach and other tissues till it reaches the thoracic muscles. Here it undergoes certain changes, and eventually, in about fifteen or sixteen days, makes its way to the end of the proboscis. Escaping when the mosquito attacks a fresh victim, it passes under the skin of the individual and finally into the lymphatics.

The *F. bancrofti* is found chiefly in tropical and sub-tropical regions, and for its spread there are required not only a person already infected, but also the appropriate mosquito, *Culex fatigans*. To prevent havoc by this worm action must be taken against mosquitoes, more or less on the lines already described in connection with malaria. The use of mosquito nets and other means of protection against the bites of these insects is also indicated.

The *F. or Dracunculus medinensis* (Guinea worm) has an average length of $2\frac{1}{2}$ feet and is found in the connective tissues of the lower extremities. The female, which alone has been recognised, produces large numbers of embryos. When these are mature the adult worm burrows her way through the connective tissue, generally in a downward direction towards the foot and ankle, where she lies with her head just under the epidermis, forming a small bleb. In a day or two the bleb ruptures, a small ulcer is formed, and the embryos are discharged. These measure about $\frac{1}{30}$ of an inch in length and have a long slender tail by means of which they swim about in the water into which they are discharged, for example, in bathing. In water they pass through the intermediate stage in the body of a crustacean, the *Cyclops quadricornis*. In time presumably the cyclops is swallowed by man and the young worm escapes to settle down in the connective tissues and produce new embryos. The process of development in man is believed to occupy something like a year.

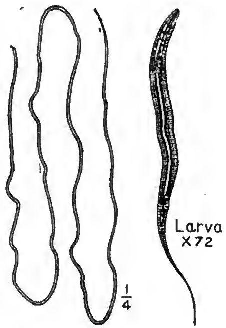

Fig. 23.—Guinea Worm and larva.

Prevention.—The chief necessity is to attend to the *water supply*. All water from suspicious sources should be boiled or otherwise treated, and persons suffering from the disease should be prevented from bathing in or otherwise contaminating sources of water supply.

The Guinea worm is practically unknown in Europe, but is common in West Africa, India, Persia, Turkestan, Arabia, and parts of Brazil.

Other Animal Parasites.—Other animal parasites to which reference might have been made here are some of those which affect the skin of man—for instance, the flea, the bug, and the louse. As these are known to act as disease carriers, however, it was found more convenient to deal with them in detail when discussing the epidemiology of disease.

The following information in addition to that given may be found useful. It is taken from a "Memorandum on the Destruction of Vermin" issued by the Society of Medical Officers of Health.

Body Vermin (fleas, bugs, and lice) are injurious to health in that—

1. They cause discomfort and loss of rest.
2. They cause indirect injury to the skin, with consequent possibility of infective absorption.
3. Under certain circumstances the vermin may directly transmit serious disease through their bites.

The destruction of the insect is easier than the destruction of the eggs.

The eggs of the flea develop in two to five days (adult insect in ten to eighteen days); of the bug in seven to ten days (adult insect much longer); of the louse in ten to fifteen days.

The value of frequent change of underclothing to remove undeveloped eggs and partially developed insects is thus strongly indicated.

Body vermin, particularly bugs, can live without food for long periods.

To Suppress the Vermin.—1. For the body and head.—Ordinary hot baths with soap are sufficient, except in the case of head lice. For these and their eggs, paraffin or dilute acetic acid (hot vinegar) should be well rubbed in overnight; the head should be thoroughly cleansed with soft soap and water the following morning, and then combed with a small-toothed comb. This should be repeated every night until there are no eggs or nits visible. It should be remembered that paraffin is very inflammable.

2. *For the Clothing.*—Heat at or above boiling point is the most efficient method of destruction of insects and their eggs. Every authority should have a steam disinfector available for vermin destruction. Paraffin or petrol, especially along the seams of the clothing, is also useful.

3. *For the House.*—Continuous cleanliness is the best measure. This prevents the development of eggs. Neither gaseous disinfection nor liquid disinfectants are to be relied upon. Some insect powders, chloride of lime and powdered naphthaline, destroy vermin. In crevices oily substances may be used with good effect.

It is a matter of urgent importance in dealing with vermin that the body, the clothing, and the house should be dealt with at one and the same time to prevent reinfection from one to another; further, for the same reason all infected persons living in the same house should be dealt with at the same time.

A mixture of oil, soap, and some disinfectant, such as naphthaline, spread over the body and clothing has been found efficacious in preventing as well as suppressing verminous conditions.

CHAPTER IX

OCCUPATIONAL DISEASES AND INDUSTRIAL HYGIENE

THE risks to health and life traceable to occupation are generally counted as being greatest in the case of the individual working with his hands, and are regarded as arising in connection with (1) the premises in which the work is done, and (2) the materials worked with and the mode of working with them.

1. *The Premises.*—The condition of the premises in which the worker is employed is clearly important, and such matters as sanitation, heating and lighting, ventilation, air space, and water supply all call for attention if his efficiency and productive power are to be maintained.

2. *The Materials.*—The damage done by the materials may be in the nature of (*a*) poisoning, *e.g.* by poisonous metals such as lead, or poisonous gas or fumes, such as carbon monoxide and nitrous fumes, or (*b*) may result from irritation or destruction of the tissues by certain salts or the grit of certain rocks.

Poisonous Metals.—Of the materials the poisonous metals and poisonous and irritating gases and fumes are regarded as most important, the metals and allied substances to which most attention is given being *lead*, *phosphorus*, *arsenic*, and *mercury*.

The industries in which these are used are regarded as particularly unhealthy and dangerous, and every medical practitioner coming in contact with a case of poisoning from any one of them, *contracted in a factory or workshop*, is required to notify the Chief Inspector of Factories at the Home Office.

Lead Poisoning.—Lead in one form or another is met with in a large number of industries. There are, indeed, risks with it from the very moment work in connection with it begins. In *lead mining* there is no special danger of poisoning, but in *lead smelting* great risks are run by the workers exposed to the fumes and dust in charging and attending to the furnace.

Spelter (zinc) and *brass workers*, especially casters, polishers, and filers, are also open to attack as well as those engaged in the making of *sheet lead*, *lead piping*, and *bullets*, and in *plumbing and soldering.*

In *printing*, compositors and stereotype and linotype operators; and in *file cutting* the cutters, who do the cutting on a bed of lead, and file hardeners, who temper the files by plunging them in a bath of molten lead, are sometimes affected.

In *tinning and enamelling* of iron a mixture of tin and lead is used, and a number of cases occur annually amongst the persons employed.

Workers in *red and white lead* are exposed to salts of lead that are readily absorbable; and since many paints contain white lead, both those who make them and the *painters* who use them encounter lead poisoning as a hazard.

In *pottery work* lead is met with in a number of processes. Persons who handle the glaze before it is fired, *e.g.* mixers, dippers, and ware cleaners, run the gravest risks from dust containing lead.

In *glass cutting and polishing* and in making *electric accumulators* there is risk, in the former slight from dust, and in the latter great because the amount of lead handled as litharge and red lead is large, and since it has been found impossible to replace hand labour by machinery, precautions are difficult to apply.

In the above the reference has been mainly to the chief industries in which cases of lead poisoning are apt to occur. There are, however, many other trades in which there are risks, *e.g.* the making of harness furniture, the tempering of springs by dipping them into molten lead, in indiarubber making, in metal sorting and handling lead, in glass making, and in using yarn dyed with yellow chromate of lead. Persons working outside factories and workshops, *e.g.* plumbers and house painters, are also exposed to risks.

Under industrial conditions lead enters the body mainly as the result of *inhalation of fumes or dust*, though there is a possibility of the metal gaining access through the mouth from fingers and from food contaminated from the fingers.

Women are apparently much more susceptible to lead poisoning than men; and though cases are more frequent in the first and second years of employment, susceptibility depends greatly upon the bodily condition. Persons with defective teeth are particularly liable to be affected.

Signs and Symptoms.—One of the earliest signs is probably the *blue line* on the gums, and one of the commonest symptoms *colic.* In the later stages the nervous system is frequently affected, giving rise to *encephalopathy* with headache and *epileptiform seizures, wrist drop,* etc. *Cirrhosis of the kidney* with albuminuria is common. About two milligrammes is the daily dose which, if inhaled as dust or fumes, may, in time, accumulate in the body and set up chronic plumbism.

Prevention of Industrial Lead Poisoning.—Wherever possible the use of lead should be dispensed with and some other material be substituted for it. *Leadless glaze* is now largely used in pottery work, and many manufacturers of paint employ zinc oxide instead of white lead.

The regulations issued by the Factory Department insist upon the fact that there are dangers from dust and fumes and as a result of the metal finding access to the body through the skin and through the mouth from contaminated fingers. The method chiefly employed in relation to *dust control* is the introduction of locally applied exhaust ventilation. As far as possible all operations in which dust is generated are carried out in the neighbourhood of an *extract ventilator,* the draught being induced by means of fans or otherwise. If the work can be done under a hood so much the better, and as far as possible attempts are made to have all grinding of material that cannot be dealt with in a wet condition done in closed-in apparatus. In dealing with *fumes,* extract ventilation and the carrying out of the work under hoods connected with a fan are essential.

Fig. 24.—Form of respirator used by workers in certain dusty trades.

In coach painting and other work in which ventilation is inapplicable reliance must be placed upon *respirators* and on the application of *personal measures* by the employees.

As to respirators it may be said that they are not comfortable and cannot be worn for any time. That recommended by the Home Office consists of a cambric bag with or without a thin flexible wire made to fit over the nose. In many trades the employer is required to provide these in addition to *overalls*.

Personal precautions include *attention to personal cleanliness*, abstention from taking of meals and from smoking and chewing in the workrooms during work.

Employers generally are required to provide *washing conveniences* with a sufficient supply of hot and cold water, soap, nail-brushes, and towels. These the employee is required to make use of, particularly before leaving the works. In some industries *baths* also are called for, and in any case the worker is advised to take at least one hot bath per week. Male workers should wear their *hair short* and go *clean-shaved.*

In addition to abstaining from *tobacco*, workers amongst lead are also advised to abstain from *alcohol* in excess and to take only the so-called sanitary drink, which consists of sulphate of magnesia 2 ounces, water 1 gallon, and essence of lemon sufficient to flavour. Dilute sulphuric acid and milk are stated also to be good beverages for lead workers.

Women and young people being particularly liable to poisoning, their employment in certain operations is forbidden. Workers whose general health is not good are also more liable to attack than those in robust health. Periodical and *preliminary medical inspections* are especially valuable in connection with these, are insisted upon, indeed, in most trades in which lead is employed. The examinations are made monthly, and particularly careful watch is kept for the blue line on the gums.

Phosphorus Poisoning.—Cases of phosphorus poisoning contracted in any factory or workshop must be notified to the Home Office. The persons liable to suffer from it are those employed in the making of *matches* composed of yellow phosphorus or in the manufacture of *phosphor bronze.*

As a result of the coming into operation at the beginning of 1910 of an Act forbidding the manufacture and use of matches made of yellow phosphorus, there has been a complete cessation of cases among match-makers in this country. Rules applicable to premises in which *phosphor bronze* is mixed and cast are also in force and have doubtless contributed to the reduction in numbers.

In the match-making industry the persons who run the gravest risks are those employed in factories in which "strike-anywhere" matches containing yellow phosphorus are made. The paste for these matches consists of a mixture of chlorate of potash, glue, powdered glass, colouring matter, and phosphorus. The amount of phosphorus used is generally about 5 per cent., and the difficulty is with the fumes given off during mixing.

In making *safety matches* phosphorus is omitted from the paste, any that is used being mixed with the striking material applied to the side of the box. In the manufacture of these matches the non-poisonous *red or amorphous phosphorus* is employed and there is no risk of poisoning. Lighting on the prepared surface only, they are, to some extent, inconvenient, and the demand for a strike-anywhere match has been met in this and some other countries by the production of an article the head of which is made from a paste containing the *sesquisulphide of phosphorus*. More inflammable than the red form, the sesquisulphide is like it non-poisonous, though persons working with it occasionally suffer from dermatitis and pustular eczema apparently due to the sulphuretted hydrogen given off.

The characteristic condition from which the worker in phosphorus suffers is *necrosis of the jaw*, the so-called "phossy jaw," young persons, females, and those with bad teeth being particularly liable to attack.

Prevention.—If all risks are to be prevented the use of yellow phosphorus must be prohibited; and having regard to the excellent results obtainable with the sesquisulphide and the safety match, there seems to be no reason why the prohibition should not be universally applied. Apart from prohibition careful regulation of the industry is necessary: workrooms must be well constructed and ventilated, covered vessels only must be used in mixing the paste, and attention to personal hygiene by the employees insisted upon.

Arsenic Poisoning.—Dangers from arsenic are encountered chiefly by persons engaged in the manufacture of *emerald green* (aceto-arsenite of copper) and other paints, in the making of *sheep dip* and in the *extraction* or *refining of arsenic*. Cases are also met with amongst persons who have to handle white arsenic or mix arsenic with lead in the *manufacture of shot*. In *pottery and glass making* at certain stages arsenic may also be encountered. The fact that at one time *wall papers* were apt to contain arsenic and that *beer* made from glucose instead of malt may give rise to poisoning may be mentioned.

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Poisoning with *arseniuretted hydrogen* occurs sometimes amongst workers in chemical and galvanising works, and *furriers* and *skin dressers* occasionally also suffer. The effect of this gas is to destroy the red blood cells and the symptoms produced are *dyspnœa*, *jaundice*, almost continuous *vomiting*, and *hæmoglobinuria*, *hæmaturia*, or even *anuria*.

Cases of arsenic poisoning amongst workers in factories etc., are notifiable, and each year a few are notified.

Arsenic finds its way into the body mainly as a result of *inhalation*, though a certain amount may be swallowed with contaminated food or may pass through the skin.

The chief signs of poisoning are *headaches*, *conjunctivitis*, *inflammation of the nose* and *perforation of the nasal septum*, *skin irritation*, *pigmentation* and *ulceration* about the scrotum and elsewhere, *vomiting* and *diarrhœa*. *Jaundice* sometimes occurs, and the urine may be blood-stained since arsenic is excreted by the kidneys.

Prevention is on similar lines to those already indicated in the case of lead. As a result of insistence upon the application of such measures in connection with the manufacture of emerald green, cases have practically ceased to occur.

Mercurial Poisoning.—Apart from the men who work at the getting or smelting of the metal, the persons liable to suffer from poisoning are those employed in such processes as the making of *compounds of mercury*, *e.g. calomel* and *corrosive sublimate*; the making of *barometers*, *thermometers*, *mercury vapour lamps*, and *electrical meters*, and the filling, packing, etc., of *detonators* and *percussion caps* in explosives factories where *fulminate of mercury* is used.

Other persons who occasionally suffer are *felt-hat makers*, *taxidermists*, *telegraphists*, *photographers*, *artificial-flower makers*, and *gun makers*. In *silvering of mirrors*, mercury is more rarely employed than formerly, and cases of poisoning amongst employees are uncommon.

Mercury enters the body mainly as a result of *inhalation of dust*. The signs and symptoms of poisoning include a *metallic taste in the mouth*, *sponginess of and slight blue line on the gums*, *discoloration of the teeth*, *furring of the tongue*, *muscular tremors*, *diarrhœa*, and *skin eruptions*.

Prevention.—Measures similar to those already laid down are applicable. In providing for *ventilation* of rooms where vapour may be generated the outlets should be placed near the floor level, as the fumes are heavy and sink rapidly.

Medical inspections should be made and persons showing signs of poisoning put under treatment and transferred to other work.

Zinc Poisoning.—The ordinary mode of entry of zinc into the body is by way of the respiratory system as a result of *inhalation* of the vaporised oxide of zinc or of the dust.

The persons who run risks are the zinc smelter or spelter worker and the zinc grinder; the *brass founder*, who smelts zinc because it is one of the elements in the alloy into which quite a number of metals, *e.g.* copper,[1] lead, antimony, etc., may enter; and *colour mixers* and *glass workers*, who encounter salts of this metal in connection with their work.

In *galvanising* and in *brazing*, *i.e.* heating two metallic objects in contact until they fuse, zinc is used, and the fumes may cause poisoning.

In *tinning* the tins and cans used in canning meat, fruit, etc., a mixture of tin, lead, and zinc is used, and persons engaged in the work may suffer from lead and zinc poisoning (" chills ") if precautions are not taken.

The *symptoms of zinc poisoning* are mainly *cough*, *shortness of breath*, *dizziness*, *headache*, *sweating*, *vomiting*, and *cramp* in the limbs. In *brass founders' ague*, *chill* and *shivering* are the common features and occur generally in the night several hours after the person has left the works.

Antimony Poisoning.—The occupations in which there are risks of poisoning with this metal include *ore smelting*, *type founding*, *brass founding*, *printing*, and *enamelling*. The number of cases met with in this country is small. The risks are mainly from *dust* and by *inhalation*.

The *symptoms* are *skin eruptions*, especially amongst smelters, and *colic* and gastro-intestinal disturbances.

Prevention.—The preventive measures to be adopted in relation to processes in which zinc and antimony are used are practically those already discussed in respect of lead.

Anthrax.—The fact that cases of anthrax occurring in persons employed in factories and workshops must be notified under the Factory and Workshop Act has already been noted elsewhere.

Poisonous Fumes and Gases.—The most important of these

[1] At one time brass poisoning or brass founders' ague was regarded as due to the copper. The present view is that the zinc is responsible, all the symptoms having been produced experimentally by burning zinc alone in a badly ventilated room.

are *carbon monoxide*, *carbon dioxide*, *sulphuretted hydrogen*, *sulphur dioxide*, *chlorine and hydrochloric acid fumes*, *nitrous fumes*, *ammonia*, *carbon disulphide*, *benzene and naphtha*, and *nitro- and amido- derivatives of benzene*.

Carbon Monoxide.—Poisoning with this gas is mainly met with amongst persons working where blast-furnace gas and coal gas are produced or largely used, though cases sometimes occur in other occupations, *e.g.* in working at *cement kilns* or with *coke ovens*, etc.

The symptoms are due to the formation of a chemical compound between the carbon monoxide and hæmoglobin and interference with the true function of the latter in relation to oxygen.

Air containing carbon monoxide in a proportion of 0·05 per cent. is dangerous. Many of the reported cases are the result of carelessness, and each year a considerable number of men are gassed while working alone or acting the part of rescuers.

Carbon Dioxide.—Poisoning occurs mainly among persons employed in the fermenting cellars in *breweries*, in *aerated-water works*, and *chemical works*.

Sulphuretted Hydrogen.—This gas is highly poisonous, setting up, when present in air to the extent of 0·02 per cent., *headache* and *irritation of the mucous membrane of the conjunctiva, nose, and throat*. With 0·1 per cent. or over, *loss of consciousness* may result, the affected person falling as though struck down. Cases are reported mainly from gas works and tar distilleries. Persons employed in cement works and in the treatment of sulphuric acid to remove arsenic, etc., are sometimes affected.

Sulphur Dioxide.—Cases of suffocation with this gas sometimes occur; mainly, however, the condition produced is damage to the organs of respiration in the shape of bronchitis, etc. The persons likely to suffer are those employed in the making of sulphuric acid and in such processes as ore burning.

Chlorine and Hydrochloric Acid Fumes.—These act as irritants of the mucous membrane of the respiratory tract and conjunctiva.

With minute quantities of chlorine, *cough*, *dyspnœa*, and *bronchial catarrh* are produced, excessive quantities leading to great *respiratory distress* and rapid *death*.

Hydrochloric acid fumes are much less irritant, but workers habitually exposed even to minute quantities, in addition to destruction of their teeth, suffer from *pallor*, *indigestion*, and *chronic cough*.

Possibly because of the chlorine present, workers in chloride of lime suffer from *dermatitis* and *skin ulceration*. The cases reported come mainly from alkali works. Makers of bleaching powder also run great risks.

Nitrous Fumes.—Great attention has been directed to these because they are encountered in connection with the manufacture of explosives. In the manufacture of nitric acid they may also be met with. The symptoms are mainly those of irritation of the respiratory tract, but the full effect of an accidental inhalation is not felt immediately, and unless workers are warned they may go on working and inhale a fatal dose.

Ammonia.—The risks with this gas are greatest in works where ammonia and ammonium salts, *e.g.* sulphate, are produced, but evolution of the fumes may occur in connection with a number of trade processes. Though *suffocation* and *death* may result, in the ordinary way the signs of irritation are transient.

Carbon Disulphide.—The persons most liable to be exposed to this gas are those employed in vulcanising in *indiarubber works*. If the process is carried out in a closed chamber and the fumes are removed by exhaust ventilation, the effects are limited to the *initial symptoms*, viz. *frontal headache, anæmia, slight mental dullness*, and *diminution in muscular tone*. If there are no restrictions in the use of the material, very serious symptoms may be produced, the nervous system and the blood being particularly affected.

Prevention.—The rules applicable to works in which vulcanising by means of carbon disulphide is carried on call for *covering of troughs* containing carbon disulphide, and the *removal of fumes* by means of exhaust ventilators. Entry to drying rooms is forbidden, and the taking of meals in any place in which the disulphide is used. *Hours of employment* are also limited and monthly *medical examinations* insisted upon.

Other Carbon Compounds.—Symptoms somewhat resembling those produced by carbon disulphide are seen with other compounds of carbon. The *vapour of the alcohols*, in the preparation of varnishes, gas mantles, and colours, and of benzene in chemical cleaning may give rise to *headache, giddiness, irritation of upper air passages*, etc.

Nitroglycerin causes intense headache, slowing of respiration and the heart's action; *naphthol and naphthaline* may give rise to headache, nausea, vomiting, and eczema, and *oil of turpentine* to headache, giddiness, tremor, and irritation of the eyes and throat.

Benzene and Naphtha.—Cases of poisoning with these are apt to occur amongst persons engaged in work on benzol stills. *Benzene* is largely used in dry cleaning processes, and workers may be affected with headache, giddiness, etc.

Quick-drying paints frequently contain naphtha, and persons using them in confined places are sometimes affected by the fumes. The so-called "dope poisoning" amongst persons engaged in painting aeroplane wings is due to the inhalation of vapour of tetra-chlor-ethane, an ingredient of "dope varnish."

In connection with the *prevention* of this form of poisoning medical examination is recommended and the provision of well-ventilated workplaces, distinct from those occupied for other purposes. Operatives on this work should have short hours and no overtime, and the process of doping should alternate with other work.

Nitro- and Amido- Derivatives of Benzene.—These substances, among which are commonly named *dinitro-benzol*, *paranitro-chlorbenzene*, *anilin oil*, *tetryl* (*tetra-nitro-methyl-anilin*), *tri-nitro-toluol* (*T.N.T. or trotyl*), are readily absorbed as fumes or dust or through the skin.

All of them act upon the blood, converting the hæmoglobin into methæmoglobin. Common signs and symptoms are *drowsiness*, *headache*, *eczema*, *loss of appetite*, and later *cyanosis* or even *jaundice*, *dyspnœa*, and *coma*. Persons liable to attack are workers in *explosives factories*.

Contact with *anilin colours* is liable to lead to dermatitis and eczema, which, like that occurring in persons exposed to T.N.T., affects the face, arms, armpits, and other parts liable to be bathed in sweat. In the case of the explosive *tetryl* (*tetra-nitro-methyl-anilin*) the eczema produced affects mainly the conjunctivæ, the openings of the nostrils, and the chin.

To ensure the protection of persons employed in the manufacture of explosives, compliance with certain regulations is called for. *Medical supervision* is most important; the taking of meals in workrooms is forbidden; lavatory accommodation must be provided, and workers must wear overalls, head coverings, and rubber gloves; means of carrying off dust and fumes must be provided, and the period of exposure should be kept as short as possible. For the prevention of eczema an ointment of castor oil and lanolin may be used.

Age seems to exert a certain influence as regards liability to poisoning with the nitro- and amido- derivatives, persons under twenty and over fifty suffering more markedly than those at intermediate ages. Alcoholic subjects are apt to be seriously affected.

Occupational Skin Affections.—*Pitch Ulceration.*—In quite a number of occupations liability to skin affections is incurred. Pitch, particularly gas-works tar pitch, as distinct from blast-furnace pitch, is a frequent cause of dermatitis and ulceration and warty growths on the skin.

In factories where patent fuel in the form of briquettes containing pitch is made, pitch ulceration is well known to occur. For the prevention of these conditions the workers must, as far as possible, be protected from contact with the material, and means of getting rid of dust must be provided. Baths and lavatories are necessary, but, as considerable pain is experienced on exposure to the sun and wind after washing, many workmen object strongly to using the facilities provided. Treatment of the pitch with formaldehyde is supposed to remove its tendency to cause irritation.

Chrome Ulceration or *Chrome Holes* occurs amongst persons engaged in the manufacture of potassium bichromate, or in trades in which it is used, *e.g.* in tanning of leather or French polishing. Bichromate attacks and destroys any portion of skin from which the superficial horny layer has been removed. Once formed, the perforation extends in the shape of a cone down to the fibrous tissue. The ulcers are very painful, especially at night, and heal slowly.

Men engaged in the manufacture of chromates and bichromates and exposed to the dust are liable to suffer from perforation of the nasal septum. This can be prevented by the use of nasal plugs or by painting the septum with paraffin. The inconvenience caused by the perforation is apparently so slight that the workers neglect the precautions.

Cleanliness and the use of disinfectants, *e.g.* mercuric chloride or cyllin or an ointment containing this last, mineral lard and paraffin wax, are useful as preventives of chrome ulcers.

Other workers liable to contract dermatitis or ulceration are those engaged in *herring curing* or in *curing guts* for sausage skins, as a result of exposure to salt; *shale workers*; persons working with *turpentine* ; persons engaged in the making of *grease* ; *engineers* and employees in engineering works exposed to lubricating or oiling mixtures containing turpentine, or mixtures containing light mineral oils, etc. The fact that workers with the explosives T.N.T. and tetryl are apt to suffer from eczema may be repeated.

Dust.—The chief risk run by those following occupations in which dust is produced is of lung trouble, and the fact that in certain forms it is important in relation to tuberculosis must not be overlooked.

The extent of the risk varies to a considerable extent with the character of the dust, and in this connection the following conclusions (set out in one of the Factory Department reports) are worthy of note :

(1) In general, dusts appear to be more injurious as their chemical composition differs from that of the human body, or from the elements of which the body is normally composed.

(2) Animal dusts, apart from the presence in them of pathogenic micro-organisms, when inhaled produce less effects than do vegetable and mineral dusts.

(3) Vegetable dusts, when inhaled, tend to produce a type of chest affection best described as "asthmatic."

(4) Of mineral dusts those composed of calcium salts are least injurious.

(5) Inhalation of mineral dusts, which do not contain free silica, tends to produce irritation of the upper air passages and respiratory diseases other than phthisis.

(6) Inhalation of mineral dusts which contain free silica is associated with an excess of phthisis ; an excess which bears a distinct relation to the amount of free silica present.[1]

Though the dusty industry may not be associated with any particular liability to phthisis, the workers do not necessarily escape other pulmonary troubles. Laryngitis, chronic bronchitis, emphysema, and asthma are common amongst employees in all trades in which there is much dust. *Bakers*, *felt-hat makers*, and workers amongst furs are particularly liable to coughs and bronchitis. Persons working amongst *cement* suffer mainly from affections of the upper respiratory

[1] In Portland the average death-rate from phthisis amongst quarriers of the local limestone was, during the years 1900–1912, 1·5 per 1,000 ; amongst all other males in 1912 it was only slightly less, viz. 1·1. In Derbyshire, on the other hand, where the stone worked with is grit-stone containing 95 per cent. free silica, the phthisis rate for those employed in and about it was 13·4 and for the general population 1·2.

passages, inducing cough, especially in the morning, with copious expectoration. In some cases *salt workers* are affected by the dust of the material with which they work, and perforation of the nasal septum not uncommonly occurs.

In dusty processes the nasal and pharyngeal mucous membrane are liable to be attacked and atrophy not uncommonly occurs. Anæsthesia of the parts most exposed to the dust is frequently noted.

Prevention.—Preventive measures are often difficult to apply

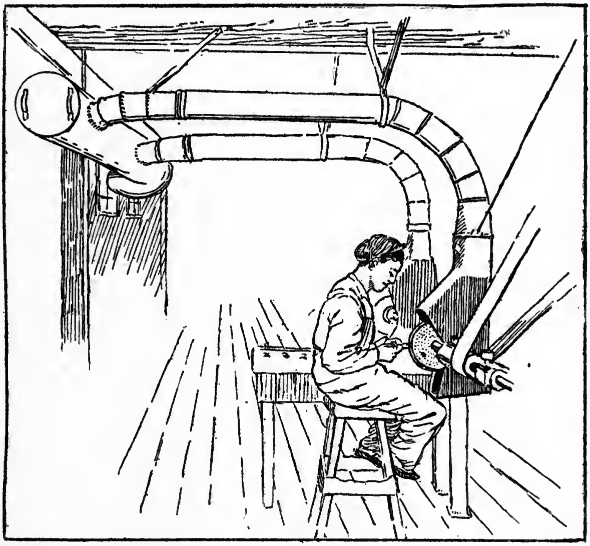

FIG. 25.—Exhaust ventilation applied locally over a grinding wheel. The dust as generated is drawn into the hood over the wheel and along the pipes to which it is connected.

in the trades in which dust is formed. As much of the work as possible should be carried out wet, and extraction fans to draw off the dust should be provided. If these steps cannot be taken, or even if they can, the workers should wear some form of respirator.

Eye Affections.—*Nystagmus.*—Nystagmus is a condition characterised by the presence of oscillatory movements of the eyeballs and occasionally headache and nervous symptoms. It is generally held to be due to working in a bad light with the eyes continually turned to one side, and is a common complaint amongst miners.

It is sometimes found also in persons whose employment calls for continued use of the eye, *e.g.* women employed at *sewing machines* or in *electric lamp factories* in laying out metallic filaments as they emerge from the press, or in testing lamps.

It is generally supposed to be due to fatigue of the extra-ocular muscles, and young persons are more liable to develop it than the old. In some cases the movements are so severe as to interfere with vision, and the sufferer may be unable to work.

Cataract or other changes in the lens is a condition noted as particularly common amongst workers in *glass factories*, especially those engaged in bottle making.

Ear Affections.—Deafness is the only condition in relation to the ear which is of importance, and persons liable to have hearing interfered with are those continually exposed to loud noises. *Boilermakers' deafness* is well recognised, but amongst those engaged where there are hammering of metal sheets and cylinders, beetling of cloth, engine driving, firing of guns, and the use of pneumatic tools a similar condition is apt to arise.

The deafness met with in these cases is not due to rupture of the ear drum, but to destruction of the nerve endings within the ear, as shown by the fact that in those affected the sound of a tuning-fork and the tick of a watch are better heard when conducted through the air than when the fork or watch is placed upon the bone near the ear. The hearing of high-pitched sounds is generally most defective, and the damage is supposed to be done in hammermen by the shrill notes in hammering and in munition workers by the sharp, penetrating reports of smaller guns.

Hammermen often hear better when spoken to when hammering is going on than when all is quiet.

In order to prevent the deafness it has been suggested that ear plugs consisting of indiarubber or cotton wool, either alone or smeared with vaseline or mixed with "Plasticine," should be used.

Abnormal Atmospheric Conditions.—Persons who are compelled to work in surroundings where the conditions as regards temperature, moisture, and pressure are abnormal are liable to suffer as a result unless precautions are taken.

Temperature.—Apart from leading to discomfort, high temperatures may actually cause damage to health, and in factories and workshops the requirement is that adequate measures must be taken for securing and maintaining a reasonable temperature in rooms in which persons work. What is to be regarded as a reasonable temperature is not, however, stated, though the mean temperature generally aimed at by factory inspectors is 60° F.

Exposure to *excessively high temperatures* in the case of firemen, stokers, steel and iron workers, in addition to causing cataract and damage to the eye, may produce heat stroke and prostration and disturbances of the muscular and nervous systems. Cardiac weakness may also be caused, and skin and lung troubles are common amongst workers in such trades.

Low temperatures also may cause danger to health. Persons working in *refrigerator store rooms* for frozen meat at a temperature of about 16° F. and those working in rooms chilled to between 30° and 50° F. for freshly killed carcases; or employed in *ice factories* and *ice stores* where the temperature is from 25° to 32° F., are prone to attacks of *bronchitis*, *rheumatism*, *lumbago*, *diarrhœa*, and *neuralgia*.

The fact that they are liable to suffocation by ammonia as a result of defects in the apparatus may also be mentioned.

To protect them from cold, proper clothing should be provided; floors should be kept in good condition and clogs worn if there is risk of dampness; a properly warmed room for meals is necessary; and in order to avoid risks of men being accidentally shut in cold rooms, doors should be made to open from inside as well as outside and means of communication by a bell, etc., should be fitted inside each room.

Alcoholic subjects stand cold very badly and should not, if possible, be employed.

Moisture.—In connection with the weaving of cotton, and other textiles, it is believed to be necessary to have the atmosphere warm and moist, and commonly steam or water is introduced into the sheds in which the work is done.

Persons exposed to atmospheres containing an excess of moisture, particularly if the temperature is high, are liable to suffer considerable discomfort, while those who work in artificially humidified atmospheres appear to be liable to bronchitis and other interference with health.

As to the necessity for humidification there is some divergence of opinion, but according to most authorities if there is attention to ventilation and the wet-bulb temperature is kept at or about 70° F. most risks will be avoided.

Air Pressure.—*Caisson Disease* is the only condition to which reference need be made in this connection. The effects produced on persons working in caissons under compressed air occur, some, while the pressure is being applied, others, the more important, during and after decompression.

The chief *compression symptoms* are *headache*, *giddiness*, and *pains in the ears* with sometimes rupture of the ear drums. The pulse-rate is reduced, and the respirations become deeper and slower. The great trouble is the loss of equilibrium between the tension of the gases in the blood and that in the air, and as soon as the individual adapts himself to the changed conditions and equilibrium is attained, the symptoms disappear.

If *decompression* is carried out too rapidly, vomiting, dyspnœa, giddiness, severe muscular and joint pains, and nasal hæmorrhage may occur. The person may lose consciousness or develop paralysis or even die from internal hæmorrhage. Sometimes symptoms do not appear for some time after leaving the caisson. The prevention of caisson disease lies in the giving of great attention to decompression, allowing it to take place very gradually in order to allow of equilibrium being gradually established.

Aviators occasionally suffer from symptoms similar to those described above after taking part in flights at the high levels now so commonly reached.

CHAPTER X

OFFENSIVE TRADES AND TRADE AND OTHER NUISANCES

The Offensive Trades.—The rules made with regard to these trades are contained not in the Factory and Workshop Act, but in the ordinary measures passed and enforced with the object of protecting the public health.

Generally speaking the materials dealt with in the offensive trades are such as are of animal origin or which if left untreated become by process of time a nuisance and annoyance.

Amongst trades regarded as offensive are: blood boiling, bone boiling, soap boiling, gut scraping, tripe boiling, tallow melting, manure manufacture, fellmongering, leather dressing and tanning, glue making, and fish frying.

With regard to the most of them provisions are laid down in Acts of Parliament, or in by-laws, and relate to the conduct of the business, the construction of the premises, etc.

Other trades which though definitely capable of giving rise to effluvium nuisance are not generally dealt with under by-laws are: indiarubber manufacture, varnish making, oil cloth and linoleum manufacture, and paper making.

The nuisance in the majority of the trades referred to in the first group may arise from improper storage of the raw material, during the treatment to which it is submitted, or from want of care in connection with the premises.

This is obviously so in the case of the *blood* and *bone boiler*, the *soap boiler*, and the *tallow melter*.

In *fish frying* the risk of nuisance is greatest when the frying is going on, as the cotton-seed oil which is used frequently splutters out of the pan into the fire or upon the stove and is decomposed by the heat.

Some of the trades which are not listed as offensive are liable to be associated with considerable effluvium nuisance.

In *indiarubber works*, for example, most unpleasant odours arise during the process of boiling and washing the commercial rubber and its treatment with various chemical substances, many of which contain sulphur. The materials used in the *making of linoleum* are powdered cork, linseed oil, resin, and gum, and smells arise during heating and when the sheets of linoleum are being dried.

Nuisance from the *keeping of animals* is very often complained of. In piggeries smells come partly from the styes in which the animals are kept and partly from the vessels in which their food is stored or prepared.

In the more densely populated parts of large districts the keeping of animals of any kind in or near the houses is generally discouraged, the Public Health Acts giving power to deal with cases in which animals are so kept as to be a nuisance. The chief trouble in these cases is with poultry and rabbits, though quite often dogs are dealt with also. Such nuisances as smells, dirt, and vermin are those in respect of which the local authority may take action. Persons disturbed by crowing cocks or barking dogs are left to find a remedy in law for themselves.

Slaughtering of Animals.—The nuisances that may arise from slaughterhouses, and from knackers' yards in which horses and other animals are slaughtered for purposes other than human food, may come from noise made by the animals brought for and awaiting slaughter in the lairs or pens in which they are kept while undergoing preparation for slaughter.

Nuisance may also come from collections of filth and manure, from offal, etc., allowed to accumulate and decompose, or from uncleanliness and neglect of the premises and apparatus. Not uncommonly fat boiling and other offensive trades are carried on on the same premises and form an additional source of nuisance. Offence may be caused also if the premises are so situated that the slaughtering may be seen by the public.

The places in which such nuisances are most likely to occur are the slaughterhouses and knackers' yards owned and run by private individuals. Indeed the remedy for all the troubles in connection with these trades is the abolition of private slaughterhouses and the substitution of sufficient public abattoir accommodation to meet the needs of the district. If, however, public abattoirs cannot be provided or are insufficient, private slaughterhouses must be licensed as required by the Public Health Acts, must be constructed and conducted according to rules laid down in by-laws, and must be supervised.

The general requirements in the by-laws are that premises used as a slaughterhouse should be at least 100 feet distant from a dwelling-house, should communicate with the external air on at least two sides and be well ventilated, should not be in any part below ground, should not be approached through a dwelling-house, and should have no room or loft over them. The premises should be well paved, the surface sloping to a trapped gully, preferably in the open air. The walls should be smooth, hard, and impervious. There should be a good water supply and a sound drainage system, and the place in which the slaughtering is done should not communicate directly with any privy or watercloset.

In order to allow of proper supervision the Medical Officer of Health and Sanitary Inspector have free right of access at all times. Walls, floors, drains, etc., must be kept in good order. Walls and floors must be cleansed of splashings within three hours of slaughtering, and the former limewashed three times a year. Dogs must not be kept on the premises at all, nor any animal longer than necessary for preparing it for slaughter, and then only in a proper lair. Non-absorbent receptacles are to be provided for offal, etc., and must be emptied and cleansed daily.

In the case of *knackers' yards* a licence is also required and the requirements as to the premises, conduct of the business, and so on are practically the same.

Smoke Nuisance.—That the large volumes of smoke passing into the atmosphere of towns from factory and household chimneys are responsible for serious nuisance, interference with comfort and possibly health, is recognised by the legislature, which has made provision in Acts of Parliament for the prevention of the discharge of black smoke in excessive quantities into the atmosphere from factory chimneys. Very generally the worst offenders in the matter of smoke nuisance are the smaller business concerns.

The house chimney, with regard to which no action can be taken, since the smoke given off is almost invariably at a lower level than that coming from the factory chimney and the dirt which it contains is likely to fall sooner is probably just as important as a source of nuisance.

In the *prevention of the smoke nuisance* the chief element so far as trade premises are concerned is care in connection with the choice and construction of furnaces, boilers, and chimneys and care in stoking, or the substitution, if possible, of electricity or gas for coal as a source of power.

In the case of the dwelling-house the only thing to do is to use gas or electric cookers and heaters instead of coal fires.

Injury to Health by Nuisances.—Though persons exposed to effluvia commonly ascribe any and every condition from which they may suffer to them, and those exposed to smoke hold it responsible for conditions affecting the respiratory system, almost always the difficulty of showing the connection between the smell or the smoke and the illness is considerable.

The impossibility of pointing to any definite effect, as a matter of fact, has more than once interfered with the taking of action in respect of effluvium nuisances. Authorities hesitate to offer an opinion as to the direct dangers to health from smells. The farthest many will go indeed is to refer to the possibility of health being *indirectly* affected, pointing out that comfort is interfered with, that windows of houses cannot be opened if smells are likely to enter, and that health may be disturbed in this way and individuals predisposed to attack by various disease germs.

Often too there is insistence upon the fact that there is a psychical effect which may be very marked in certain persons and may lead to disturbance of digestion with vomiting, which may, in the case of a pregnant woman for example, be dangerous. When the source of the effluvium is animal organic matter or premises in which animals are kept, the possibility of nuisance and danger from flies is generally referred to and is a point of some importance.

The dangers from smoke are largely indirect also. For the sake of cleanliness it is the common practice in smoky districts to keep all windows tightly shut, which is, of course, objectionable.

That there is any great risk of damage to the tissues of the organs of respiration by the particles of soot and possibly grit in the smoke is difficult to say. Lung troubles certainly seem to be common amongst the inhabitants of the more densely populated parts of manufacturing towns and districts, but other conditions than the pollution of the air by smoke, *e.g.* bad housing, overcrowding, and such-like, must be taken into consideration.

Prevention of Nuisances.—Something has already been said as to methods to be adopted in respect of the various nuisances mentioned, and it has been indicated that local authorities are given very full control over offensive trades, since their consent must be obtained before certain of them may be established, and a heavy penalty may be imposed by the courts upon any person who begins business without first obtaining consent. Provision is also made for punishing any one guilty of a breach of any rules laid down as to the conduct of the trades.

Further, if it is certified by, amongst others, the Medical Officer of Health or two qualified medical practitioners that certain processes are so conducted as to be a nuisance or injurious to health, proceedings may be taken against the person carrying on the trade.

CHAPTER XI

CLIMATE AND METEOROLOGY

Climate.—The climate of any place is stated to be its average state in regard especially to temperature, the direction and strength of the winds produced by differences in pressure, and the amount of moisture held as vapour or precipitated as rain. More generally the term is defined in meteorology as the sum of all the atmospheric variations viewed especially in their relation to and effect upon animal and vegetable life.

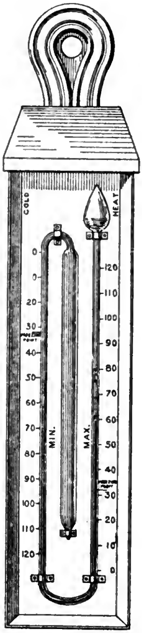

FIG. 26.—Form of combined Maximum and Minimum Thermometer.

In making observations with regard to temperature and other conditions special instruments and procedures are necessary.

Temperature.—Observations are made by means of *thermometers*. For special observations specially arranged instruments are required, *e.g. maximum and minimum thermometers*, *dry and wet bulb thermometers*, and *earth thermometers*.

The *maximum thermometer* contains mercury and is mounted horizontally. It contains an index which rises with the column of mercury and remains to mark the highest point reached since it was last set. The index may be a portion of mercury detached from the main column and separated from it by a bubble of air or a constriction in the tube, or may consist of a small rod of glass or metal. The index is set by raising the thermometer into the upright position, or, if it consists of metal, by means of a magnet.

The *minimum thermometer* contains coloured alcohol. It also is set horizontally and indicates the lowest temperature reached since the index was last set. The index lies in the spirit and can be drawn back, but not pushed forward, by the liquid.

A combined maximum and minimum thermometer (fig. 26), containing both mercury and alcohol may be used, instead of the separate instruments described.

The thermometer used in making ordinary observations on the air temperature must be screened from the direct rays of the sun. To attain this object, while not interfering with exposure to air, a special form of box known as *Stevenson's screen*, which consists of a box with a roof and louvred sides but no bottom and is mounted on legs four feet high, is employed.

The hours for reading thermometers if two readings are taken are 9 a.m. and 9 p.m. If only one reading is taken it should be done at 7 a.m., when the highest and lowest temperatures of the preceding twenty-four hours will be obtained. The highest daily temperature is generally reached between 2 and 3 p.m., the minimum about 3 a.m.[1]

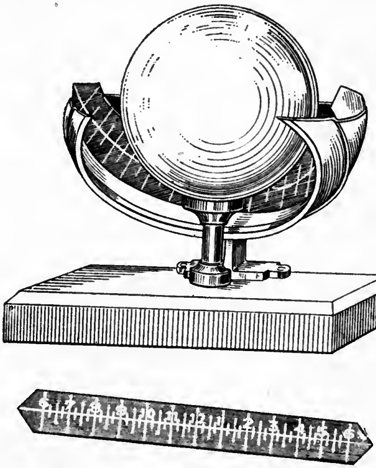

Fig. 27.—Campbell-Stokes Sunshine Recorder and Scale.

Earth Temperature.—For taking the temperature at various depths below the surface a special *earth thermometer* is used. The instrument used for this purpose is more sluggish than the air thermometer and is mounted on a heavy frame to which a chain is attached. The whole fits into a strong iron tube, which having a pointed end can be driven into the soil to any desired depth. The usual depths at which the temperature is taken are one foot and four feet. The relation between soil temperature and epidemic diarrhœa is considered in the chapter on soil.

[1] All the times named are Greenwich time.

Sunshine is recorded usually by means of a *Campbell-Stokes Recorder*, which consists of a glass ball so arranged as to focus the sun's rays on a strip of graduated cardboard, along which they travel tracing out their path as a charred line. The recorder must be set due south in accordance with the latitude of the place where the observations are made.

Jordan's Photographic Recorder is sometimes used instead of or in addition to that first described.

Clouds.—Records of clouds are kept according to a scale 0–10, the former representing a clear sky and the latter one completely overcast. The class of cloud noted is also stated, viz. *Cirrus*, or white and feathery-looking streaks; *Cumulus*, or heaped-up masses; *Stratus*, or horizontal stretches of fog or mist; *Nimbus*, or dark masses discharging rain or snow. Combinations of these classes are commonly seen. Clouds exercise a considerable effect on temperature, hindering radiation from the earth's surface and absorbing much of the heat radiated from the sun.

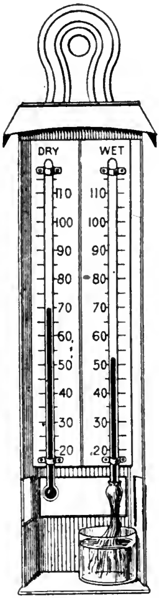

FIG. 28. — Wet and Dry Bulb Thermometer.

Humidity is measured most commonly by means of the *wet and dry bulb thermometer*, or *psychrometer*. This consists of two thermometers usually mounted side by side. One, the dry bulb, simply records the ordinary air temperature. The other, the wet bulb, is covered with a layer of soft muslin which is kept continually moist from a small vessel of rain or distilled water, with which it communicates through a piece of wool or lampwick.

The temperature recorded on the wet bulb thermometer is practically always lower than that on the dry bulb because of the evaporation from the muslin. The dryer the air the greater the difference between the readings. If, however, the atmosphere is saturated with moisture the two readings will be exactly the same.

In regard to moisture in the air it should be noted that the amount depends upon the temperature; the higher the temperature the greater the amount of moisture absorbed. When the air has absorbed all it is capable of absorbing, the point of *saturation* is reached. Air may be saturated at any temperature, low or high. To the actual amount of moisture in the air the name *absolute humidity* is given, *relative humidity* for any temperature being the moisture present, expressed as a percentage of the amount which would be present if the air were saturated at that temperature.[1]

The usual relative humidity runs from 50 to 75 per cent., and it is very commonly stated that the best figure from the point of view of health and comfort is from 60 to 65 per cent. It is difficult, however, to form a definite opinion from the percentage of relative humidity alone, and the temperature should also be stated.

The *dew point temperature* is calculated from the wet and dry bulb reading, and is that at which the moisture present in the air (absolute humidity) would suffice to saturate it if the temperature fell. If the temperature is brought below the dew-point, the moisture deposits in the form of dew.

The dew-point is obtained by finding the difference between the dry bulb and wet bulb temperatures, and, after subtracting this figure from the dry bulb temperature, multiplying by a factor known as *Glaisher's Factor*. The factors differ for each reading of the dry bulb thermometer, and are to be found in special tables worked out by Glaisher.

Humidity protects the earth from the more intense rays of the sun by day and prevents excessive heat radiation during the night.

Wind.—The instrument commonly used for measuring and recording velocity of the wind is *Robinson's Anemometer*. This consists of four arms each with a hemispherical cup at its outer end and rotating horizontally round an axis. The concave surfaces of the cups all look in one direction, and the wind striking on these sets the apparatus in motion. The movements are communicated to a recording machine upon the dials of which the number of revolutions is indicated. The anemometer should be placed at least 20 feet above ground.

[1] The relative humidity may be calculated by multiplying the *pressure* of the aqueous vapour at dew-point by 100 and dividing by the pressure of the aqueous vapour at the temperature of the air. These pressures can be measured in inches of mercury, and tables showing the pressure for each temperature have been prepared and when consulted will give the information required for working out the relative humidity.

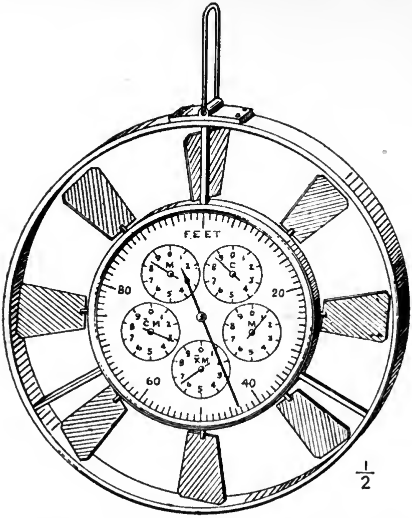

FIG. 29.—Form of Pocket Anemometer. This instrument is used mainly for measuring the rate of flow of air and the amount delivered through ventilation openings. The movement of the vanes is communicated to the indices through clockwork. In using the instrument it should be held to one or other side of the centre of the opening.

The wind's velocity is stated as miles per hour and may vary from three to ninety miles an hour, the former being about the movement in what is commonly known as a *calm* and the latter in that known as a *hurricane*.

Direction is usually measured to 8 points of the compass, viz. N., N.E., E., S.E., S., S.W., W., N.W. The relative frequency of each of these winds during a given time at a given place may be shown by means of a *Wind-rose.* This is a diagram of the points of the compass with lines drawn to scale from a centre.

Winds are due to differences in atmospheric pressure, which in turn are produced by changes in temperature and moisture. The fact that the south-west winds are those most prevalent in this country arises because the atmospheric pressure diminishes from the south of Europe northwards to Iceland.

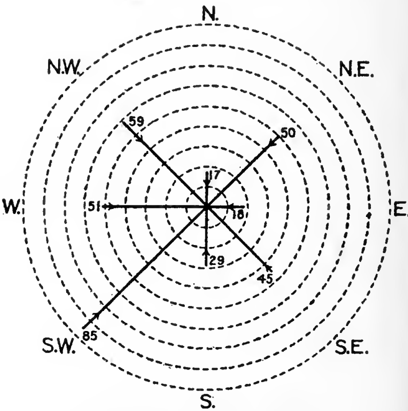

FIG. 30.—A Wind-rose.

South-west winds are most prevalent in winter because the diminution in atmospheric pressure is most marked at that season. Mountain ranges and the sea exert a great influence in relation to winds, which commonly blow from sea towards land or from plains towards hills during the heat of the day and in the reverse direction during the evening. Very little diurnal variation occurs over the open sea or at the equator.

Land and sea breezes depend on the rapidity of cooling of the surfaces concerned, the former giving up its heat more rapidly than the latter. During the day the land gets a great deal of heat, and during the day also gives it off quickly, therefore the wind sets in from the sea. Later in the day and towards evening the amount of heat given off by the sea is greater and the breeze then blows off shore. Diurnal variation is commonly less marked in winter than summer, and the wind may blow off the land continuously for several days and nights together.

The *relation of wind to moisture and rainfall* is marked, and certain winds are commonly recognised as rain-bearing winds. The power to pick up moisture depends largely on the temperature of the wind and whether or not it passes over tracts of water. Winds from the direction of the equator pick up large quantities of moisture. The south-west wind is a moist wind, since it comes from warmer regions and from the sea. North and north-easterly winds are cold and dry because they come from the direction of the pole and are mainly land winds.

Winds like clouds give up their moisture when they pass into a colder region or strike a range of hills. Rainless districts are those that are warm and comparatively free from ranges of mountains. Districts on the side of mountains facing the wind, such as are found on the west coast of Britain, always have the largest rainfall.

Rainfall observations relate to duration and amount. The former are taken by means of a self-recording rain gauge; the latter by means of a standard pattern rain gauge, which consists of a circular copper funnel to catch the rain and carry it into a bottle or other collecting vessel into which the tube of the funnel projects. The funnel has a sharp circular rim generally 8 inches in diameter, though in some patterns it may be 5 inches. Rainfall is measured in inches of water over a certain area, and in order to permit calculations to be made the area of the collecting surface of the funnel must be known. For measuring the amount of rain collected the water is poured into a measure graduated to represent tenths and hundredths of an inch on the area of the gauge. To measure hail or snow it is necessary to melt it by means of heat or by the addition of a known quantity of hot water.

The rain gauge should be set in the ground to such a depth that the edge of the rim is at least 12 inches above the surface and perfectly level. It should be well in the open and clear of trees, etc.

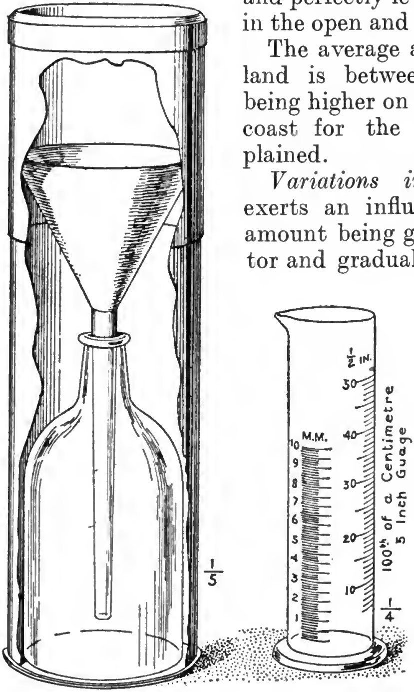

FIG. 31.—Form of Rain Gauge.

The average annual rainfall in England is between 25 and 30 inches, being higher on the west than the east coast for the reasons already explained.

Variations in Rainfall.—Latitude exerts an influence on rainfall, the amount being greatest near the equator and gradually diminishing as the distance from it is increased. *Elevation* also affects it, rainfall being very heavy on high hills adjacent to wide oceans. The proximity of *large surfaces of water* and the wind are factors of importance. The south-west winds are the rainy winds of this country for the reason that they have received warmth and moisture from the Gulf Stream and the hotter southern and equatorial regions. These same winds are a source of heat for this country for the reason that the contained moisture in condensing to form rain gives off its latent heat.

Atmospheric Pressure is measured by means of a barometer, using either the Kew or Fortin barometer, the latter being particularly sensitive and easily manipulated. In fixing a barometer it is necessary to see that it is hung vertically in the shade, in a cool place; and as temperature readings should be taken at the same time as the readings of the barometer, a thermometer should be fixed on or near the instrument.

Barometers in this country are graduated in inches and pressure is stated to be equal to so many inches of mercury. Recently objection has been taken to the measurement of pressure in length units instead of pressure units, and a new scale known as the "millibar scale" has been devised to overcome this.[1]

Variations in Barometric Pressure.—Daily variations are comparatively slight in this country, generally not more than about 0·02 inch. The maximum pressure is noted about 9 a.m. and 9 p.m., and the minimum in the afternoon and at night. Annual variations also occur, the maximum occurring in early summer and the minimum in early winter. Increasing atmospheric temperature and humidity favour a low; and decrease of temperature, dryness and compression of lower atmospheric strata, by pressure of wind at a higher level, a high barometric pressure. High readings are common in high latitudes, over continents, and in very cold countries; low readings are noted in the tropics and over oceans.

Information with regard to barometric conditions at outlying stations is regularly received at the Meteorological Office, and with these what is known as a *synoptic chart* is formed on the map. In this all places having the same barometric pressure at the same time are linked up by means of lines called *isobars*.

Commonly these isobars, or lines of equal barometric pressure, form circles or ellipses with in some cases the lowest, and in others the highest pressures in the centre. In cases in which

[1] In the millibar scale the unit employed is the *bar*, which represents the pressure of the "atmosphere," *i.e.* the pressure of 1,000,000 dynes per square centimetre, the dyne being the unit of force. The bar, it happens conveniently, is approximately equivalent to 29·5 inches of mercury at 0° C. and standard gravity, and is subdivided into centibars and millibars. The centibar is equal to $\frac{1}{100}$th and the millibar to $\frac{1}{1000}$th of the bar, and both centibars and millibars are shown on the scale. In stating the readings there is some difference of opinion as to whether the form taken should be so many centibars or so many millibars. Fortunately the difference is only one of a decimal point, and it matters little whether a pressure is stated to be, for instance, 100·97 centibars or 1009·7 millibars. The fact that the monthly weather reports always refer to millibars and the scale is called the millibar scale seems to suggest that the latter is more acceptable.

the lowest pressure is at the centre what is called a *cyclone* is formed. When the pressure rises from the periphery to the highest point in the centre the name *anticyclone* is given.

Types of Climate.—Chiefly because they depend largely

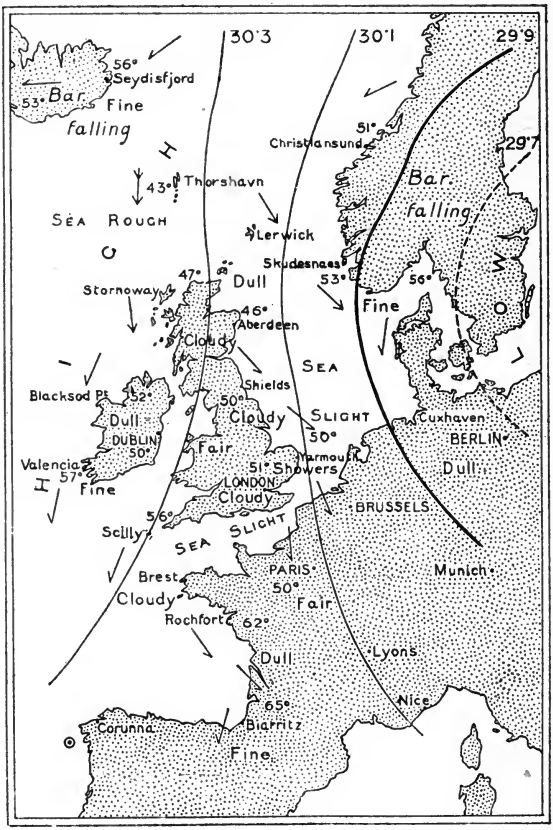

FIG. 32.—A Synoptic Chart involving the British Isles and part of Western Europe.

upon latitude and the temperature of the latitude, climates are commonly classed as (*a*) hot or warm (equatorial, tropical, and sub-tropical), (*b*) temperate, and (*c*) cold.

In addition, however, because of the influence exerted by the sea, they are sometimes classified as (1) ocean, (2) continental, (3) insular, and (4) mountain.

The differences between these various types of climate are fairly marked. In *hot or warm climates* the mean temperature may be as high as 80° to 84° F., decreasing with distance from the equator. In them the rainfall is heavy, and there is a distinct wet and dry season. In *temperate climates* the mean temperature is about 60° F., the rainfall is moderate, and there are four seasons. *Cold climates* have a mean temperature ranging from 5° to 40° F. In them there is little rain but much snow and two seasons only, a short summer and a very long winter.

The *oceanic climate* shows the effect of the sea most markedly and can only be found on or very near the sea. It is characterised by an absence of liability to violent changes of temperature; the air is pure, moist, and frequently contains ozone; winds are frequent and the humidity very constant.

The *continental climate* is that found on large tracts of land far from the sea or open water. It is dry generally, and the variations of temperature between heat and cold are great.

The *insular climate* resembles the ocean climate. It is very equable, and the differences between the summer and winter temperature are much less than in the case of the continental climate. In the British Isles the climate, particularly on the west coast, where the Gulf Stream makes its influence most felt, approximates very closely to the oceanic type. On the east coast there is a nearer approach to the continental, the temperature being less equable and the moisture less.

The *mountain climate* is characterised by dryness and rarity of the atmosphere and a great amount of sunshine. It is to be found mainly in places above a level of about 3,000 feet. There is a marked difference between the day and night temperatures and a low barometric pressure. The amount of rainfall depends mainly on the proximity of the sea and the direction of the prevailing winds.

The *conditions exerting an influence in relation to climate* are chiefly: (1) Distance from the equator. (2) Height above the sea. (3) Distance from the sea. (4) The prevailing winds.

In addition to these, so far as regards definite localities, must be included (5) the general character of the country, physical and geological, *e.g.* nature of the soil and sub-soil, slope and aspect, cultivation of the soil, vegetation, and so on.

Perhaps the most important factor is *distance from the equator*, the sun's rays becoming less powerful as they fall obliquely in travelling from the equator. Even this, however, is subject to modification under the influence of others of the factors noted above.

Elevation affects climate by affecting temperature and barometric pressure. Places lying near the sea have generally a more equable climate than those more distant, partly because of the presence of moisture in the air, partly because of ocean currents flowing from the equator to higher latitudes.

Winds exercise an effect by affecting the temperature and the degree of moisture in the air. Winds always carry with them the temperature of the air over which they have passed, and if the prevailing winds of a place come more or less from the south its climate is likely to be warmer than one exposed mainly to northerly winds. Winds blowing over an ocean are usually moist winds.

The General Character of a Country.—Soils have an important influence; a dry sandy soil is warmer because it conducts heat less than a damp clayey soil, and change in climate can be produced by attention to drainage of soils. Ground covered with *vegetation* has a more uniform temperature than bare soil because the sun's rays are kept out and radiation is interfered with. Further, vegetation attracts and itself gives off considerable quantities of moisture.

Forests have a tendency to equalise climate. Trees radiate heat slowly and make the night warmer and the day cooler. They also influence rainfall greatly, as the trees attract moisture from the clouds. Destruction of forests in certain districts has led to considerable change in the climate and particularly to a lengthening of the periods of drought.

Where the slopes of a hill are clothed with trees the temperature of the sides and base is generally high, for the reason that the trees obstruct the currents of cold air descending from the top.

Climate and Health.—While it is probable that, on the whole, the temperate type of climate is more favourable to health than the tropical or polar, in which extremes are the rule, in it also the climatic conditions do exert an influence in connection with the incidence and prevalence of disease.

Though the seasonal variations are not generally excessive, nevertheless they are apt to prove trying to the very young, the very old, and others of feeble resistance. Quite regularly in winter and spring, even in the most sanitary districts, the sickness and death returns show a preponderance of diseases of the respiratory organs, while in summer diarrhœal conditions are those mainly to be noted, and apparently climate is largely responsible.

No less than in tropical countries, temperate climates have their characteristic epidemic diseases and they also show their dependence upon season and weather. October and November see scarlet fever at its maximum, the minimum occurring about March. Measles has two maxima, one in June and the other in December, and is at its lowest in February and September. The maximum of whooping-cough shows about March and the minimum about October. Diphtheria, which is comparatively rare in tropical countries, is generally at its worst in October and November.

Sanitation and health measures generally have not affected these diseases as regards periodicity, and it seems safe to take it that climatic conditions play some part.

In tropical and warm climates there exist temperature and environmental conditions exceptionally favourable to bacterial growth as well as to the spread of bacteria, *e.g.* by means of insects, and germ diseases are common and epidemics often widespread. Diseases of the respiratory organs, with the exception of pneumonia and pulmonary tuberculosis, are comparatively rare in tropical countries.

Apart from the germ diseases, conditions definitely climatic occur in these countries. *Sunstroke or insolation* and *heat stroke* are much more commonly seen there in a severe form than elsewhere.

With these as with the diseases the result of invasion of the body by organisms, it is the new-comer from a temperate climate who shows the greatest liability to attack and who suffers severely. Attack in these cases is not of course inevitable, the human body, particularly the young adult body, having a remarkable power of adapting itself to changes of climate and becoming more or less rapidly acclimatised. So far as the organismal diseases are concerned, the care exercised by individuals from temperate climates in respect of hygiene and sanitation probably also plays a great part in prevention.

In cold climates organismal diseases, except such as may be traceable to the overcrowding that is apt to occur as a result of huddling together of individuals for the sake of warmth, are not common. On the whole perhaps moderate excesses in the matter of cold are better stood than corresponding excesses of heat. The body is more apt to be stimulated by cold and to adapt itself to it; but if excessive in duration or intensity, interference with bodily functions and death may result.

Apart from temperature, variations in others of the elements concerned in the determination of climate are not without influence on health.

The fact that *humidity*, if excessive or deficient, may prove detrimental to health has already been noted.

Atmospheric pressure under natural conditions practically never varies enough to cause inconvenience, and it is only if pressure is markedly increased and diminished suddenly, *e.g.* in caisson workers, that symptoms are apt to appear.

The effects of diminished pressure are seen in climbing mountains and making balloon and aeroplane ascents. At great heights, 5,000 or 6,000 feet and over, mountain sickness with giddiness, vomiting, and possibly hæmorrhage from the nose and ears may occur. At 16,000 feet the atmospheric pressure is reduced by one-half, being only 7½ lb. per square inch. As is well known, advantage is often taken of the stimulating and tonic effect of mountain air obtained at between 3,000 and 6,000 feet in connection with the treatment of certain diseases.

Climate and the Treatment of Disease.—Climate not only plays an important part in connection with the maintenance of health, but can be used also in relation to the restoration of health. In the treatment of tuberculosis, for example, clean air and plenty of it, dryness of soil, brightness, not too much heat and not too much cold are the most favourable climatic conditions, and in a temperate region districts showing such conditions are not too difficult to find.

Districts suitable for tuberculous patients are in the main appropriate for those suffering from chronic respiratory troubles, and for the treatment of rheumatic affections dryness is of course the chief necessity. In chronic affections of the kidney, a warm and not too dry climate is the most suitable.

The fact that change from a tropical to a temperate climate is often beneficial to persons suffering from diseases peculiar to tropical and warm climates is well known. As a matter of fact, however, change of air, of scene, and of climate tend to improvement in a large number of diseases, particularly those that are apt to be more or less chronic or in which the "nerves" are involved.

Changes from town to country, from low-lying to more hilly parts, and from inland to seaside districts are generally recognised to be advantageous not only to those who are ill or run down, but to the apparently healthy as well. Why these changes should do good it is difficult to explain. Probably the reasons are many, not the least important being the getting away from the settled routine, and the stimulation resulting from new impressions through the eye and other sense organs.

CHAPTER XII

DISPOSAL OF THE DEAD

Recognition is now general that it is undesirable to retain dead bodies for longer than necessary amongst the living, and that disposal should be carried out as far as possible from human habitations.

Removal of bodies from houses rarely gives trouble, though occasionally amongst the poor, whose accommodation and arrangements are such that the deceased should be removed at once, it is necessary to employ pressure. Means of applying this is provided in the Public Health Acts, where power is given to a magistrate, on a certificate granted by a medical practitioner, to order removal to a public mortuary and interment within a certain time of any body in such a state as to endanger the health of the occupants of any house or room; or which, being infectious, is retained in a living- or sleeping-room.

Disposal.—The chief methods of disposal are burial in the ground or *earth burial*, *cremation*, and *vault burial*. The object of these, as of all methods of disposal, is to ensure the ultimate complete and rapid disappearance of the body, or its resolution into its component elements. From the sanitary point of view there is little to choose between them, provided attention is given to the necessity of avoiding danger to the living by contamination of air by organisms in or associated with the body, or by gases formed during the process of destruction, or by the pollution of water supplies or soil in the neighbourhood of dwellings.

Earth burial is the oldest and most widely practised of all methods. It is claimed for it that it is the most natural, and that, in disintegrating, the body gives off something to the soil calculated to enrich it. It is urged against it that nothing is to be gained by enriching the soil of burial grounds, and that as a matter of fact the chief objections to it are that the products of decomposition do pass into the soil and that their distribution is difficult to control.

By reason of the danger that may occur great care is required in connection with the choosing of a *site* for a burial ground : its situation in relation to dwellings ; its elevation ; the character of the soil and the direction taken by any drainage from it. Attention must be given also to the construction of graves, their extent and particularly their depth, and to the type of receptacle used for the bodies that are to occupy the graves.

Cemeteries and Burial Grounds should be placed as far as possible from any collections of houses, and in no case should any part of the ground be nearer a dwelling than between 100 and 200 yards. The whole cemetery must be surrounded by a wall or railings 8 feet high, and precautions taken against contamination of water and soil by providing proper drains, and wherever possible causing them to discharge into sewers. A dry soil is the best for a cemetery, and loam is the most satisfactory of all. Clay is bad because it is damp and is apt to delay dissolution and to crack in dry weather and so allow of the escape of carbonic acid and other gaseous products of decomposition. While a loose soil is preferable, one containing too much gravel or sand is unsuitable unless bedded on a deep layer of clay or other less permeable material.

The *size* of cemeteries depends upon the extent of the population and the possibility of increase in the size of the district. The usual custom is to allow a quarter or half an acre per 1,000 persons.

Drainage of the soil should be attended to before any interments take place. Careful note should be made of the depth of the subsoil water. This should be at least 10 feet below the surface of the ground, and not less than 2 feet should intervene between it and the bottom of the grave. Trees and shrubs should be planted in order to assist in drying the soil and absorbing carbonic acid gas, which is always more plentiful in the air of cemeteries than in ordinary atmospheric air.

The *grave space* for adults should be at least 4 square yards, and for children 2 square yards. Unless exclusive right of burial is obtained, not more than one body, except members of the same family, are to be buried at one time in a grave. If it is done the coffins must be separated by at least one foot of earth. The minimum time limit for opening graves is for children under twelve, eight years; and persons over twelve, fourteen years.

In earth burial the dissolution is brought about partly by the organisms contained in the body, partly by those derived from the soil, which, since oxygen is more plentiful there, are more numerous and active in the upper layers. For this reason coffins of children under twelve are required to be buried 3 feet and of persons over twelve 4 feet below ground. The Conseil d'Hygiène Publique had also this reason in mind when in 1871 they recommended that the best way of dealing with the victims of the Franco-Prussian war was to leave them where they fell, covering them with a layer of earth no thicker than about 15 or 20 inches. The earth for the mound was to be brought from a distance of 1 to 2 yards in order to avoid disturbance of the soil and the formation of trenches by the side of the mound. Bodies dealt with in this way disappeared very rapidly. In the recent great war, where this method was inapplicable, power was obtained from the French Government to incinerate bodies of men and animals, after they had been sprinkled with a special preparation of tar.

Coffins of heavy wood, *e.g.* oak, and those lined with or made of lead, delay dissolution and should be replaced by those made of wickerwork or unprepared wood or even paper.

The products of decomposition are mainly carbonic acid, ammonia, sulphuretted hydrogen, and organic compounds. Excepting the anthrax bacillus, pathogenic organisms very rapidly disappear from the body after burial, possibly because of the presence of large numbers of other harmless bacteria.

Cremation.—The process of dissolution in this method of disposal occupies only about one hour on an average, and takes place without risk to the living either from organisms or gases. When cremation is completed all that remains is odourless and harmless ash, which can be placed in a vase occupying only a small amount of space, and as a result the necessity of providing large areas of ground for interments is avoided.

Mainly on sentimental and religious grounds there is a great deal of opposition to this, the most hygienic of all methods. Of other objections raised, the most worthy of consideration is that it may be used to conceal crime. To prevent any possibility of this, very careful precautions are taken in this country, where it is required that before cremation can be carried out there must be produced two medical certificates from qualified men who have seen the body, and that, thereafter, permission must be obtained from a medical referee, who may call for a post-mortem examination before he grants it.

Burial authorities may undertake to provide crematoria on condition that they are not placed nearer than 200 yards to any house without the consent of the owner, nor within 50 yards of a roadway. No crematorium may be used until the site and plans have been approved by the Local Government Board.

In rapidly growing districts cremation is undoubtedly the most economical method both in respect of money and land; as regards land used, however, it may be noted that cemeteries can never be considered absolutely waste, since they serve as open spaces when in use and afterwards can be transformed into public gardens and play-grounds.

The apparatus used in cremation consists essentially of a large metal box into which the coffin of very light wood is introduced after the usual religious ceremony. The heat, which reaches between 1,500° and 2,000° F., is commonly derived from gas flames produced outside the metal box and playing upon it.

The gases produced during the incineration are carried up a tall shaft connected with the furnace, but before reaching it are made to pass through the furnace itself so that all possibility of escape of smell is prevented.

Vault Burial.—The requirements with regard to this are that vaults must be enclosed in strongly built brick or stone walls and that coffins must be properly built or concreted in within twenty-four hours.

Embalming is carried out in cases in which for any reason a body must be retained for longer periods than the average before being buried or otherwise dealt with. In America, where it has received much attention, prominence has been given to a method which does away with the necessity of interfering with the viscera. The fluid recommended consists of formalin (40 per cent. formaldehyde) 12·5 cc., borax 5·0 grammes, and water sufficient to make 100 cc. Of this an amount equal to 15 per cent. of the body weight is injected, a certain proportion into each femoral and brachial artery and the common carotid of one side.

In the case of the carotid a small percentage is directed towards the head and a larger amount towards the heart. The surface of the body is washed and the mouth and other orifices plugged with wool soaked in the fluid. In order to prevent drying of the body surface, it is recommended to anoint liberally with vaseline and afterwards apply bandages.

Undertakers in this country, if the body is only to be kept for a few days longer than usual, generally content themselves with injecting a few pints of formalin into one brachial artery.

CHAPTER XIII

FOOD

The Necessary Constituents of Food are classified usually as Proteins, Fats, and Carbohydrates, with in addition salts of various kinds and water.

In choosing foods greatest regard is given to the first three, because on these depends the carrying out of the various functions of the body, viz. (1) energy production; (2) heat production; (3) growth of the body; and (4) replacement of waste.

So far as items (3) and (4) are concerned chief reliance is placed upon the proteins or substances containing nitrogen, though they have a part in (1) and (2) as well.

The fats and carbohydrates, because they consist of carbon, hydrogen, and oxygen, and burn up too rapidly to act as body builders, are mainly heat and energy producers. The salts and the water, though essential, take no direct part in the performance of the functions mentioned.

Choice of Foods.—For the ordinary purposes of life it is generally held that a man requires a diet containing 1 part of protein to 3 or 4 of the other constituents, or about 4 ozs. of proteins, 18 ozs. of carbohydrates, and 2 ozs. of fat, with, in addition, 1 oz. of salts.

With the exception of milk, however, none, or very few, of the articles ordinarily used contain all of the essentials in anything like these proportions, and in order to obtain them it is usual to adopt what is called a "mixed diet" and to choose one food because it is mainly or largely protein or nitrogenous, another because it is chiefly carbohydrate or starchy, a third because it is fatty.

The simplest choice is meat for proteins, bread or potatoes because they provide carbohydrates as starch, and butter since it is mainly fat. That choice need not, however, be limited to these, and that there are great numbers of other articles which can take the place of one or the other, in some cases with advantage, will be seen from the following summary.

Protein Foods : *Beef.*—For the supply of the bulk of the protein it is usual to look to beef, which, since it contains roughly 20 per cent. protein, 5 per cent. fat, and 75 per cent. water, is mainly a nitrogenous food. It has a high nutritive value and is comparatively easily digested, provided it is properly butchered, properly hung, *i.e.* kept till the rigor mortis is well over, properly cooked, and properly masticated.

The chief protein is *myosin*, which is contained in the muscle fibre ; in addition, however, there are *albumins* of various kinds from the blood and serum. Various *salts* which are of value are also found, viz. phosphate of potassium, and small quantities of sodium chloride, lime, and magnesia. Extractives such as kreatin, kreatinin, xanthin, etc., are mainly derivatives of proteins.

Even in normal times beef is a somewhat expensive food. In joints and chops much more is paid for bone than it is really worth. Steaks even, because they are so often badly cooked, are uneconomical also. Frozen or chilled beef, which is cheaper than the home-killed varieties, is not to any great extent inferior to them in nutritive value, the freezing or chilling exerting practically no influence in this connection. The fact that it can be bought cheaply compensates for any possible disadvantages.

Substitutes for joints and prime cuts occasionally used by the more economical of the poor are what are known as "pieces of meat." These consist of pieces of lean beef cut from joints and so on, and since in normal times they are usually sold at 3*d*. or 4*d*. per pound they are excellent value.

Some of the edible internal organs of cattle, *e.g.* the *liver*, can be obtained comparatively cheaply, and are of good nutritive value and fairly easily digested. *Tripe* is well known to be cheap, and if well cooked is easy of digestion.

Veal is the flesh of calves. It is less nutritious, less easily digested than the flesh of the adult animal. It cannot be regarded as a cheap food. Calves' liver is comparatively cheap, digestible, and nutritious. The younger the calf the less nutritious the flesh ; and though attempts are made at times to put on sale veal of calves only two or three weeks old ("bobby calves") or that of animals newly born or even born dead ("slink" veal), local authorities and their inspectors try as far as possible to prevent it. One of the objections to such veal is that it offers a suitable nidus for putrefactive organisms and rapidly goes bad.

Mutton differs very little from beef as regards nutritive value. It is generally a little cheaper, and being somewhat more digestible is more suitable than beef for persons leading a sedentary life.

Lamb stands in the same relation to mutton as does veal to beef.

Pork, because it contains more of fat and is more difficult to masticate, is less digestible than beef or mutton. Particularly in the form of bacon it is exceedingly expensive. Cheap cuts of cured or uncured pork are, however, obtainable and may be recommended if a change from beef or mutton is desired. Bacon and beans is an example of a diet containing all the essential elements—proteins, fats, and carbohydrates.

Poultry is expensive, and though generally the flesh is easily digested and nutritious, it is rather poor in fats and carbohydrates. To make up for the poverty in these essentials bacon and various sauces are usually eaten with fowl. The flesh of *game birds* is harder and rather less digestible than that of fowls fed for the table.

Game in the form of *rabbits* is widely used by all classes. Large quantities of wild rabbits are now imported and are usually cheaper than the Ostend variety. They are fairly easily digested, and are not uneconomical.

Fish generally are nutritious and easily digested. *Herrings* fresh or cured (kippers and bloaters) and mackerel, because the flesh contains a fair proportion of fat, are perhaps less digestible than the white-fleshed fish, *e.g.* haddock, whiting, and even cod, which retains most of its fat in the liver. The flesh of salmon is rich in fat, but like that from all red fleshed fish it is highly nutritious.

Fish, when it can be bought cheaper than meat, is an excellent substitute. The advantage of such as have fat flesh is that they are more nourishing.

Shellfish are indigestible and generally unsuitable as alternatives to other articles of diet. The fact that digestive disturbances, urticaria, and even blood poisoning are, in addition, commonly associated with their use as food, and that they may be the vehicles for enteric fever and other germs, is to be remembered, *Eggs* contain a large amount of protein in the form of albumin, to a great extent in the white. The yolk consists largely of fat in the form of an oil. Protein is present also as vitellin as well as a certain amount of phosphorus and iron. The percentage of water present is about 76 per cent. Carbohydrates are only small in amount. The average weight of a hen's egg is 2 oz. The duck's egg is heavier and richer in fat. Eggs, though nutritious and digestible, cannot be regarded as a cheap substitute for meat.

Milk is an emulsion of fat in water containing proteins, carbohydrates, and salts in solution. The fat occurs in the form of globules ; the chief proteins are casein, serumalbumin and globulin, and the carbohydrate milk sugar.

Cows' milk contains about 4 per cent. of proteins and 4·5 of sugar. The legal standard for fat is 3 per cent., though the average is about 3·5. In human milk the proteins reach 2 to 3 per cent., the fats 4 per cent., and the sugar 6·5 per cent. The specific gravity of cows' milk is about 1032 and of human milk 1027. The percentage of water is approximately about 88 per cent. in each.

The fact that it contains all the necessary elements makes milk the one form of food that could be used alone and be sufficient for all the purposes of the tissues. In the case of an adult, the objections to its use alone are that it is deficient in sugar and is expensive. In the case of the child, milk, especially human milk, is a perfect food, containing everything required by the tissues. Cows' milk, since it contains more protein than the child can deal with, and less fat and sugar than it requires, must be modified, partly by the addition of water, before it can be made suitable. One very important difference between human milk and cows' milk is that while the former can be digested in from one to one and a half hour, modified cows' milk takes two or three hours, and raw cows' milk four hours.

Apart from costliness, the great disadvantage of cows' milk, in towns particularly, is that it is exceedingly difficult to get it clean and pure and of good quality. A typical food for the infant, it is also an excellent medium for the growth of organisms and a common means of spreading tuberculosis, enteric fever, scarlet fever, and diphtheria. Nevertheless it is so frequently taken from the cow under improper and even filthy conditions, is so carelessly handled and exposed throughout the whole course of its journey from the point at which it is obtained to the point at which it is consumed, that it quite commonly becomes most grossly contaminated.

For the reason that such laws as there are are not enforced, and most of the precautions in connection with cleanliness are neglected, milk produced in country districts for the town market is much less likely to be safe than that obtained from the few remaining cowsheds in large towns. The cows in these, it is true, are regarded merely as milk givers; they enter the shed soon after calving, when the milk is becoming fit for use, they never leave it for about a year, when, having

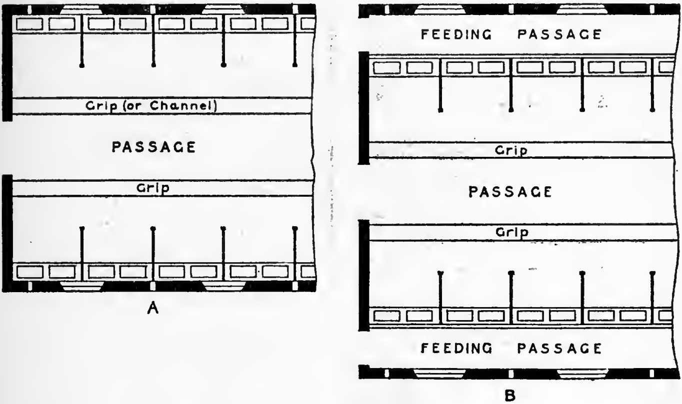

FIG. 33.—Types of Cowsheds. A. In this the cows are tethered head to wall. B is a more modern type; in it there is a space between the head of the stall and the wall which reduces the necessity of disturbing the cows at feeding times and also makes for cleanliness and improved ventilation.

ceased to give roughly about twelve quarts of milk per day, they are driven out to be slaughtered. While they are in the shed, however, they are kept under supervision; the shed is clean; they are well fed, on artificial and dry foods mainly; they are well groomed, their udders are kept clean, and the person who milks them, in England generally a man, is kept clean also. Proper apparatus is provided for cleaning cans; the milk is filtered and also, because it interferes with rapidity of multiplication of organisms and improves the keeping qualities, it is cooled.

In some country dairies, of course, these and even greater precautions are taken, but these are the exceptions, and the reason given for neglecting them is that the milk will be more costly to get, and must be sold at a higher figure. The fact that some dairymen can attain a very high standard of cleanliness and in some cases can have their cows tuberculin tested and weed out those that react, and still sell milk at the ordinary price or only very little more, rather suggests that the risks of adding to the cost are exaggerated.

The difficulty with which the person who does not take precautions has to contend is that the milk readily goes sour.

Fig. 34.—An Insanitary Cowshed and Dairy. Note the heap of manure and the collection of drainage close up to the entrance to the shed.

To meet this, the practice of adding such antiseptics as boric acid, formalin, and hydrogen peroxide was widely followed. Recently, however, regulations forbidding the use of preservatives under pain of heavy penalties have come into operation, and instead of using chemicals many of those commercially interested in the keeping properties of milk now employ heat, and carry out what is known as *pasteurisation*.

From the point of view of interference, *pasteurisation*, which involves heating the milk to and keeping it at 180° F. for twenty minutes, is infinitely preferable to any other method of treating milk, either with a view to improving its keeping qualities or rendering it bacteriologically safe. Though bacteriologically safe, however, the milk is not necessarily clean and fresh, and it is a clean fresh milk that is required.

To get a fresh milk, it is necessary to forbid the use not only of chemical preservatives, but even of treatment by heat. To get a clean milk, it is essential to have cleanliness at all stages of collection and distribution. Precautions adopted, particularly by farmers who send milk long distances, are filtering and cooling, using special apparatus for the purpose. These are unobjectionable, and give good results. Better results still, however, are obtained if, in addition to ordinary cleanliness, the flanks of the cows are damped and the udder washed immediately before milking; if the milkers wear clean overalls and wash their hands before milking, and a special covered milkpail is used.

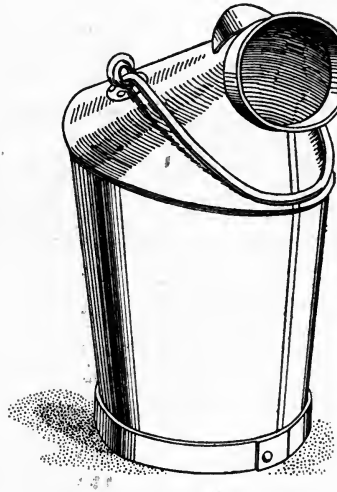

Fig. 35.—Improved Milk Pail. By making the opening lateral, the risk of the entry of dust and dirt is reduced.

Useful as these measures are, much more is necessary if the milk is to be prevented from acting as a carrier of tuberculosis. The herds, in fact, must be cleared of tuberculous cows, and this is so large and difficult an undertaking that many years must pass before it is even attempted on any scale.

In the meantime, therefore, on account of the risks, milk given to infants and children should be boiled, since this is easier and more readily carried out in the home than *pasteurisation*.

Adulteration of Milk.—Milk, in addition to being liable to pollution, and suitable for the growth of germs, lends itself very readily to adulteration, and one of the most important duties performed by authorities, so far as food is concerned, is in connection with the prevention of any interference with the quality of milk.

The chief constituent of milk from the nutritive point of view is the fat. Having great monetary value and being comparatively easy to withdraw, either by centrifugalisation or skimming, it is the constituent mainly attacked by the adulterator.

The legal standard for fat is 3 per cent.; and while there are many dealers who sell the milk exactly as they get it, there are many also who, with the object of making more out of it, take care never to sell any that is not just of the right standard, or a little below. This is usually done by the judicious mixing of whole milk and separated milk, a process which is commonly described as *toning*. The addition of water is crude, and is moreover easily detected. Toning, on the other hand, is difficult to detect if skilfully done, and even highly qualified analysts are frequently deceived.

Colouring of Milk.—In order to mislead with regard to the quality of milk, it is quite a common practice to "colour" it with a vegetable dye known as *annatto*. In proper quantity, this gives a yellow creamy look to the milk, and leads, as it is intended to lead, to the conclusion that the sample is rich in fat. Quite good firms are forced to resort to the use of annatto, in order to permit them to compete with other firms dealing exclusively in coloured milk. Annatto is largely used for colouring butter.

Milks that have been deprived of part of their fat are commonly sold as *skim* or *separated milk*. Of the two the skimmed milk, in which the skimming is done by hand, contains a larger proportion of fat, about 1 per cent. The fat removal is more thoroughly done in the case of separated milk, when a centrifugal apparatus is used. The percentage of fat left is something like 0·25 per cent.

The centrifuge is sometimes used as a means of cleansing milk. The rotations in this case, it is stated, though sufficient to drive down the dirt as a deposit, are not strong enough, nor maintained for a period long enough, to separate the cream.

Condensed Milk is largely used by the poor as a substitute for fresh milk, and very commonly for the feeding of infants. There are three varieties: (1) condensed unsweetened whole milk, (2) condensed sweetened whole milk, and (3) condensed sweetened skim milk. Of the three the first is the best. It is largely used by British people abroad for infant feeding and other purposes, because it is safer than the milks obtainable locally, and more easily digested. The dilution used should be one in three of water. The poor in this country use mainly the third variety, because it is the cheapest. Its use probably is one of the commonest causes leading to rickets among the children of the poor.

Condensed sweetened whole milk contains too much sugar for infants. It is therefore too fattening, and its use also is not uncommonly associated with rickets.

Condensed milk is made by driving off a large part of the water contained in ordinary milk. It is said to represent three times the volume of fresh milk. Tins containing skim or separated condensed milk must, according to legal requirements, be so marked. Only well-known brands should be used, and tins that are dented or that show any exudation or stickiness should be rejected.

Dried Milk is largely used in infant feeding, and many authorities recommend it particularly during the warm "diarrhœa" months. It is easy to work with and is quite sterile, having been exposed to great heat.

Cream is a valuable food, but being entirely fatty is somewhat difficult of digestion. A quantity of cream should always, if possible, be added to the feeds of a bottle-fed baby. "Set cream," *i.e.* cream which has risen naturally and has been removed by hand, is more easily digested than the separated variety. Since cream is very expensive it is usual to recommend codliver or olive oil for the use of the hand-fed babies of the poor.

Cream is very commonly preserved. The law with regard to preservatives is that they shall only be added if the fat content of the cream is 35 per cent. or over. If there is less than this amount, no preservative is allowed. The substances permitted are boric acid, borax, or a mixture of these, or hydrogen peroxide. All preserved creams must be labelled as such, and the name of the preservative used must be stated. In the case of boric acid, the maximum amount present must be given as a percentage.[1]

Buttermilk, the milk remaining after the butter has been churned out, contains a considerable quantity of lactic acid and a certain amount of fat. The proteins are in an easily

[1] These provisions are contained in The Public Health (Milk and Cream) Regulations, 1912.

digested form and, for this reason, buttermilk is sometimes used as a temporary diet for delicate infants.

Butter is made usually from new milk or from cream by churning at a suitable temperature. It consists almost entirely of fat, and, as the churning has broken the coverings of the fat globules, it is easily digestible. A certain amount of protein (casein) is generally present also. The more thoroughly butter is washed after churning, the better it keeps, and the less tendency it shows to go rancid. Salting also has this effect. The legal maximum limit for water in butter is 16 per cent.

The quantity of butter produced in this country is comparatively small, mainly because it pays better to sell milk than to turn it into butter. Partly for this reason, and partly also because butter is expensive, several substitutes are prepared and sold. Some of them also are used as adulterants of butter and a considerable trade is done, and large profits are made out of such adulterated materials.

Margarine and *Milk-blended Butter* are well-known substitutes and are often palmed off on retail customers as butter. More refined adulteration consists in adding a certain amount of margarine to the butter, or working the butter up with oils of various kinds, *e.g.* cocoanut oil.

Margarine is supposed to be made from animal fats, but a very large number of margarines contain cocoanut or palm oil. It is cheap and, from the dietetic point of view, quite a good substitute for butter. It lacks the delicate flavour of butter, but that is probably all. The legal limit in respect of water is 16 per cent. as in the case of butter. With the object of preventing fraud, anything that is not butter or milk-blended butter is to be regarded as margarine, and labelled and sold as such.

Milk-blended Butter is made by incorporating milk with butter. It is somewhat cheaper than butter, but more expensive than margarine. The legal maximum limit of moisture is 24 per cent., which makes it distinctly uneconomical as a food.

One of the cheapest and best substitutes for butter is *beef dripping*. A considerable trade is done in this substitute amongst the poor, but it might with advantage be more widely used than at present.

Lard, the internal fat of the pig's abdomen, is mainly used for cooking purposes, *e.g.* in the making of pastry. Pure lard should be free from water and foreign fats, such as beef fats and cotton-seed oil, but these are frequently used as adulterants.

Cheese contains casein, the curdled portion of milk, much of the fat, and the salts precipitated by the addition of rennet. The best cheese are made from the whole milk. Most varieties are excellent and cheap foods, though they are somewhat indigestible.

There is no legal standard for cheese. A paste consisting of tallow, barytes, and iron oxide is sometimes used as a covering for certain cheeses, *e.g.* gorgonzola, doubtless with the object of making more out of the cheese.

Vegetable Foods.—The principal constituent of foods derived from the vegetable kingdom is starch; but the cereals, wheat, oats, barley, maize, and rice, all contain a certain amount of protein and fat in addition. In certain of the flours and meals derived from cereals the protein present is in the form of *gluten*, which, when mixed with fluid, forms a sticky, tenacious mass. The flours in which gluten is present in fair amount are those from which bread can be made.

Flour and Bread.—Wheat flour contains from 8 to 12 per cent. of gluten, and is therefore particularly suitable for bread making.

For this purpose quite a number of grades of flour are produced and used. The appearance which they present and, according to some, their nutritive value depend upon the amount of the entire grain they possess.

For very high-class breads, and for cakes, the flour may be sifted clear of all except the kernel. The flours for the lower-priced breads are less carefully sifted, and are therefore darker in colour. One of the advantages claimed for *standard flour* and the "standard bread" made from it is that, by including much of the grain generally rejected, most of the fat and nearly all the protein are retained.

Most of the whiter flours are subjected to *bleaching* and are *improved.* In bleaching, nitrogen peroxide, produced electrically or from ammonia, is used. In certain countries, amongst them America, Australia, and Switzerland, for the reason that the nitrates used may very easily be present in sufficient amount to cause harm to the consumer, bleaching of flour is forbidden. The same remark applies to "improvers."

In addition to the flours commonly used, there are others known as "specials," and used for making certain advertised kinds of bread, which claim to have higher nutritive qualities than ordinary bread. Some of these flours contain the bran or outer covering of the grain ground to a very fine powder, or otherwise treated; others may contain malt, lentil flour, or banana meal.

Self-raising Flour is usually made by adding sodium bicarbonate and acid calcium phosphate. Lower-grade phosphates contain a considerable proportion of calcium sulphate, which is objectionable.

Adulteration of flour and bread is not particularly common. Foreign and cheaper starches may be added to flour, but flour starch has certain distinctive features, and can be distinguished microscopically from those derived from other sources.

Macaroni and *Vermicelli* are made from a flour derived from wheat particularly rich in gluten, and are highly nutritious and comparatively cheap.

Oatmeal is a valuable food, as it contains on an average 13 to 14 per cent. of protein, and 6 to 7 per cent. of fat. Being poor in gluten it is unsuitable for bread making, but made into cakes and porridge it is highly nutritious and cheap. In the preparation of patent oatmeals, which are softer and less irritating to the digestive tract, the oats, instead of being ground and heated, are rolled.

Barley is poor in gluten, but contains a fair amount (10 per cent.) of other nitrogenous matter. It is not suitable for bread making, though barley bread and barley cakes are sometimes made. *Barley Water* is sometimes recommended as a substitute for plain water in the dilution of the feeds of bottle-fed infants. Its chief advantage is that it makes the curd formed from the milk in the stomach more flocculent and more easily digested. It is difficult to make properly, however, and does not keep well. It is found safer not to recommend it for use amongst the poor.

Maize (*Indian Corn*) is both nutritious and cheap, and is fairly commonly used by all classes in this country in the form of corn flour, which is maize flour deprived of some of its proteins and fat by treatment with a weak solution of soda. Maize flour is sometimes added to ordinary flour more or less as an adulterant.

Rice contains more starch and less protein and fat than the other grains referred to above. It is cheap and forms a valuable addition to the diet of the poor, by whom it is used to a considerable extent. "Polishing" of rice with talc with the object of improving its appearance is very largely resorted to. One of the objections is that the person purchasing polished rice usually obtains also a considerable quantity of mineral matter. More important still, highly polished rice is deprived of something to which the name "vitamine" has been given. This resides mainly in the outer covering of the grain, and *beri-beri*, which has long been supposed to be associated with the eating of an exclusively rice diet, is now believed to be due to a deficiency of vitamine.

Potatoes.—Only about a quarter of the bulk of the potato consists of solid matter, the most important constituent being

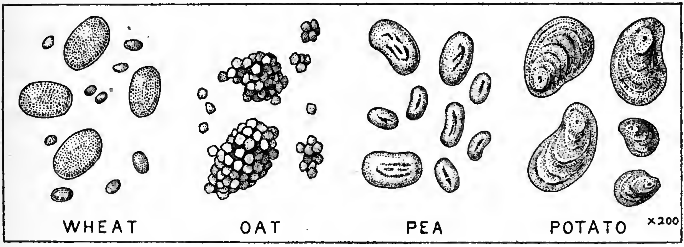

FIG. 36.—Microscopical appearance of certain starches.

starch. Like all vegetables, it contains vitamine, which is supposed to act as a preventive of scurvy, if not of other conditions. The protein present amounts only to a very small percentage of the total solid portion, so that potatoes, though of value, can only form part of a diet. A diet of potatoes and buttermilk, the latter supplying the protein and fat, is stated to be capable of supporting life for long periods.

Potatoes are very frequently uneconomically used. The skin is commonly removed before cooking, and is thrown away. This waste could be prevented if the stock-pot were an institution and the potato skins were added to the other ingredients. The most economical if not the best way of cooking potatoes is in their skins.

Other Vegetables, amongst them onions, carrots, turnips, cabbages, and so on, are greatly used either as flavouring agents in cooking or in addition to potatoes. Onions and carrots, ordinarily, are cheap and are excellent value, containing more nourishment than cabbage.

Peas, Beans, and Lentils contain a great amount of protein, and might very well be used as an alternative to meat. The protein present in peas and beans is as high as 21 to 25 per cent. The dried varieties contain more than those that are green, though they are somewhat indigestible, and require to be soaked for some hours, and carefully cooked, and to be eaten with some oily substance, *e.g.* fat bacon, dripping, or suet pudding. As they are deficient in starch also, rice may be taken along with them.

Lentils are particularly rich in protein, and, besides being highly nutritious and cheap, are easily cooked and digested.

Sago and Tapioca consist mainly of carbohydrates, and are more expensive than rice.

Fruits have some nutritive value, mainly on account of the sugar which they contain. They are to some extent indigestible, but when cooked are much more easily dealt with by the digestive juices. Apart from nutritive properties they possess vital and antiscorbutic properties in a marked degree.

Carbohydrates.—*Sugar* is a most important article of diet, and most people use either cane or beet sugar as a sweetening agent.

Lactose or Sugar of Milk is very commonly recommended for use in infant feeding, but is more expensive and less soluble than the sugar usually employed.

Honey is not so much used in this country as in continental Europe. By the poor it is practically never bought, although it has great sweetening properties, and may on occasions be actually more economical than sugar.

Jams and Preserves are particularly nourishing on account of the contained sugar. They are less economical than butter, and do not go so far as margarine or dripping.

Treacle and Golden Syrup are often used as alternatives to jam, and are particularly useful for puddings.

Sugar and sweetening agents are quite commonly adulterated, usually by the substitution of a cheap form of sugar for a more efficient and higher-priced article.

Demerara Sugar, a cane sugar, which has a brown or yellowish tint and is moist, is greatly favoured by the poor for its sweetening qualities. Ordinary beet sugar dyed yellow is frequently substituted.

Cooking.—Cooking renders food more palatable and tempting, and in addition brings about some amount of sterilisation and renders the articles more digestible since warm food is more easily digested than cold, certain of the harder substances are softened, and, especially in the case of vegetable foods, insoluble carbohydrates are transformed into others that are more soluble.

The chief methods of cooking adopted are roasting, baking, boiling, stewing, and frying.

Roasting has the disadvantage that it is wasteful, although it depends largely upon the cooker employed, and whether the cook is good or bad.

Boiling is better than stewing, which is apt to make meat indigestible by saturating the fibres with fat and gravy. Soft water should be used.

Frying has somewhat the same effect as stewing, so far as digestibility is concerned.

Steaming is a good method of dealing with fish and vegetables. Potatoes particularly are best steamed in their jackets, since in this way practically nothing is lost. Green vegetables retain their colour well if steamed. In boiling the same result is obtained if they are left uncovered throughout the process.

Variations in Diet.—The quantity and character of the food consumed or required vary with age, with condition as to health, with occupation, with climate, and with season.

With regard to age it is to be noted that it is the diet of young children that requires most careful attention. Relatively more proteins than fats and carbohydrates are required in childhood than in adult life. Fat is often distasteful to children and difficulty is commonly experienced in inducing them to consume it. Butter, suet pudding, and well-cooked bacon fat are useful forms. Within limits and provided they are not taken just before retiring to bed, good-quality sweets are unobjectionable.

The tendency in later adult life is towards an increase in the amount of food; it is better, however, to curtail rather than increase the quantity taken. Women as a rule require about one-tenth less food than men.

Occupation exerts a considerable influence in relation to diet, and generally speaking the more strenuous the work the greater the quantity of proteins taken. For the brain worker the lightest and most digestible of materials are the most suitable.

In cold climates and seasons, fats and other heat-producing substances should be increased. In warm climates and seasons fats and proteins should both be diminished.

Beverages.—The amount of water contained in the more solid articles of diet being generally insufficient, additional fluids are necessary. Milk consisting so largely of water, infants usually get quite enough, but sometimes they experience thirst, and cry for this reason. To relieve the thirst, plain water or barley water is better than milk, since it throws no strain on the digestion. For infants who are entirely bottle fed, water containing a little orange juice or grape juice is likely to be found useful. Apart from water no other beverage should be given to infants, nor indeed to children under the age of five or six. The alcoholic beverages should never be given in health, and during illness only when ordered, and in the quantities prescribed, by a medical man. Tea and coffee should only be allowed in very small quantities, diluted with milk. Cocoa, which is less stimulating than tea or coffee, is an excellent substitute.

Beverages for Adults.—For adults water is the only beverage really necessary, and others are only taken because they possess flavour and are more stimulating. *Tea* owes its taste and aroma to certain volatile substances extracted from the leaves in the course of infusion. It stimulates because it contains the alkaloid *theine*, and is taken warm. The bitter flavour is due to tannin, and milk or cream alone, or milk or cream and sugar, are added to mask it. The pleasant taste of *coffee* is due to extractives, and its stimulating power to an alkaloid named *caffeine*. *Cocoa* may be used as a substitute for tea and coffee. It is less stimulating than these, though it contains a stimulant called *theobromine*. It is more of a food than tea or coffee, since it contains proteins, fats, and carbohydrates.

The Alcoholic Beverages.—Beer, wine, and spirits are taken because the taste is less insipid than that of water, from the presence of certain aromatic bodies, and because they are believed to be more stimulating on account of the alcohol which they contain. In most of them, some of the essential elements of food required by the tissues are present, but, on account of the contained alcohol, which interferes with the activities of the tissues, they are unsatisfactory articles of diet. That alcohol itself is capable of acting as a food is doubted by many, the tissues being unable to use it or to properly oxidise other more suitable substances in its presence.

Other observers hold that alcohol is valuable as a food, since, if it is not used itself, it prevents the waste of other substances. Even those latter persons, however, agree that to get the full benefit of the alcohol only small quantities should be taken, at the most two ounces in the twenty-four hours. The quantity of alcohol contained in various alcoholic beverages varies from 5 per cent. in beer to about 60 per cent. in brandy. For the normal human being, alcohol is not really necessary, and as its use is attended by a considerable number of disadvantages he is better without it.

In a manifesto issued by the army and signed by a number of distinguished members of the medical profession, the following statements were made with regard to alcohol:

(1) It slows the power to see signals.
(2) It confuses prompt judgment.
(3) It spoils accurate shooting.
(4) It hastens fatigue.
(5) It lessens resistance to diseases and exposure.
(6) It increases shock from wounds.

Effects just as serious, it seems probable, are produced by alcohol in civil life. The fact that arsenic has been and may still occasionally be found in beer in quantities sufficient to give rise to poisoning should not be forgotten. The source of the poison in the majority of cases was proved to be the sugar employed in the brewing process.

Condiments.—*Condiments* are such substances as salt, pepper, mustard, vinegar, curry, and certain spices, used mainly with the object of giving piquancy to food. With the exception of salt, they probably play no other part. Flavouring agents in cooking should be used towards the end of the process, since if added earlier they are apt to lose their flavouring power. Adulteration of the condiments is fairly common. Pepper and mustard, for example, are sometimes diluted by the addition of inert starches. Vinegar is often diluted with water and inferior varieties substituted for those prepared by fermentation of wine and beer.

Preservation of Food.—Food of any kind goes bad as the result of the action upon it of organisms, which may be within the food itself or find their way in from without as the result of exposure.

Broadly speaking, methods of preservation aim either at inhibiting the activities of the organisms already present or at preventing attack by extraneous organisms. Some methods are applied with the object of attaining both ends, and these are probably the most important.

The death or exclusion of germs, or both results, may be obtained by the application of cold, by the application of heat, by drying, or by the use of chemical preservatives.

Cold.—The fact that milk is cooled in order to inhibit the activity of contained organisms has already been noted. In the preservation of food, particularly meat, on a large scale, cold is very largely employed, and vast quantities of meat are imported yearly from great distances and are kept from going bad by no other means than a mere reduction of temperature.

In relation to meat two methods are employed, viz. freezing and chilling. In *freezing*, the meat is exposed to a temperature of about 10° F. as soon as possible after the animal has been killed, and before rigor mortis sets in. It is kept at this temperature till required for use. Considerable quantities of frozen meat come from the United States and the Argentine. Frozen mutton comes from Australia and New Zealand. Large quantities of frozen rabbits are imported from the colonies also.

In *chilling*, the temperature at which the meat is maintained is between 20° and 30° F. Chilled beef comes largely from the Argentine.

For the shipment of frozen and chilled articles special provision is made on board ships taking part in the trade, and for storage after their arrival special stores are to be found in many large distrcts.

The appearance of meat in the frozen state is characteristic. The carcase is dry, hard and cold to the touch ; if the hand is kept on it for a time it becomes wet. The flesh is pale, and the fat deadly white and not bloodstained. In chilled meat the flesh is stiff and cold, but slightly moist.

Fish is often preserved by means of cold. Such as are caught by trawlers are boxed in ice, and none are sent any distance to tradesmen otherwise than in ice. Quantities of frozen salmon come from the United States, Canada, Russia, Siberia, and even Japan.

For the preservation of apples and other *fruit*, cold is now commonly employed. The temperature of storage is 35° to 36° F. and the fruit keeps better if wrapped in paper in the store.

Heat, either domestically or as part of other large-scale processes, is commonly adopted. The housewife who boils milk or fish or any other article to "make it keep" applies this form of preservation. Even though *boiled* and thus freed of risks from organisms that may have entered prior to the boiling, simple boiling will not abolish all risks of putrefaction. Bacteria, it should be noted, may attack the boiled article. In canning of foods the material is not only boiled, but it is protected from extraneous organisms by sealing it off from contamination. Any kind of food practically may be dealt with in this way. In preparing tinned meat, the portions chosen are placed in the tin, which is then filled up with gravy. The lid is sealed on except for a single opening to permit of the escape of steam while the heating is going on. After the boiling has continued for a certain time, the opening is sealed with solder.

Many imported articles which reach this country in tins, *e.g.* tongues, are removed after their arrival and placed in glasses.

In the case of tinned fruits a saturated solution of sugar and water is introduced before the heat is applied.

That there are certain *dangers to health from tinned foods* is well known, and that tinned food is less digestible, less nutritious, and less valuable as a food as well as more expensive are also well-recognised facts.

Drying as a method of preservation is sometimes applied to meat, fish, and fruit. Fish may be dried in air or over specially prepared kilns. Drying and smoking are often combined in the case of fish and meat. Pemmican is a mixture of dried meat and fat. Biltong is an example of dried meat. Dried milk has already been referred to, and dried (desiccated) vegetables, raddishes and so on, are readily obtainable.

Chemical Preservatives.—For the preservation of meat and fish salt is quite commonly employed, both domestically and commercially.

Salt beef and pork are prepared by immersion in brine or a solution of saltpetre, *i.e.* pickling. A certain amount of the fresh colour of the meat is lost in this way, perhaps less with saltpetre than brine. The meat loses also to some extent in nutritive value, and is rendered harder and more difficult of digestion.

Other chemicals sometimes used are boric acid and formalin.

The boric acid may be sprinkled over the meat, etc., and the formalin may be brought into contact by soaking the material in it. In some cases preservatives are injected into carcases. Alum, formalin, and salt are occasionally used in this way.

In the *preservation of eggs* solutions of chemicals are sometimes used, but this is mainly with the object of excluding air, the eggs being immersed in brine or lime water. Coating of the shell with lard or butter as soon as possible after the egg is laid has a similar effect.

Sausage meat is very commonly preserved with boric acid, and as much as 35 grains to the pound is sometimes employed.

With the possible exception of common salt, all preservatives are open to grave objection, and foods preserved by means of chemicals, except perhaps those that are salted, are always to be regarded with suspicion.

Food Adulteration.—Speaking broadly, the foods most commonly adulterated are those classed as dairy produce. Milk, butter, cream, and cheese are all open to adulteration, and can, as already indicated, be fairly easily adulterated in such a way as to defy detection except on careful analysis.

Dairy produce is not, however, the only kind of food adulterated. Very little indeed escapes, and very generally the form which adulteration takes is the addition of some material which resembles the real article or mixes easily with it and is cheaper.

The following table shows a number of articles used as foods or additions to diet, and commonly adulterated, and indicates the adulterants found to be employed:

Name of Article.	Adulterants.
Bread	Minerals, *e.g.* alum and calcium sulphate. Potatoes are almost invariably used in baking to make the bread "light."
Butter	Water in excess, foreign fats, *e.g.* margarine. Preservatives, *e.g.* borax and boric acid.
Coffee	Other beans, spent beans roasted with sugar, chicory, peas, bran, rye, barley, turnip, date-stones, acorns, dandelion, etc.
Jams	Use of cheaper fruits; apple pulp very commonly used to increase bulk. Apple juice commonly added to improve setting of jams when fruit is not quite fresh.
Milk	Abstraction of fat, addition of water or skim milk. Preservatives, chalk, condensed milk mixed with water.
Mustard	Wheat flour, turmeric, maize and potatoes, cayenne pepper, gypsum and clay.
Sugar	Dyes, sand, sulphuric acid, or chloride of lime.
Tea	Mineral matter, iron and brass filings, sand, exhausted leaves, leaves of sloe, elder, and willow, borax and sodium carbonate, mixtures of gypsum and Prussian blue, etc.

Tinned foods lend themselves to adulteration, and are very often adulterated. What is sold as tinned salmon, for example, is quite frequently not salmon, but hake or some quite common sea fish, coloured with cochineal.

Sausages also are easily adulterated, and whilst most contain breadcrumbs in addition to meat, many contain very much more bread than meat. Preservatives are usually also present.

Such adulterations as these cannot be interfered with, since no standard has been set up in relation to sausages and tinned meat or fish. Interference can only take place if they are found to be diseased or unsound, and the methods to be adopted in examining for unsoundness will be described later.

Food Inspection.—In addition to food sampling for the detection of adulteration, food inspection is carried out with the object of preventing as far as possible the sale of unsound or unwholesome or diseased articles. Meat naturally receives a considerable amount of attention, and the following points with regard to its appearance should be noted.

Meat.—Healthy meat should be red in colour, and neither too dark nor too pale. The flesh of young animals is always pale in colour, the tint deepening with age. The flesh of the bull is darker and coarser than that of the ox.

The fat should be firm, white or pale yellow, though it is darker in Jersey and Guernsey cattle and in those fed on oil cake. Owing to the presence of thin layers of fat in the muscular tissue a marbled appearance is produced.

The surface of meat should be dry.

The marrow of the bones should be fairly firm and pale pink in colour. The odour should be faint and not disagreeable, and no bad smell should be given off when a piece of flesh is bruised in a dish containing hot water.

The flesh should be firm to the touch and elastic, and should not pit on pressure. No fluid should exude on pressure. The reaction should be acid. A final opinion is never passed until *rigor mortis* or "setting" is complete, usually at the end of about twelve hours.

The primary object of inspection of meat is to discover whether or not it shows any departure from these characteristics, and also to find whether or not it shows any signs of disease.

The detection of badness in meat is usually not a matter of any great difficulty, particularly if the putrefactive changes are at all advanced. In the early stages it is less easy. Meat that goes bad quickly is very often such as has been derived from an animal that has died of an exhausting or inflammatory disease, or has for one reason or another been insufficiently bled. The appearances presented by the meat in these cases is somewhat as follows:

The flesh of an animal dead of an exhausting disease is pale red or pink in colour. There is also a diminution in the amount of fat. The flesh of animals insufficiently bled is dark, and may be purple in colour. Lividity indicates commencing putrefaction, the colour changing to green in the later stages.

The fat in bad meat may be dark in colour and soft. When the animal has died of an inflammatory disease, the flesh is dark, badly set, flabby-looking, and moist on the surface.

A bad odour may be the first sign of decomposition. It will be first noted close to the bone, or in the marrow, which becomes soft and darker in colour. The best way to detect any bad odour is to insert a knife blade or a skewer into the flesh, and to smell the instrument after removal. A bad odour is readily made out if the flesh be bruised in a glass containing hot water, and minced meat and sausages are commonly tested in this way.

Bad meat is less firm than good meat, and moisture exudes on pressure. Flesh from animals dead of kidney or heart disease is especially moist (dropsical). The reaction of decomposing meat is alkaline.

Diseased Meat.—With regard to "diseased" meat, the condition most commonly found is *tuberculosis*. Because of the importance attached to the disease in the human subject, and the possibility of infection occurring as a result of the consumption of tuberculous meat, a very close inspection is made for signs of the disease at the ports and other places where carcases are examined.

Amongst other conditions found may be mentioned anthrax, actinomycosis, trichinosis, fluke disease, pig measles or cysticercus disease, various inflammatory affections, *e.g.* puerperal fever, pleuro-pneumonia, foot and mouth disease, and swine fever.

Tuberculosis.—Tuberculosis is most common amongst stall-fed cattle, and very common amongst pigs. Sheep rarely suffer. The disease may be generalised or may be found affecting the lungs, pleura, peritoneum (including the mesentery), lymphatic glands, liver, bones, or udder.

When the pleura or peritoneum is badly affected, it is usual to find large nodules sometimes adhering together in grape-like clusters. This arrangement gives rise to the name "grapes" or "tubers" commonly used by butchers.

Very frequently the glands in the neighbourhood of any part affected are enlarged, and may be caseous. Often they are the only structures affected, and in pigs those about the neck are very generally involved. The liver is more frequently affected than any other abdominal organ. Affections of the udder are common.

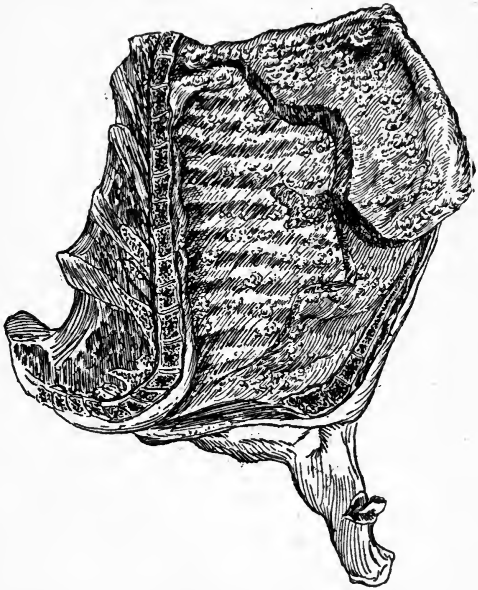

Fig. 37.—Fore-quarter of beef showing tuberculosis of pleura and lung.

Knowing that the presence of tuberculosis is commonly a reason for forbidding the sale of the whole or part of the carcase, butchers frequently attempt to remove signs of the disease. Glands are excised or the pleura is dissected off, or "stripped" as it is technically described, internal organs are removed, or the udder cut away. Tuberculous meat is unfit for human consumption, and when met with by health officers is seized and destroyed or otherwise dealt with.

The person in possession of the diseased meat is liable to be summoned and, if found guilty of knowingly selling or exposing the material for sale, may be heavily fined. Seizure, it may be noted, can only be carried out by specially authorised officers, and only the authorities through their officers can take proceedings. A private individual may not do so.

Anthrax.—One of the most characteristic features in this condition is enlargement of the spleen. The organ is much softer than normal, and filled with a substance resembling black-currant jelly. The flesh is moist and pale, save where hæmorrhage has taken place. The flesh sets slowly and badly. The blood remains fluid much longer than normal and teems with *B. anthracis.* The carcase must be handled with the greatest care. The flesh is quite unfit for food, and should be destroyed without delay.

Actinomycosis.—On account of the tendency shown by the actinomycotic nodules to undergo suppuration and softening, this disease is sometimes mistaken for tuberculosis. The bones and the liver are sometimes involved. The affected parts of the carcase should be destroyed as unfit for food.

Trichiniasis or Trichinosis.—When man becomes infected with the *Trichinella* (*Trichina*) *spiralis* it usually results from the eating of infected pork. The disease is rare here, both as regards man and animals, but a number of cases have recently come to light in America; and in Germany, where pork sausages and ham more or less raw are commonly eaten, it was formerly quite common. Since the practice of carefully examining pork was introduced, trichinosis has become rare. The muscular tissue of the diaphragm is the part most commonly affected in the pig, but the encysted worms may be found in other muscles. The larval worm does not escape from the capsule and form the adult until the flesh has reached the intestine.

After copulation the male worm dies. The larvæ are deposited by the female in the lymph channels in the intestinal wall. Thence they pass all over the body, eventually finding their way into the muscles, where they proceed to destroy the fibres and make for themselves a capsule. They may remain encysted and alive for long periods, even up to thirty years. Not uncommonly, however, they die in a short time, and the whole nodule becomes calcified. Trichinosed pork must always be destroyed.

Fluke Disease, which affects the liver and is due to the fluke worm (*Distomum hepaticum*), is found commonly amongst sheep. In an affected liver the bile ducts are usually found distended and contain large numbers of the worms. Cirrhosis of the organ itself occurs in long-standing cases. The liver alone is usually destroyed.

Pig Measles or *Cysticercus Disease* affects pigs chiefly, oxen and sheep less frequently. The cysticerci (*Cysticercus cellulosæ*) are the embryos of tape worms, and only develop into full-grown worms when they reach the intestines.

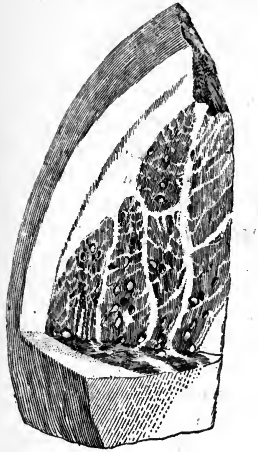

FIG. 38.—"Measly" Pork. Some of the cysts of the *Cysticercus cellulosæ* are seen embedded in the muscle, while others have become detached.

The pig cysticercus is the most common. It occurs in the muscles in the form of tiny cysts each about the size of a pin's head. Infection of the muscles follows the swallowing of material containing the eggs of the tape worm, which undergo development in the intestines and pass thence to the muscles of the tongue and shoulder. Here they curl themselves up and form cysts. When the muscle is eaten by man, the cycle is completed by the development of the embryo into a tape worm. The cysticercus is readily killed by heat, but infected pork should be destroyed as unfit for food.

The form of tape worm derived from the pig cysticercus is the *Tænia solium.*

In appearance the ox cysticercus (*Cysticercus bovis*) resembles that found in the pig. It gives rise to the *Tænia mediocanellata.*

Horseflesh.—The sale of horseflesh for human food is forbidden, unless the premises on which the trade is carried on shows a sign indicating the fact. Horseflesh is more or less easily distin-

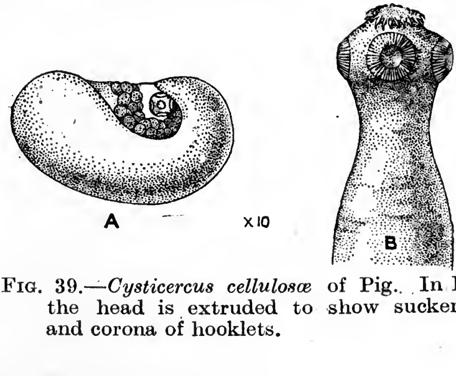

FIG. 39.—*Cysticercus cellulosæ* of Pig. In B the head is extruded to show suckers and corona of hooklets.

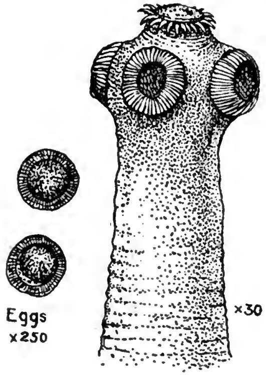

FIG. 40.—*Tænia solium* and ova. Note suckers and hooklets on head of adult worm.

guished from oxflesh, though attempts at substitution are sometimes made. It is darker in colour and coarser. After standing the flesh takes on a bluish sheen, and the odour is less pleasant than that from other meat. The subcutaneous fat is light golden yellow in colour and soft, while that of the ox is whiter and firmer. The horse, it may be noted, has eighteen pairs of ribs against thirteen in the ox. In the horse the radius and ulna unite; in the ox the ulna is distinct and separate. The horse has a fibula, the ox has none; the horse has a smooth tongue, broad at the point; the tongue of the ox is rough and pointed. The horse's liver has three lobes; in the ox it is one mass with a small lobe on the upper and posterior surface.

Examination of Other Articles.—F i s h when sound should be more or less stiff, and when held out by the head should not droop too limply. The flesh should be firm and not friable, and not too easily detached from the bone. The eyes should be bright and prominent, not dull and sunken. The gills should be red and clear. Slime and blood should be clear.

The scales on a scaly fish should not be too e a s i l y detached. The smell should be not unpleasant; very commonly

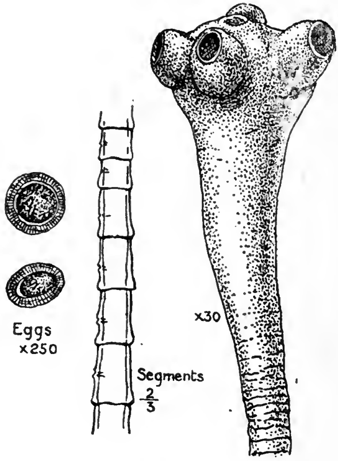

FIG. 41.—*Tænia mediocanellata.* Note that the head of the adult carries suckers but no hooklets.

the first signs of putrefaction are noticeable about the gills, and here a bad smell is easiest and most readily detected. The more rapidly a fish is gutted and iced, the longer it will keep.

Curing of fish by smoking or drying is often postponed until they have "gone off" a little, unless they are very plentiful and cheap.

Since *shellfish* are apt to be exceedingly dangerous when bad they require careful watching. Mussels and oysters when bad usually open; cockles even if bad always remain closed, but when opened appear thin and dry. Crabs and lobsters that have gone bad are discoloured under the "apron" and tail respectively. Salmon infected with the cysticercus of the *Bothriocephalus latus* are practically never seen in this country. They are unfit for food.

Poultry suffer from tuberculosis sometimes, the throat and the abdominal organs being most commonly affected. Thin emaciated birds should always be examined for signs of this disease. The nodules formed are small and yellowish in colour. *Coccidial disease* of the liver is not uncommon; this is due to the *Coccidium oviforme*, which produces small yellowish-white nodules and renders the liver, but not necessarily the remainder of the bird, unfit for food.

Rabbits also suffer from attack by *Coccidium oviforme*. The liver is again the organ affected and the part to be condemned. Occasionally a cat is substituted for a rabbit, the fact that it is a cat being concealed by removing the tail, the clawed feet, and the internal organs as far as possible. The head is the great difficulty, and sometimes it is replaced by a rabbit's head, more or less carefully sewn on.

Eggs.—Large quantities of eggs are imported from Russia and Siberia, and often they are bad. It is usually possible to distinguish between a good and a bad egg by noting their behaviour in water containing salt; the good egg sinks, and the bad one floats. Egg dealers rely more upon "candelling," however, *i.e.* examining in front of or over a light. A good egg is clear and free from spots and the yolk can be readily seen. A bad egg, on the other hand, may be "spotted" and show clear only at the large end. The spot in a "spotted" egg is due to the growth of a mould on the inner surface of the shell. This condition is said to be produced by storing eggs in damp straw. Spotted eggs are unfit for food.

Tinned Foods.—In the case of tinned foods it is not always easy to tell that the contents of an unopened tin are unfit for food. The tin should always be completely closed, and if there be any signs of leakage from it it is very probable that organisms will have found an entrance and that decomposition will have occurred. Inequalities and bulgings may be produced on the surface of the tin if decomposition of the contents has led to the production of gas. The presence of more than one solder mark leads to the suspicion that the can has been tampered with, probably to allow gases of decomposition to escape. Cans in which the central part has been soldered in should be condemned, as this part has probably been cut out after the can has been filled, being afterwards refixed with

FIG. 42.—"Blown" tins, the contents of which have undergone decomposition with formation of gas.

solder. A badly filled tin and one which contains gas will emit a hollow sound when struck with a mallet and a splashing sound will be heard when the can is shaken.

Diseases Due to Food.—*Diet and Health.*—Damage may be done to health and the body generally by defective dieting, and may result from insufficiency of food or from improper feeding. The signs of insufficient food are very often seen in the children attending the elementary schools of large towns. Such children are dull, backward, anæmic, without energy, and stunted in growth. In adults the signs are very much the same.

Improper Feeding.—Fortunately, in many cases, the signs of starvation noted are due not so much to actual want of food as to improper feeding and insufficiency of one or other of the essentials of diet. In most cases a deficiency of proteins in the diet is less well borne than a deficiency in either fats or carbohydrates. Deficiency in fats is more serious than deficiency in carbohydrates.

A starved baby may have received food in good quantities but quite of the wrong type; an overfed baby, particularly a bottle-fed baby, not uncommonly appears to have been starved.

A common condition found amongst insufficiently or improperly fed infants and children is *rickets*. The rickety child is usually a bottle-fed child, and one who, in addition to having been brought up wrongly as regards food, has been deprived of fresh air and sunlight. The affected child often looks plump, but the tissues are soft and resistance is greatly reduced.

Scurvy like rickets is a "deficiency disease," and is now believed to be due to the absence of vitamine from the diet. The efficiency of fruit and fruit juices, *e.g.* lime juice, though frequently traced to the acids and salts present, may conceivably be due to the presence of some such substance as vitamine.

Beri-beri, another deficiency disease, is traced to the absence of vitamine also.

Overfeeding.—The body tissues require only a certain amount of food, and if more than they need is presented to them they reject it, and ultimately resent it. As far as possible the materials that cannot be used by the tissues are stored, some in the liver, some as fat, while some is got rid of with the waste products. An overfed person is commonly a weakly person. Overfed babies often possess less resistance than those actually underfed.

Amongst conditions resulting from overfeeding are *bilious attacks* from overloading of the liver, *dyspepsia* from overstrain of the digestive organs, *constipation*, *gout* and other *poisonings* due to retention of by-products of digestion.

Food and Disease.—Broadly, food may cause harm or give rise to definite diseases (*a*) because it harbours the organisms of disease, either bacterial or parasitic, (*b*) because it has "gone bad" or contains organisms and their products or toxins, or (*c*) because it contains poisons of various kinds absorbed by or added to the article used.

(*a*) *Bacterial Diseases.*—Bacteria capable of causing specific diseases enter the body mainly but not exclusively with animal foods, and are present either because the animal from which the food was derived was diseased or because the food has been contaminated as a result of careless handling or unnecessary exposure.

Quite a number of diseases fall into the class of infectious conditions common to man and animals. For the reason that they primarily affect certain animals, but are communicable to man and other animals, they are sometimes spoken of as *Epizootic diseases*. The most important of those that may be conveyed by means of food are tuberculosis, anthrax, and foot-and-mouth disease. Diphtheria and scarlet and Mediterranean or Malta fever, the last named traced to the consumption of the milk of goats infected with the disease, should also possibly be included in this group.

Many of the diseases from which animals suffer may be communicated by contact or inoculation, but not so far as is known by consumption of food derived from them, *e.g.* actinomycosis, glanders and farcy, vaccinia, etc. These nevertheless are held to render the infected portion or the whole carcase unfit for human consumption. A similar remark applies to many diseases which seem to be definitely non-communicable in the case of man, *e.g.* swine fever (pig typhoid), cattle plague, pleuro-pneumonia, etc.

Of the proved epizootics, tuberculosis is by far the most important, and though it is possible that the risks of infection from tuberculous meat are slight, great quantities are destroyed on account of this disease. In certain Continental countries attempts are made to save some of the meat condemned as tuberculous by the establishment of what are known as "Freibanks." All carcases showing any evidence of tuberculosis are sent to these depots after they have been thoroughly examined and all tuberculous lesions have been removed. There they are sterilised by steam, and sold at special stalls as inferior meat. Other diseased meats, *e.g.* those containing parasites such as cysticerci, trichina, etc., are also dealt with in this way.

Contaminated Food.—The diseases that may be conveyed as a result of contamination of food with germs are enteric fever, scarlet fever, diphtheria, cholera, and epidemic diarrhœa The outstanding causes of contamination are neglect in handling and insufficient protection, particularly of articles that are either not cooked prior to consumption or are taken cold after having been exposed.

Parasitic Diseases that may be acquired from food form a fairly considerable group. The worms associated with the more important of these are described elsewhere.

(*b*) *Bacterial Food Poisoning.*—The name suggested for the group of conditions produced as the result of ingestion of food that has "gone bad" and contains organisms and their products or toxins is "Bacterial Food Poisoning and Food Infections." It includes all cases or outbreaks of food poisoning due to infection of the food by bacteria, which either before or after their ingestion produce substances to which the symptoms are due.

In the majority of instances the food to which the infection is traced is generally meat, unpreserved or preserved in tins, etc., or made up in special forms, *e.g.* as sausages, pies, or "potted meats." Mussels, potatoes, cheese, cream, *e.g.* in cakes, and ice cream have also been found to be associated with outbreaks of disease of which the outstanding features are gastro-intestinal disturbance, sickness, vomiting, fever, depression and nervous symptoms of various kinds, sometimes ending in death.

Mussel poisoning is due to the mussels having become poisonous from the production in them of chemical poisons, by the action of bacteria derived from sewage. What the bacteria are, and what the conditions which lead to the production of the poisons, are not yet known. The poisonous substance at one time was held to be a ptomaine named *mytilotoxin*, but whether it is or not is not yet decided.

Cheese poisoning is not uncommon, particularly in America. In some outbreaks examination of the cheese has shown the presence of intestinal organisms, *e.g. B. coli communis*, and for the poisonous substance formed the name *tyro-toxicon* has been suggested.

Potato poisoning, at one time supposed to be chemical in origin, is now regarded as due to organisms. Potatoes contain nutrient media very suitable for the growth of bacteria.

Cream and ice cream poisoning are undoubtedly due to infection of the material with bacteria, probably mainly intestinal in origin. Bacteria grow well in cream, and readily produce their toxins in it.

In most of the outbreaks of poisoning, meat or articles derived from meat are the foods blamed. Being so extensively used and forming so admirable a medium for the growth of the organisms with which it can be so readily contaminated, this is not surprising.

At one time regarded as due entirely to toxins to which the name *ptomaines* was given, the symptoms of food poisoning are now generally believed to be traceable in the majority of cases to the action of bacteria. These activities may to some extent be shown on the food itself, but mainly they occur within the body. In the meat the organism probably devotes most of its energies to increasing in numbers; in the body it mainly produces toxins. The period that intervenes between the taking of infected food and the appearance of symptoms varies considerably. Sometimes it is as short as thirty minutes; sometimes it is as many hours, and may be several days. The length of the period depends probably on the number of organisms taken, or, in those cases in which the incubation period is short, the earlier symptoms may be produced by toxins already present in the food.

The organisms generally found or suspected to be present are intestinal in origin. They may be some form of *B. coli communis*, but that generally now regarded as of chief importance is the so-called *Gærtner bacillus*. In favour of this organism as the cause is the fact that, in a number of cases of food poisoning, when tested against the serum of the patient, it has been found to undergo clumping in the same way as does the *B. typhosus* when acted upon by the serum of a case of enteric fever.

The Gærtner bacillus may come from the intestine of the animal from which the food is derived, and be sown upon the food while the butcher is dressing it; or it may actually be present in the flesh if it forms part of a carcase of an animal which has suffered from disease prior to slaughter. *Rats* are common hosts of Gærtner bacilli, and in some cases the meat giving rise to the infection may have been contaminated by these vermin.

In the case of prepared foods, contamination may come later in the course of preparation. The opportunities for doing so are very numerous, since in preparing pies the gravy or jelly, or a great part of it, is added after the meat has been cooked in the paste, and investigation in certain cases has shown the prepared jelly to be stored in most unsuitable places and exposed to contamination from water-closets, drain openings, and such-like. In cases in which no jelly was added after the pie had been prepared it was found that the meat was not thoroughly well cooked, and that in all probability the organisms escaped. Toxins, it may be noted, are probably unaffected by the heat to which they are exposed.

In the case of *tinned foods* the organism probably enters through some defect in the can, and careful examination should be made of tins for signs of leakage and irregularities. The possibility also that there may have been some failure in connection with the cooking and the sealing up of the contents must not be overlooked, and it should be borne in mind that the *B. Gærtner* is capable of resisting fairly high temperatures. Gas production, with bulging of the can and splashing on shaking, are generally taken as indications that decomposition has occurred, and that the contents are dangerous. Gas production and signs of decomposition are not, however, necessarily present in foods that are highly dangerous from the food-poisoning point of view. Meat that is of itself quite fresh and quite free from putrefactive taint may be contaminated with Gærtner bacilli and may be consumed without giving rise to suspicion.

Whether or not the organisms associated with putrefaction, and the production of signs characteristic of this condition, are capable of causing poisoning is not definitely settled, and probably it is essential that Gærtner bacilli must be present before anything can occur.

Amongst the substances produced by the activity of the putrefactive germs are the so-called *ptomaines*. These were and still are believed to be the dangerous substances in meat that has "gone bad," and cases of food poisoning are still popularly regarded as "ptomaine poisoning." In the scientific view *the Gærtner group of bacilli and the toxins produced by them in the body are the responsible elements.*

Nevertheless meat that shows signs of putrefaction is to be avoided, and it is to be borne in mind that prepared foods may be decomposed or undergoing decomposition even though they show no signs. The flavouring agents that have been added and the pains taken to make the articles look tempting usually are successful in masking all signs.

Sometimes in pies the jelly instead of being firm when in a cold state is more or less liquid. This is often a sign of bacterial activity, and should be regarded as a suspicious circumstance.

Flesh that is most liable to invasion by putrefactive organisms is that derived from cattle that have been suffering from or have died of some inflammatory condition. It is for this reason that they are generally condemned when discovered.

Botulismus.—Sausages are highly dangerous from the food-poisoning point of view. A condition known as *botulismus*, in which the main symptoms are referable to the central nervous system, and which is frequently fatal, has been more than once described. It is due to an organism named the *Bacillus botulinus*, which seems to come from the intestines of pigs. The sausages giving rise to the disease are usually liver or blood sausages which are eaten raw. Pickled or smoked meat and tinned or preserved meat have also been associated with botulismus.

Other conditions than botulismus are sometimes traceable to the sausage. Very often not too much care is taken in choosing the meat to be used or in preparing the articles, and the seasoning used is frequently capable of hiding signs of decomposition. The preservative employed is commonly not strong enough to destroy the organisms concerned with the production of food poisoning.

Usually on the occurrence of outbreaks of food poisoning inquiries are carried out by the health authorities; but as the mischief has generally been done before these are made, it is often difficult to be quite certain as to the food which was responsible. Though outbreaks do not seem to be much less numerous, it may be taken that the work done in relation to meat inspection and the supervision of places where food is prepared, stored, or handled is on the right preventive lines.

(*c*) *Diseases Due to Absorbed or Added Poisons.*—The poisons that are or may be absorbed or rather dissolved by foods are mainly metallic. The most important is probably *lead*, though *arsenic* and *copper* may also be found. The two latter are, however, more commonly added accidentally, as in the case of beer where the arsenic found its way in along with the sugar. It is not often used now as a colouring matter for sweets and so on, vegetable dyes having taken its place. Copper is found in tinned or bottled peas chiefly, and is added with the object of preserving the green colour. Generally copper sulphate is used, and it is commonly stated that the quantity added is insufficient to do harm.

Lead is sometimes found in beer, and also in ginger beer and other aerated waters, and is derived from pipes through which they have passed in the course of preparation. The activity of the liquids upon the metal is increased as a result of the presence of carbonic acid gas. In aerated waters the lead may come from the top of the siphon.

That lead may be picked up by meat from cooking utensils may be mentioned.

The *added poisons* are generally preservatives, *e.g.* borax, boric acid, formalin, and salicylic acid. The addition of preservatives to milk has been forbidden, but sausages and tinned and potted goods are still preserved by the addition of boric acid.

Many people tolerate boric acid very badly, and it is undesirable that the practice of adding it to foods should be allowed to become widespread.

In cases in which proceedings are instituted because of the presence of boric acid or other preservatives it is often found very difficult to show that any harm is likely to result from the quantity liable to be taken, and cases are often dismissed, which is unfortunate, since though boric acid in one article may not be bad, if the individual is compelled to take a quantity with every article consumed the matter becomes serious.

Salicylic acid is sometimes used, *e.g.* in wine, lime juice, etc. It cannot be regarded as a pleasant addition to a food or beverage.

Tin was formerly quite commonly found in tinned goods, but is rarely detected nowadays. Recently the American authorities have forbidden the importation of foods containing more than 2 grs. of stannous salts to the lb.

Food Legislation.—The law with regard to food has for its objects (*a*) the prevention of adulteration and (*b*) the prevention of the sale of articles which are diseased, unsound, unwholesome, or unfit for human consumption.

The provisions with regard to the former are contained in the *Sale of Food and Drugs Acts*, and certain other Acts dealing with special substances, *e.g.* butter, margarine, and milk-blended butter. There are also certain regulations which lay down standards for various articles, particularly milk, separated milk, margarine, and butter, and forbid the addition of preservatives to milk and to cream, except, in the case of cream, under certain conditions.

The administration of all the Acts is in the hands of the Health Authorities, the bulk of it in those of the Local Authorities.

Amongst the matters which are regarded as offences against the Sale of Food and Drugs Acts are mixing of foods (or drugs) so as to render them injurious to health, and selling to the prejudice of the purchaser any article of food or drug not of the nature, substance, and quality asked for.

In order to prevent the occurrence of such offences, samples are taken and submitted to the Public Analyst for examination. Persons found guilty of selling adulterated foods or of any offence against the Acts render themselves liable to penalties. It is to be noted, that including the Medical Officer of Health, the Sanitary Inspector, and the Markets Inspector, only certain officers may take samples under the Acts. The analyses must be carried out by the Public Analyst, specially appointed, and a certain definite procedure must be adopted.

Private individuals may not sample or take proceedings under the Acts, but if they have suspicions they should communicate with the Medical Officer of Health of the district in which they reside.

The Acts with regard to butter, margarine, and milk-blended butter contain definitions of these substances, state the maximum limit of moisture they may contain (16 per cent. in the case of butter and margarine, and 24 per cent. in milk-blended butter), make certain provisions with regard to construction and situation of factories and the registration of manufacturers, and suggest that regulations as to the prevention of the use of adulterants and preservatives are to be made.

In this country, up to the present, comparatively little has been done in the way of setting up standards as to the composition of foods. In the case of milk some attempt at doing so has been made, and it is laid down in certain regulations (*Sale of Milk Regulations*, 1901) that a milk that contains less than 3 per cent. of fat and 8·5 per cent. of milk solids other than fat is not genuine. Skimmed and separated milk must contain not less than 8·7 per cent. of milk solids other than fat.

Standards, already mentioned, with regard to the percentage of moisture in butter, margarine, and milk-blended butter are laid down in the Act (*The Butter and Margarine Act*, 1907) dealing with these substances. There seems to be some intention of extending the practice of fixing standards, but generally the feeling is that they are liable to cut two ways: it may be possible to find and punish the individual who deals in articles below the standard; there is still, however, the person who just keeps on the standard or a little below it, and unless it is a very liberal one the purchaser suffers.

The law as regards *unsound food* is contained in the ***Public***

Health Acts, and in these it is forbidden to store, prepare, sell, or expose for sale any article that, being diseased, unsound, or unwholesome, is unfit for human consumption.

Power is given to search for such material, to examine and inspect animals alive or dead, and all articles intended for food. In the event of the discovery of disease or unsoundness or unwholesomeness, power to seize is given as well as power to prosecute the person having it in his possession. A necessary preliminary to this is condemnation of the article, as unfit for food, by a magistrate, and the issue by him of instructions for its destruction.

All these powers are given only to Medical Officers of Health and Inspectors, and vast quantities of food are dealt with annually. No lay person may of course seize or proceed in the manner directed by the law, and the proper course to adopt is to submit any article bought and found to be unsound, or any information with regard to suspected food, to the local Medical Officer of Health.

In order to cope with the vast amount of meat imported from abroad, certain regulations (*Foreign Meat Regulations*) have been issued which classify various articles, pork for example, and give instructions as to the course to be adopted at the ports. Various duties are imposed on the Customs Officers, Medical Officers of Ports, and Port Sanitary Authorities by these Regulations. In order to encourage the making of proper examinations in the countries from which meat is sent to this country it is provided that preferential treatment shall be given to such as carry a certificate that they have been examined and passed.

Articles other than meat are dealt with under the ordinary powers granted by the Public Health Acts.

CHAPTER XIV

AIR

Composition of Air.—Atmospheric air is a mixture of gases and has the following composition :

Oxygen (O_2) . . .	20·94 per 100 volumes
Nitrogen (N) . . .	78·09 ,, ,, ,,
Carbonic Acid (CO_2) . .	0·04 ,, ,, ,,
Argon, Ozone, Ammonia, Hydrogen, Neon, etc. .	0·93 ,, ,, ,,

Other gases and substances occasionally or even constantly found in varying proportions include *water vapour*, *organic matter*, *dust*, *bacteria*, various *acids*, *carbon monoxide*, and *sulphuretted hydrogen*. These are important, and some reference will be made to them in due course.

In the meantime the following points in regard to oxygen and carbonic acid are worth noting.

Oxygen, from the health point of view, is the most important constituent of air. Though it may vary a point or two in amount from time to time and in different situations, being a little higher in high-lying open districts and in mid-ocean than in the centre of towns, generally it forms about $\frac{1}{15}$th of the total bulk of air. This lack of variation in the case of oxygen applies with regard to other normal constituents as well, so far at least as the open air is concerned. All over the surface of the globe they are constantly found in the proportions named, the main reasons for this being that the quantity of air is so enormous, and that *uniformity* is maintained by the continual stirring up and mixing brought about by winds and currents.

For the process of living and in connection with combustion, oxygen is absolutely essential. The air inhaled by man at each *respiration* is deprived of about one-fifth of its oxygen content before it is expired, since ordinary air contains 20·94 per cent. and expired air 16·03 per cent. In combustion much larger quantities are used, and *fermentation*, *decomposition of organic matter*, and certain *trades* and *manufactures* also lead to a reduction. After a fall of *rain* and where there is growing *vegetation* the amount of oxygen is generally slightly increased.

Carbonic Acid in atmospheric air is generally present to the extent of 0·03 to 0·04 per cent. In calculations and in the various problems in relation to ventilation the amount generally taken is 0·04 per cent. or 0·4 per 1,000.

The bulk of CO_2 in the atmosphere, though the percentage appears small, is very large. In the outer air the proportion is remarkably constant and uniform in different areas and at various levels. Near the ground, because the air in the soil is rich in the gas, atmospheric air contains slightly more CO_2 than that some little distance above it. The sources of carbonic acid gas are *combustion*, *fermentation*, and various *chemical actions* in the soil and organic matter. During *fogs* the amount is generally increased.

All the processes which were stated to be responsible for a reduction in the amount of oxygen lead to an increase in the amount of CO_2. They act, of course, more powerfully in closed spaces; and even in industrial centres, though large quantities are thrown into the atmosphere daily, the proportion of the gas is little if at all above the normal.

The balance is supposed to be maintained by the action of green growing *vegetation*, which absorb the gas and, by virtue of the chlorophyll they contain, break it up into carbon and oxygen. The activity of the chlorophyll is greatly increased by sunlight. The oxygen produced is mainly returned to the atmosphere, while the carbon is used for building up carbohydrates within the plant.

Apart from vegetation, *rain* and *high winds* help to keep the amount of CO_2 down, the former by dissolving it, the latter by diffusing it. In *night air* the quantity of the gas is found to be slightly lower than in air taken during the day for examination. The amount added by *respiration* is considerable, expired air showing about 4·4 per cent. against 0·03 to 0·04 per cent. in inspired air.

The amount which an individual adds depends upon the rate and depth of his respirations, the average amount per hour being about 0·6 of a cubic foot, and during exercise as high as 1 cubic foot per hour.

Combustion in an enclosed space produces very much more. A *gas jet* burning 6 cubic feet of coal gas per hour adds about 3 cubic feet of CO_2 in that time, and besides using up the oxygen at a more rapid rate than a man can, produces about five times as much CO_2 as a man would, and leads to other and more important changes.

The statement commonly made with regard to CO_2 in relation to the air of rooms is, that such as contains 0·06 per cent. of this gas is *fresh*, that containing 0·08 to 0·10 per cent. being close, while such as shows a percentage of from 0·12 to 0·14 is distinctly *disagreeable*. This, of course, suggests that it is the CO_2 that is to blame. Experiments have shown, however, that provided the air is kept moving, and the amount of moisture and heat is kept at a level reasonably comparable with that of the outer air, no feeling of discomfort ever is experienced.

It is, in short, entirely a question of the ease or difficulty with which *heat regulation* in the body is allowed to go on. In stagnant air, overheated and loaded with moisture, this function is greatly interfered with: the surface blood-vessels are dilated, and though the sweat-glands excrete plenty of fluid, evaporation takes place only slowly, or not at all, and no reduction of the body temperature results.

Reduction in the amount of CO_2 in a room in such a condition as described does not produce any modification in the symptoms; whereas if steps are taken to set the air in motion, to reduce the temperature and the amount of moisture, or to bring about all three, improvement does follow. The amount of CO_2 which can be breathed without discomfort, and with impunity so far as health is concerned, is very considerable. The respiratory centre by automatically changing the rate and depth of respiration provides for the keeping of the quantity of O_2 and CO_2 within the body at the required level. The higher the percentage of CO_2 in the air and the lower that of oxygen, the more rapid and deeper becomes the respiration. The person least aware of the change in rate and depth is the person affected, provided, of course, the change is not too marked, and until the CO_2 reaches 3·5 per cent. the atmosphere does not become really difficult to endure.

Important as these observations are from the scientific point of view, so far no change has been made in the methods of making calculations in regard to ventilation. The CO_2 or *chemical standard* is still that which is fixed and worked to, and it must be remembered that in atmospheric air the amount is 0·04 per cent. (0·4 per 1,000), that expired air contains 4·4 per cent., that a human being discharges about 0·6 of a cubic foot per hour, and that air containing above 0·06 per cent. of CO_2 (0·6 per 1,000) is no longer fresh.

It should also be noted, that in factories and workshops as a rule the standard adopted is the CO_2 standard, the maximum fixed being generally from 10 to 12 volumes per 10,000 at breathing level.

Other Constituents of Air.—*Water Vapour* is always present to a certain extent, even in the driest of air, the amount varying with the temperature and the presence or absence of bodies containing or consisting of fluids from which evaporation can take place.

The occupants of rooms affect the humidity of the contained air very considerably, the lungs giving off about 10 oz. in the twenty-four hours, and the skin from 20 to 25 oz.

Water is also one of the products of combustion of coal gas and coal, and a batswing burner consuming 5·5 cubic ft. of the former per hour produces 7·3 cubic ft. of moisture.

In certain trades, especially those in which cloth and such-like materials are manufactured, moisture assumes a very serious importance, and legal provisions have been enacted with the object of fixing a *standard of humidity* such that while the trade processes are not interfered with, the workers should not be made to suffer.

It probably need hardly be mentioned that if the moisture in the air is excessive, there is a diminution of evaporation from the body, and *vice versa* when the humidity is low. In both cases the effect is to lower the resistance of the body, and particularly of the respiratory organs, to bacteria.

Ammonia (NH_3) has its source in the decomposition of organic matter. Though present in traces in atmospheric air, in places in which active decomposition is going on it is greatly increased. It occurs in air either free or as a carbonate or nitrate. Like CO_2, because it is absorbed by water, it is diminished by a fall of rain.

Sulphuretted Hydrogen (H_2S) is occasionally found in the air in and around chemical and other works, but it is also a product of decomposition. If large quantities of chemical refuse are discharged into the sewers, or if the sewage is stagnant and undergoing rapid decomposition, the sewer air is apt to contain the gas. It is highly poisonous, and even when present in such small amounts as 0·05 part per cent. may produce serious effects. In minute quantities it leads to headache, giddiness, and sickness, and in larger doses to loss of sensibility and even sudden death.

Carbon Monoxide (CO) except in the case of large towns is not found, or occurs only in the merest traces in the free open air. It is colourless and odourless, and it comes chiefly from charcoal, particularly if the combustion is imperfect. In the burning of coal and coal gas a certain amount is always given off. Many of the symptoms produced by the inhalation of coal gas are traceable to the CO present in it. The relation which the monoxide bears to other constituents of coal gas depends very much upon the purity of this gas and the extent to which it is mixed with water gas. Because water gas can be cheaply produced, many gas companies like to use it, but in most places a limit is placed on the amount that may be added. Coal gas contains about 8 per cent. and water gas about 45 per cent. of CO, and the risks from it are considerable should it escape through leaks or defects in the lighting system.

Several cases are on record in which the coal gas causing the trouble had escaped from a defective gas pipe outside the building. As the gas in its passage through the soil is apt to lose its characteristic odour, its presence usually remains undetected until it has given rise to illness or caused one or more deaths.

Stoves, particularly if defective in structure, may prove a source of CO, though it is stated also that it may be given off from the metal itself if it is overheated.

The damage done by CO is due to the fact that it unites very readily and firmly with the hæmoglobin of the red blood corpuscles, and keeps out oxygen required by the tissues and the respiratory centre. Quite small quantities (0·05 per 1,000 volumes of air) will give rise to symptoms—headache, nausea, giddiness, and pallor. If taken in minute doses for a period marked anæmia results.

Sulphurous and Other Acids.—These come mainly from combustion. Acids of various kinds may be found in the air around alkali and other works; but since the introduction of legislation requiring condensation of the gases, and the limitation of the quantity of acid in the smoke, etc., discharged by the chimney, there has been a great deal of improvement in this respect.

In rooms in which coal gas is used as an illuminant sulphurous acid gas is practically always found in varying quantities, and may cause irritation to the organs of respiration.

Sewer Gas, though it may contain H_2S, differs little in composition from the outside air, particularly when taken from well-ventilated and properly constructed sewers. Except when H_2S is present, sewer gas is generally odourless.

Smells and *emanations* indeed only arise if sewage has been allowed to stand for some time. If a sewer acts as a channel for sewage, and so fulfils its proper function, its contents should always be fresh and always on the move. Even if emanations are given off, though they may be unpleasant, they can only cause actual harm if *organisms* escape from the sewage. Germs apparently rarely do escape, since vast numbers of examinations have been made of the air of sewers, and only the ordinary air organisms have been found. Men who work in sewers are practically without exception quite healthy.

Sore throat and other conditions found to occur amongst occupants of badly drained premises are organismal in origin. The bacteria may have come from the defective drains or from soil polluted by the materials that have escaped. Lowering of health and of resistance to disease and attack by bacteria, such as those of sore throat, sometimes traced to defective drainage, may have resulted from other defective arrangements on the premises, since such as have very defective drainage systems very usually are defective in several other ways, being damp, badly ventilated, etc.

In any case it is to be noted that the same investigations that proved sewer air to be comparatively harmless showed drain air to be much more likely to be a menace on account of the bacteria which it might contain.

Suspended Matters and Dust.—Dust consists mainly of *inorganic matters*, particularly of carbon, silica, and salts of various kinds. The *organic matters* are partly of vegetable and partly of animal origin, pollen, seeds and spores, and plant cells, particles of wool, cotton, etc., epithelial scales, fragments of hair, and such-like. *Bacteria* vary considerably in number, but in the main are harmless, the bulk being moulds and yeasts. In the open country the quantity of dust and suspended matters of all kinds is infinitely less than in towns, where the supply is maintained by the traffic that grinds down the paving, by the manufactories that pour all sorts of matters into the air, and by the human and other living creatures which give off organic and other particles from their bodies and during the performance of various functions.

Dust particles per cubic inch of air have been found to vary from 2,000 in the open country to 3,000,000 in towns. The quantity indoors is always much greater than out-of-doors, and the character generally speaking more objectionable, the organic matters being larger in amount. In some of the larger towns the solid matter deposited has been shown to amount approximately to between 200 and 300 lb. per acre in a month. The particles of dust vary greatly in size, and though dust has been stated to be of advantage in that it is the cause of the limitation of the humidity of the air by bringing about rainfall, it has disadvantages also, being possibly an irritant and the vehicle for disease organisms which, though they are difficult to detect, are almost certainly present in air. Bacteria are always found most numerously where the air is impure and dusty.

Effect of Respiration on Air.—This is evident mainly in enclosed spaces, and in general terms it may be stated that chiefly what is done by man to air provided for his use is to take oxygen away from it, and to add CO_2, heat, moisture, and organic matter, and a small amount of NH_3.

The extent to which oxygen is reduced is by about 4 per cent., ordinary air containing just over 20 and expired air just over 16 per cent.

The amount of CO_2 given off per hour by a man is from 0·6 to 0·8 of a cubic foot, though rather more is produced during hard work. It is produced by the combustion or using up of the tissues, part of the carbon of which they consist uniting with oxygen and passing off as waste.

The *heat* and *moisture* added to air as a result of respiration are derived from the surfaces with which it comes in contact. The fact that some of the heat and moisture that may cause discomfort in overcrowded rooms come from the respiratory passages of the human occupants themselves should be noted.

That expired air is rich in *organic matters* has been long recognised, and numerous attempts have been made to isolate them. For some time after it was more or less generally admitted that any deleterious effects traceable to the respiration of vitiated air could not be due to CO_2, the blame was laid at the door of the organic matters. The smell in overcrowded rooms has also been alleged to be due to these substances, and it was largely because the air did smell, and because the smell was thought to be due to the organic matters, that they were regarded as poisonous.

Absolute proof that there is any poison in expired air has never been offered, and it has been found to be quite impossible to show what part, if any, of the smell in closed occupied rooms is produced by respiration.

Air and Disease.—Health may be affected or definite disease caused if there is deprivation of air, or if the individual is compelled to breath impure air or air containing impurities.

Deprivation of Air.—That a person deprived of air to a greater or less extent is likely to suffer is so obvious that it hardly requires mention.

Impure Air.—Air that is impure, or, as it is frequently called, *vitiated air*, is definitely a cause of interference with comfort and health. The vitiation may be produced in a variety of ways, but that resulting from respiration is regarded as the most important.

The effects that follow the breathing of such air vary considerably, mainly on account of the power of the body to adapt itself to changes in the composition and character of the air. Nevertheless it is well known that the great majority of persons compelled to breathe impure air in overcrowded and badly ventilated places suffer at least discomfort, and may have headache and be considerably distressed. If the exposure is continued for long periods, as for example in the case of persons who work and live in close, ill-ventilated, and crowded rooms, health inevitably becomes affected.

Headaches are frequent, anæmia develops, and there is less of resistance to conditions that may cause disease. The exact element in the vitiated air leading to these effects is not definitely known, but that the air is responsible is clear, since improvement always results if the person is given air more closely resembling the outer air. It may be that it is because the air is cooler, or contains less moisture, or more oxygen or less carbonic acid, that improvement results ; the important point is that improvement does result.

Children suffer most from impure air, and react more rapidly to improvements in the quality of the air supplied.

Impurities in Air.—The impurities in air which may prove harmful may be *gaseous* or *solid*, or *living organisms*.

Gaseous Impurities.—The most serious results from gases occur in closed spaces, particularly work places. In the outer air the dilution is so great that anything beyond temporary inconvenience rarely results.

Poisoning with gases being most commonly industrial in origin, reference was made to the various forms when dealing with diseases of occupation.

Solid Impurities.—As in the case of gaseous impurities, it is from the occupational point of view that the solid impurities are most important, and information with regard to them will be found in the chapter on Occupational Diseases.

Living organisms, *i.e.* bacteria in air, are almost invariably of a type harmless to man, though under exceptional conditions the organisms of suppuration, and of tuberculosis, enteric fever, and some other diseases have been found.

The part played by the air in the transmission of disease is not properly understood. Except in so far as its currents lift and carry or propel the bacteria or the matter in which they lie, it probably plays no active part whatever. Air, being a mixture of gases, affords no sustenance to bacteria. Organic matter is necessary, and in all probability few bacteria get into air except in association with such matter. The length of their life in air, as elsewhere, depends largely upon the amount and nature of the organic matter present, and the power of the organism to resist the heat, cold, dampness, and other conditions encountered.

Examination of Air.—In the examination of air the investigation is directed chiefly to an estimation of the amount of CO_2, and in some cases of the number of organisms present.

Quite a number of methods and forms of apparatus have been devised for use in estimating the amount of carbon dioxide, some of them with the object of allowing the calculation to be made fairly rapidly.

In laboratories probably the method most commonly applied is that of von Pettenkofer. The air to be tested may be collected in clean dry jars, or by passing a fixed quantity through a weak alkaline solution, *e.g.* lime or baryta water. The estimation of the amount of CO_2 present is made by estimating the alkalinity of the solution before and after its exposure to the acid CO_2.

Amongst the rapid methods may be mentioned Haldane's, Angus Smith's, and Scurfield's; of these the first named is probably the most scientific, the two last being more or less rough-and-ready.

Estimations of the amount of CO_2 present in the air are sometimes made in factories and workshops, where a CO_2 standard has been fixed by the Home Office.

The *number of organisms present* in air may be estimated by exposing special plates (*Petri dishes*) containing a nutrient medium, usually in the form of a jelly, to the air for a certain time with proper precautions, counting the numbers after having incubated the medium at a suitable temperature.

Alternatively, a measured quantity of air may be drawn through a tube coated internally with a jelly culture-medium. The counting in this case is done, as before, after the tube containing the medium has been incubated.

The numbers found vary considerably, but depend very largely, perhaps entirely, upon the amount of organic matter present in the air. On mountain tops there are comparatively few, and probably those that are found come from the persons making the observations. In the air of towns there are many more than in the air of the open country. In crowded rooms they are most numerous, because of the amount of organic matter, the number of sources from which they may be given off, and so on.

The chief types are moulds and sarcinæ. Organisms of disease are found only where there are excreta or discharges from the body or other matters containing such organisms.

CHAPTER XV

SOIL

Chemical Composition.—The chemical composition of soil, so far as its *mineral constituents* are concerned, depends largely upon the character of the rock from which it is derived. In addition to mineral matter, however, soil contains *organic matters* in varying amounts, partly of vegetable and partly of animal origin, the former derived from the dead and decaying vegetation falling upon the surface of the soil and becoming incorporated with it; the latter from animals, both when they are alive and after they are dead.

In the neighbourhood of human habitations, unless special precautions are taken, contamination of the soil with animal organic matter is very apt to occur. If the amount is, as it is not unlikely to be, excessive, both water and air may be polluted from the soil. The risks from natural soils are, however, small as compared with those from what are known as *made soils*, which consist largely of refuse from roads, houses, and so on. Generally these made soils are very rich in organic matters, and stringent regulations have been passed forbidding the erection of buildings upon them until the objectionable matters have become or been rendered innocuous.

Nitrification and Denitrification.—The changes that take place in the course of transforming these substances into others more or less harmless are generally referred to as *nitrification* and *denitrification*, and are entirely brought about by organisms present in the soil, some of them known as nitrifying, others as denitrifying organisms.

Bacteria in Soil.—Organisms as a matter of fact are fairly numerous in soil, and probably are mainly engaged in this work. Occasionally members of the pathogenic group of germs are present, amongst them the bacillus of *tetanus* and the bacillus of *malignant œdema* and of *anthrax*. The organisms of *enteric fever* and *cholera* are capable also of living for considerable periods in soil, and the presence of various intestinal organisms, *e.g.* *B. coli* and *B. enteritidis sporogenes*, has frequently been demonstrated.

The specific organism of *epidemic diarrhœa*, though believed to occur, has never been isolated from soil. The *B. diphtheriæ* is only rarely found there, and tends to die out rather rapidly.

Generally with regard to organisms in relation to soil, it should be noted that it is in the upper layers, where most organic matter and air are found, that the majority reside. In the deeper layers they occur in smaller numbers, and below a certain level may not be present at all.

Ground Water.—The great bulk of rain water that finds its way into the earth goes to join the *underground or subsoil water*, which has its bed upon the upper surface of the first impermeable stratum below the ground level.

This water is continually on the move through the permeable soil to find an outlet as a spring or into a river, lake, or other collection of water. Movement vertically also occurs, the upper level varying with such factors as the rainfall, the nature of the soil, the depth of the impermeable stratum, and the temperature.

The most suitable site for buildings in relation to ground water is one in which the level is low and there are no very marked and sudden variations in the level which may lead to flooding of premises. Information on these points may be obtained from the wells in the district, note being made of the level in a number of these in different parts of the area and at different times.

Disease in Relation to Ground Water.—Certain diseases, *e.g.* cholera and enteric fever, are commonly supposed to show variations in incidence to correspond with variations in the level of the underground water.

When the level is low the number of cases is also low; when there is a rise to such a level that the ground is moistened the number of cases increases; when the rise is rapid and the level is maintained there is a fall.

Though differences in the amount of contamination of well water resulting from the variations in the movement of the ground water are sufficient to account for the increase or decrease in the number of cases, the explanation that has been offered is, that in the first case the dryness of the soil interferes with the virulence of the organisms, the moisture in the second being just the amount required by them, and in the last case the amount is excessive and the organisms are drowned out.

Ground Air.—In addition to providing accommodation for water, the interstices of the soil serve as a place for air also. This *ground air* varies greatly in composition, but contains on an average more carbonic acid, moisture and organic matter than atmospheric air. Ammonia, sulphuretted hydrogen, and other gases are not uncommonly found, and in towns coal gas that has escaped from gas mains is sometimes present also.

The amount of carbonic acid increases with the depth from which the ground air comes. Like the ground water, the ground air rises and falls. When the water rises the air is naturally driven out, but variations in temperature, either of the atmosphere or of the soil, tend to inward and outward passage of air to or from the soil.

Increase in the temperature of a building may lead to aspiration of ground air, and if, as may be the case with made soils, it is contaminated with the gases resulting from the decomposition of organic matter, injury to health may result. It is to meet the possibility of rise of ground air as well as of ground water that building sites are covered with concrete.

Temperature.—The heat in the soil is derived primarily from the sun, but to some extent also from chemical and other changes going on within itself.

That absorbed from the sun is taken up very quickly, and is also given up fairly rapidly. Such as passes downwards does so slowly, soil 3 or 4 feet from the surface taking quite an appreciable time to respond to an increase in the atmospheric temperature. At 24 feet the wave of summer heat does not produce a maximum temperature until about the middle of the succeeding January.

On the surface and a few inches below there is more correspondence, though, because the soil rapidly radiates heat, there is rarely absolute coincidence. Dark soils absorb heat more quickly than light-coloured soils, and the amount of moisture and vegetation exercises a considerable influence.

The fact that there is a relation between the temperature recorded by a thermometer at 4 feet below the ground surface and mortality from diarrhœa is one commonly referred to, but no definite explanation has been offered to account for the coincidence of the maximum of deaths from the disease with the maximum 4 foot earth temperature rather than the maximum of the air temperature.

Healthy and Unhealthy Soils.—Mainly because it is so comparatively easy by drainage, concreting, and so on to deprive a soil of any possibility of causing harm, and so many other conditions play an important part in relation to its healthiness, nowadays little attention is paid to the mere geology of the soil as a health factor.

In towns particularly the suitability or unsuitability of geological formations for the erection of houses has little or nothing to do with the determination to extend or not extend in any particular direction.

Even in country districts villages have not been, and are not, formed because from the health point of view the site seemed desirable. Though generally disregarded, it is essential, nevertheless, to make some reference to this matter, and broadly the geological formations that favour slope, dryness, warmth, and a moderate amount of vegetation may be taken to be the healthiest.

Granite, basalt, and others of the *harder rocks* all do so, and are for these reasons good soils upon which to build. *Millstone grit* and *limestone* are also good. The fact that *gravelly soils* are dry and healthy is generally accepted. For the reason that the contained ground water is apt to stand at a high level, gravel in a hollow is apt to be damp and objectionable.

Provided that they are not mixed with or based on clay, *chalk*, *sandstone*, and *sand* are of the class of healthy soils.

Clay, as is well known, is likely to be damp and cold. Generally it is condemned, although there are not a few authorities who consider that too much is made of the objections and that if proper precautions are taken it can be made fairly safe. In times of drought it is apt to crack and give rise to cracks in walls and drains of buildings.

Alluvial soils are practically always damp; they rarely have any slope and always favour rank vegetation. A point that must not be lost sight of is the effect that various soils exert on water, and it may be noted that mineral impurities may be added by limestone, chalk, and sandstone, and organic impurities by alluvial soils.

Soil and Disease.—The majority of diseases regarded as related to soil arise chiefly because it is damp, or unclean as well as damp. The disease most commonly held to be caused by dampness is *rheumatism*, and residence on a damp soil by lowering resistance may possibly predispose to attack even if the condition, as many believe, is organismal in its origin. The fact that rheumatism is not by any means limited to wet years or wet climates rather lends support to the view that apart from dampness there are other factors and predisposing causes. In any case, however, it is advisable that persons who suffer from attacks of any of the manifestations of rheumatism should avoid damp soils and damp houses.

Practically the same remarks apply to *consumption*, which has been shown to be common in damp districts. In certain towns, well known to be damp and to suffer from a very high consumption death-rate, matters have been greatly improved in this respect by drainage.

In considering this disease it was noted that while many regard dampness or the possibility of dampness as of great importance, others attach more weight to the *aspect* of the site in relation to causation, and produce statistics to prove that it is districts exposed to strong, prevalent rain-bearing winds that suffer most. These in addition to advising the phthisical to avoid damp houses on a damp site, advise also against sites that are exposed to strong rain-bearing winds.

An *unclean* soil is a dangerous soil, because the air which it contains and the gases which are manufactured in it are apt to find their way into buildings and to cause damage by lowering resistance or causing " general ill-health."

When the uncleanness is bacterial in nature more serious and definite results are to be expected. Organisms which are commonly regarded as capable of flourishing in soil, once they find their way there from an infected person or animal, are those of *enteric fever*, *cholera*, *epidemic diarrhœa*, *diphtheria*, and *tetanus*.

The best kind of soil for the development of the organisms of disease is that which is organically polluted and in which the ground water, because the ground is porous and the impermeable stratum is not too deep, has free play up and down.

Under such conditions the chief mode of spread is by way of water supplies. In connection with *epidemic diarrhœa* and *enteric fever* it may be pointed out, however, that the greatest occurrence is always noted in districts where soil pollution is a common feature, where, for example, the yards attached to houses are fouled from privies or in other ways. In these cases the excessive incidence occurs whether or not there is any real possibility of contamination of water supply and may be due to dust infection or to the carriage of filth by flies.

In the case of *diphtheria*, though it is commonly stated that the disease is related in some way to the condition of the soil, no definite explanation of the relationship has been forthcoming. The fact that in newly built neighbourhoods cases are not uncommonly noted may be due to something else than the mere disturbance of soil that has accompanied the building operations.

In *tetanus* the infection is frequently derived from soil and to some extent it is regarded as a soil disease. The organism, it should be noted, does not live and thrive in the soil merely because it is soil. The important factor is the manure that is applied to the soil. It is this and not the soil that contains the organism, and infection with tetanus may be obtained in stables and in other situations where manure occurs.

As already noted, malaria, cancer, cerebro-spinal meningitis, and polio-myelitis are also alleged to be associated with soil.

Chills and Pneumonia are frequently declared to be "caught" from moist soils. To those who believe that the "chill" is nothing more than a symptom of some other condition and that pneumonia is an organismal disease, the belief that exposure to dampness can do more than predispose a person to attack by reducing resistance is impossible.

Anthrax bacilli and spores may be found in soil, and infection may be contracted as a result of contact with it or the vegetation which grows upon it. It is not, however, the soil that is responsible, but organic matter such as manure, or blood, dropped upon the ground.

Geological formations are believed or have been shown to exert some influence in relation to *goitre*, which is most common in hilly districts where magnesian limestone is a prominent feature. Whether or not the condition occurs as a result of the presence in the water supply of minerals derived from this is not clear, and goitre certainly occurs in districts in which magnesian limestone is not found.

CHAPTER XVI

WATER

Although an individual could and many individuals do find smaller quantities adequate, in the majority of towns in order to meet various requirements, an allowance of from 20 to 30 gallons of water per head of the population per day is generally made.

Of this amount at least half is supposed to be used for drinking, cooking, bathing, washing, and other domestic purposes, the remaining half providing for trade and communal purposes, street washing, public baths and lavatories, with a certain proportion for unavoidable waste.

In districts in which there are few or no water closets a smaller quantity will be sufficient, but in most towns at least the amounts named are allowed. In London, for instance, the allowance is 28¼, and in Glasgow 50 gallons. In St. Helens, in Lancashire, the allowance for domestic purposes is 25 gallons and for other purposes 13 gallons.

Sources of Water.—Primarily all water is derived from the condensed moisture descending upon the earth as rain, dew, snow, or hail. After it has fallen some of it returns whence it came as the result of the evaporation caused by the heat of the sun, the remainder either flowing along the surface of the ground to fall into rivers or lakes, or percolating through the soil to reach such collections as these or to appear again as springs through cracks or fissures in the strata. The underground water is also fed by it, its level varying with the amount of water falling on the ground surface.

Water supplies may be derived directly from the rain water; from the water flowing over the surface; from the collections of water into which the surface water falls, or from the percolated water through springs or wells.

No matter what the source may be, what is required of it is that it can be depended upon as regards *quantity*, *continuity*, and *wholesomeness*. To be a good drinking water it must be clear, cool, colourless, odourless, and palatable; be moderately aerated and possess a neutral reaction and no visible sediment. On chemical examination it should show itself to be fairly soft and free from evidences of pollution. It must as far as possible be bacteriologically pure, *i.e.* it must contain no pathogenic organisms and only a small number of other organisms, possibly, though it is difficult to set up a standard, not more than 100 per c.c.

Rain Water.—In most of the respects named rain water is not too dependable, and in this country it is practically only in rural districts and where well or other water of good quality is unobtainable that it is used. Except in the tropics it is rarely looked to to supply the needs of populations of any size.

It is apt to contain a number of impurities picked up from the air and from the surfaces upon which it falls and from which it is collected.

Near the sea appreciable quantities of salts, particularly chlorides and sulphates, and in towns, ammonia, acids, soot, and dirt, are generally present.

Even if rain water reaches the ground fairly clean, a great amount of care must be given to collection. In the case of a house the usual collecting surface is the roof, and from this it runs into the eaves-gutters and thence by the rain-water pipes to a tank of some sort, usually, though not always, under ground. Quite commonly in older houses, both here and abroad, the tank is constructed under the building.

When rain water is to be collected for the supply of populations of any size, special collecting surfaces constructed of concrete or other impervious material must be provided as well as tanks or reservoirs to which the water may be conducted by means of pipes. In these cases, as in the case of the single house, steps must be taken to prevent the rain water picking up pollution from the collecting surface. The large area must be kept scrupulously clean and well protected, and it is advisable to exclude from the tanks the first quantity of rain water that falls.

In the case of the roof, contamination may be expected from such materials as bird droppings, vegetation, soot, and dust. As far as possible the first portion of rain should be regarded as a roof washer and should be rejected. To keep it out several schemes have been adopted, and amongst them may be mentioned *Robert's Rain Water Separator*.

In this by means of a tippler arrangement which works automatically the first portion of rain is collected and discharged into the house drains, and not until this has been got rid of is a way through to the collecting tank provided. In some places some dependence is placed upon this apparatus, but in the majority of instances no such precautions are taken.

As a source of supply rain water is somewhat uncertain and is apt to fail when most required. There are some risks of pollution, but apart from these it is fairly palatable and, because it is soft, from the domestic point of view has some advantages. That there is a necessity, where rainwater butts are used, for preventing them from becoming breeding-places for mosquitoes has already been mentioned.

The fact that, being soft, rain water is apt to act upon lead should ensure that this metal is not employed in the construction of the tanks in which it is stored.

Surface Water is the rain water which has reached the ground and is on its way to join a stream or other collector of such water. If it is to be used as a source of supply some means of catching it must be provided, and as it is liable to obtain impurities from the ground upon which it falls and over which it flows attention must be given to purification before it is used.

In many quite large districts surface water collected from high, open stretches of moorland is used, special methods, to be referred to later, being adopted in connection with its collection and treatment.

Springs and Wells.—The water that percolates continues its journey downward through the soil until its farther passage is stopped by a layer of the earth's crust that is non-porous or only partially so. To this layer or stratum the name "impermeable stratum" is given.

What becomes of the water thereafter depends mainly upon the nature and condition of this stratum. If it is cracked or fissured some may pass on through the openings until a deeper impermeable stratum is encountered, or, in the case of chalk, for example, into cavities in the stratum itself; or it may simply remain on the surface of the impermeable stratum, forming part of the great body of water which, as already indicated, is known as the underground water; or because the impermeable stratum is exposed or has "outcropped" at the ground surface it may reappear in the form of a spring.

Springs are known as surface or deep springs according to the depth from which the water has come and the distance it has travelled. Generally speaking, the water yielded from a *surface spring* is liable to have been contaminated in its passage through the soil, and to be both unsatisfactory and unsafe for human consumption.

In the case of the *deep spring* the water is generally safer, having been filtered in its passage through the earth. It appears at the surface because it has been forced up through cracks as the result of pressure.

Water forced up in springs need not necessarily, of course, discharge on the surface; quite commonly springs appear in the bed of a river, a lake, or the sea.

Wells.—In addition to returning naturally to the surface through springs the percolated water may be brought back as the result of the efforts of man, through wells.

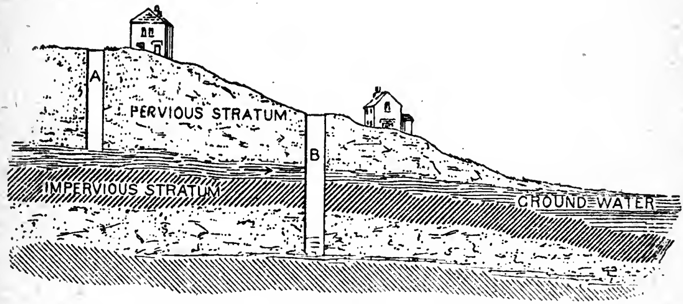

FIG. 43.—Wells. A, a shallow or surface well; B, a deep well.

The commonest types of well are the *Shallow or Surface*, the *Tube or Abyssinian*, the *Deep*, and the *Artesian*. All of these are formed by perforation of the strata or layers of soil or rock forming the earth's crust and by tapping the percolated water.

Shallow or Surface Wells.—In the case of the shallow or surface well, the water tapped is the underground or subsoil water; that which rests upon the first impermeable stratum. The name "shallow well" indeed is applied to it not because it does not attain a great depth, but merely to indicate that its bottom lies above this stratum. A much better name is *surface well*; which indicates, as is the case, that the water derived from it is mainly surface water.

Being surface water it is liable to be polluted, containing the impurities which it has picked up on its way over and through the soil. Unless such a well is very carefully constructed and protected, since it draws from a radius extending to about four times its depth and forms a sort of catchpit for all surface washings and for the drainage from manure heaps, leaky drains, and cesspools, the water which it yields may be very grossly polluted.

Shallow wells are rarely used as sources of supply for populations of any size. In villages the whole supply may come

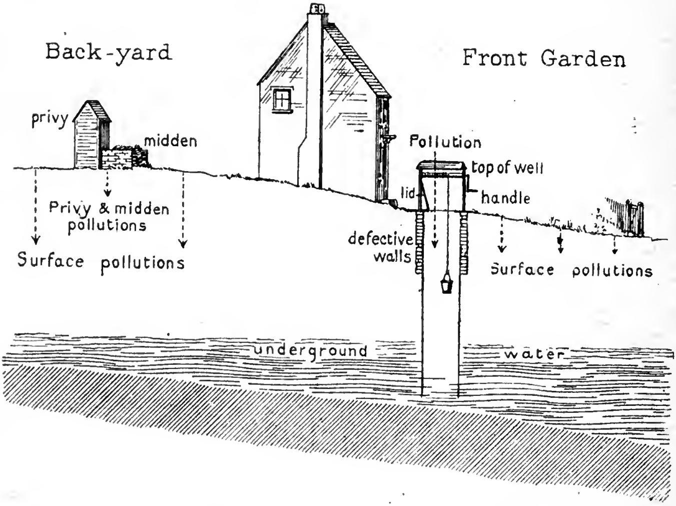

FIG. 44.—Showing various sources of pollution in the case of a shallow well.

from them, however, and quite commonly cottages and even mansions in country districts may obtain their water from such wells. In such cases the well should not be too close to the house. Further, it should be as far as possible from, and if the ground slopes, at a higher level than the privy, the cesspool, the manure heap, and any other possible source of pollution.

To ensure that the water entering the well from distant points shall have undergone a certain amount of filtration, the bottom should be made the only point of entry. The walls should be carried down to the water level at least and be built of bricks jointed in cement and backed with a thick layer of puddled clay, *i.e.* clay thoroughly worked up with water and well pounded in.

To prevent the entrance of surface washings the wall should be carried above the ground level and surrounded by cement sloping downwards and outwards from the top of the wall all round. In all cases the well should be covered and the water drawn by means of a pump and not by a bucket. In addition to risks of pollution with a shallow well there is always a possibility

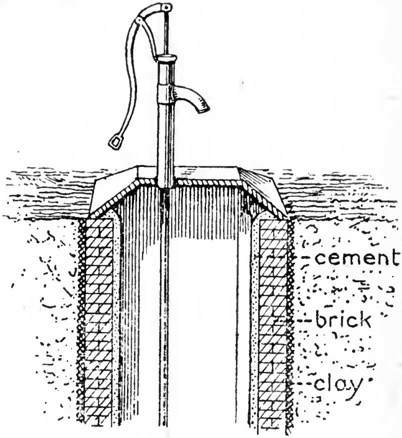

FIG. 45.—Showing how the risks indicated in Fig. 44 may be met by constructing the well properly.

of the supply failing during very dry weather.

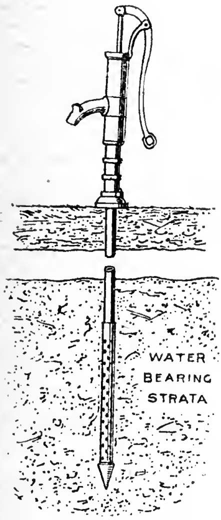

FIG. 46.—Tube or Abyssinian Well. This type is fairly commonly used in sandy or gravelly soil.

Tube or Abyssinian Wells are simply shallow wells formed by driving Norton's iron tubes into the soil, using first one that is pointed and perforated and jointing on additional lengths until a good supply is struck. This form of well is used chiefly in loose gravelly soils and the water generally must be pumped.

Deep Wells.—The word "deep" as used in this connection bears no relation to the actual depth of the well. It is merely employed to indicate the fact that the bottom of the well lies below the permeable layer of soil that rests upon the first impermeable stratum.

A deep well should be constructed with as much care as a shallow well, though there is perhaps less risk of pollution. The wall should be carried down to the level of the impermeable stratum, and such portion of it as lies in the permeable layer should be built as in the case of shallow wells.

The water from such a well has usually travelled some distance, has been fairly well filtered, and is pure and safe. Generally it is bright and sparkling and occasionally hard, as it may have taken up some of the mineral matter, *e.g.* lime or magnesia, which it has encountered in its journey through the various strata.

Artesian Wells may be either natural or artificial. They are formed in situations in which a permeable (water-bearing) stratum lies between two impermeable strata all dipping downwards from the surface to a bowl-shaped arrangement. The water enters at the point where the impermeable strata are exposed or outcrop and passes downwards to lodge in the bowl. At the lowest point of the bowl it is under considerable pressure, and if an exit, natural or artificial, passing downwards from the surface to this point is provided, it may be forced straight up to the ground level. If tapped elsewhere in the bowl the water may have to be pumped.

With regard to *wells* and *springs* generally, it may be noted that in each instance the deep variety is more likely to yield a safe water, though it is apt to be somewhat hard. For private-house use precautions in connection with construction are no less necessary than in the case of the shallow variety.

As an example of a fairly large town drawing its supply mainly from springs Lancaster may be mentioned. In this case the collecting area consists of about 2,300 acres of upland surface situated on the upper slope of certain fells. Springs arising from the sides of these fells are covered over, the water issuing from them being at once conducted into lines of pipes from which one service and two storage reservoirs are fed. In order to ensure the protection of the gathering ground or catchment area from pollution it is very carefully guarded. The daily supply is 33 gallons per head.

St. Helens, with a population of nearly 100,000, may be given as an example of a large district depending on wells for a supply. Here the water is pumped from deep wells in the new red sandstone. The pumping stations are six in number and provide a daily supply of nearly six million gallons. From the various wells the water passes to a central reservoir from which it is distributed. These wells are, apparently, a satisfactory source, since an allowance of 36 gallons per head per day for all purposes can be provided.

Water derived from wells in the chalk is used at Croydon, Ramsgate, and Guildford amongst other places. In Shrewsbury the drinking water supplied to the town is drawn from wells. That used for other purposes is taken from the River Severn.

The water from artesian wells is usually plentiful and pure, and districts, sometimes of a considerable size, in this and other countries obtain their supply or part of it from such wells. Crewe may be quoted as an example.

Rivers and Streams.—The great bulk of the rain water that flows over the surface of the ground finds its way into rivers and streams. Indeed, with the assistance of springs, rain water forms them and more or less they are the natural drains of a district. The water which they receive is very often polluted, since, in its journey towards them, it may have picked up filth and organic matter from the surface over which it has passed. In addition, the drainage from houses close to rivers and streams may discharge into them and add considerably to the pollution.

As it flows along, tumbling over stones and mixing thoroughly with air, the water gets an opportunity of purifying itself; before complete natural purification can occur, however, a considerable distance must be traversed, and in this country, partly because of the short course of the rivers and streams, partly because the opportunities of further pollution are so great, nothing like perfect self-purification of their water occurs.

River and stream water, as a matter of fact, is not really a safe supply unless it is taken near the source or above habitations and manured fields, or is subjected to filtration or some other form of treatment before it is distributed. If the supply of a house is to be taken direct from a river, it is well to go as far out from the bank as possible and to filter the water before use.

For the supply of districts, streams and rivers are sometimes impounded near their source to form reservoirs. Occasionally also, as in London, the water is taken direct from the river and used for all purposes after storage and filtration. In Shrewsbury part of the supply is derived from the Severn. Before delivery it is subjected to treatment and is not supposed to be used for drinking purposes.

Many districts take river water at or close up to the source and before there has been much chance or risk of pollution. In such a case the water of the river and its tributaries or of streams is collected into reservoirs. Care is taken, however, to get control, as far as possible, of the land from which the river and streams draw their surface water. This is called the gathering ground or *catchment area*. The water collected in this way is generally of the class known as *upland surface water*. The size of the catchment area required depends mainly upon such considerations as size of the population and the rainfall.

The reservoir provided to catch and contain the water is preferably formed by building a dam across the valley through which the river runs and by walling the water in on as many sides as necessary by means of embankments. In any case the reservoir must be strongly constructed and any dams or building work must be of such a strength as to resist a considerable amount of pressure. Undermining or disintegration of dams and embankments must also be guarded against and the floor of the valley must be carefully examined for geological defects through which water may escape.

It is rare that all the water brought by the streams feeding the reservoir is stored. In times of flood, for example, when the water is dirty it is usual to divert it, and means for bringing this about must be introduced. Means of emptying the reservoir distinct from the pipe that carries the water away for distribution must also be provided. Such a provision allows of the cleansing of the reservoir from time to time and the removal of vegetable and other matters deposited in the course of self-purification of the water.

The *size of reservoir* provided depends mainly upon the size of the population to be catered for, the amount allowed per head per day, and the number of days' supply (usually 150 at least) it is considered necessary to store.

Lakes are, like rivers, formed from surface water and springs, and in place of damming a river and constructing a reservoir many very large towns, Glasgow, Liverpool, etc., gladly use a lake or lakes. In order to protect the water from pollution provision is made for obtaining control of the ground from which the feeders of the lake come. Lake water, like the majority of other collected waters, is generally treated before distribution, though it shows a great tendency to self-purification as a result of settlement and aeration.

Impurities in Water.—The chief contaminating agents to which water is exposed may be classed as *Mineral matters*, *Organic matters*, and *Germs*.

Mineral Matters.—The minerals present, or that may be present, in water are picked up mainly from the soil through which it passes towards the point at which it is to collect or appear.

Hardness of Water.—In the early stages lime and magnesia are the most important minerals found, and upon the amount present depends the hardness of the water. The extent of the hardness is estimated with standard soap solution and stated in *degrees*, each equal to 1 grain of calcium carbonate per gallon. A water of average hardness is one containing 8 to 10 grains of the mineral per gallon, or of 8 to 10 degrees of hardness. One with 20 grains per gallon is extremely hard. Soft waters rarely hold more than 3 to 4 grains per gallon.

Hardness is classified as *temporary* or *permanent* according to the effect produced upon the water by boiling. Whether the hardness is temporary or permanent depends upon the nature of the salts present. Of these perhaps the carbonates are the commonest, and a water containing them is usually possessed only of a temporary hardness, since, because the carbonates are held in solution as bicarbonates, boiling of the water by driving off the carbonic acid gas will lead to the falling of the carbonates out of solution and the consequent softening of the water.

The fur which forms on the inside of a kettle consists of carbonates which have precipitated as a result of the driving off of carbonic acid gas during boiling. The addition of lime to the water produces an effect similar to boiling, since in uniting with the carbon dioxide loosely held by the bicarbonate it sets free carbonates which in turn deposit.

The hardness in permanently hard water depends upon the presence of the salts of lime and magnesia other than the carbonates. It may be produced also by iron or alum.

Waters possessed of temporary or of permanent hardness alone are rare. Usually temporary and permanent hardness occur together and go to make up what is named *total hardness* of water. A considerable amount of importance is attached to hardness, because hard water is wasteful from the domestic point of view, as regards soap especially, and also because boilers and pipes may be interfered with by furring.

Soft Waters are soft because they contain mineral matters in small proportions. The more closely a water resembles rain water the softer it is. *Upland surface waters* are the softest of all, but both as regards these and the underground waters it is entirely a question of soil and strata.

The great difficulty with a soft water is that in storage and distribution it may exhibit what is known as a *plumbo-solvent power* and act upon lead.

This *plumbo-solvency* is most marked in peaty waters from a moorland source and depends upon the fact that such waters have a distinct acidity due to the presence in them of acids known as *peaty acids*, and formed by the action of bacteria on peat. In addition to a plumbo-solvent action some waters have actually the power of eroding lead, and are therefore *plumbo-erosive*. The effect of the water is always most marked when heavy rains follow a period of prolonged drought, the flush of water carrying with it the acid that has been accumulating in the peat.

Organic Matters are more seriously regarded from the point of view of contamination than minerals. They may be of either animal or vegetable origin, and are either picked up by the water from the surfaces upon which it falls or added to it while it is flowing to or after it has reached the places where it is to collect.

Falling on a roof the water may pick up vegetable matter or bird droppings; falling on soil it may take manurial or other kinds of contamination. Flowing over the surface it may be contaminated in this way also; and flowing along in a channel above or below ground as a stream or river, or when collected in wells, lakes, reservoirs, and such like it may have contaminating substances passed into it from manure heaps, from cesspools, or from drains or sewers so defective as to allow their contents to escape.

The presence of organic matter, as shown by chemical analysis, always suggests contamination with sewage and filth, and when these are present germs also are generally present.

Germs.—In nature, germ-free waters are practically unknown. The rain as it falls through the air picks up a certain number; the majority, however, are added after the water has reached the ground. The usual run of organisms present are quite harmless, and include several rarely seen elsewhere than in water and others commonly present in the air.

The *total number* found varies considerably, and though a standard in relation to the bacterial content is sometimes set up, it is not really possible to base a conclusion as to the purity of the water on an enumeration of the bacteria alone. It is with regard to the *kind of organisms* present and their probable source that information is required, and it is because the bacteriological test can give such information that it is described as the most delicate test of purity. The most important pathogenic organisms that may be found are those associated with enteric fever, cholera, dysentery, and perhaps diarrhœa; but because there happen to be many bacteria present in a water it is not possible to say that organisms such as those mentioned are also there.

In this country the organism chiefly to be guarded against is the *B. typhosus*; but as it is exceedingly difficult to isolate, it is usual to regard it as possibly present if other intestinal or sewage organisms, particularly the *B. coli*, are detected. The presence of this organism in such small quantities of water as 1 or 2 c.c. is usually taken as an indication of sewage contamination. *Streptococci* and the *B. enteritidis sporogenes* are also regarded as indicating such pollution.

Diseases Due to Water.—The most important diseases associated with the consumption of water are those due to the mineral and organic matters and germs considered above.

Of these due to *mineral matters*, *lead poisoning* is by far the most important, though it should be noted that waters containing substances tending to make it hard are not well borne by a considerable number of people. *Intestinal troubles*, diarrhœa particularly, are occasionally traced to them and iron in water in many cases gives rise to headaches also.

The formation of *calculi* may be dependent upon the presence of minerals in water, and *goitre* and *cretinism* are believed to be due in part at least to chemical impurities.

Soft waters are said to be factors in the production of *rickets*, though this is not generally accepted. Overcrowding, improper food, absence of fresh air and sunlight are infinitely more important.

Lead Poisoning.—In relation to lead poisoning, *upland or moorland surface waters*, because of their tendency to act on the metal, are most important.

The lead taken up by the water comes mainly from lead pipes and lead-lined cisterns, though lead-lined or soldered vessels, kettles, and cooking appliances may also yield a certain amount. In districts in which peaty waters capable of acting on lead is supplied, tap water has frequently been shown to contain the metal. The water first drawn in the morning, having been in contact with the pipes all night, usually contains most lead, and for this reason it is always advisable that the first of the flow should be allowed to run to waste.

Since it is a soft acid water that exerts the greatest influence on lead, the course usually adopted as regards *prevention* is either to harden the water by adding lime or to neutralise the acid by the addition of soda or other alkali. Not uncommonly both alkalinisation and hardening are carried out by the addition of a mixture of lime and soda.

The effect exercised by lime is mainly on plumbo-solvency. The erosive ability of the water is not reduced, may even be increased. It is not, however, so important as the solvent action, and is most marked on clean, bright lead surfaces.

In districts in which the water is known to have a plumbo-solvent power lead pipes should be used as little as possible. Lead-lined cisterns are not now commonly found.

The conditions associated with the consumption of *organically polluted water* are *diarrhœa* and such others as affect the intestinal canal. The most dangerous water of all is that polluted with *organisms* capable of finding their way into water and of retaining their vitality therein for a longer or shorter period.

The commonest organisms in this connection are those of *cholera*, *enteric fever*, and *dysentery*. Sufficient has already been said with regard to water-borne outbreaks of these conditions, and it is unnecessary to do more here than to introduce a note as a reminder.

Certain *worms* and their ova or larvæ are capable of maintaining their existence long enough in water to give rise to infection in man when consumed. The *Bilharzia hæmatobia* (*Schistostomum hæmatobium*) so common in Egypt and South Africa, the *Oxyuris vermicularis* or thread worm, and possibly also the *Ascaris lumbricoides* or round worm, the latter found commonly enough in this country, may be mentioned as examples.

Treatment of Water.—Water may call for treatment because it is too soft or too hard or is or may be bacteriologically impure.

The process of hardening and the reasons for carrying it out have already been described.

Softening is usually only undertaken when the water is of considerable hardness and domestic and manufacturing processes are interfered with as a result. Since even reasonably hard water is not particularly objectionable from the health point of view, interference for this reason is rarely necessary.

What is done generally is to add slaked lime (hydrated calcium oxide) and to adopt the *Clark process* or its modification the *Porter-Clark method*.

In *Clark's* method the lime is added to and thoroughly mixed with the water. The amount used depends upon the degree of hardness, but in any case only sufficient to take up the carbonic acid gas is employed, otherwise the hardness will be increased and not diminished. When thoroughly mixed the precipitate formed is allowed to settle.

In the *Porter-Clark method*, instead of allowing the precipitate to fall down, the water is forced through layers of canvas or cloth by means of which the lime is filtered off. In this way a considerable amount of time is saved, though the process is rather more costly than the other.

These methods affect only the temporary hardness. If the permanent hardness is to be reduced, soda must be employed.

Special softeners involving the use of machinery for mixing lime and soda with the water are on the market, but as they are mainly used in connection with manufactories they need not be described.

Bacterial Impurities may be dealt with in various ways. *Boiling* of course would be the best and surest of all, but on a large scale it is inapplicable.

The oldest known method and that at present most commonly adopted is *filtration*.

The usual type of filter is one containing a layer of sharp sand about 2 feet thick supported on a bed of gravel and stones, increasing in size till the bottom of the filter, where the outlet pipes are situated, is reached.

The water from the reservoir is turned on to the sand in the bed to a depth of 2 or 3 feet and allowed to pass *slowly* through it. The rate of flow is of great importance and must be carefully regulated. Generally it is from 3 to 6 gallons per hour per square foot of filtering surface. In its progress, provided this is not too rapid, the water is deprived of the great bulk of the organisms, certainly of those known to be pathogenic.

This purification is partly mechanical, but largely also it is taken to be more or less of *a vital process* and due to something, plants possibly, formed on the surface and in the substance of the filter. The fact that the sand does not attain its maximum efficiency till it has been in use two or three days is taken as proof of this. Further, sand filters must not be continuously used, since it appears that the purifying agencies require to be rested occasionally. Also as the pores of the upper part of the sand tend to get blocked, these layers must be scraped off and washed at intervals.

As a preliminary to filtration *storage of water* in special reservoirs for about thirty days is strongly recommended as applicable in the case of river waters particularly. With this

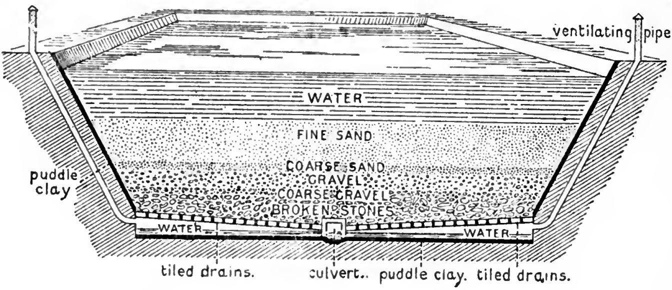

FIG. 47.—A Sand Water Filter.

method difficulties sometimes result from the growth of algæ which may discolour and alter the taste of the water. Apart from this, however, it gives remarkable results, not only as regards the disappearance of typhoid bacilli, but in the reduction in the number of organisms generally.

As a preliminary to storage the water may be run through small reservoirs, remaining about a day to allow of rough deposit taking place. In the storage reservoir a great deal of subsidence naturally occurs.

The *self-purification* of water noted as taking place in the course of storage occurs also in lakes and other naturally formed bodies of water. In rivers there is a tendency also to purification. In all cases it results from aeration of the water and exposure to sunlight, and from the warring of the bacteria one upon the other. Plants other than bacteria probably also play a part in purification. According to Houston, typhoid bacilli generally disappear completely in about a month, though the time taken depends somewhat upon the temperature, the colder the weather the slower being the rate of disappearance. During storage organic impurities also disappear or are reduced in amount, as a result mainly of oxidation.

Sometimes in place of sand alone in filter beds, sand mixed with other substances, *e.g. carbide of iron, spongy iron,* or *polarite*, is used. In some cases the sand and other materials are arranged in alternate layers, and good results are obtained by this means, particularly with brownish peat-stained waters, which, in addition to being purified, are also rendered practically colourless.

Most filters exert a certain amount of influence on the plumbo-solvency of peaty waters, an influence that can be greatly increased by mixing limestone or chalk with the sand.

One of the objections to the sand filter is that it is slow. To meet this, and also because they possess the advantage of occupying less space, *mechanical filters* have been introduced. In the majority of these, though the filtering material is still sand, in addition to undergoing filtration the water is exposed to the action of a chemical or chemicals such as *sulphate of aluminium*, *alum*, *iron*, or *mixtures* of these. The chemicals form a jelly-like precipitate which entangles bacteria and objectionable organic matters, to be in its turn entangled in the pores of the filtering material when the water is driven through it.

In these filters cleaning of the sand, which very rapidly becomes clogged, is brought about by driving water through it in the reverse direction and stirring it up by means of revolving arms or blasts of compressed air. A well-known example of this type of apparatus is the *Bell Mechanical Filter*.

The Candy Filter is used to a considerable extent, and differs from others in that no chemicals are added to the water to be filtered. Purification is brought about by saturating the water with air under pressure and afterwards forcing it through a specially prepared filtering material.

Mechanical filters are very largely used in America in districts with quite large populations, as high even as about 400,000. The experience is that while they are cheaper to install than sand filters they cost more to maintain.

Chemical Purification.—Chemicals alone are capable of bringing about purification of water, and in some places are used permanently and in others in emergency. Some of these when added to the water act more or less mechanically, clearing the water by carrying down bacteria and solids.

Alum, *lime*, and *sulphate of iron* may be quoted as examples of such materials.

Potassium permanganate, which acts mainly as an oxidiser of organic matter and a germicide, is supposed to operate partly in this way also.

Sulphate of copper exercises a coagulating influence and is considered to be particularly useful in keeping down algæ and growths which give trouble in storage reservoirs by rendering the water smelly or unpalatable. The great objection to it as a germicide is that considerable quantities must be added and there may be danger to consumers.

As a matter of fact opposition is generally offered to the addition of chemicals to water, particularly if the appearance or taste of the liquid is at all interfered with.

The addition of *hypochlorites*, which have already been referred to in dealing with enteric fever, is commonly objected to for this reason. Nevertheless, the hypochlorite process is regarded as having distinct possibilities, particularly as it is comparatively a cheap method of purifying water by killing off the germs.

The hypochlorites employed may be either those of lime (*chlorinated lime* or *bleaching powder*) or of soda. The former is the cheaper, and has been employed in London water successfully for some time. The amount of chlorine used varies, but for a fair ordinary water ·5–1 part per million parts may be added. In some places in which the method has been adopted, special apparatus is used for getting rid of the chlorine after contact. Filtration through charcoal has been recommended for the purpose also, and has proved successful where tried.

Electrically produced *ozone* has been recommended as a water steriliser, and is used in some continental towns. The results obtained have been good, but the method is expensive.

Ultra-violet rays, which purify the water by killing off the contained organisms, are used in Marseilles and other places. The rays are obtained by passing currents of electricity through mercury vapour enclosed in quartz lamps. These are placed in the water, which apart from rough filtration undergoes no further treatment.

Domestic Purification of Water.—Generally speaking, in large communities in this country it is perfectly safe to use the water without any treatment other than that applied by the local authority. A number of persons for one reason or another do, however, consider it necessary to take additional precautions, and special apparatus and methods have been devised and may be used by them or where large-scale purification is not carried out.

Boiling of such quantity as is to be drunk is probably the most certain of all, and when water is obtained from private sources with regard to which there is any doubt it should certainly be boiled for a period of at least ten minutes. After the water has been cooled, in order to re-aerate it and to get rid of the flatness which results from the driving off of the air, it should be shaken up or poured from one vessel to another, preferably through a sieve.

As boiling is rather troublesome, other methods are commonly preferred. Some of the chemicals, *e.g. potassium permanganate*, may be used, but few persons really care to risk adding such materials to the water to be drunk.

Filtration, if properly done and the filter is well looked after and kept clean, is probably the least objectionable method. *Charcoal filters*, which soon get very dirty and if not frequently cleaned with boiling water tend to become a source of contamination, are best avoided.

The best filters are those made of mixtures of *porcelain and clay* and moulded into candles. The candles are placed in metal cylinders by means of which they may be attached to the water tap.

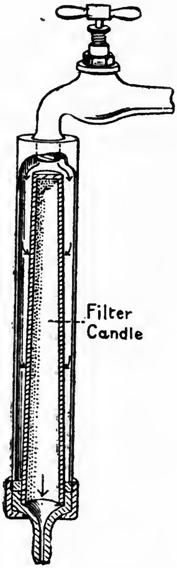

Fig. 48.—Domestic filtration of water through Pasteur-Chamberland Filter.

Since pressure is required to force the water through the filtering medium, the use of these filters is somewhat limited. The pores in the filtering material in time become clogged, and great care is required to keep them clean by regular washing, scouring, and boiling. The best-known filters of this class are the *Pasteur-Chamberland* and the *Berkfeld.*

Water Purification in the Army.—The purification of water for soldiers in the field is a matter of considerable importance, and in addition to *filtration* through batteries or groups of filter candles, *boiling* has been recommended.

Unfortunately neither of these methods is particularly easy to carry out. The candles call for a great deal of attention and the process of filtration is slow. In the case of boiling, though many ingenious machines have been devised and tried, the trouble is the source of the heat, and fuel may not always be accessible or may give out at critical moments.

Chemical purification has apparently not always given entire satisfaction when applied in bulk, though recently results regarded as sufficiently good seem to have been obtained from treatment with chloride of lime and filtration. In using chlorinated lime it is the free chlorine that is depended upon for carrying out the destruction of the germs, and it is estimated that sufficient of the lime to yield one grain of the gas would destroy in fifteen minutes the objectionable bacteria in 14 gallons of water. The amount necessary to be added can be determined by testing for free chlorine by means of potassium iodide and starch. If a blue colour appears when the chlorinated water is mixed with the iodide and starch, a certain amount of chlorine is still present and unreduced by the organic matter, and it is unnecessary to add more. If no blue colour appears there is still necessity for free chlorine, and more chlorinated lime must be added and the test repeated. An interval of fifteen minutes should elapse between the addition of the lime and the application of the test. In order to get rid of the taste of chlorine it is recommended that thiosulphate of soda should be added.

From time to time attempts have been made to find a suitable chemical agent for distribution among the men, but with little success, and whatever process is adopted it is essential to impress upon the soldiers the risks they may run and the dangers they may cause to others by carelessness in relation to water. In most campaigns, though this is less true of the present than of previous wars, more men are lost or incapacitated through disease, mainly intestinal complaints, than in the actual fighting. It is important therefore that nothing which will lead to a reduction in the number of fatalities so caused should be overlooked.

Great stress is now laid on the examination of the *water bottles* served out to troops, and it is a common-sense procedure that should not be omitted.

Examination of Water.—From the state of a water as regards appearance, clearness, and taste, no definite opinion as to fitness for consumption can be formed. A water that is highly dangerous may be as clear, bright, and sparkling, and taste as sweet, as one that is absolutely pure.

The presence of sediment, also, proves little or nothing, and a water that has a distinctly brown tint may be suffering from nothing more serious than peaty discoloration and be perfectly wholesome.

Before a conclusion can be arrived at, a thorough chemical and bacteriological examination must be carried out and the results carefully considered.

Such examinations should be entrusted to specialists, chemists, and bacteriologists. Their opinion will be given not only on the examination of the material itself, but after consideration of information with regard to the source of the sample, the position and surroundings of the well or other collection of water from which it was drawn. With all samples forwarded for examination such information should always be sent.

For the *collection of samples* for chemical examination a clean winchester quart bottle, which holds about half a gallon, fitted with a *glass* stopper, should be used.

Before collecting the sample the bottle should be well rinsed with the water to be collected, and in case of wells, rivers, lakes, and reservoirs the portion to be examined should be obtained by plunging the bottle below the surface. If taken from a tap the first quantity that runs off should be rejected in order to prevent the entry of possible impurities from the pipe.

Smaller quantities are required for *bacteriological examination.* They should, of course, be collected in perfectly sterile vessels and stored, in ice if possible, till the examination is made. It is advisable to communicate with the bacteriologist who is to carry out the investigation, as probably he may desire to send a special outfit for the collection and forwarding of the specimens.

As regards the examination made and the methods adopted by the chemist and bacteriologist nothing more need be said than that both carry out their investigation *qualitatively* and *quantitatively.* The former examines, or may examine, for minerals, metals, and organic matter, and estimates the amounts of these as well as the degrees of hardness per gallon. The bacteriologist, in addition to estimating the total number of organisms present, makes a special examination for intestinal and sewage organisms.

Distribution of Water.—Usually the reservoirs in which the water for a community is collected are placed at a sufficiently high level to permit of its distribution by gravitation, and it is not uncommonly the case in large districts that *supplementary or service reservoirs*, to which the water is conducted in open or closed aqueducts, are placed at various points to facilitate distribution to certain areas. Sometimes it is necessary to pump the water to these reservoirs, but the course adopted depends entirely upon the geography of the district.

Filtration is generally carried out before the water is distributed, and unless preliminary storage is to form part of the process of purification the filter bed is the earliest destination. From this the water goes to settling tanks and thence through aqueducts direct to the mains or the service reservoirs.

As far as possible, in order to avoid escape of water and to prevent entrance of contaminating materials from outside, the aqueducts should be closed. The so-called *water mains* are always closed pipes and run underground. They are practically invariably made of iron in order to withstand pressure, and consist of lengths of piping of varying diameter all carefully and securely jointed with lead.

The jointing is very important, particularly in roadways, since the sewers and gas mains are usually not far off, and should there be any leakage from these the soil will become impregnated and the rush of water in the water main is quite capable of sucking in materials from the soil through a very small defect.

From the mains the water is distributed by *service pipes* to the various houses. The pipes used are ordinarily of lead, since this material is easy to work and to carry to any point within the premises at which the water is to be delivered. The only objection to it, as already noted, is that it may be acted upon by soft water.

Domestic Storage of Water.—Since it is the exception rather than the rule that the supply made by an authority is *intermittent*, *i.e.* cut off for certain periods each day instead of being constantly on or *continuous*, the provision of a cistern as a means of domestic storage is not really essential. Nevertheless, in many districts, it is insisted upon, the reasons usually given being that if the supply is continuous there is risk of waste, whereas with a cistern the water is better conserved and there is less chance of a house going without if, for any reason, it is turned off at the main.

Water Cisterns.—These risks are generally regarded as exaggerated, but water companies have great powers, and if a *cistern* is insisted upon it must be provided. In such a case it should be *properly constructed*, properly *covered* to keep out dirt, conveniently *accessible* for cleansing and thoroughly and regularly *cleansed*. The best material for cisterns is undoubtedly *galvanised iron*, though, occasionally, slate and lead tanks are seen. Because slate is apt to crack and lead is apt to be dangerous, neither of these materials is really satisfactory. In any case the covering, the accessibility, and the cleansing referred to above must not be overlooked. Local authorities usually insist upon attention to these matters, and many have by-laws giving powers to require that they be attended to.

Every cistern should be provided with an overflow pipe discharging in the open so that it may serve as an indication should the valve or other fitting fall out of order. The pipe should not be taken into another pipe; certainly not into a drain.

With both the continuous and the intermittent system there should always be at least one tap in each house drawing water from the main for drinking purposes. Cisterns are so apt to be neglected that this is important.

Even where the supply is continuous there should be small cisterns for use in connection with each of the water closets, and one also for the supply of the boiler which provides hot water for the house. With regard to the *closet cisterns* it should be stated that water companies and authorities always insist upon them and lay down provisions as to the size of each cistern or, as it is sometimes called, the "water waste preventer." The capacity generally allowed is from 2 to 3 gallons.

Since the *hot-water cistern* is one exceedingly liable to be neglected and hot water is more apt to act upon lead pipes than cold, it should never be used for culinary purposes.

Law as regards Water.—The *Public Health Acts* contain a number of sections dealing with the supply of water, and making provision for its protection from contamination.

Local authorities are given wide powers for obtaining supplies and incurring expenditure in the construction of reservoirs and other necessary apparatus in connection therewith.

In the case of premises without a supply the owner may be compelled to provide it, and in some instances, if he fails, the local authority may make the provision and recover the cost.

In London and in rural districts in England no new house may be used for human habitation until a certificate that there is an adequate supply of water has been obtained from the sanitary authority.

Further, in rural districts it is the duty of the local authority to see that each occupied house has a supply of water within a reasonable distance. It may be mentioned, however, that views as to what is a "reasonable" distance vary, and in some instances the nearest supply may be a quarter of a mile or more away from some of the houses.

As regards purity of water, persons who foul a supply with gas washings are liable to heavy penalties.

Wells and cisterns yielding polluted water may be closed, but the procedure to obtain closure is somewhat complicated and may be prolonged.

CHAPTER XVII

HOUSING

The New House

Rules governing the erection of new houses are contained either in special by-laws or in Acts of Parliament having reference to buildings. These deal with such matters as the sites upon which houses or other buildings may be erected: the nature of the soil, its drainage and treatment; the amount of space which must be left open in front of and behind premises; the construction of the foundations; the thickness and structure of the walls; means of lighting and ventilation; drainage and sanitation generally.

The Site.—In towns particularly the matter of sites receives little attention from any but the business side, and generally it is regarded as more important that it should be well placed and conveniently accessible than that it should comply with the requirements of hygiene and be (1) in an open situation, (2) convenient for drainage and water supply, (3) in a quiet and unobjectionable neighbourhood, (4) not too exposed, and (5) have a clean warm and dry soil.

Yet all these matters are very important:

(1) It is essential that it should be situated in a more or less *open position* and that *light* and *air* should have free access to all parts of the house. If there cannot be open space all round there must at least be space in front and behind. Most by-laws demand this, and, since the passing of the *Housing, Town Planning, etc., Act*, 1909, the construction of what are generally known as "back-to-back" houses has been forbidden.

Such houses, fairly frequently seen in the midlands, are built in pairs or rows, and have a common back wall or a back wall that is blind. There is no open space in connection with them;

no openings for light and air except at the front to the roadway from which they are entered.

(2) That there is a necessity for convenience for *water supply* and *drainage* is obvious. The site that otherwise seems to be ideal ceases to be so when it is found that there is no water within a reasonable distance and no means of getting it to the building if erected. Equally, if the situation is such that the liquid and organic wastes made on the premises, as well as the soil drainage, cannot be got away even to a cesspool, the site becomes at once quite unsuitable.

(3) The site must be as far as possible removed from sources of *noise and smoke and other nuisances.* Unfortunately, in manufacturing districts, however, it is often impossible to get away from noise, and a most desirable site may be spoiled by the proximity of busy railway lines or noisy and smoky industries. A building already erected and housing a trade which cannot be carried on without the emission of noxious fumes and odours will render any site unsuitable for the erection of healthy houses.

Of the two it is quite possible that the noisy neighbourhood is the more objectionable, since rest is disturbed, but smells which interfere with opportunities for thorough ventilation of rooms are open to considerable objection.

In the interests of the young, neighbourhoods in which there are drunkenness, violence, and immorality, and other objectionable sights, should be avoided.

The present tendency to concentrate industries of various kinds in certain parts of towns and to discourage the erection of dwellings in too close proximity to them, from the health point of view is a good one.

(4) The site should not be too exposed: that is to say, the *aspect* should be considered, and, while airy and open to the sun and the wind, the site should be protected as far as possible from the colder winds. In the case of hospitals, schools, and other institutions this is most important, but it has its importance also in relation to houses. An unscreened house on the very apex of a hill, though splendid for light and air and drainage, is likely to be a cold house. No matter how strongly built the walls may be, the heat from the interior filters through them and is gradually dissipated. The ideal building is one effectively shaded from the winds from the north and east and to some extent and in certain districts from the strong glare of the sun from the south and west.

Trees, if not too close up, make an excellent screen, and a good belt of trees on the exposed and cold sides is most valuable. A site on the northern slope of a hill or even an open bleak plain is as bad from the exposed point of view as one on the summit. A site on any of the other slopes is almost certain to be satisfactory, while one in a valley is likely to be too much shut in.

(5) *Soil.*—The various points of importance in relation to soil are so fully considered in an earlier chapter that it is unnecessary to do more here than indicate the necessity for seeing that the soil is *clean*, *warm*, and *dry* before deciding in favour of any site.

Building Construction.—The site chosen, the next step is the planning of the building and the formation of an idea as to how it is to be placed upon the site.

The *planning*, of course, depends largely, if the building is a house, on the class of house, and need not be discussed.

In placing the building upon the site the object should be to arrange as far as possible that all living-rooms get some sun during some part of each day, and will be largely attained if the corners look to the points of the compass. The sitting-rooms and principal bedrooms will take the south-eastern and south-western sides; the food places, the rooms only used at certain times, *e.g.* the dining-room, the apartments in which food is prepared or stored, and the less-important bedrooms, the N.W. and N.E. aspects.

In the case of houses built in streets or on sites in towns there is usually no choice in connection with placing of the building. If the street runs east and west the houses must look north and south and *vice versa*, and if the arrangement of rooms receives any attention at all it is generally accidental.

Matters in this connection are generally worst in the case of back-to-back houses and *blocks of flats*. In the former if the house faces due north no part will ever get any sun at all, and if it faces N.E. and N.W. it will get a little, but not nearly enough. Back-to-back houses facing one of the other directions get too much, particularly in summer, since, ventilation being inadequate, there is no way of escape from the heat. As already noted, the erection of back-to-back houses is now forbidden, and in connection with the aspect of the houses this is a matter of great importance.

Foundations.—In connection with the construction of houses great attention is paid to such matters as foundations and building materials. As regards the former most by-laws in towns require that, in addition to covering the site with a layer of concrete at least six inches thick, the foundations upon which the walls are erected shall be properly constructed.

Usually it is required that there shall be "sufficient thickness of good concrete," and though, according to persons engaged in the supervision of buildings, the bed should be at least 18 inches in thickness and should extend 6 inches be-

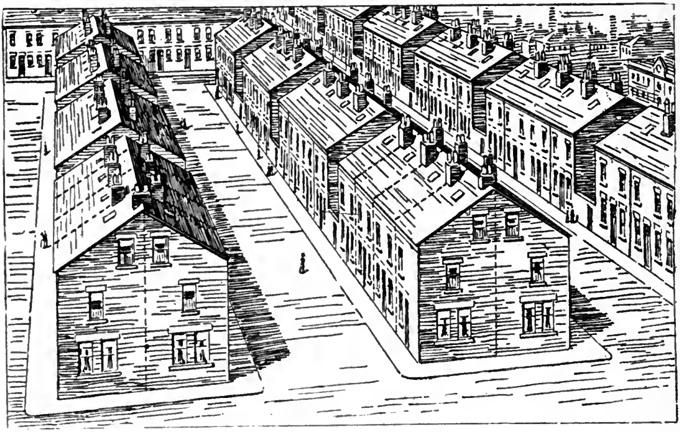

Fig. 49.—"Back to-Back" Houses. In several midland towns streets of houses arranged as shown are common. The dotted lines show the extent of the houses. Sanitary conveniences, ashpits, etc., for the use of the occupants of the houses occupy the spaces between the blocks.

yond the base or footings of the wall on each side, much less is generally passed as sufficient.

The *concrete* used should consist of a mixture of clean sand-free gravel, or broken brick or stones, and lime or cement in the proportions of 1 part of the gravel to 6 or 8 of lime and cement respectively. Concrete made with cement is much stronger than that made with lime.

The *walls* should be constructed of stone or bricks, and in most districts the material chosen is generally that which is most accessible.

Bricks are made of a standard size, usually 9 inches long, 4½ inches wide, and 3 inches thick. There are, of course, many varieties of bricks, but unless they are "purpose made" they are of the dimensions mentioned. The majority are now made by machinery, and consist largely or entirely of clay, hardened by heat. The harder a brick is the better, since, though most bricks are capable of absorbing water and are to a certain extent permeable to air, the better they are made and the harder they are burned, the less liable are they to exhibit signs of porosity and permeability.

The *stone* used for building should be of a hard variety; should be free from defects, and should be properly dressed and "weathered" before it is laid. In laying the stone, particularly if it is made up of layers, *i.e.* is *stratified*, it is important to place it exactly as it lay in its natural bed. If these precautions are observed the life of the stone will be greatly prolonged. In building with hard stone, *e.g.* granite, such precautions are less necessary. In many brick buildings certain parts, window ledges and doorsteps, for example, are commonly made of stone, though concrete blocks and slabs are now widely used. Concrete indeed is very largely taking the place of stone in buildings of a certain class, and when strengthened by means of strips of iron or steel (reinforced or *ferro-concrete*) it is of great value, being less permeable both to moisture and air than either stone or brick, and less liable to be affected by the weather and smoke and acids or gases in the air.

Weathering is particularly to be guarded against in the case of stone, and seasoning by exposure for longer or shorter periods is very necessary.

The layers of brick or stone are held together by means of cement or mortar, which is a mixture of sand and slaked lime or cement.

The strength of walls depends largely upon the way in which the materials are laid as well as upon the thickness.

In the case of bricks there are three common methods of laying or *bonding*: the *Flemish*, the *Old English*, and the *Bastard Bond.*

The difference between these bonds is shown in the accompanying illustration (Fig. 50). Unless the bricks are specially made or broken (technically a broken brick is called a "bat"), the wall with these bonds will be at least 9 inches thick, this being the length of the bricks laid transversely.

The object of the bonding is, of course, to avoid as far as possible having joints between the bricks running straight up and down the wall. Technically this is known as "breaking the joint."

The *thickness of the wall* depends almost entirely upon the height, the minimum being usually 9 inches. The greatest thickness is required at the lower parts, and the *footings* which are formed by making the brickwork extend to a certain distance—usually half the thickness of the wall—on one or both sides of the main wall. Walls other than those forming the outside of the structure are usually permitted to be somewhat less in thickness.

Damp-proof Courses.—Since, because of capillary attraction, there is a possibility of moisture passing up into the wall from below or from the side where earth may come in contact with

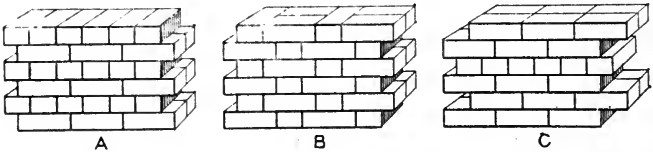

FIG. 50.—Bonding of Bricks: A, Old English; B, Flemish; C, Bastard Bond.

it, it is generally regarded as essential that in addition to concreting the site other preventives should be provided.

In respect of moisture from below, what is generally done is to introduce into the structure of the wall a layer of impervious material at some point above the ground level but below the lowest woodwork. This layer is known as the *damp-proof course*, and it may consist of sheet lead or asphalt or stoneware or slates in cement.

To prevent the absorption of water from soil in contact with the wall, particularly in houses or buildings where there is a basement or the floor of the lower rooms is below the ground level, the earth must be pushed back from the wall down to a point below the level of the lowest floor. This may be brought about by constructing the ordinary area or by means of a *dry area* which is formed by holding back the earth from the main wall by means of brickwork and leaving a space, afterwards covered over, between this wall and the main wall. Sometimes the wall is built hollow from the footings up to a point above the surface of the ground and two damp-proof courses are introduced, one below the lowest woodwork and the other just above the ground level. Instead of leaving the space between the two layers of wall hollow, it is not uncommon to fill it up with asphalt or other impervious material and so form a vertical damp-proof course.

To exclude moisture that may be driven through them, particularly on exposed sides, the walls may be made double

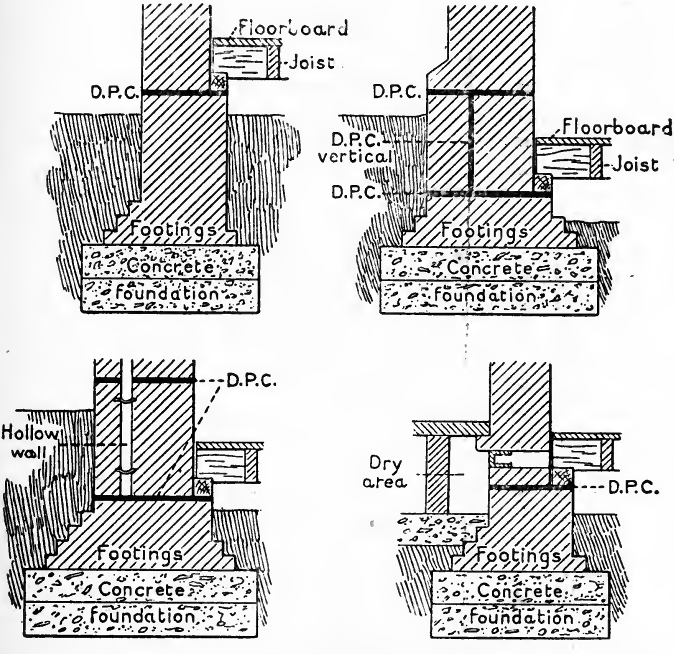

FIG. 51.—Showing methods of protecting a building against dampness. Damp-proof course (D.P.C.) is shown in each case below the lowest woodwork in the building.

or coated with cement or "rough cast" with mortar and small stones or flints, or they may be painted or pitched. As the mortar forming them is apt to perish in time, joints require particular attention and must be pointed at intervals with cement.

In the construction of *roofs* the aim is to get something durable as well as incombustible. *Slates* and *tiles* are easily fixed, but the latter have the disadvantage that they are rather heavy. *Lead* is commonly used in connection with roofing and is probably the best material for flat roofs. *Zinc* is sometimes substituted, but it is less durable. *Cement* roofs are not uncommon. *Thatch*, though cool in summer and warm in winter, is rather combustible and dirty, and is liable to decay and to harbour birds and insects.

In order to assist in the prevention of dampness from the roof it is necessary to fix *rhones* or *eaves gutters* at the free edge of the slope. These collect the rain water that flows over the slates or tiles and conducts it to down pipes or rain-water pipes, which discharge in the manner to be described later.

Though the construction of the wall itself and the treatment of the outer surface are usually sufficient to keep dampness out, sometimes it is necessary or advisable to treat the inner surface with a special cement such as *Kean's* or *Parian cement*, both of which set very hard and are capable of taking on a high polish. Several substances consisting largely of *fish glue* and *water glass* are recommended also. *Plaster*, which consists largely of lime or cement and is most commonly used as a smooth dressing for the interior of walls and ceilings, is more or less porous and incapable of keeping out moisture.

The parts of walls most commonly calling for treatment are gable walls and those in the basement. *Basements* and *cellars*, though they may protect the living- and sleeping-rooms from the ground and ground air, are nearly always damp and difficult to light and ventilate properly.

If possible all living-rooms should be placed above the ground level, and a basement should only be constructed if adequate lighting and ventilation can be provided and dampness can be kept out. If there is no basement, it is advisable to provide a space between the ground and the flooring of the ground floor by raising the floor boards some 6 or 12 inches above the concrete on wooden brackets placed upon the top of the footings. To assist in the removal of any ground air that may escape into this space and also to prevent *dry rot*, means of ventilation in the shape of iron gratings or perforated bricks are let into the wall. This ventilation is known as *sub-floor ventilation* and is exceedingly important.

Space about Buildings.—Open space around buildings is especially necessary in large and crowded districts, and all building by-laws require that it shall be provided.

In front of a house a minimum width of 24 *feet* is called for, and at the rear an absolutely open space of at least 150 *square* *feet*, extending the whole width of the building and measuring not less than 10 *feet* across.

The effect of this last provision is to do away with the possibility of the erection of back-to-back houses, and it was because Medical Officers of Health continually complained of the unhealthiness of such houses in the districts in which the by-laws did not prevent their erection that special provisions against them were introduced into the Housing and Town Planning, etc., Act, 1909. In blocks of flats, back-to-back tenements may still be erected provided the local Medical Officer of Health grants a certificate that proper means of lighting and ventilation have been introduced.

Windows.—In order that proper advantage may be taken of the space in front and behind the building, windows must be provided in the outer walls. According to the by-laws there must be at least one such window, and its total area, or if there be more than one their total area, clear of frames, must be equal to *one-tenth of the floor area of the room*. Each window must be so constructed that one half at least may be opened, the opening extending in every case to the top of the window. Speaking generally, a window of the size mentioned is fairly satisfactory, but for lighting and ventilation, provided excessive cooling of the air is guarded against, the larger the window the better. To assist the window in connection with ventilation there must be a *fireplace with a flue* in each room, or if there is no fireplace an *air shaft* or opening equal to at least 100 square inches. To obtain the best results as regards ventilation the window should be in the wall opposite to the fireplace.

In order to secure through ventilation of the house, windows should be placed in the staircase. Windows in the roof, or *skylights*, are difficult to keep clean and are apt to get out of order and to give rise to nuisance from dampness.

In regard to glazing of windows it may be noted that large panes give better light and are more easily cleaned than small ones, and that *plate glass* is by far the strongest and best. *Ribbed and obscured glasses* are depressing, though by breaking up the light rays they increase the amount of light and are useful in badly lighted rooms.

Floors are ordinarily made up of *boards* which rest upon joists running the length and breadth of the room. The *joints* in floor boards should be as close as possible in order to prevent the collection of dust and its passage through into the space between the floor of the one room and the ceiling of that immediately below.

The *joists* for the floor boards should be distinct from those for the lath and plaster of the ceiling of the lower room, in order to deaden sound as much as possible. To prevent risks of fire joists should not run under the hearth or anywhere near the fireplace and chimney breast. As a special protection *fireproof floors*, which are made by laying the floor boards or wood blocks on concrete and iron instead of wood, or floors of *teak*, an excellent fire-resisting wood, may be laid.

Ceilings are usually made of lath and plaster except in the case of fireproof buildings, when wire netting is used in place of wooden laths. Attics should always be ceiled in order to prevent loss of heat.

Decoration.—Decoration of walls, etc., is not generally undertaken until the building has been absolutely completed and all drains have been laid and the various pipes for water and gas and wires for electricity and so on have been introduced.

As a first step the walls and ceilings are made absolutely smooth, and for the purpose *plaster*, mainly because it is comparatively cheap and easily made and easy to work with, is most commonly used.

The covering for the plaster may be either *paint* or *paper*. As a general rule paint is more expensive than paper, but is better, as it lasts longer and is more easily cleaned. The so-called *washable distempers* are very good, and are comparatively cheap and easily applied.

Wall papers for the sake of cleanliness should be as smooth as possible. The glazed or washable varieties are to be recommended for kitchens and apartments used as lavatories, bathrooms, and water closets. In the colouring of wall paper arsenic was formerly used to a certain extent, but as a result of the publicity given to a few cases of poisoning that were traced to it, its use was discontinued.

CHAPTER XVIII

VENTILATION

THOUGH the shelter provided by a house has advantages, it has the disadvantage that it deprives the human being of the opportunity of obtaining a full and proper supply of pure and fresh air and of escaping from air vitiated by respiration and otherwise.

In order to allow of this, special measures must be adopted, and to these the term *ventilation* is applied. This word means wind-bearing or carrying, and the object aimed at in the process of ventilation is to supply the occupants of the house with wind or air having as nearly as possible the same composition as that outside.

The difficulty in the way of keeping air inside always of the same composition as that outside arises entirely from the occupants, who, by living on it and in it reduce the amount of oxygen and increase the amount of carbon dioxide. In addition, as already explained, they interfere with it by adding heat and moisture to it.

The extent to which they interfere is always determined by estimating the quantity of carbon dioxide and regarding air that contains over a certain amount of this gas as likely to be injurious. For practical purposes the limit of safety is taken to be 0·6 parts per 1,000 parts of air, the normal proportion being 0·4 per 1,000. In ventilation the object is to ensure that if possible 0·6 per 1,000 is never exceeded. This can be secured by bringing in fresh air to replace that containing the excess of carbon dioxide or to dilute it. The frequency with which the fresh air must be brought in is worked out as follows:

The proportion of carbonic acid gas in ordinary air is 0·4 of a cubic foot per 1,000 cubic feet; an adult gives off 0·6 of a cubic foot in an hour; air to be good must contain not more than 0·6 per 1,000. All air must, therefore, be taken away from an individual as soon as or before he has added 0·2 per 1,000.

Giving off 0·6 of a cubic foot in an hour, obviously he will give off 0·2 in a third of an hour, and in that time will raise the 0·4 naturally present in 1,000 cubic feet of air to the limit of 0·6.

No human being should be required, therefore, to use 1,000 cubic feet for longer than twenty minutes. In other words, he must be provided with 1,000 cubic feet of fresh air three times in every hour, or with 3,000 cubic feet per hour. When the space occupied by the individual is 1,000 cubic feet, a flow of 3 feet per second will lead to a complete changing of the air content three times per hour and will provide the three changes necessary to keep the carbonic acid gas down to 0·6 parts per 1,000. For the reason that a flow of 3 feet per second permits of the changes to occur without the production of draughts and the discomfort and chilling associated with them, this rate of flow is regarded as ideal. Because with 1,000 cubic feet of space the 3-feet-per-second flow need never be exceeded in order to provide 3,000 cubic feet of air per hour, it is regarded as ideal too.

In addition to ensuring reduction or removal of the carbon dioxide, 3,000 cubic feet of air per hour will also bring about removal of excess of moisture and organic matter and keep the temperature within reasonable limits. For reasons already noted, excessive moisture and heat and respiratory organic matters are objectionable, and the fact that by ventilating up to 3,000 cubic feet of air per hour their effects may be obviated is important.

Though on all grounds 1,000 cubic feet of space is sufficient and 3,000 cubic feet of air per head per hour satisfactory, in large numbers of dwellings nothing like these amounts are obtained or obtainable. In order to prevent too dangerous a reduction, minima have been fixed for various classes of dwellings. In tenement houses, for example, 300 cubic feet of space per head has been fixed as the minimum in a sleeping-room. This means that there is a diminution in the space allowed for the movements of the body; that the air must be changed at least 10 times per hour if it is to be kept pure; and that the 3 feet per second of flow must be exceeded and draughts produced if the air is to be changed.

Small as an allowance of 300 cubic feet is, it is not by any means the lowest limit reached, nor is 1,000, satisfactory as it may be, the maximum. The following table shows some of the limits laid down in Acts and otherwise, and it will be noted particularly how small an amount is required in schools and canal boats, and how comparatively generous is the provision made in hospitals :

Premises.	Space required per head.
Fever hospitals	2,000—3,000
General hospitals	1,000—1,500
Workhouse hospitals	850—1,200
Military hospitals (home)	1,200
,, ,, (tropics)	1,500
Barracks	600
Common lodging-houses	300
Workhouses	300
Tenement houses (living-rooms)	300
,, ,, (living- and sleeping-rooms)	400
Factories and workshops (day)	250
,, ,, (overtime)	400
,, ,, (working- and sleeping-rooms)	400
Underground bakehouses (overtime)	500
Schools (new)	120
,, (old)	80
Canal boats	60

To arrive at the *cubic capacity* it is necessary to multiply together the height, breadth, and length of the space, and to deduct from the figure obtained the capacity of the furniture and other contents of the space. With regard to height, it is provided that no matter how much higher the space may be, since any circulation of air that occurs there is not sufficiently extensive to bring it down to a level at which it could be used by occupants, nothing above 12 feet is to be included in the calculation.

Svstems of Ventilation.—In carrying out ventilation, in addition to providing sufficient space for the reception of the air, it is essential to provide sufficient openings through which it may enter and leave, and in addition ensure that there shall be means of bringing it into and taking it out of the space.

The classification of methods of ventilation into *natural* and *artificial* is based upon the forces relied upon or provided to do this.

Natural Ventilation.—In the natural method, as the name suggests, natural forces are trusted to ; in the artificial the natural are either specifically excluded or are assisted by the introduction of mechanisms to drive the air through the inlets into the space or to draw it out of the space through the outlets or even to do both.

The natural or physical forces depended upon in natural methods are (1) the diffusibility of gases, (2) the wind, (3) the differences in respect of weight and bulk between heated and cold air.

Diffusibility or Diffusion of Gases assists comparatively little, though in the case of brick structures interchange does take place between the air inside and that outside. The *action of the wind* is two-fold and depends upon its force and direction. It may blow directly into the inlets through the space and out at the outlets. It may blow across the outer opening of the outlets, and suck the air through the inlets and the room and out at the outlets. Because it is irregular both in force and direction, and moreover is impossible to control, the wind cannot be depended upon to any extent in relation to ventilation.

With regard to the influence of the *differences in weight and bulk* between heated and cold air. Air when heated becomes lighter and more bulky; when cooler it becomes heavier and less in bulk. Hot air tends to rise and cold air to fall: as a result currents are created, all of them setting from the colder surfaces to the warmer and back again, and so keeping up a more or less continuous circulation. The heated, lighter, more bulky air, seeking greater accommodation, tries to escape from the space in which it is contained. In a room it makes for the outlets, and if these are in the upper parts of the space the air makes its way through them. To take up the space vacated by the escaping air, new fresh air enters at the inlets, and ventilation or carrying through of air is brought about. The heat affecting the air in a room is obtained partly from the occupants of the room, partly from the heating and the illuminating apparatus. The cold that affects the air and leads to its contraction and increase in weight, and incidentally also to its circulation, is derived from windows, walls, and doors.

Aids to Natural Ventilation.—Mechanisms to keep air in motion and circulating are now very commonly used to assist ventilation. The *electric fan* and *electric stirrer* may be quoted as examples, and are used mainly to assist in the production of currents and circulation. In any adequately naturally ventilated and occupied room there comes a time when all the surfaces are heated and all the air is more or less of the same temperature. Circulation then ceases, the body is compelled to retain a considerable amount of its heat, and discomfort is experienced. Stirring up of the air when this occurs sets matters right by re-establishing circulation; and the individual can go on for quite a long time though no change whatever takes place in the composition of the air.

Other appliances assisting the natural forces aim also at increasing air circulation, but the majority of them do so by supplementing either the inlets or the outlets, and increasing the amount of air that comes in or the amount that goes out.

As a general rule, in ordinary dwellings, the windows, doors, and chimneys act as inlets and outlets. The *doors* and *windows*, especially the lower openings, act as inlets, the chimneys as outlets. As far as possible outlets should at least equal the inlets in area. In some rooms the normal openings are insufficient, and must be supplemented by others, either connected with the existing openings or constructed entirely apart from them. As examples of the appliances used may be mentioned *open gratings* let into the lower part of the outer wall or walls. *Ventilating bricks*, which are ordinary bricks perforated to permit air to enter, may also be used.

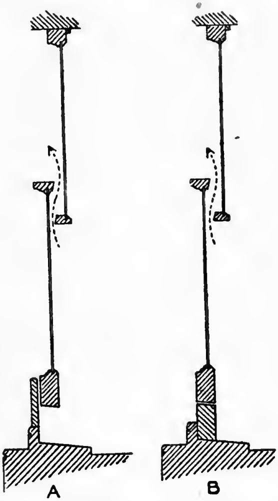

FIG. 52.—Window Ventilation. Two methods of making use of the space between the upper and lower sash by raising the lower. A, the original; B, modified Hinckes-Bird's method.

When the lower half of a window is made to act as an inlet, to prevent draughts, a board 6 to 12 inches high may be placed along the lower part of the window, or the lower panes may be shielded by a *projecting glass structure*, the upper part of which is hinged and may be raised. A window hopper also may be used, or the modified *Hinckes-Bird's method*, in which the lower sash is permanently raised upon a block of wood running the whole breadth of the window, to leave an interval between the upper and lower sashes through which air can enter.

Louvred panes, which resemble a venetian blind in their arrangement, or *Cooper's ventilator*, are sometimes introduced.

Outlets should be placed high up in the room, since the heated vitiated air tends to rise. The upper sashes of the windows may be pulled down for the purpose, or special openings may be made through the ceiling and the roof in the form of *McKinnell's tubes*. *Ventilating gas globes*, which are connected with a tube passing through the ceiling, may be introduced. The gas alight within the globe and acting as an illuminant

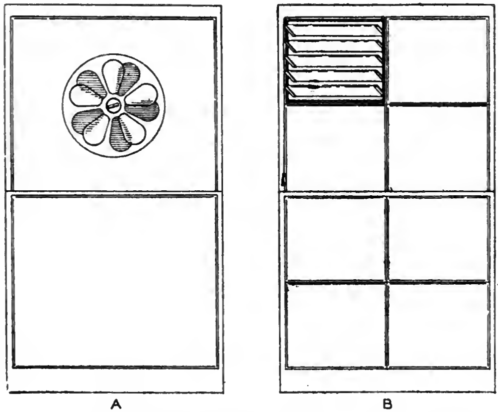

FIG. 53.—Window Ventilators. A, Cooper's; B, Louvre ventilator.

for the room assists in ventilation by causing an up draught in the tube. Neither of these methods is easy of adoption in houses, though in halls and schools either may be employed. The heat passing from the fire up the chimney may be taken advantage of in connection with grated openings in the chimney breast.

In order to take advantage of the wind and air currents outside, inlets and outlets may be provided in the shape of *Sheringham's valves* (Fig. 54). These are fixed on each side of the room about 5 or 6 feet from the floor, and are the inner coverings of grated openings through the wall.

One or two points regarding contrivances used to assist natural ventilation must be borne in mind. The best height for inlet openings is from 5 to 6 feet from the floor level. In this position draughts will be avoided. About 72 square inches of inlet should be allowed per head, and a similar amount of outlet. Several small inlets are better than one large inlet, and will distribute the air more uniformly if properly placed.

When *Tobin's tubes* (Fig. 54) are used, it is well to make the

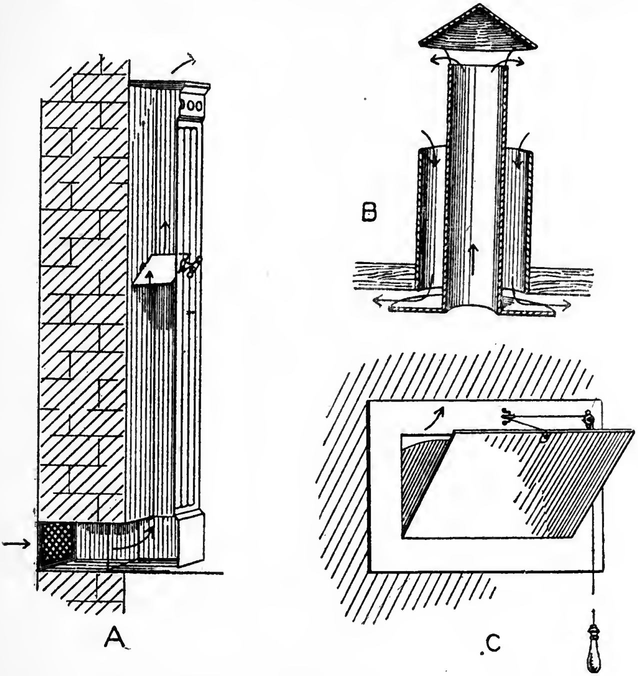

FIG. 54.—Aids to Natural Ventilation. A, Tobin's tube; B, Mckinnell's tube; C, Sheringham valve.

actual openings rather larger than the calibre of the tube. The tube should be circular, with a diameter of 6 to 12 inches.

Artificial Ventilation.—The term "artificial ventilation" includes two things: *artificial ventilation proper* and *mechanical ventilation*.

Artificial ventilation proper includes systems in which the heating or lighting appliances are made use of to draw the vitiated air out of the room, or, especially in the case of the heating appliances, to draw it in and prepare it for breathing purposes.

Mechanical ventilation includes systems in which special machinery is employed to force the air into the rooms of a building or to draw it out. The former method is known as the *propulsion or plenum method*, and the latter as the *exhaust or vacuum method.* Not infrequently the two methods are *combined.*

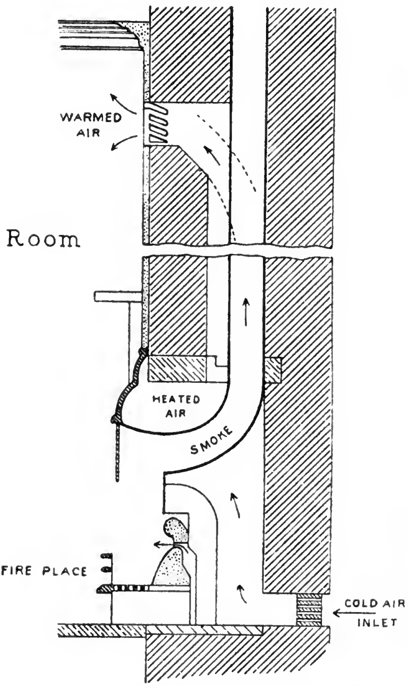

FIG. 55.—Galton's ventilating fireplace.

Ventilation and Warming.—The connection between warming and ventilation is so close that it is commonly stated that no system of warming that does not to some extent assist ventilation should be considered, and various methods of combined heating and ventilation are in vogue. If fires are used, the so-called *ventilating fireplaces* of which Galton's is the type may be employed. If stoves are employed, one or other of the many ventilating stoves may be installed.

When *hot water or steam heating systems* are resorted to, heating and ventilation may be made to go hand in hand, and the steam or hot water pipes arranged as radiators in the rooms opposite the air inlets, warming the air as it comes in. Or the hot pipes may be placed elsewhere than in the rooms, and heating and ventilation brought about by driving into the rooms air which has been warmed by contact with the pipes. This is the arrangement found in the form of mechanical ventilation known as the propulsion or plenum method.

When the former method is adopted it is better to provide several small radiators in front of several inlets than a single large one in front of one inlet. Each inlet should be made in the wall opposite the lower part of the radiator, which is encased in order to compel the air to pass upwards amongst the pipes, which, with the object of increasing the radiating surface, should be more or less fluted instead of circular. In order to keep out dust and other particles the air inlets should in all cases be provided with gratings and be fitted with wire gauze. The gauze should be easily removable, so that it can be taken out and cleaned. Radiators should always be fixed so that it is possible to get all round and under them with a brush.

One great objection to this form of ventilation is that it is impossible to answer for the purity of the air supplied, since the air enters the room at several points and from a number of sources. By attending to the air inlets, however, and having them cleaned at regular intervals, this can be overcome to a certain extent.

Effect of Breathing Hot Dry Air.—Another objection is that the air is apt to be deprived of its moisture. The capacity of the air for moisture is very much increased by warming it, and the skin and the respiratory passages of the persons in the room are amongst the sources from which the moisture is drawn. As a result the air passages become dry and irritated, and sore throat and catarrh are apt to be produced on account of the changes from the hot, dry air of the room to the cold, moist outside air. This tendency to drying of the air both by hot water radiators and stoves is generally recognised, and constitutes one of the chief objections to this method of heating. The usual method of trying to overcome it, by placing a small dish of water on or near the heating apparatus, is futile.

Mechanical Ventilation.—*Propulsion.*—A well-recognised method of combining heating and ventilation in large buildings is that in which hot air is propelled into each room, all the warming being brought about by this means. This is the *propulsion method*, and in it the air drawn from outside is forced by means of fans into the rooms, escape of the foul air being brought about by the greater pressure in the room, which drives the air out through special openings. The chief disadvantage of the method is that it is expensive. Its great advantage is the amount of control given: the temperature can be regulated; the source of the air can be carefully chosen; and the air can be filtered, moistened, and otherwise treated before it is sent into the rooms.

The point or points from which the air is to be drawn should be as high above the ground as possible. From this point the air is driven, by means of a fan which is propelled by electricity or water, into a specially built chamber situated usually in the basement. In order to deprive the air of dust particles and to clean it, it may be passed through screens of jute or hemp, the strands of which are kept moist by means of a fine stream of water. Having been washed and filtered by passing through the screens, the air next passes over a series of radiators, where it is heated, and thereafter is distributed by special ducts which open into the various rooms.

The velocity of the incoming air should not exceed 6 feet per second, and it should enter through several small inlets placed about 8 feet from the floor. The foul air may be permitted to find its way out through windows, chimneys, etc., or special extract tubes may be provided. In the latter case the *outlets* should be equal in number to the inlets, and should be situated about 6 inches from the floor, preferably on the *same side* of the room as the inlets.

Exhaust or Vacuum Method.—In the exhaust system the air is drawn from the room by means of fans or through a common outlet shaft placed by the side of the boiler stack, the heat of which helps to carry the air upwards. When the plenum and exhaust systems are combined, power in the shape of a fan is used to drive the air in, and power, either heat or a fan, is used to draw the air out of the rooms also.

Of the above methods the combined method is probably the most satisfactory, the plenum coming next, while the exhaust occupies the third place. They all labour under the disadvantage of being costly. Moreover, and this is perhaps the greatest objection, they interfere with the air and rob it of its freshness. To some extent this can be overcome if the mechanism is properly looked after and regulated and the ducts are examined and cleaned regularly.

Ventilation in Practice.—*Ventilation of Houses.*—In the house it is almost invariably the rule to depend upon the normal openings, windows, doors, and chimneys, to act as inlets for fresh air and outlets for vitiated air, and so long as they are used properly they serve the purpose satisfactorily.

In certain houses it is not uncommon to find *Hinckes-Bird's method* adopted, or the *louvre*, or the *Cooper ventilator* fixed to the windows. Occasionally a *Tobin's tube* is erected or a mica valve outlet placed in the chimney breast; but in the ordinary-sized room these are usually unnecessary, and the two latter may become objectionable, the former because it collects dust, and the latter because, in addition to being noisy in windy weather, it is rather apt to get out of order and to allow smoke to escape back into the apartment. As a matter of fact the person who is prepared to use his window and his door properly, or even his window alone, needs no special contrivances.

It is in the night chiefly that the open window is most required, and if the body is kept well covered no one will come by any harm as a result of sleeping with the night air playing upon him.

In order to assist in the proper use of the doors, windows, and chimneys, these should be properly constructed, and the windows particularly should be properly hung to allow of their being easily opened.

The assistance that may be rendered to ventilation by a fire of some kind will be discussed later; it should be pointed out, however, that even if the fire is not alight, the fireplace and chimney are capable of playing a part in ventilation, and should not be screened or blocked up in summer.

Overcrowding.—In connection with houses a very great deal of importance attaches to the *amount of space* provided, and it is very necessary to see that overcrowding is prevented. In many cases the provision made is absolutely inadequate, and in the houses of the poor particularly overcrowding is one of the most commonly seen sanitary defects, and much of the time of the health officer is given to dealing with it. His efforts are very often unsuccessful, because poverty is usually at the root of it, and, as space costs money and money is lacking, the poor are in the unfortunate position of being unable to remedy the defect.

Commonly, however, they make matters very much worse by giving over the space to articles not worthy of house room, and by neglecting to use windows, and so on. In certain districts an attempt has been made to enforce the opening of windows during certain hours each day by means of by-laws.

These apply in the case of *common lodging-houses* and what are known as *tenement houses* or houses let in lodgings. So far as the former are concerned, the law is generally obeyed. In the case of the house let in lodgings it appears to be rarely complied with.

Ventilation of Large Buildings.—The ventilation of large buildings, schools, halls, churches, and so on, is commonly a very difficult problem. In *schools* mechanical methods, plenum or vacuum, are sometimes introduced; but for the reason that they are expensive and require a great amount of attention, they occasionally fail to give satisfaction.

In the bulk of schools natural methods are depended upon, and additional air inlets or outlets provided. If the normal and additional openings are properly placed and looked after, quite a good supply of fresh air should be obtained. In addition to ensuring a regular supply, it is generally advised to throw windows and doors open at intervals in order to get a good through draught and a flushing of the rooms with fresh air. This may be done when the children are out of the room or are having physical exercises.

In *halls* and *churches* very often ventilation is greatly neglected, and the windows provided for lighting, or on account of architectural considerations, are trusted to to do all they can with assistance from the door. In other cases, *roof ventilators*, *Tobin's tubes*, and *Sheringham valves* are provided.

In *theatres* the old-fashioned *sun gas fitting* is now more or less replaced by the sliding roof, which proves useful on warm dry evenings. Because it is necessary to exclude daylight the *cinematograph theatre* is extremely difficult to deal with in regard to ventilation. In the larger buildings used for this or indeed for any other purposes, mechanical contrivances for drawing air in or driving it out are practically essential. *Fans* working in connection with outlet shafts are commonly employed and *Sheringham valves* and *Tobin's tubes* and *electric stirrers or fans.*

Ventilation of Factories and Workshops.—In the administration of the law relating to factories and workshops as contained in the *Factory and Workshop Act*, 1901, very particular attention is paid to the provisions dealing with ventilation.

The fact that rules are laid down with regard to the amount of space per head during ordinary working hours, and also when employees are employed for overtime, may be mentioned. In addition, however, there is a definite requirement that both factories and workshops shall be adequately ventilated and kept free from effluvia. If in the course of the work carried on high temperatures are reached or dust is produced, the owner may be called upon to provide appliances for reducing the temperature and getting rid of the dust.

To a very large extent the natural openings are depended upon for ventilation, but very often they are found to be inadequate or neglected. As far as possible the endeavour is made to have permanent means of ventilation in the shape of gratings, louvres, and so on, introduced, but, in workshops perhaps more than in factories, the difficulties in the way are very great.

Places in which work calling for the use by individual workers of gas-heated appliances, *e.g.* soldering irons or gas irons, are particularly difficult to deal with. Even places in which gas stoves are used for heating irons present difficulty, since, in addition to the fouling of the air by the occupants, there is an infinitely greater fouling and overheating by the burning gas.

That there is danger from such appliances is now recognised by law so far as laundries are concerned, and it is forbidden to use gas irons emitting fumes, or to place stoves for heating irons on an ironing-table or in an ironing-room. In tailors' workshops there is no such provision, and the only thing to be done is to try to obtain improvements in the ventilation of the room and in the type of iron and stove used. Much of the difficulty can be overcome by the use of electric irons, and in many places these are now used with advantage.

For dealing with the *dust*, fans and appliances for drawing the particles away from the worker are sometimes fitted, and if looked after properly work very well.

CHAPTER XIX

WARMING

The agents commonly used in connection with warming are *coal*, *coke*, or *gas*, and *electricity*, *steam*, *hot water* or *air*, each calling for the use of special apparatus.

No matter what is used, however, the heating is brought about by *convection* or *radiation*.

By *convection* is meant the conveyance of heat by heated particles, *e.g.* particles of air, from one part of a room to another. In *radiation* the heat rays pass from the agent giving them off, through the air, to be transformed into heat when they reach some solid object, such as a piece of furniture or the walls of the room or an individual.

From the heated objects a certain amount of convection takes place, the particles of air coming in contact with them becoming heated and carrying heat with them in their movements. The movements set up in the air in this way are called *convection currents*.

Of the two forms, radiation is generally regarded as the better, because the heat rays passing through the air do not directly affect it, and do not dry it up by removing the moisture from the particles. In the case of convection, the air, being warmed by contact with the heated surface, undergoes at the same time a considerable amount of drying.

Though it is usual to talk of various forms of heaters as definitely radiators or convectors, it is rare to find one which acts only by radiation or only by convection. An agency may act mainly by radiation or mainly by convection, but not entirely.

Coal Fires.—Fires burning coal are typically radiators; and it is because it provides the advantages of radiation in connection with non-drying of the air, and is in addition cheerful, comfortable, and companionable, that the coal fire is still the favourite form of heater in this country.

The objections to it are that it is inconvenient and dirty, and besides being wasteful of heat and fuel, provides its heating effects irregularly.

Despite these objections, some of which are economic and some hygienic, mainly because it is cheerful and comfortable, it is doubtful if it will ever entirely disappear from use in this country. Even in domestic dwellings of the highest class the fireplace is still constructed, and indeed, mainly probably

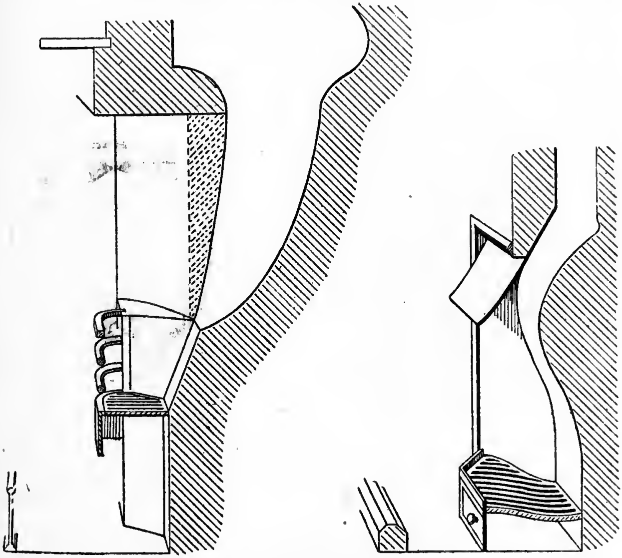

FIG. 56.—To show the difference between the old-fashioned type of fireplace (on the left) and the new. Note how in the latter the fire bars are placed low down and the flue outlet is made very narrow.

because of the flue attached to it, is called for by most building by-laws. In constructing it, it is necessary to see that it is not placed against an external wall, on account of the likelihood of waste of heat. It should have one wall to itself, and the entrance to the room should not, if possible, be exactly opposite to it. If it must be in the opposite wall, it should be more or less to one side.

The *type of grate* to be fixed is a matter of some importance, and there are many which, by means of special devices, seek to overcome one or other or all of the objections to the fire as stated above. Generally the modern grate is much lower than the old-fashioned form. Many are only an inch or two above the hearth, and control over the amount of air passing through the fuel is provided by means of a moveable shield. The back of the fireplace is made to bend forward, while the flue outlet is made as narrow as possible in order to economise heat. In working-class houses grates which seek to make use of all smoke and heat passing up the chimney for heating water are occasionally fitted. Ventilating fire

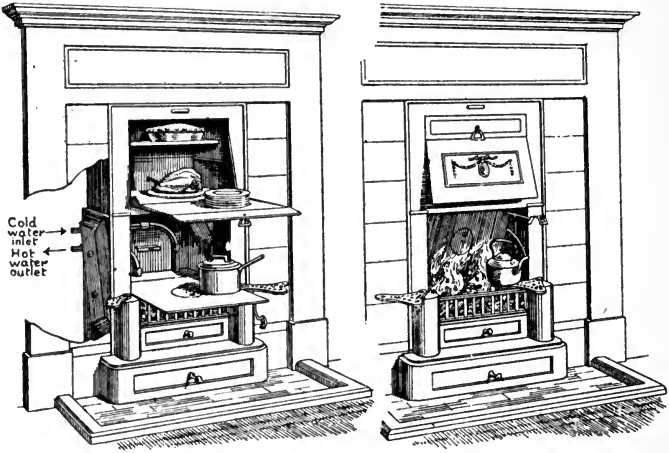

FIG. 57.—Combined Fireplace: This fireplace may be transformed from an ordinary sitting-room grate into a cooking range. Much of the heat that escapes with the smoke is used for heating water in the boiler at the back of the grate.

grates, of which Galton's is the type, are sometimes introduced.

Stoves.—Coal and coke stoves are cheaper than coal fires, but are cheerless, and, as most of their heating is done by convection, the air is apt to be dried. Risks of contamination of air by carbon monoxide are also associated with their use, especially when coke is used and the stove or its flue is not quite sound. Stoves burning anthracite coal are clean and convenient, and if properly looked after, though mainly convectors, are satisfactory.

Gas Fires.—The great advantage claimed for gas fires over those burning other forms of fuel is that they are cleaner and more convenient; but unless they are well made and properly fitted, gas and the products of its combustion may escape into the apartment and prove unpleasant and possibly dangerous.

The modern type gas fire is stated to do most of its heating by radiation. Generally, however, there is a good deal of drying of the air, and though the heat is capable of regulation, it is commonly very intense. Gas stoves without flues for use in halls and apartments unprovided with fireplaces and flues are on the market, and are alleged to be free from risks of giving rise to contamination of the air. Speaking generally, if gas is used for heating purposes it is much safer to see that the burning is done under a flue through which products of combustion and gas itself, should there be any defect in the apparatus, may escape.

Steam, Hot Water, and Air.—These are only applicable in cases in which central heating is installed, and this does not seem to appeal to the bulk of the population. The subject is more fully discussed under Ventilation, and need not be further entered into here.

Heating by Electricity.—This form of heating has all the advantages and none of the disadvantages of the other agencies referred to in previous pages. It is cleanly, convenient, cheerful, and comfortable. At present unfortunately it is not as a general rule cheap, and this constitutes practically the only objection to it.

The heat which an electric fire gives off is produced as a result of the passage of a current of electricity through wire, and as nothing is burned there is no interference with the composition or cleanliness of the air.

In some forms of heater the wire is left naked; in others it is embedded in quartz, and in others still it is enclosed, like the lighting filament used in electric lighting, in a glass globe. The two first-named arrangements are recommended for large rooms, because with them more heat is given off. The glow from them is generally red. The globes containing the coils of wire are used for making up what is called the "lamp radiator," which is now less commonly used.

The heat obtained from electric fires is almost entirely radiant, and its amount depends upon the size of the apparatus. Provision for regulating the heat is always made in the form of switches by means of which current may be turned on or off.

Electricity for heating has so many advantages over other forms, from the health point of view, that it is surprising that greater use has not been made of it. Largely, probably, it is a matter of cost, and if and when this is reduced many more houses will be electrically heated as well as electrically lighted than is the case at present.

Heat in Relation to Cooking.—The agents usually employed in this connection are coal, gas, or electricity. The oldest is coal, and just as there are many who prefer the coal fire in the living-rooms, there are many also who prefer the *cooking range burning coal* for the preparation of their food.

The objections to it are that it is inconvenient and dirty and difficult to regulate. It requires constant supervision, and time that might be given to cooking is given to stoking, and the hands of the cook are very apt to get soiled. A vast amount of the heat too is wasted, and in warm weather the kitchen becomes almost unbearably hot.

The *gas cooker* is more convenient, and more cleanly, and the time saved on watching the fire can be used for watching the cooking. In fixing it the fact that there may be contamination of the air by the fumes from the gas should not be overlooked, and some means of collecting them, *e.g.* in the form of a hood communicating by means of a flue with the outer air, should be provided.

So far as the oven part of the apparatus is concerned, the usual method of burning naked flames inside and leaving the bottom unsealed, so that air and objectionable matters from the floor level may be drawn or wafted in, is open to serious objections.

Electric Cookers.—Large numbers of apparatus using electricity for special forms of cooking, such as toasting, boiling, and grilling, are widely used. Complete cookers are also obtainable, and because it has been found that, unlike the gas cooker, they can actually be placed anywhere without the slightest fear of their giving rise to contamination of the air, they are found in large numbers of houses in districts in which electricity is readily obtainable.

Speaking broadly the electric cooker can do everything that a gas or any other cooker can do. It is, if anything, more convenient to use, and it is infinitely more cleanly. The usual allegation against it is that it is more expensive.

Hot-water Supplies.—In houses in which coal is used for cooking, any heat not required for this purpose is generally employed for heating water in a boiler attached to the range. Particularly in frosty weather there may be risks of explosions with such an arrangement. With properly constructed and installed systems, however, these risks are comparatively slight.

In the case of the cooker using electricity or gas, the heat is employed for cooking only, and in every way possible waste is prevented. These apparatus have no heat to spare for heating water, and if it is required special provision must be made.

When gas is used, either what is called a *geyser* or a *hot-water* circulator may be introduced. Provided they are properly fixed and used, these are remarkably convenient, but that there are risks with the first named must not be overlooked.

If electricity is the agent used, a water heater somewhat on the lines of the geyser can be fitted, and is equally convenient.

In many better-class houses, where cooking is done by gas or electricity, separate furnaces and boilers for the supply of hot water are commonly introduced. In many medium-sized houses *slow-combustion stoves* burning coke or coal are fitted in the kitchen and linked up with the ordinary hot-water installation, and are comparatively cheap and satisfactory.

CHAPTER XX

LIGHTING

Natural Light: *Windows.*—In the chapter on Ventilation certain statements were made as to the position and size of windows, kind of glass, etc., which are important in relation to lighting. In addition it may be noted that, not only because it is useful in preventing the collection of foul air in the upper parts of a room, but because the most effective lighting is from this part, the top of the window should be carried as near as possible to the level of the ceiling. The rays entering there strike farthest into the room and help to show up corners on the side away from the window.

The point to which the lower edge of the window reaches is less important. Convenience and regard to safety are probably the best guides.

The *breadth* given to the window is affected by the necessity for having regard to the stability of the wall of the building; but if there be two or more windows in a room it is not advisable to have too wide a space between them since this interferes greatly with lighting.

Artificial Lighting.—Artificial illuminants may be roughly divided into two classes: those that produce light as a result of combustion, and those that give light without combustion.

In the former class the agents most widely used are *coal gas* and various *oils*; *candles* and *acetylene gas* being of those less commonly used. In the second group there is only one agent, viz. *electricity*.

The chief advantage possessed by the members of the first group is that they give light with comparative readiness; the objections to their use are that they burn in the atmosphere of the place to be lighted, and use up oxygen, and produce heat and objectionable substances.

Electricity gives light with equal or greater readiness and, as it burns nothing, adds neither heat nor products of combustion to the atmosphere, and does not use up oxygen.

Coal gas is probably more largely used than any other illuminant, though both oil and electricity run it very close. It consists of a mixture of gases, not all of them illuminating, and while burning produces, in addition to *heat*, *carbon dioxide* and a certain amount of *carbon monoxide*, *sulphur dioxide*, and *moisture*.

The quantity of carbon dioxide produced is about 0·52 cubic foot for every cubic foot of gas consumed. In one hour a flat-flame gas burner producing illumination equal to fifteen candles, is calculated to be capable of vitiating as much air as five adults, and an incandescent light as much as three adults.

The volume of the sulphur compounds depends upon the amount of sulphur present in the gas, and may be considerable, as removal is costly. In London the average amount was recently stated to be 24½ grains per 100 cubic feet. The quantity of sulphur dioxide produced as a result of consuming gas containing such an amount of sulphur, in addition to causing considerable damage to the decorations and furnishings of rooms, is objectionable also to the respiratory organs.

Incandescent Burners.—In order to meet some of the objections raised against gas as an illuminant, the fishtail and other burners have been largely replaced by the *incandescent burner*. This is constructed on the principle of the Bunsen burner in which, because it is mixed with a considerable proportion of air, the gas is much more thoroughly consumed. The flame produced is very hot, but almost non-luminous. In order to obtain light a thin mantle of asbestos is exposed to the flame, and being heated to incandescence gives off a glow of light. The burner and the mantle require a considerable amount of attention if satisfactory results are to be obtained.

In using gas for illuminating purposes it is always necessary to bear in mind that, in its raw state, it is an exceedingly dangerous compound. To prevent accidents all pipes and fittings should be overhauled and tested from time to time by skilled persons.

Oils.—*Paraffin oil* is that most usually employed for illuminating purposes. The light which it yields, provided the lamp is regularly and carefully attended to, is fairly satisfactory. The flame, however, is apt to be dirty and to give rise to heat and to air contamination.

Acetylene Gas.—This is obtained as a result of the interaction of water on calcium carbide, and in many large country houses plant capable of producing the gas in considerable amount has been laid down. It has a very high illuminating power, and can be produced fairly cheaply and easily. The raw gas is highly poisonous and exceedingly explosive even in weak dilutions, but as it has a very marked and disagreeable odour, leakage is readily detected.

Electricity.—Light is obtained from electricity by the passage of a current through thin filaments of carbon, platinum, or some other metal. The heat produced within the filament, on account of the resistance offered to the passage of the current, throws it into a state of incandescence sufficient to cause its destruction if exposed to air. To prevent this the wire is enclosed in an airtight globe. Because combustion does not occur, and the heating that leads to the production of light takes place apart from the atmosphere of the place to be illuminated, electricity, besides being cool and convenient, is an absolutely clean, hygienic lighting agent.

The chief objections urged against it are that it is expensive and trying to the eyes, and that it does not assist ventilation.

So far as *expense* is concerned, it is quite possible that in some districts electricity does cost more than gas; but provided the necessary wiring and fittings are available and everything be taken into account, the saving on decorations, for example, the difference is probably very slight.

As regards *injury to eyesight* it may be said shortly that as electric lights can be so easily shaded and arranged to suit the person using them, there cannot be any great risk. As to *ventilation*, it is sufficient to say that, as the light does not affect the air, it is probable that the other agents and appliances concerned with ventilation can carry out all the work that is necessary in rooms lighted by electricity.

CHAPTER XXI

REMOVAL AND DISPOSAL OF REFUSE AND WASTE

House Drainage and Drains

As soon as a house is used for occupation, three classes of waste and refuse appear, viz. (1) excreta, (2) waste waters and water soiled by use for cooking, washing, etc., and (3) refuse of food; dust, ashes of fuel, and other ordinary household refuse; and provision must be made for their *Collection*, *Removal*, and *Disposal*.

Commonly what is done is to collect each separately and to combine numbers (1) and (2) for purposes of removal and disposal. The third, the household refuse, is usually collected, removed, and disposed of separately.

Occasionally in small and backward districts the household refuse and the fæcal excreta are dealt with together, and the liquid wastes, though possibly collected separately, are removed and disposed of together. In some cases the three wastes are not only collected, but also removed and disposed of separately under the so-called *separate system*.

To the first of these methods, which can only be adopted where there is a good supply of water, the name *Water Carriage System of Sewage Removal and Disposal* is given, the combined wastes making up what is known as *sewage*.

The name given to the second method of removal is *Conservancy System*. It is only adopted in districts in which the water supply is deficient or in which the arrangements for properly removing and disposing of the sewage are insufficient.

In a future section it is proposed to discuss the question of collection, removal, and disposal of household refuse. Here the various points in connection with the other wastes will be considered.

The Water Carriage System.—*The Drainage System.*—For dealing with the liquid and excreted wastes there must be provided apparatus suitable for collecting and apparatus for removing them, the whole making up what is known as the *drainage system.*

The part of this system concerned with collection includes appliances such as water closets and sinks designed to receive excreta and other wastes.

The apparatus for removal of the drainage consists of pipes or channels to which the name *drain* is generally applied, though certain parts receive special names from the functions which they perform: *e.g.* the pipe carrying the materials collected in the water closet is named the *soil pipe*; that carrying the waste collected from sinks, baths, and such-like is called the *waste pipe*; and that serving as a channel for the rain water which falls upon the roof and which is collected in the *rhones* or *eaves gutters* running along the lower edge of the roof is named the *rain-water pipe.*

Overground Drains.—These three pipes are all overground pipes, and are supported usually against the outer wall of the building in a position convenient for receiving the materials from the collecting apparatus. The most important points in connection with their construction are noted below.

Soil Pipes.—With regard to the soil pipe it is generally stated that wherever practicable it must be placed outside the building, and constructed in drawn lead or heavy cast iron. For the reason that iron is cheaper and more easily erected it is usually preferred; lead, however, has certain advantages, being more durable and stronger. In London if the soil pipe is to be placed inside premises, it must be of lead.

Whether of lead or iron, the soil pipe should be circular, and have an internal diameter of not more than 4 inches, in order to ensure thorough scouring of the interior by the water that passes along with and helps to carry the excreta away. A pipe of this size is sufficient to carry the discharge of as many water closets as are likely to be found in any ordinary building.

The pipe should run as straight a course as possible, and in all cases should extend from the bottom of the house, where it joins the drain, to above the eaves. It should be near the head of the drainage system and completely open throughout its entire course, in order to assist in the circulation of air in the drainage system and allow of the escape of any gases generated in the drain. The top of the pipe should be as far as possible from windows, and in order to keep birds out should be protected by a wire cage.

The soil pipe must not connect with any collecting apparatus other than a water closet or other appliance provided for the reception of urine or other excretal filth, *e.g.* a slop sink. Under no circumstances must rain water or waste from sinks or baths be allowed to discharge into the soil pipe.

Whether of lead or iron, soil pipes are made up of lengths

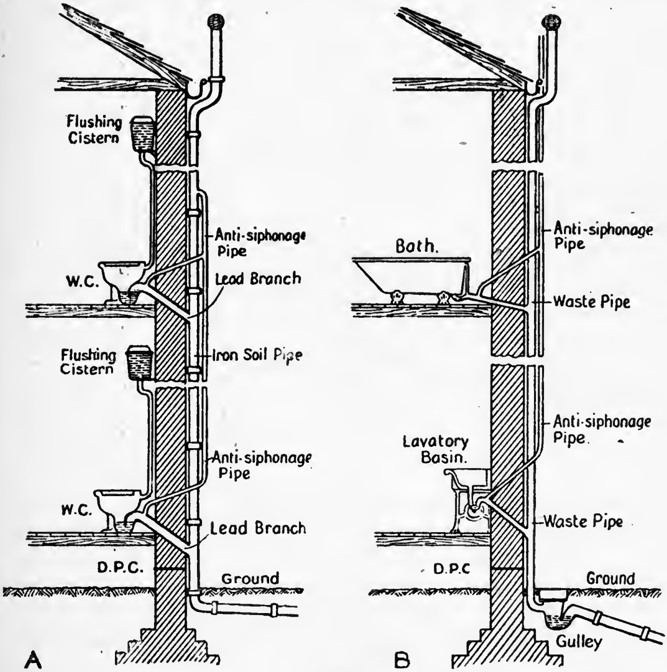

FIG. 58.—A, Soil pipe. Note position of antisiphonage pipes and connection of soil pipe with underground drain. B shows method of disconnecting the waste pipe from drain through a trapped gully.

of pipe, and great care must be exercised in connection with the jointing of these. Iron pipes are so cast that one end is provided with a socket and the other left plain. The former is known as the "socket" end, and the latter as the "spigot" or "faucet" end, and it is required that the socket shall be a certain depth and that in jointing a spigot into a socket molten lead and not putty or red lead shall be used. In the case of lead pipes no special sockets are provided, the plumber shaping the ends to be united to suit the form of joint he proposes to make.

Waste Pipes.—Waste pipes are almost invariably made of iron, but need not be so heavy as soil pipes, and need not have a diameter greater than about 2 inches. The joints are made in the manner described for soil pipes. The waste pipe should be situated outside the building, and should run a straight course. Like a soil pipe it should be carried up full bore to above the eaves of the roof, where it may be protected by a cage; it must not connect directly into the drain, but discharge over or into a gully as described later.

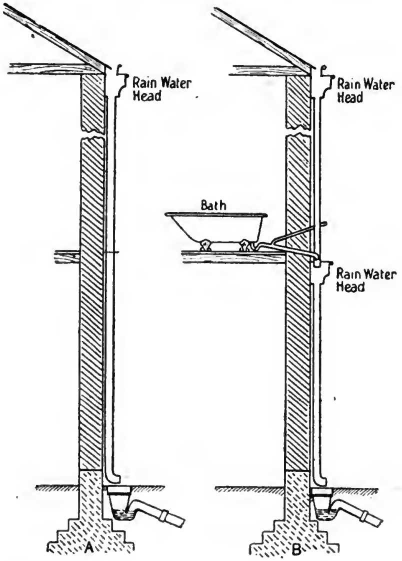

Fig. 59.—Showing method of collecting and discharging rain-water from roof. In B, bath waste is shown discharging into the rain-water pipe at a *head* or *hopper*. This is bad practice, as smells are apt to arise from decomposition of deposit on the sides of the hopper or pipe.

Rain-water Pipes.—As experience shows that defective arrangements for the removal of rain water are amongst the commonest sources of dampness in houses, it is essential that some care should be given to them. Iron pipes, perhaps a little lighter than those used for soil pipes, are probably best. They should be provided with a good socket, and the joints should be carefully made. Red lead and putty are frequently used, mainly because the socket is not strong or large enough to allow of the introduction of molten lead. Joints of this kind are not durable, and the material is very liable to crack.

Rain-water pipes should be placed outside the premises, and should be circular, though, for ornamental purposes, they are sometimes made square. The internal diameter will depend upon the extent of the roof area with which the pipe is connected. The lower end must discharge not directly into the drain, but over or into a gully.

Gullies and Traps.—The direct connection of rain-water and waste pipes with the underground pipes is prohibited, mainly with the object of ensuring that none of the gases from the drain shall escape into or near the building. With this object what is known as a gully, or to give it its full name a *trapped gully*, is used. In its simplest form this consists of iron or glazed stoneware, and is provided with an inlet and an outlet, the portion of pipe between being bent more or less into the shape of a U to retain water and to act as a "trap" or obstruction to gas or air from the drain.

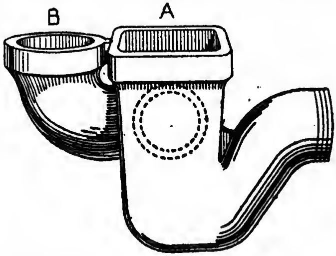

Fig. 60.—A trapped gully showing (A) top and (B) side inlets.

In constructing the drainage system the gully is so placed that the inlet is at the ground level, the trap is underground, and the outlet is connected up with the underground drain, the position occupied depending mainly on the point of discharge of the waste and rain-water pipes. It should be placed outside in the open air, and the rain-water and waste pipes made to discharge above or below the grid covering the inlet.

In most small houses one gully usually receives both rain and waste waters, and there is no objection to this arrangement. In paved yards and areas gullies to collect the surface waters are required, and the slope of the paved surface should be towards the inlet of the gully.

Traps.—Reference has already been made to the question of *traps*, and, as it will be necessary to mention them frequently, it is convenient at this point to give some details with regard to them.

The object of the trap is to prevent the return of gas or air from the interior of the drain while at the same time allowing of the passage of wastes into the drain, and in practically every case the obstruction is formed by means of fluid retained by a bend made on the pipe through which it is to pass.

In every drainage system in addition to the gully traps there is or should be one under each wash-hand basin, sink, bath, and water closet. A very important one is that placed at the outlet of the whole drainage system, and known as the *house intercepting trap or interceptor.*

Because of their shape and the fact that they act more or less on the siphon principle, they are called *siphon traps* or *P.* or *S. traps* according as the outlet passes directly outwards or more or less downwards.

If a trap is to be effective, it should be neither too deep nor too shallow, and the inner surface should be smooth. The curve of the portion in which the water lies should be as "easy" as possible, so that if deposit occur at all it may be readily washed out when the trap is flushed. This object will be attained if the trap is not too deep; at the same time, however, the depth should be sufficient to form a *water seal* of from $1\frac{1}{2}$ to 3 inches. The *water seal* is that part of the water in the trap standing in the ascending arm and measured from the surface of the water retained there downwards to the point where the ascending arm begins.

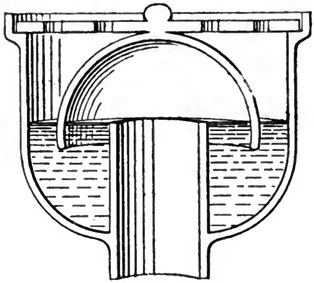

FIG. 61.—The Bell Trap. This is a bad form of trap; it is readily blocked, and when the grid to which the bell covering the drain is attached is raised, the trap is broken.

So long as the bend retains the water, the gases will be kept back, but the barrier does disappear sometimes and the trap becomes *unsealed.* This may result (1) from *disuse,* the water left at the time of flushing gradually evaporating off; or (2) from the violent *backward passage of gas* from the drain driving the water out; or (3) from the *sudden discharge of a large volume of fluid* into the apparatus with which the trap is connected or along the pipe to which the outlet of the trap is united. In the last case the unsealing is due to *siphonage* of the water, and in most traps means, which will be noted later, are provided for its prevention.

Prior to the introduction of the modern type of trap a number of others, none of which was really satisfactory, were employed. Illustrations of a number of these and a statement with regard to them will be found elsewhere. Broadly speaking the chief objections to them were that they were dirty, and that, since the seal was easily broken, they were generally inefficient. Drainage systems in which they are found are generally defective in other respects.

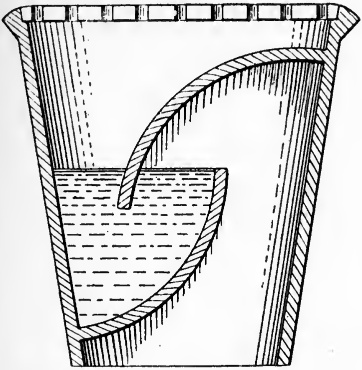

FIG. 62.—Lip (Antill's) Trap. This is a bad form; the water seal is inadequate, and blockage readily takes place.

Underground Drains.—In most instances the underground portion of the drainage system consists of a *main drain* and of *branch drains*. Of the branches some carry the excreta brought by the soil pipe or soil pipes from the water closets, while others take the rain water and sink and other wastes from the gullies. The main drain receives the contents of both these sets of branches and carries them to the point where they are discharged. As far as possible the underground, like the overground pipes, should lie outside the house. Especially in towns, however, it is often impossible to arrange for the main drains, and even the branch underground drains, to run otherwise than through and under the house.

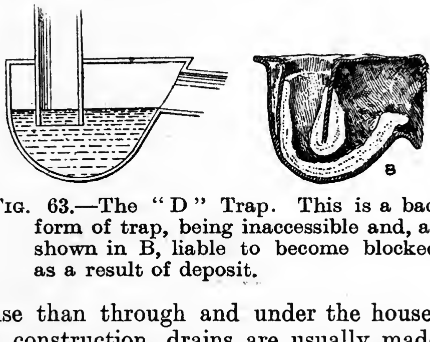

FIG. 63.—The "D" Trap. This is a bad form of trap, being inaccessible and, as shown in B, liable to become blocked as a result of deposit.

For convenience in construction, drains are usually made up of a series of pipes varying in length according to the material of which they are made. Whatever this may be it must be *non-porous*, and generally iron or glazed stoneware or earthenware is used. In order to permit of the separate lengths of pipe being conveniently put together, each is provided with a socket on one end. Into this the unsocketed or spigot end of another pipe fits and is jointed with molten lead, in the case of iron pipes, and with cement, in the case of glazed pipes. Because of the lead joints iron drains generally are more costly to put in, but are stronger and more durable than those of glazed ware.

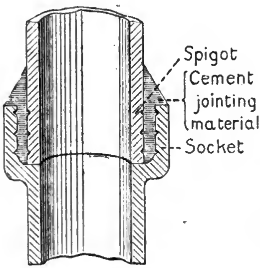

FIG. 64.—To show spigot and socket end of stoneware pipe.

In laying drains a firm foundation or "bed" must be provided in the bottom of the trench by laying down concrete

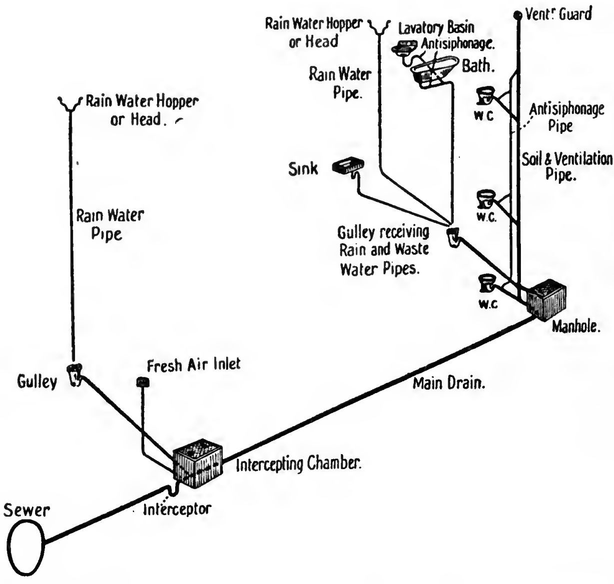

FIG. 65.—Schematic representation of house drainage system.

(which consists of cement and pieces of stone, gravel, or brick), and making hollows to receive the sockets, which *always face the direction from which the sewage is coming.*

The bed must be given a slope or fall towards the sewer or other outlet, the amount depending primarily on the size of the pipes. For the general run of houses a drain with a 4-inch bore is quite large enough, and the minimum fall for this is 1 inch in 40. For 5-inch pipes, a size commonly introduced when iron is used, the fall may be 1 in 50, and for 6-inch pipes or larger 1 in 60. The bed of concrete laid down is usually at least 6 inches thick, and to protect the drain from fracture it should be covered in with a similar thickness of concrete.

Junctions and Chambers.—Branch drains *should never enter the main square,* but should form more or less of a V, the point of which looks in the direction which the flow takes in the main. As many branches as possible should join at what is called a *manhole* or *chamber,* consisting of a brick pit built in the ground, through the centre of which the main drain runs and through the sides of which the branch drains open. The advantage of a chamber is that it allows of ready access to the interior of the drain to remove any obstruction, since it has for its top an iron plate or cover, which a man can readily raise, and, in addition, is of such a size that a man can get his arm if not his body into it.

Both the main and the branches, once they pass into the chamber, become open channels with glazed surfaces, which simplifies inspection and cleansing of the drain and the removal of obstructions.

The manhole or chamber *cover* should be carefully sealed down by means of grease, which is melted before being applied, afterwards solidifying to form a gastight joint. To connect the main drain to the sewer, a socket is built into the wall of the sewer to receive the house drain which is jointed into it with cement. Very frequently the socket is provided with a metal flap which opens towards the sewer, shutting when nothing is flowing through the pipes to keep back gas and possibly also rats.

To act as a further protection, a special form of trap known as an "intercepting trap" or "interceptor" is generally fixed on the house drain. In this, in order to permit of access to the portion of drain between the trap and the sewer should it get blocked, a piece of pipe is connected to the far side of the

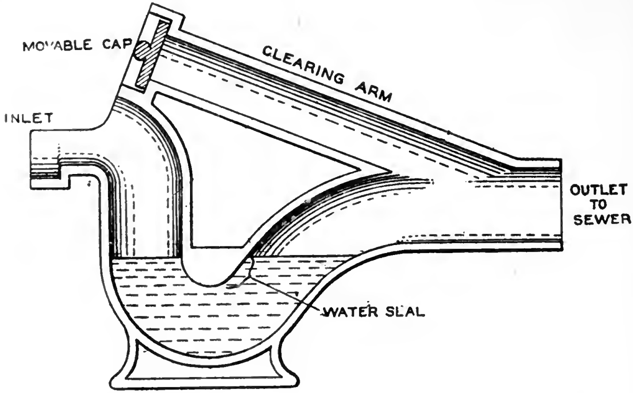

FIG. 66.—Intercepting trap shaped to allow of building into wall of manhole.

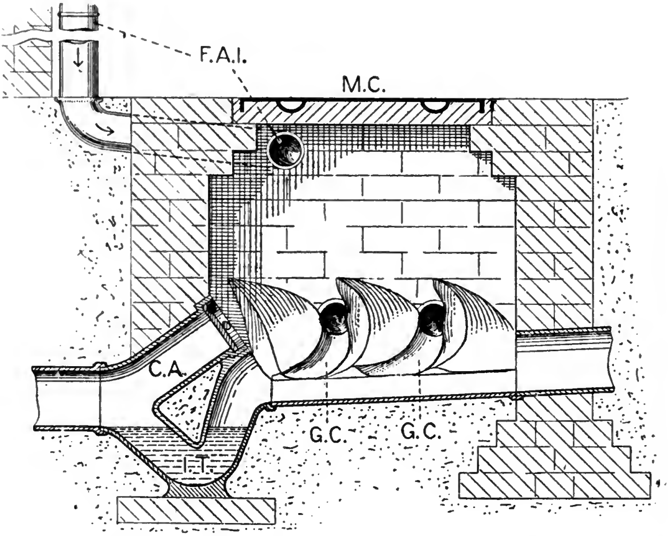

FIG. 67.—Section of access or inspection chamber or manhole with intercepting trap. F.A.I., Fresh air inlet; M.C., manhole cover; G.C., glazed channels in floor of manhole connected with branch drains; C.A., clearing arm; I.T., intercepting trap.

outlet from the trap, and carried back to open above the entrance to the bend. This pipe is called the "clearing arm," and, in order to prevent the escape of sewer gases through it, it is generally fitted with a cap, which should be firmly fixed in by means of cement or otherwise. Usually the interceptor is so placed that the drain enters it at a chamber sometimes called the "disconnection" or "intercepting chamber" and constructed at the front of the house. If there are any branch drains in this position, they can conveniently be connected up with this intercepting chamber, which may also be fitted with an air inlet to assist in the ventilation of the whole system.

Sometimes the branches carrying soil from the water closets and those carrying rain and waste waters are kept separate, each set opening into a distinct main, which discharges independently. In some places such an arrangement is rendered necessary by the fact that the sewers are not sufficiently large to carry all the drainage; in others, especially country places, it is done because the waste waters are discharged into a stream or over land, while the excreta are taken to a *cesspool.* Whatever arrangement is adopted, the drains must be laid in the manner described, and the same remark applies to those houses in which the conservancy system is adopted in connection with the dry and the excretal refuse, and drains are only made to carry the waste waters to a cesspool or to discharge into or over the land.

Drain Ventilation.—Because of its situation and construction, the soil pipe is often made to act in connection with the ventilation of the drain by serving as an outlet for gases pro-

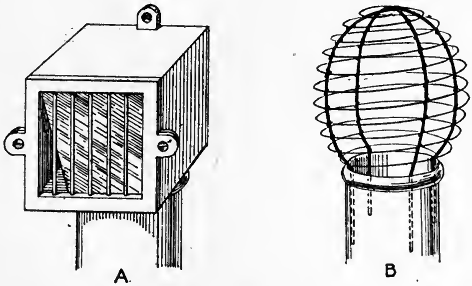

FIG. 68.—Drain Ventilators. A, Mica valve box of fresh air inlet; B, form of wire cage used for protecting top of soil or ventilating pipe.

duced in the drain. If a soil pipe is unnecessary because there are no water closets above ground level, a special pipe constructed in the same way as the soil pipe must be provided to take its place as an outlet ventilator. To assist in ventilation, by providing an *inlet for fresh air*, a pipe leading from the disconnection chamber and opening above the ground, and called the "fresh air inlet," is introduced. To ensure that, while air may pass into it, none of the gas shall pass out, the top of the pipe is finished off with a kind of box containing a delicate flap of mica, so hung that it will open to a draught from without, and close if there is a back draught from the drain.

Sanitary Conveniences and Appliances.—*Water Closets.*—The apparatus used for the collection of excreta is generally placed in an apartment known as the water closet, which should be so situated that at least one of its walls is an external one abutting upon an open space. In this wall there must be a window opening directly into the outer air and measuring at least 2 feet by 1 foot exclusive of the frame. Entry to a closet placed indoors must not be directly from a living-, sleeping-, or work-room, but from a landing or passage, or a space lighted and ventilated from the outer air.

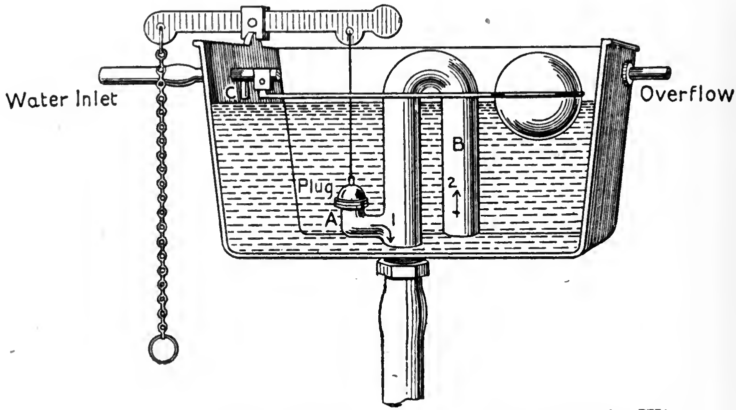

Fig. 69.—Form of Water Waste Preventer commonly fixed. When the chain is pulled, water enters at A, and passing in the direction of arrow 1 sets up siphonic action whereby water passes into B in direction of arrow 2; when all the water has disappeared, a further supply enters through C, the valve having been opened by the sinking of the ball.

Many of the precautions referred to above are necessary to prevent nuisance from smell and to allow of the person using the apartment having a certain amount of privacy, a matter the importance of which is not always recognised in poor districts. Formerly it was supposed that there was some disadvantage attending the placing of closets inside a house, and even now in poor neighbourhoods they are commonly erected outside, though experience has shown that, provided they are properly constructed and placed, there are no objections.

The appliances with which the apartment must be furnished include (*a*) a separate flushing *cistern* of adequate capacity, (*b*) a suitable *flushing apparatus*, and (*c*) a proper *pan*, basin, or receiver.

Flushing Cisterns have a capacity usually of from 2 to 3 gallons, the size used depending upon the quantity of water allowed by the regulations of the local water company. The object of requiring a separate cistern is in order that there shall be no direct communication between the ordinary water supply and the closet.

In the flushing cistern commonly used, siphonic action is depended upon in connection with flushing, and arrangements are provided whereby this may be brought into operation automatically when necessary. The quantity of water discharged at each operation is only such as the cistern is capable of containing, which has led to the application of the name "Water Waste Preventers" to the cisterns.

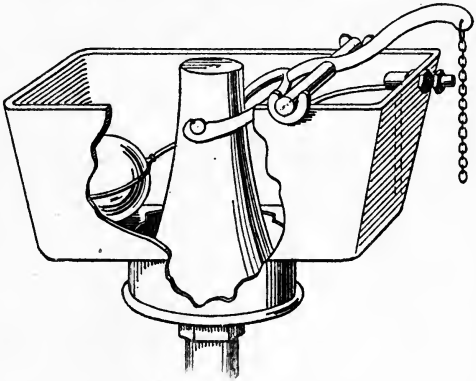

Fig. 70.—In this form of Water Waste Preventer, when the bell is raised by pulling the chain the water escapes into the pipe leading to the closet basin. After the disappearance of the water, the bell sinks into its former position. The entrance of water into the cistern is controlled by the ball valve.

In order that the full advantage of the water for driving out the excreta and cleansing the pan may be obtained, the cistern should be about four feet above the pan and immediately over it to ensure that the down pipe, which should have a diameter of 1½ to 2 inches, may run a quite straight course.

The Closet Basin.—The *pan* or *receiver* provided should consist of non-absorbent material, and be of such a size and so shaped and constructed as to receive and contain a sufficient quantity of water and to allow any filth to fall free of the sides and directly into the water. Immediately beneath the pan there must be a trap capable of maintaining a water seal between the pan and the drain or soil pipe to which it is connected.

Amongst the closet apparatus that comply with these requirements are the *wash down*, the *siphonic*, and the *valve patterns*. Those that fail to comply include the *pan* and the *long hopper*, the *short hopper* and the *wash out*.

Good Types of Closet.—*The Wash Down* is the most commonly used, and consists primarily of a pan and trap of glazed earthenware made in one piece. In order to assist in the falling clear of the excreta, the back of the pan should be as straight as possible, and the pan neither too deep nor too narrow, the front and sides sloping more or less gradually down towards the trap. At the back of the pan there should be the water inlet, and from this point the rim should be turned down all round so as to form a channel along which the water may pass to be discharged downwards over the whole surface of the pan and into the trap.

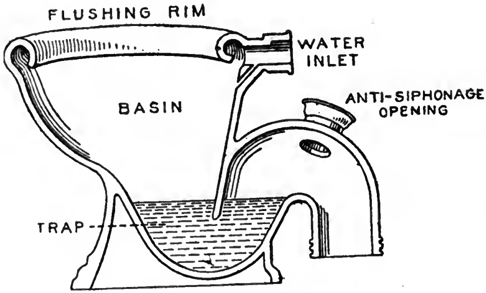

Fig. 71.—"Wash-down" Water Closet.

To ensure cleanliness the pan should be brought fairly well out from the wall so that it is possible to get all round it, and the only woodwork connected with it should be the seat, which should be hinged to lift up.

The Valve Closet.—In this form the pan and the trap are quite distinct, the water in the pan being retained by a valve connected with a pull-up plug at the side of the closet which, in addition to operating the valve, controls the discharge of water into the pan and trap. For flushing purposes a larger quantity of water is required than in the wash down, and for this reason it is not a favourite with water companies. From the hygienic point of view it has the objections that it is complicated in structure, the distance between the pan and the trap is considerable, and the pipe between them is apt to get fouled despite the fact that large quantities of water are discharged into it. In flushing there is always risk of the pan overflowing, and in order to guard against this an overflow pipe is necessary and the floor under the pan must be covered with a lead tray. To prevent escape of smells from the closet trap the overflow pipe is also trapped.

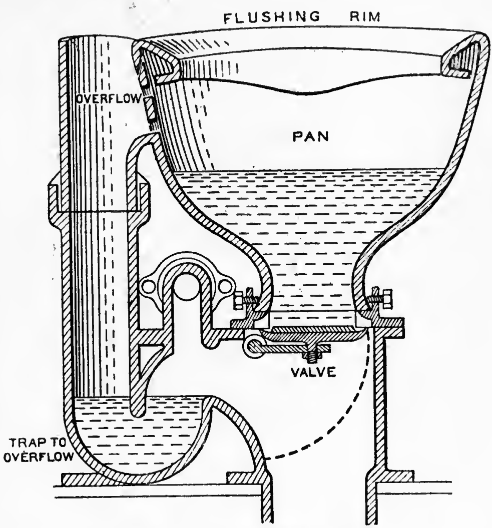

FIG. 72.—Valve Water Closet.
The trap is at a lower level and is not shown.

This type of closet is usually only found in better-class houses and is quite unsuitable as well as too costly for use in those occupied by the poor and working-classes.

The Siphonic Closet is so formed that there is more or less of a double trap, one in connection with the glazed stoneware pan, and another of lead beyond it just before the closet connects up with the soil pipe.

When flushing is carried out the water is directed more or less simultaneously into the pan and the second trap, the discharge of water leading to a siphonic action whereby the contents of the pan are sucked through the trap into the soil pipe. By means of an after flush the pan is refilled with water to receive the next discharge of excreta.

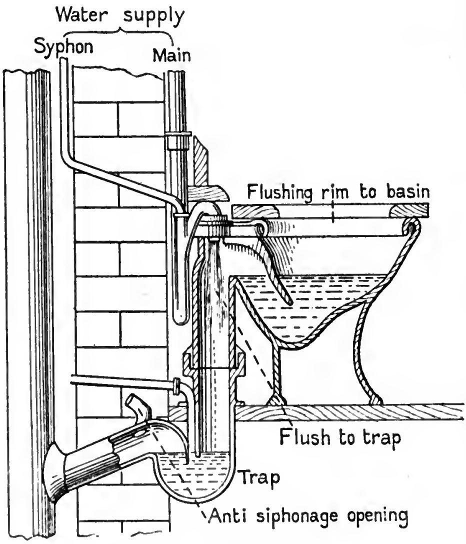

FIG. 73.—A Siphonic Closet.

This, like the valve closet, is expensive, and is complicated and rather difficult to fix.

Bad Types of Closets.—*The Pan Closet* consists of an earthenware basin closed below by a movable metal pan which can be tilted up so that its contents may be discharged into another metal receptacle known as the *container*. From the lower end of the container a pipe passes through the floor of the chamber into a D-shaped arrangement of lead known as a *D trap*. The outlet pipe of this trap passes off from one of its sides to open into the soil pipe. The floor immediately beneath the container is covered with a lead tray. The tilting of the receiver is brought about by means of a pull-up plug at the side of the closet; simultaneously with the tilting of the receiver a discharge of water into the basin is started, and continues until the pull-up arrangement is pushed down again. The objections to this form of closet are that:

(1) The metal receiver is apt to become eroded and to get out of order, and if the water should escape smell comes into the house directly from the D trap and the inside of the container.

(2) The container itself is a bad arrangement, since it is apt to get splashed from the receiver with matters which

adhere to the sides and decompose there, so that every time the receiver is tilted the odours from the decomposing material will pass into the house.

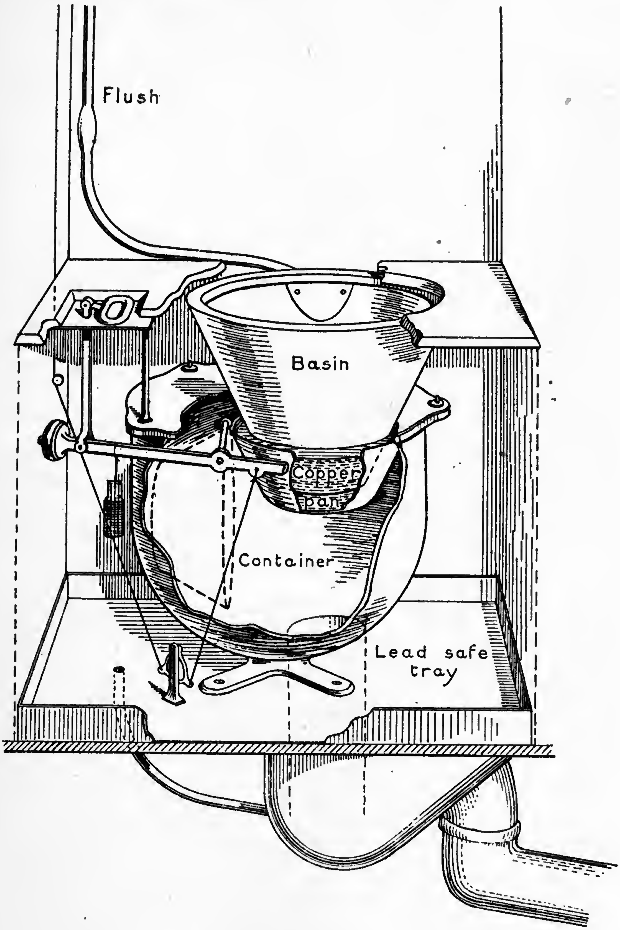

FIG. 74.—A Pan Closet.

(3) The *D trap* is practically a small cesspool, the odours from which escape into the house every time the receiver is

tilted. It is impossible to get this trap thoroughly empty at any one time, and no matter how much water is discharged into it, on account of its shape all its surfaces are not properly washed.

(4) The tray underneath the container is apt to get fouled by splashings from the basin or from a leak in the container.

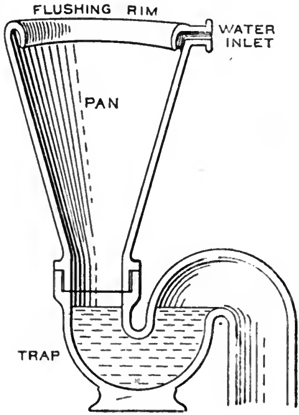

Fig. 75.—Long Hopper Water Closet.

(5) The water for flushing the closet is generally derived from the cistern supplying water for general purposes, and since the overflow pipe from the cistern may open into the soil pipe or the D trap, or the pipe ventilating the trap pass through the cistern to ventilate over the surface of the water, contamination may result.

In the *Long Hopper Closet* the pan is so long and narrow that the trap is rendered practically inaccessible for cleansing and is apt to be neglected and to become exceedingly foul.

The Short Hopper is objected to on account of its shape and because the water retained after flushing lies entirely in the trap.

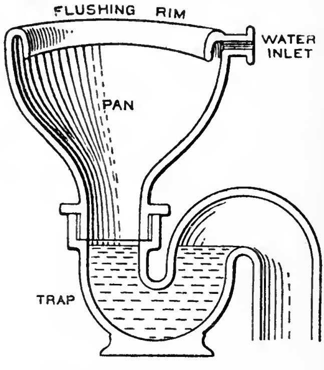

Fig. 76.—Short Hopper Water Closet.

In the *Wash Out* form the pan or basin acts also as a receiver, the water in the pan being prevented from leaking into the trap by a raised ridge, which, if it be too high, is apt to break the force of the flush, and if it be too low allows only of the retention of a very small quantity of water. In this type of closet the whole force of the flush is not directed into the trap, which is apt to become dirty, and being inaccessible is usually neglected.

Other Forms of Water Closet.—The Slop Water Closet.—In this the closet consists of an oval pan placed over a siphon trap which acts as a receiver and flushing is brought about by means of the waste waters of the house. These are collected into a tipper holding generally about 3 gallons, which automatically discharges its contents when full.

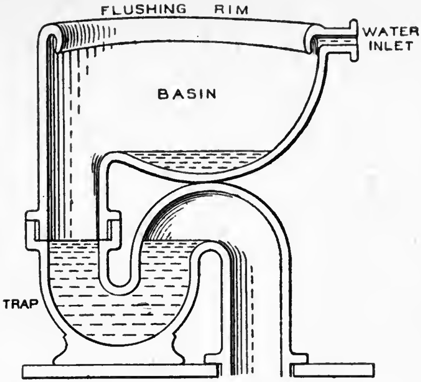

FIG. 77.—Wash-out Water Closet.

The main advantages of the slop closet system are the

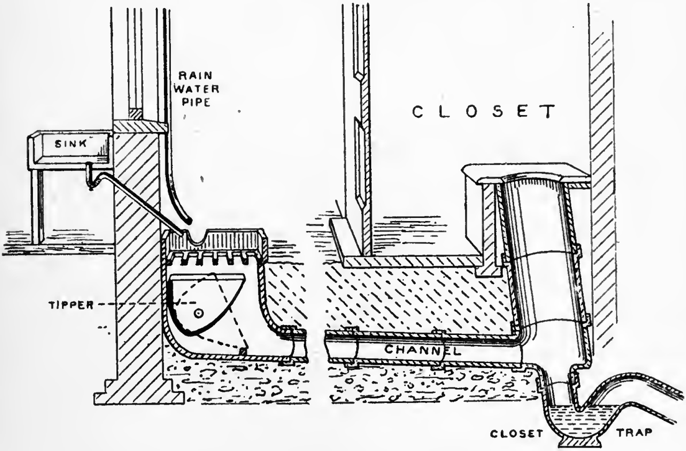

FIG. 78.—A Slop-water Closet.

saving of water and the diminution in the quantity of sewage to be carried in the sewers. In addition such a closet does not so readily get out of order during frosty weather. The objections to it are that the pan is apt to get fouled, the flushing of drains and sewers is not well carried out, and the sewage is more concentrated and may be less easily dealt with.

The *Trough Closet*, formerly greatly in favour in such places as barracks, factories, schools, and for blocks of small houses, is now rarely fitted. It consists of a trough, usually of stoneware, divided into a series of closets separated the one from the other by partitions. The bottom of the trough slopes slightly to the outlet end, and to permit of the retention of a certain quantity of water more or less of a weir should

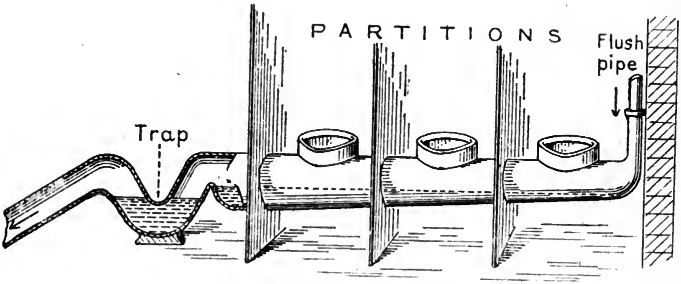

FIG. 79.—Trough Water Closet.

be formed at this point. At the outlet there should be a siphon trap between the trough and the drain, and at the opposite end there should be situated an inlet for a pipe connected with a large automatically acting flush tank. Usually the end of the siphon trap next the trough is protected by bars with wide interspaces so that articles mischievously dropped into the trough may be excluded from the drain. The chief objection to this type of closet is that in the intervals between flushing nuisance may arise from any fæces deposited in the trough.

The *slop closets* or sinks found in hospitals and large establishments are sometimes known as "housemaid's sinks," and must not be confused with the slop-water closets referred to above. They are used for the reception of bedroom slops, and in hospitals bedpans are commonly cleansed in them.

In addition to having an ordinary flushing cistern, water taps are usually fixed over them in order to supply water for the cleansing of bedpans, etc. They should be trapped, constructed, and treated on the same lines as water closets.

Connection of Closet Apparatus to Soil Pipe.—Closets on the ground level inside or outside the house usually connect directly with the underground drainage by means of a cement joint between the outlet of the trap and a socket on the drain.

Closets on the upper floor of the building connect with the soil pipe, and as this is generally outside the house it is necessary to lengthen the outlet end of the trap by fixing to it a length of lead piping and carrying this through the wall to a specially prepared opening on the soil pipe.

The joints between the earthenware and the lead extension pipe and between the latter and the iron or lead soil pipe, since

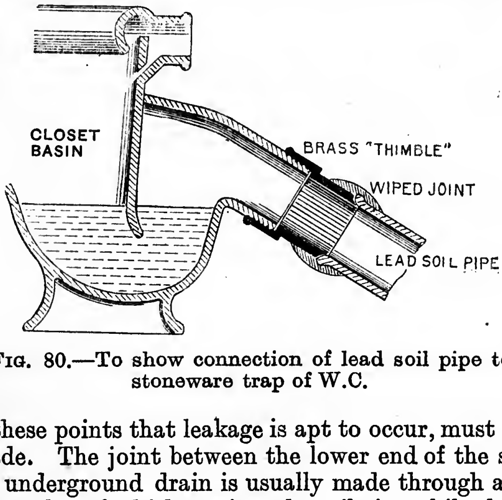

FIG. 80.—To show connection of lead soil pipe to stoneware trap of W.C.

it is at these points that leakage is apt to occur, must be carefully made. The joint between the lower end of the soil pipe and the underground drain is usually made through a curved pipe, the socket of which receives the soil pipe while the spigot passes into a socket on the drain. The method to be employed in making these joints secure need not be described.

Prevention of Siphonage.—In dealing with traps reference was made to the subject of siphonage, and it should be noted that when there are two or more closets placed one above the other and opening into the same soil pipe there is always a risk that, in flushing the upper closets, water may be sucked or siphoned from the traps of those below. The carrying of the soil pipe full bore to the top of the house tends to prevent this, but in addition, *anti-siphonage pipes* running from the highest point of the closet trap, beyond the water seal, through the house wall to a vertical pipe placed alongside the soil pipe may be provided. Generally this pipe terminates above by opening into the soil pipe after having received the anti-siphonage pipe from the highest water closet, but if there be only one closet the anti-siphonage pipe may open into the soil pipe itself. In most closets the trap is provided with an opening, the "ventilation or anti-siphonage horn," for an anti-siphonage pipe.

Sinks.—These, along with the baths and lavatory basins, are the appliances provided for the reception of wastes. They are best constructed of glazed ware preferably white, though in butlers' pantries where much silver is washed sinks of lead or teak are not uncommonly fitted. To assist in cleansing and to favour cleanliness, the sink should always be placed in a position where there is plenty of light.

Since woodwork is apt to get sodden and dirty, boxing in of the sink is to be avoided. Any ledge at the side of a scullery sink should be of teak or other hard wood.

For carrying away the waste waters a length of lead pipe

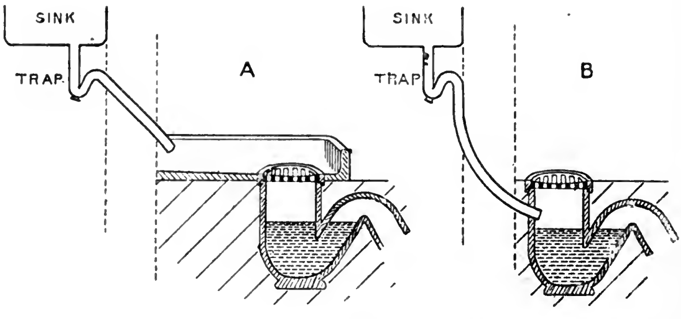

Fig. 81.—To show sink waste-pipe discharging: A over a channel leading to a gully, and B through a back inlet between the grating and the upper surface of the water in the trap. The latter is the better arrangement.

should be jointed to the outlet of the sink and carried to discharge, if the sink is on the ground floor, over a gully, or if higher up the building into a vertical waste pipe.

Since the interior of any pipe carrying waste waters is certain after a time to become foul with grease and organic matters which decompose and give off bad smells, it should always be trapped by bending it upon itself to form something resembling the letter S laid on its side, thus : ᔕ.

To prevent siphonage of the water from the trap it should be ventilated by carrying a second pipe off from just above the upper bend of the trap and letting it open in the fresh air. If there is only one sink connected with the waste pipe, this ventilation or *anti-siphonage or puff pipe* may open just outside the wall of the house; if more numerous, all the anti-siphonage pipes may be collected into one vertical pipe and carried up the wall beside the waste to a point above the eaves.

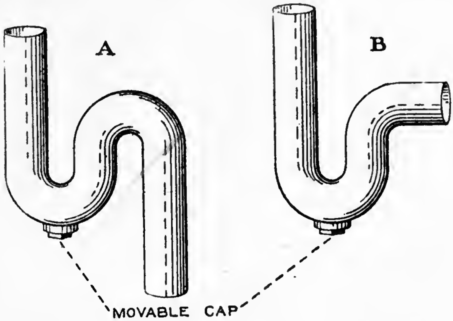

FIG. 82.—Sink waste traps: A is an S and B a P trap. Note the movable screw cap at the bottom of the bend.

Lavatory basins should be constructed of the same material and on the same general principles as the sinks, and should be trapped and anti-siphoned where necessary. In some houses it is not unusual, because it is convenient, to place such basins in dressing-rooms and even bedrooms. If this is done, particular care should be taken in their construction, and they should be kept very clean. The possibility of maids using them as slop sinks must not be overlooked, and since it is almost impossible to guard against such uses it is probably inadvisable to fix them in bedrooms.

The bath is to a great extent merely a large sink, and should be constructed and treated on similar lines. It should never be boxed in, and wherever possible should be raised off the ground and not placed against a wall. The waste pipe from the bath should be trapped and discharged in the same manner as the sink waste. Since the quantity of water discharged from a bath is usually large and siphonage is very apt to occur, the trap must in all cases be provided with an anti-siphonage pipe. Any overflow from a bath or basin should discharge above the water in the trap.

The connections with the main pipe from the sinks and so on are frequently (Fig. 59) made at what are known as "hopper heads" suitably placed near windows to receive them. As a result of splashings these rapidly become coated with deposit and inevitably give rise to nuisance. For this reason this arrangement should not be permitted, but the provision of a separate stack for the wastes and the rain water insisted upon.

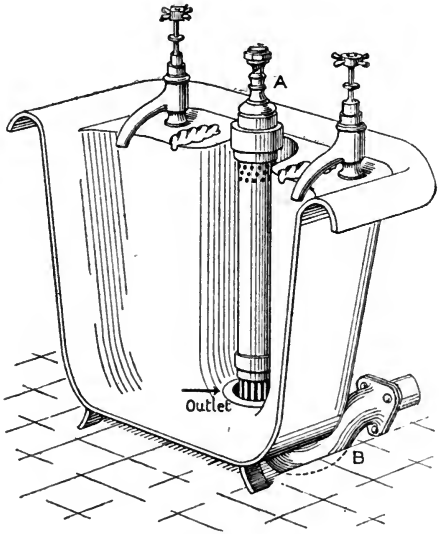

Fig. 83.—Head of bath. The plug A can be completely removed to allow of access to the trap B.

Examination and Testing of Drainage Systems.—In most districts, particularly those of any size, drainage work is carefully supervised. Visits are paid by inspectors while it is in progress, to see that suitable materials are used and that the work is done thoroughly. In order to discover if the joints at all points are strong enough to prevent leakage both of gases and liquids, various tests known as *Smell, Smoke, Water*, and *Air tests* are applied.

Smell Tests.—The most commonly and most easily applied smell test is that in which *calcium phosphide* is employed. This substance in the presence of fluid breaks up into its component parts, and in addition *phosphuretted hydrogen*, a gas with a characteristic smell of garlic or onions, is formed.

As the slightest amount of moisture leads to this action, the phosphide for use in testing is put up in small closed boxes to which is attached a string by means of which they can be opened after they have been introduced into the drain.

The person applying the test places the box part in the trap of a water closet; the free end of the string is then fixed to some convenient point and the box is washed through the trap by discharging the water from the closet cistern. If there are any defects in the joints or any other

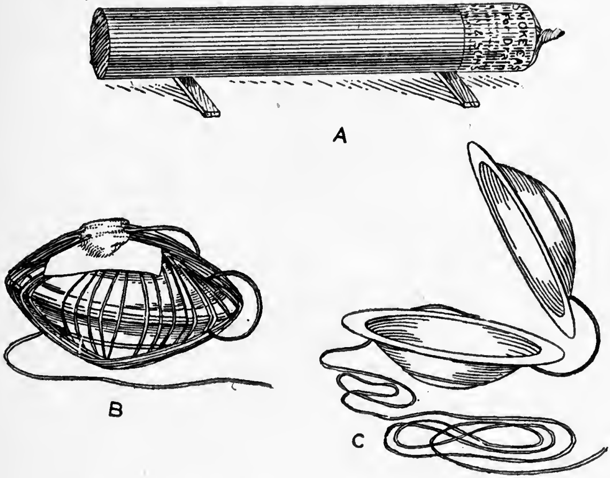

FIG. 84.—Drain-testing appliances. A, smoke rocket; B, capsule containing calcium phosphide ready for use; C, the same after use.

parts of the system the gas generated escapes through these and is readily detected.

Another smelly substance used at one time was *oil of peppermint*. It is applied in much the same way, but is less satisfactory.

The Smoke Test.—The smoke for the test is derived from some slow-burning material, *e.g.* oily waste or specially prepared paper. A special apparatus is required and is illustrated in Fig. 85.

When the pipe from the apparatus is in the drain it must be surrounded with clay or a damp cloth to keep the smoke in. Then pumping is commenced and continued till smoke is seen issuing from one of the drain openings, *e.g.* the top of the soil or ventilation pipe. All openings are then closed with clay or wet cloths and the pumping is resumed. If the drain is sound the cover of the cylinder rises when the drain is full of smoke. If there are leaks the cover does not rise. The situation of the leak is usually indicated by the escape of smoke. Smoke may also be applied by means of *smoke*

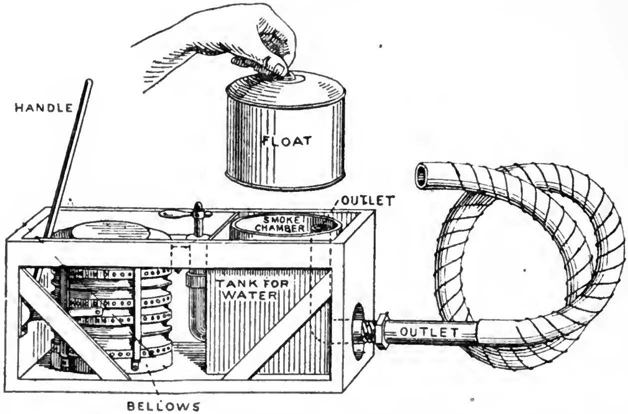

FIG. 85.—Form of smoke machine used in testing drains. The smoke is obtained from the combustion of some slow-burning material which is placed in the smoke chamber. By operating the bellows, the material is kept alight and the smoke driven into the drain through the pipe marked "outlet." If the drain is sound, the float rises as the pressure increases. In the case of defective drains, smoke escapes at the defective points.

rockets. These resemble large fireworks, but contain a powder which in burning gives off dense volumes of smoke. They are lighted in the same way as ordinary rockets, and when alight are placed in the drain. The drain outlets are closed when the smoke is seen escaping from them. Smoke rockets are commonly employed in testing soil pipes.

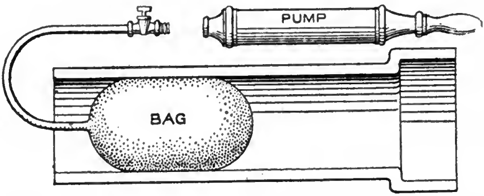

FIG. 86.—Bag used for stopping drains when the water test is to be applied.

The Water or Hydraulic Test is applied by filling up the drain with water. The outlet of the pipe must be stopped first and water poured in from some convenient opening, *e.g.* a water closet or gully. When this apparatus is full the level of the water is marked and the amount of fall, if any, during a period of a half or one hour noted. In applying the test it is necessary to introduce a lead or rubber pipe into the apparatus in order to provide some means for the escape of the air displaced by the water.

The Air or Pneumatic Test is less commonly used than the water test, but it is a very searching one. The only objection to it is that although it reveals the presence of a defect it does not locate it.

For convenience the smell test with *calcium phosphide* has many advantages, but the water test is by far the most useful.

Any of these tests may be applied, of course, to existing drains when it is desired to discover whether or not they are in a sound condition. On the ground that it is unfair to expect an old drain to stand the pressure caused by anything of a head of water, many persons object to its application and require that reliance should be placed on the smell or smoke tests.

Drains and Disease.—The dangers traceable to bad drains arise because fluids, solids, gases, and germs are not confined to the interior of the channels, but are allowed to escape into the air to be breathed, or into the soil and so into water or air.

In many cases the condition produced amounts only to what may be called impairment of health, though, on the other hand, quite a number of definite diseases are stated to be due to defective house drainage, *e.g. enteric fever*, *diphtheria*, *scarlet fever*, and *sore throat* or "poisoned throat."

That there may be some connection between these diseases and defects in drains seems quite probable. Enteric fever can sometimes be definitely traced to the drinking of water which has been contaminated by leakage from a defective drain. In the others, since the trouble is largely in the throat, it seems not at all unlikely that the infection may come from the polluted air, but if not, the undermining of the health and the lowering of resistance which result from breathing the contaminated air are likely to render a person more liable to pick up infection elsewhere.

A "bad throat" is so commonly found in cases in which defects in drainage have been discovered that the fact that there is a connection between them may be regarded as established.

Dampness in houses, which is so often associated with phthisis, rheumatism, and rheumatic affections, is sometimes produced by leakage from drains. The fluid causing the dampness may come either from the overground or the underground drains, and of the overground drains the rain-water pipe is very frequently found to be responsible. Quite often this pipe gets blocked, either at the top or lower down, by leaves and so on, and the water overflowing causes great dampness.

In investigating cases of infectious disease, particularly those mentioned above, in communities at least, an examination of the drainage system is almost invariably carried out.

Practitioners as a rule are alive to the possible relation of defective drainage to disease, and very wisely refer cases to the Medical Officer of Health with a view to having an examination of the drains made and defects, if any, remedied.

CHAPTER XXII

REMOVAL AND DISPOSAL OF REFUSE AND WASTE
(*Continued*)

SEWERS AND SEWAGE

THE channels provided for the collection of the drainage from the various premises in a district are known as *sewers*, and generally, in addition to carrying household and excreted wastes, they take also wastes made on premises used for manufacturing purposes and occupied otherwise than as dwellings, and the fluids collected in the street gullies, the most important of which is the rain water that falls upon the road surfaces. To all this collection the name *sewage* is given.

Construction of Sewers.—In the construction of sewers the object is to ensure that there shall be no leakage and that the contents shall flow along smoothly and reach their destination as rapidly as possible. Speaking broadly, the sewerage system of a community, inasmuch as it consists of branches and mains, closely resembles the drainage system of a house. The *branch sewers* collect from streets and small groups of houses, the *main sewers* serve larger districts, and to them the branches connect.

In the case of branch and small sewers generally, pipes are used and are laid and jointed in exactly the same way as house drains. If a diameter of more than 18 inches is required, *built sewers* are usually put in, specially hard strong bricks being used in order to resist damage by the grit and stones contained in the sewage. Sewers of any size are commonly built with a double wall strengthened by filling the space between the layers with cement. Further, in order that as little resistance as possible shall be offered to the flow of the sewage an oval shape is preferred, the narrow portion of the egg forming the lower end or "invert," the broad end the top or "crown" of the sewer.

The gradient or fall for sewers of from 12 to 24 inches diameter should be sufficient to produce a velocity of not less than $2\frac{1}{2}$ feet per second, and in larger sewers not less than 2 feet per second.

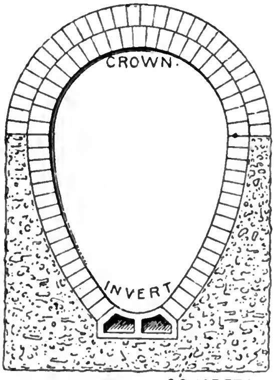

FIG. 87.—Section of egg-shaped sewer.

If a sufficient velocity cannot be attained, some automatic pumping apparatus such as *Shone's ejector or pneumatic system* must be introduced. In this, by taking advantage of any natural gradient there may be, the sewage is collected into a specially constructed tank containing a mechanism which, as soon as a certain level is reached, permits the entrance of air under pressure, whereby the materials are driven into another segment of the sewage system and so onwards until the final outlet is reached. The Shone pneumatic system is in use at the Houses of Parliament and in various provincial towns, amongst them Southampton and Warrington.

To assist the flow of sewage, sewers must be constructed in as straight lines as possible, and when changes of direction are necessary the bends must be given a gentle curve. Branch sewers should enter the main obliquely in the direction of the flow of the sewage, and at these points and wherever there is a change of direction means of access in the shape of a manhole should be constructed.

Ventilation of sewers is considered to be essential, and inlets and outlets for air must be provided. In one method *open gratings* fitted in the top of manholes are looked to to perform both functions, and in another, in addition to providing gratings to act mainly as air inlets, *outlet shafts* connected with the crown of the sewer and fixed to the sides of adjacent buildings, chimneys, and so on are erected.

In some places *ventilating gas lamps* are used. In these gas is continually kept alight, and is supposed, in addition to drawing air from the sewer with which the lamps are connected, to consume some part of it and so prevent nuisance.

One suggestion offered is that the *drain ventilating shafts* might be taken advantage of and made to serve the sewers as well as the drains. In order to bring this about it would be essential to omit the house intercepting trap, and for this reason there are many who object, despite a statement commonly made and well supported that the trap, in addition to being useless for keeping back gas from the sewer, is an obstruction to the free flow of drainage.

A Departmental Committee of the Local Government Board, which inquired into the matter of intercepting traps, more or less decided in favour of omitting them from house drains, and in the course of their report bring out some interesting points with regard to the air of sewers and drains. It is shown, for example, that in sewers in which the sewage is moving the sewer air does not differ from that outside, and that, apart from smell which is sometimes present and which comes from sulphuretted hydrogen and other volatile substances, it is practically harmless. The bacteria present are related to the organisms of the air outside and not to those in the sewage, and, speaking generally, there is so little real danger from sewer air that it is practically not worth while to adopt special measures to prevent its passage into house drains. The air found in drains, as distinct from that in sewers, is much more likely to be harmful since, as a result of splashing, sewage bacteria escape from the contents and may be present in considerable numbers in the air.

Separate Systems of Drainage.—In the majority of districts the *single-sewer system* is preferred to the *separate system* in which one set of pipes carries ordinary sewage and another takes rain water only. The chief advantage of the separate system is that it reduces the expenditure in connection with sewage treatment and disposal, since it is always possible to run the rain water straight into a river or the sea and limit treatment to the sewage proper.

The great objections to it are that two sets of channels are necessary, and that the sewage is apt to become too concentrated and the sewers very foul as a result of the exclusion of the rain water.

Disposal of Sewage.—Local authorities in addition to providing sewers for the carriage of sewage must also provide a place at which, and a method by which, it may be disposed of.

The simplest method to adopt is, naturally, to discharge the sewage either into the sea or into a river.

To the former there is comparatively little objection, and in a number of coast towns the greater part of the sewage is disposed of in the sea, discharging it at a point well below the lowest low-water mark.

Discharge of sewage into *rivers* is generally regarded as objectionable, and the law forbids the discharge to take place until the material has been purified, since not only may nuisance be caused, but, as river water is largely used for drinking purposes, danger to health also.

Sewage Purification.—Purification of sewage means the removal of most of the organic and oxidisable matter and is brought about in a number of ways, the methods generally employed being (*a*) chemical, (*b*) land, (*c*) bacterial or (*d*) combinations of them.

Purification by Chemicals.—This method, though sometimes applied as the sole method of treatment, is best suited for use as a preliminary to other methods. The chemicals commonly employed are combinations of *iron, lime, and alumina.* A mixture consisting of these in certain proportions is added in fixed quantities to the sewage, which thereafter is run into tanks where it stands until precipitation has taken place. The precipitate, which is technically known as *sludge*, consists of the chemicals which have been added and the solid particles of sewage. Usually before the chemicals reach the sewage the larger masses of fæces are removed by making the sewage flow through grids or screens, so that only comparatively small particles are left to be dealt with. In many places, in addition to *screening* the sewage, it is allowed to settle in special *settling tanks* before the chemicals are introduced and the mixture is run into the *precipitation tanks.*

When precipitation is complete the more or less clear fluid or *effluent* is run off and the sludge dug out or otherwise removed and mixed with the gross materials filtered off by the screen and deposited in the settling tank. When collected, the sludge may be dug into land, or pressed into cakes and used as manure, or dumped into the sea.

Apart from removing the gross particles by precipitation the chemicals do very little more, and the effluent, though sometimes it is passed straight into a river, still contains large quantities of organic matter and bacteria and is still capable of undergoing decomposition and of causing nuisance and danger to health. To get rid of the objection, further treatment is necessary, and either the land or bacterial methods may be applied in addition, though they involve additional expense and the occupation of considerable quantities of land.

Land Treatment.—Land may be used in connection with sewage treatment either in the form of intermittent downward filtration or as broad irrigation.

For *intermittent downward filtration* a porous loamy soil is the best, and at least *one acre per* 1,000 *of the population* must be provided unless the process is secondary to chemical treatment, when one acre per 2,000 may be sufficient. The land to be used must be laid out in plots and dug up to form alternate ridges and furrows. The ridges should be some 18 inches in

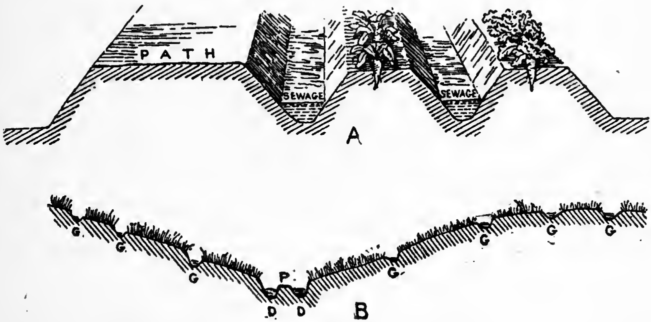

Fig. 88.—Land treatment of sewage. A, intermittent downward filtration; B, broad irrigation.

height and about 5 feet apart. The soil should be underdrained at a depth of 6 feet.

The sewage to be treated is run into the furrows and is purified by the action of vegetation planted upon the ridges and as a result of bacterial action and filtration through the soil.

As soil and vegetation are only capable of dealing with a limited amount of sewage and readily become what is called *sewage sick*, arrangements are made whereby the direction of flow may be changed from time to time. The usual practice is to feed one set of furrows only for a short period and then to allow a period of rest. An acre of land should not be called upon to deal with more than about 200 inches of sewage, or

2·6 gallons per square yard per annum. The effluent collected after filtration may be run straight into a stream.

In *broad irrigation* land with a gentle slope is required, and again a porous soil is to be preferred. If naturally sloping land cannot be obtained, wide ridges 20 to 40 feet apart must be made.

In this method the amount of land required is considerable, at the outside 1 acre to every 300 of the population, and in order to obviate sewage sickness the irrigation should be carried out intermittently. The sewage should be screened before it is run over the land.

In flowing over the slope from carriers placed upon the top of the ridge, the sewage is oxygenated, and in the superficial layers of the soil the organic matter is broken up by the action of bacteria. To assist in this process it is usual to raise crops of various kinds on the land, though the return from sewage farms is not often great.

Although the fear is occasionally expressed that vegetables raised on a sewage farm are unwholesome, there is no reason to believe that this is the case.

Bacterial Methods.—In some of the bacterial systems chief reliance is placed upon anaerobic organisms. In others the aid of the aerobes, which, unlike the anaerobes, require free oxygen, is sought, while in others still both sets are allowed to act.

Anaerobic Systems.—The chief of these is that usually known as *Cameron's septic tank method.* In this the sewage, after having been allowed to settle, is passed into a long, narrow covered tank of a size sufficient to hold twenty-four hours' flow of sewage. When the sewage enters, part of the solids fall to the bottom, while part remain on the surface, where a thick scum rapidly forms. As a result of the action of the organisms all the solids are liquefied. What escapes is entirely fluid and comparatively clear. Before this effluent can be allowed to enter a stream it must undergo oxygenation and purification by passage over land or through a filter.

Another system which is partly anaerobic is known as the *Scott-Moncrieff.* In it the sewage passes upwards through a filter of broken stone, gravel, etc., and in its passage the solid matters are attacked by anaerobic organisms in the interstices of the material. The effluent coming out at the top is led into a channel and thence into troughs which automatically fill and overturn and discharge their contents over trays containing a fine filtering material of clinker. The trays are arranged in series one above the other and each is supposed to harbour a special type of aerobic organism. The final effluent is very good and clear.

Aerobic Systems.—Broadly there are two methods of dealing with sewage aerobically, viz. on the *contact bed* or on the *continuously aerating filter.* In the former, of which the type is that known as *Dibdin's system*, the sewage, after it has been more or less freed from solid matter, is run into a tank filled to a depth of 3 or 4 feet with coarse clinker or stone. Here it remains for two hours, passing afterwards to a second bed of

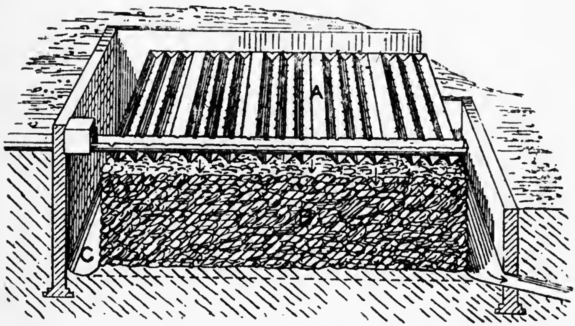

Fig. 89.—Sewage Filter. The sewage passes from the perforated channels (A), and after filtration through the filter medium (B) into the channel (C).

finer material or to a filter bed. After the contact bed is emptied it requires and is generally given a rest of four hours in order to allow aeration to take place.

In the *continuously aerating filter* the sewage freed from solids is fed or sprayed on to the surface of the bed slowly and steadily by means of some automatic arrangement such as a revolving sprinkler. The filter bed consists of broken stones, clinker, and gravel, surrounded by a strongly built wall provided usually with openings for the aeration of the filtering material.

In passing through the filter the fluid undergoes purification as the result of the activity of bacteria which are supposed to be mainly aerobic, and the effluent is collected from the bottom of the bed into channels.

Filters of this kind are generally from 4 to 6 feet deep, but may be deeper. They may be used as a preliminary to land or other treatment, or as a secondary to septic tank treatment, or to filtration through a rougher filter if the filtering material is very fine. All filters require a certain amount of rest from time to time.

The Conservancy System.—In modern and properly organised districts all that the householder is required to do in relation to refuse and waste is to provide the apparatus for collecting it and carrying it away from his premises.

In rural and backward districts and houses erected in isolated situations usually the person who makes the refuse must also see to its disposal and carry it out in such a way that no nuisance shall be caused either to himself or the public. Under such circumstances, though the water-carriage system may be used, quite commonly the so-called *conservancy or dry method* is adopted and the excreted matters, particularly the solids, are collected apart from the liquid wastes and each is dealt with separately.

Cesspools.—If the water-carriage system is introduced, the drainage is arranged in exactly the same way as already described, but the main drain instead of discharging into a sewer is connected up with a *cesspool.*

The position chosen for this should be at least 50 feet from the dwelling and 80 feet from the water supply, and if possible the cesspool should be so arranged that the slope of the ground in which it lies is from the house or the water supply, towards the cesspool. The walls of the receptacle should be of brick, jointed with cement, backed with puddled clay and faced with cement. It should be arched or covered over and ventilated by means of a shaft similar to that provided for drains and carried up to as high a point as possible. An opening should be made in the top through which access may be obtained for emptying or cleaning. This should be fitted with an iron cover sealed down as in the case of manholes.

Just before the drain enters the cesspool an intercepting chamber with a trap and fresh-air inlet should be introduced.

In the ordinary type of cesspool the contents are generally removed from time to time, preferably by means of a pump, and disposed of over land. If, as is sometimes done, an outlet pipe is provided it should draw from below the surface, over which a dirty brown scum, similar to that seen in septic tanks, readily forms. In many cases, indeed, the cesspool is used as a septic tank, the fluid flowing away through the outlet passing into or over the soil where it undergoes purification.

Sometimes instead of constructing a cesspool, a disused well is employed, or in chalky districts a blow-hole in the chalk; but as leakage and contamination of water supplies are likely to occur, these are unsatisfactory. For large mansions specially constructed septic tanks or artificial filters are not un-

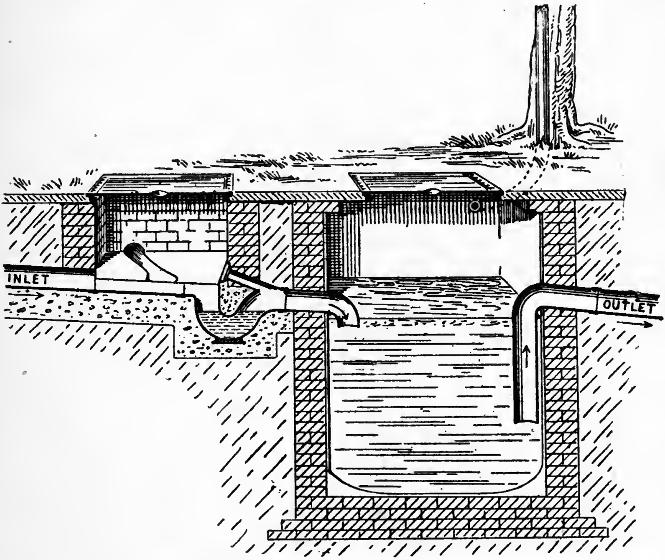

Fig. 90.—To show construction of cesspool. Note intercepting trap between the drain and cesspool.

commonly provided and, if there is plenty of land available, work very well. In some instances a cesspool is provided for the excreta only, the other wastes being carried in a separate set of pipes and distributed over land, reaching a stream after more or less purification has occurred.

In the conservancy or dry system drains and a cesspool may be provided for the carriage and reception of the liquid wastes, though in small cottages it is not uncommonly the case that they are got rid of simply by casting them upon the surface of the ground. As nuisance is apt to be caused, the drains should not be allowed to discharge into a ditch or water-course.

The question of the treatment of the excreta in the dry method is usually met by providing *privies*, *pail closets*, or *earth closets*.

Privies.—Of these the *privy* is the most primitive. In some cases it is taken to mean simply a shelter more or less removed from the house and covering a seat with an opening through

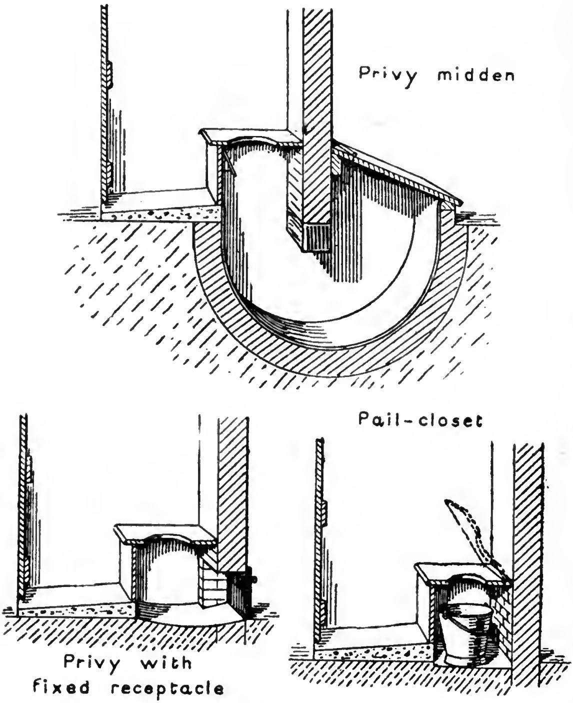

FIG. 91.—Various forms of convenience used in connection with conservancy system.

which the excreta falls upon or into the ground, or the midden provided for the household refuse. Such an arrangement is not uncommon in country districts, and is a source of nuisance and danger to health from saturation of the soil, from leakage into drinking water, and from flies.

As an improvement on this type of convenience what is required is a proper fixed or movable receptacle for the excreta. If the receptacle is fixed it should not be too large, and should be constructed of non-absorbent material and arrangements made for the frequent application of ashes or dry refuse to the filth. Leakage must be guarded against, and no fluid other than urine must be admitted. The seat should be so adjusted that access to the receptacle to empty and cleanse it is easily obtained.

Pail Closets.—The movable receptacle generally provided is a pail, and the privy then becames a *pail closet.* In this form the whole space beneath the seat upon which the pail rests should be flagged or asphalted and raised some distance above the ground and the sides of the space should be well built and cemented. The pail should have a capacity of, at the outside, 2 cubic feet, and arrangements for removing it should be made by making the seat to lift up or the front to pull out.

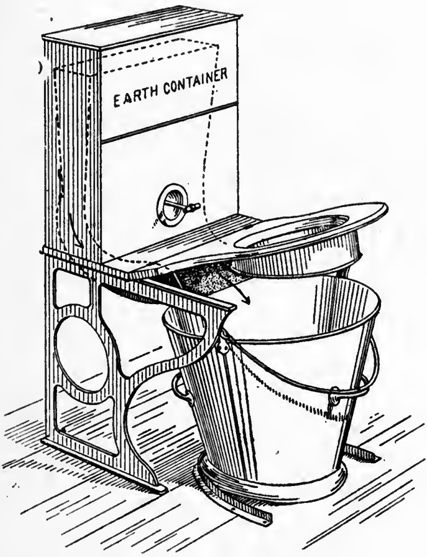

Fig. 92.—Earth Closet.

Though the pail-closet system is really only suitable for country districts, it is still in vogue in a number of English towns. In these the local authority takes the responsibility of removing, cleansing, and replacing the pail, generally at least once a week, though daily removal is really essential if nuisance and danger to health are to be prevented.

In order to diminish the nuisance from the pail the fine part of the house refuse may be directed into it through a sieve upon which the refuse is thrown, or *deodorants, e.g. sulphate of iron*, or special types of pail may be used. In the

Goux system adopted in Halifax the pail is lined with an absorbent material such as chaff or straw.

Privies with fixed or movable receptacles should be properly constructed, and at least 6 feet from any dwelling-house or public building and 40 feet from any well or water supply.

Earth closets are merely privies in which arrangements are made for the application of earth to the filth either by hand or automatically through a mechanism attached to the seat or by the operation of a plug similar to that found in some forms of water closet. The receptacle for excreta may be either fixed or movable. If fixed, it must be watertight and of such a capacity that it must be emptied every three months. In any case the capacity must not exceed 40 cubic feet.

The ordinary form of movable receptacle is a pail having a capacity of, at most, 2 cubic feet. Means of access must be provided for emptying and cleansing.

It is important that the earth used should be dry and capable of bringing about deodorisation and disintegration of the fæces and even the toilet paper. *Garden mould* is the best, but *sand*, *charcoal*, and *sawdust* have also been recommended. When the receptacle is emptied it is usual to dig the contents into the soil and take advantage of any manurial value possessed by the excreta.

In some cases the mixture is set aside to dry, and when disintegration is complete the earth is again used for application to further quantities of excreta. The amount of earth applied is generally about a pound and a half to each deposit. *Moule's earth closet* (Fig. 92) is a good example of the type of convenience commonly used in better-class houses in country districts.

CHAPTER XXIII

REMOVAL AND DISPOSAL OF REFUSE AND WASTE

(Continued)

Household Refuse

Household refuse, since it includes organic and decomposable materials such as scraps of food, is liable to produce nuisance and danger to health, and should be dealt with as carefully, thoroughly, and quickly as possible.

In country districts the occupier of the premises is generally himself responsible for disposal; in communities, the authorities carry out the collection and disposal, leaving it to the occupier to put together the refuse he desires to be removed in such a place that it can easily be got at for removal and at the same time be incapable of giving rise to nuisance or danger to health.

Dustbins.—As regards apparatus, the general requirement nowadays is that this shall take the form of a *portable metal bin* of a convenient size, cylindrical or more or less conical in shape and fitted with a cover.

The bin should be kept outside the house and be placed where the contents can be kept dry and where there is no risk of matters or smells from the bin coming in through windows or doors. The chief carriers of refuse from bins are the wind and flies. If the bin is kept properly covered there is little risk of diffusion in these ways, but flies often choose the dustbin as a breeding-place and very readily find a way in, particularly if it is used for food waste and organic refuse. The rule with regard to refuse should be that nothing should go into the bin that can be burned. Since the introduction of gas and electric cookers, much material that formerly went into the fire now finds its way into the bin, and in such cases it is advisable to wrap vegetable and food refuse in paper before placing it amongst other refuse.

In large establishments in this country, and generally in America and the colonies, the food refuse is placed in separate bins and either sold as " hog wash " or disposed of separately. Bins used for this purpose are apt to become very foul and must be regularly and frequently cleansed. The ordinary dustbin, if flies are to be kept down, must also be cleansed and may be well sprinkled with carbolic powder or other dry disinfectant. Liquid disinfectants are less satisfactory. Flies object very strongly to paraffin, and its use has been suggested, but cleanliness and the exclusion of moist organic matters, and particularly frequent removal, will go a long way towards preventing nuisance from these insects.

Refuse Collection in most districts is carried out at least once

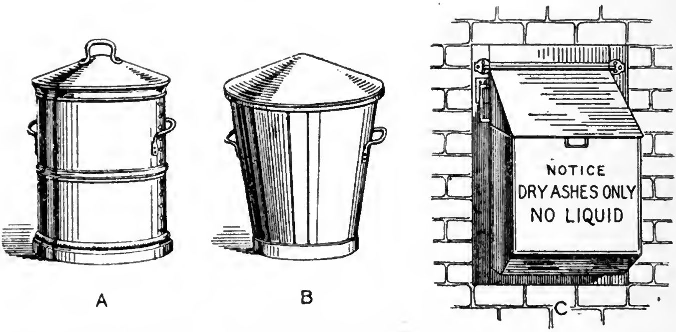

Fig. 93.—A and B, ordinary forms of dust-bin; C, form used in some districts in which yard walls abut upon streets. The figure shows the house side of the wall. The lid being hinged ensures that the dust-bin is always covered.

a week, but the far more satisfactory and sanitary arrangement is to visit each house daily for the purpose of taking away any refuse that may have been produced in the previous twenty-four hours.

When movable bins are provided collection is made from the kerb of the footpath, but in districts in which the collection is made from streets or lanes running between the backs of two sets of houses, the arrangement illustrated in Fig. 93c, is sometimes found and works very satisfactorily.

In cases in which fixed ashpits instead of portable ashbins exist in houses the difficulty of collection is increased, since the dustmen must go on the premises and dig the material out, place it in a basket or some such receptacle, and so carry it to the dustcart. Partly because of this and partly because, no matter how careful the dustmen may be, complete clearance is almost impossible, and the breeding of flies is likely to go on undisturbed, this form of receptacle is always associated with risks of nuisance.

A system in which each house is provided with two bins, one that has been cleansed and disinfected being left in exchange for that removed when full, is strongly advocated and theoretically is an excellent system. Unfortunately it is expensive, and no local authority in this country apparently has as yet adopted it.

In the majority of districts refuse collection is carried out during the night or early hours of the morning. In this way the risk of nuisance is considerably reduced except possibly from noise. Where the dry method of sewage removal is in vogue and pail closets are used it is almost imperative that the collection should be done by night and that special covered carts should be provided for the purpose. In some instances the contents of the pail are emptied direct into the cart, and in others the pail itself, after it has been covered, is removed and replaced by another which has been cleaned. The latter arrangement is by far the most satisfactory, and is adopted in some of the larger towns in which there still exist houses with closets not yet connected up to the sewerage system.

Disposal of Refuse.—In districts of any size destruction of the material, as distinct from disposal by barging it out to sea or tipping it upon waste land or into trenches or worked-out mines or quarries, is the method of disposal preferred.

Generally speaking, the form of destruction applied is burning, and special apparatus known as *destructors* are erected for the purpose.

Roughly, a destructor consists of one or more furnaces so constructed that when the refuse is placed in them and set alight it rapidly burns itself out into a confused heap of hard ash or clinker. In most forms the furnace is arranged to allow of the passing in of the refuse at the top and the removal of the clinker below, and in addition appliances for increasing the amount of heat obtainable from the refuse and for obviating the possibility of nuisance from smoke and dust produced during combustion are provided. The temperature reached during the process may be as high as 3,000° F. in the main flue.

The object of the destructor is to destroy the refuse and to reduce its volume and transform it into something free from nuisance and easily disposed of; but though it undoubtedly offers a good means of getting rid of refuse, the apparatus is apt to be expensive, and numerous attempts have been made to gain something by using the heat to produce steam for public purposes, *e.g.* lighting, and by selling the clinker.

Generally, however, it is found that attempts to transform the destructor into a money-saving or money-making apparatus

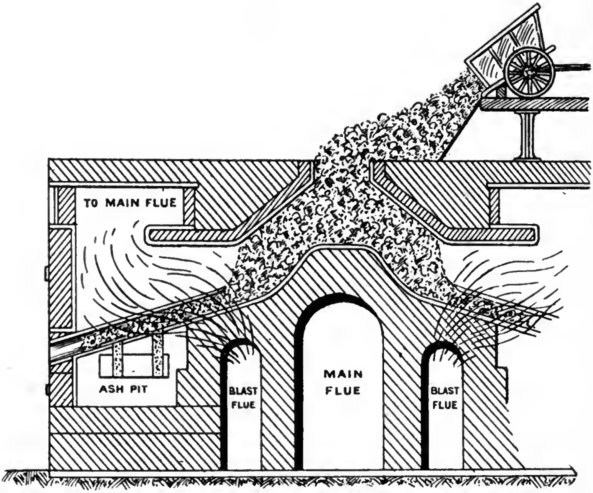

Fig. 94.—Section of Refuse Destructor.

has a tendency to interfere with its utility as a destructor, and in most districts it is used as a destructor only.

In some districts in which material from pail closets is collected it is disposed of by burning. In others it is transformed into a powder by means of heat and sold as manure.

Instead of using an apparatus for burning the refuse, an appliance known as the *Lightning Dust Crusher*, which crushes it into a fine powder, may be installed and gives satisfactory results.

Occasionally complaints are made of nuisance from dust destructors, but if the apparatus is properly manipulated there is little likelihood of this occurring. If it comes at all it is from the fresh refuse awaiting destruction. Most destructors are provided with high chimneys to carry away any objectionable gases, and if dust should escape from the chimney it is because the apparatus is not properly worked or is out of order. In any case it is doubtful if such dust could cause any real injury to health; having been exposed to a very high temperature, it is almost certainly free from germs of disease.

CHAPTER XXIV

THE EXISTING HOUSE

A GREAT deal of space has been given to the discussion of various points in regard to the construction of new houses, the materials to be used, the system to be adopted in relation to draining, ventilation, lighting, heating, and so on, although, as already explained, no provision is made by the law or by the bodies referred to in enactments for any part of the work being under the supervision of the Medical Officer of Health.

Not until the building is completed is this officer given any concern with it, and then he is charged with the duty of preventing any damage to the health of the occupants as the result of occupying it. If he discovers any defects in the building or if he finds or suspects that any condition from which an occupant is suffering is due to a possible defect, he is required to indicate the defect, state how it is to be remedied, and to supervise the carrying out of the remedial work, and to put machinery in motion that will lead to the removal or remedying of the defect.

Inspection of Houses.—In order to assist them in discovering the defects which they are empowered to see put right, health authorities and their officers have had very full powers conferred upon them. Amongst these should be mentioned the power and duty of carrying out a *House-to-House Inspection* of the district, and a visitation and inspection of every house. The extent of the inspection is laid down in a set of rules issued by the Local Government Board, and this omits practically nothing from the front to the back and from the roof to the very lowest part of the house. In order to assist the officers they are given absolutely full *powers of entry* on any premises, and if entry is refused, a warrant may be obtained and any person offering obstruction may be punished.

The defects that may be encountered and dealt with are important and may be summarised.

Drain Defects.—The public and many members of the medical profession attach great importance to defects in drainage as sources of danger to health. Because of this in every public health department a very considerable percentage of the complaints received allege that the drains are bad and that great quantities of "sewer gas" find their way into the premises to the detriment of health.

Proof that there is a justification for such statements is difficult to find, since it can be demonstrated that defective drains are exceedingly common in most districts, and very many instances might be quoted of families living for years without illness of any kind in houses where the drains are seriously defective.

Nevertheless, a defective drain and the soil contaminated from it may at any time become a serious danger. Without warning, germs capable of causing disease in a susceptible person may escape. As soon, therefore, as the existence of defects is discovered, they should be given attention in order that any possible danger to health may be removed.

The reasons for stating that even when the conditions are very bad there may be no evidence, such as smell, for example, have already been given, and nearly always an examination by an expert is necessary before anything definite can be established.

An examination of the drainage system is made always at house-to-house inspections and after complaint. In some districts also it is made after receipt of a notification of a case of any infectious disease, but particularly if the disease happens to be diphtheria or enteric fever. These inspections are carried out by the sanitary inspectors, and it is because they are called upon to make them and to supervise the work of remedying defects and reconstructing of drainage that they are required to possess a very full knowledge of drains and drainage work.

The tests that may be applied to drains are referred to in the chapter on drains. Any or all of these may be applied, though probably the *smell test*, because it is the most convenient, is most frequently used.

The practice in relation to *exposing drains for examination* varies considerably, but power to enter premises and make such an examination is given in the Public Health Acts, which require also that notice shall be given to the occupier in the first instance.

After the discovery of defects it is the duty of the authority of the district to give instructions for the service of notice on the owner to carry out the work necessary to make the drain sound. A reasonable amount of time must be allowed, and if the work is not completed when this time has expired application may be made to a Court and an order requiring it to be done obtained. The person failing to comply with the notice may also be fined.

Overcrowding.—Many complaints as to overcrowding are made to Medical Officers of Health, and in large districts particularly many instances are detected in the course of house-to-house inspection.

Generally speaking, a house or a room is held to be overcrowded if it does not contain sufficient cubic space to allow of each adult occupant having 300 cubic feet in a sleeping-room, or 400 cubic feet if the room is used both as a living- and sleeping-room, and each child half these amounts.

The condition is one difficult to detect, for the reason that the persons who overcrowd know quite well that overcrowding is illegal and do not give accurate information with regard to the number of occupants. It is difficult to deal with also because it is the poor who overcrowd, and they only do so because they have not the means to pay for full and proper accommodation. Great hardship is apt to be caused if the legal provisions against overcrowding are too strictly enforced, and generally each case is considered on its merits and often considerable latitude is allowed.

Amongst the conditions associated with overcrowding are anæmia, rickets, tuberculosis, and probably other infectious diseases, since the resistance of persons exposed to overcrowding is apt to be reduced, either on account of it or the attendant poverty. Amongst school children a very large proportion of those who suffer from adenoids is found amongst those whose homes are ill-ventilated and overcrowded.

Dirt and Vermin.—Houses that are dirty or verminous or both are only too frequently found in the poorer parts of most districts. A house that is dirty can easily be shown to be in such a state as to be a nuisance or injurious to health, and there is every justification for serving notice calling for cleansing and for removal and renewal of the wall covering. If there are also vermin it is required further that steps be taken to destroy these.

The difficulty in getting rid of bugs is often great, and it is essential that all old wall papers be removed and that some strong disinfectant or acid be introduced behind woodwork and especially into corners. Furniture, pictures, beds, etc., should be attended to also.

In all the Public Health Acts it is provided that if a medical practitioner certifies that cleansing of any premises is necessary in order to prevent the occurrence or spread of infection the local authority must order it to be carried out.

Dampness is a fairly common nuisance and may be associated with defective construction of the premises, viz. absence of a damp-proof course or of concrete over the site. It may arise also from defective drains or rain-water pipes. Some indication as to the source is to be obtained from the situation of the dampness. Defects in drainage and in rain-water pipes are of course easily dealt with, but dampness due to absence of a damp-proof course is exceedingly difficult to get rid of. The conditions generally regarded as apt to occur in damp houses are rheumatism, phthisis, and respiratory troubles.

Special Classes of Dwellings.—*Common Lodging Houses* are places to which members of the poorer classes resort and, though strangers to one another, occupy the same room. The occupation is for short periods only, generally one night, and payment is made nightly.

The person in charge of such premises is required to comply with a certain standard as regards closet and lavatory accommodation (one to every twenty lodgers) and space (300 cubic feet per head). No premises may be used until registered and no person may act as a common lodging-house keeper until he has been registered. Medical Officers of Health and inspectors may enter the premises at any hour, day or night, to see that rules, particularly as regards the amount of cubic space per head and overcrowding, are complied with.

Cleanliness and *ventilation* are very strongly insisted upon, and in the event of infectious disease occurring on the premises immediate removal of the patient to hospital may be required.

The common lodging house is of great importance in connection with infectious disease and particularly smallpox, as the lodgers are continually coming and going and are apt to carry infection with them.

Tenement houses or houses let in lodgings are created by dividing up houses originally intended for one family only and letting them by floors or rooms furnished or unfurnished to several families. The difficulty in them is to fix on any one person the responsibility for keeping the premises clean and free from nuisance. As in the case of common lodging houses, special provisions are laid down in by-laws with regard to registration of the premises and as to sanitary conveniences, cleansing, prevention of overcrowding, and other matters. In London it is required that there should be one water closet to every twelve occupants, and that the cubic space in sleeping-rooms per head should be 300 and in living- and sleeping-rooms 400 cubic feet. Cleansing is to be carried out once a year. Inspectors are given the power to enter and see that the various rules are obeyed.

Underground rooms are sometimes described as "cellar dwellings," and unless they comply with certain requirements as to width of area in front, height of ceiling above ground, and so on, they may not be occupied. The objection to such rooms is that they are difficult to light and ventilate and are for this reason unsuitable for human occupation.

A local authority may close such as are unsuitable for sleeping purposes and forbid them to be so used.

Closure and Demolition of Houses.—The powers of the local authority over houses are sufficiently great to allow them to close them if they are unfit for habitation and to have them demolished if they cannot be made fit. These powers were only granted in 1909 ; prior to that date only the courts could make the orders for closure and demolition.

The closing order of the local authority is made after receipt of a representation from the Medical Officer of Health or other officer, but any person who has formed the opinion that a dwelling is unfit for habitation may report directly to the authority or, preferably, to the Medical Officer of Health.

With regard to condemnation of houses it is to be noted that the condition of the premises and all the circumstances must be considered before arriving at the conclusion that the only possible procedure is by way of a closing order.

The possibility of carrying out repairs and alterations must always be taken into consideration, and the Medical Officer of

Health is practically bound to consider these matters before he calls upon the local authority to take advantage of their powers.

Medical practitioners must also bear these points in mind, since, in more than one section of the Acts relating to housing, reference is made to representations and reports from practitioners as to the condition of houses.

CHAPTER XXV

SCHOOL HYGIENE

School Construction.—Many of the suggestions as to building construction offered in earlier chapters apply equally to schools, and here it is only proposed to mention such matters as may be regarded as peculiar to such institutions.

The School Site should be elevated and sufficiently large to allow of the provision of an open, airy *playground* of such a size as to provide at least 30 square feet per child. Near the centre of large cities difficulty may be experienced in obtaining even this space and sometimes a playground is provided on the roof. The buildings should be as far as possible from others likely either to interfere with the lighting of the school or the air to be breathed by the children, and, because of the risk of accidents to the children and the nervous strain produced by noise, a site amongst mean, noisy, and busy streets should not be chosen.

The School Building.—Size.—If the school is to be properly managed, no one person can be expected to control more than 400 to 500 children, and a one-department school need not therefore provide accommodation for more than this number. Very commonly, however, schools consisting of two or more departments are erected and accommodation for 400 or 500 children in each may have to be made.

The *height* of the building depends upon the size of the site and the size of the school, but in order to reduce the number of stairs, which strain children and are a danger in case of fire, a two-storied building is probably high enough.

In regard to the placing of the school on the site the rules laid down as to other buildings apply, and should be followed.

The School Plan.—In drawing up the school plan, the classroom should be considered first. The number of classrooms to be provided will depend upon the number of pupils to be accommodated and the number of classes into which they are to be split. The rule should be one class to one room, each accommodating not more than from forty to forty-five children with an allowance of 15 square feet per child. In elementary schools, classes much larger than this are allowed, with a minimum floor space of 10 square feet.

In *shape* the classroom should be more or less oblong, since lighting and supervision can be more satisfactorily carried out than in a quite square room. The dimensions suggested for an oblong room to contain forty-eight pupils are: length 30 feet, width 25 feet, and height 13 feet. In such a room each child would have 15 square feet of floor space and

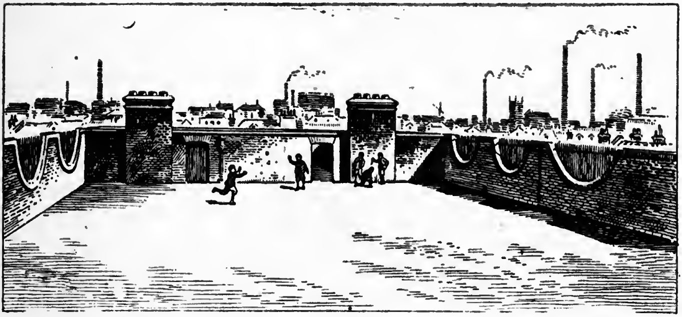

FIG. 95.—A school playground on the roof of the building.

slightly over 200 cubic feet of air space. In *height*, classrooms should not exceed 12 or 13 feet, since ventilation and cleaning difficulties increase with any height above this.

The *distribution* of the rooms depends upon whether the assembly hall be central or lateral. The chief objections to the central hall are difficulties in connection with ventilation both of the hall and the classrooms. With the lateral assembly hall with classrooms on one side only, because it can have windows along one side, more or less through ventilation both of halls and classrooms is secured.

Apart from classrooms, *cloakrooms* are also called for. They should always be distinct and separate from the classrooms in order that the unpleasant odours from the garments and any infection which they may harbour may be excluded. They should open direct from the corridors and should be well lighted and ventilated, and allow a space of at least 150 square feet for every fifty pupils. The hat and coat pegs should be at a convenient height, and the space between individual pegs should measure from 12 to 15 inches. Umbrella racks with proper drip channels are useful, and hot-water radiators to assist in the drying of wet garments should not be omitted.

Corridors should be 10 to 12 feet wide, and well lighted and ventilated by means of windows. Light may be borrowed from classrooms, but no classroom should receive its main

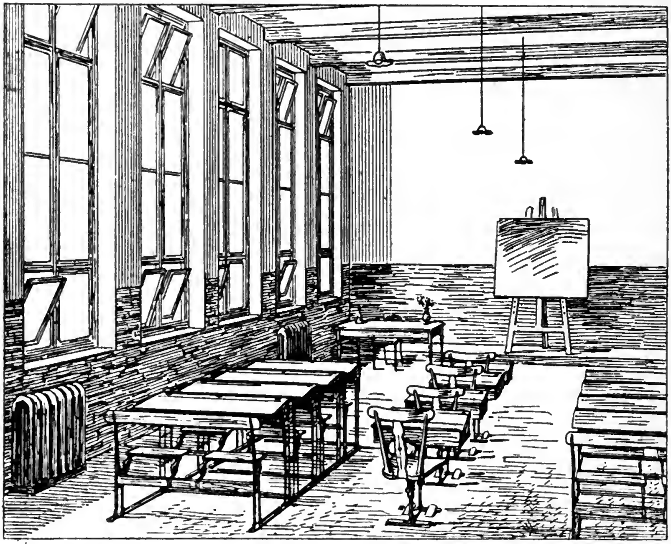

Fig. 96.—A school classroom, showing method of arranging windows in relation to lighting. Both single and dual seats and desks are shown.

light from a corridor. The walls should be smooth and light-coloured and the floors of asphalt or other hard material.

Staircases should be easily accessible and well lighted. They should be at least 5 feet wide, and the flights should be short and straight with a landing at every eight or ten steps, each step being not more than 6 inches high and 12 or 13 inches wide.

Doorways to rooms should be at least 3 feet 6 inches wide; doors if not made to open both inwards and outwards, should open outwards. The entrances to the school building should be wide and from quiet thoroughfares.

Lighting of Classrooms.—Windows.—The *window area* in relation to the size of the room should be one-fourth of the floor space. The windows giving the chief light should be placed on that side of the room which is to be to the *left* of the pupils. Windows on other sides—*supplementary light windows*—though of assistance in ventilation, are apt, if too large, to interfere with the main lighting. Supplementary windows, if any, should be on the right of the pupils. The glare from windows in front of the children is apt to dazzle the eyes and that from windows behind to cast a shadow on the pupils' work. Top lights are unsatisfactory and should not be used.

The windows should be wide and not too far apart, and should go as close up to the ceiling as possible in order to obtain as many rays inclining from above downwards as possible. The window-sill should be about 4 feet above the floor and the panes of *glass* should not be too much broken up by woodwork. No room is satisfactorily lighted in which small print cannot be read in any corner when held at a distance of from 12 to 16 inches from the normal eye.

Artificial lighting is best brought about by means of electricity, but if electric light cannot be obtained, incandescent gas is probably the next best. The lights should be arranged in such a way that the whole room is well lighted and that shadows are not cast over the pupils' work.

Ventilation.—Theoretically, the only satisfactory way of ventilating a school building is by artificial means, but as mechanical methods are so expensive and so difficult to control, the natural method and the windows, doors, and fireplaces are generally depended upon. In addition to the natural openings, contrivances, such as those already described, which permanently assist in ventilation are occasionally introduced.

Warming.—In large classrooms *steam* or *hot-water pipes*, arranged in the form of *radiators*, are almost essential, and as already explained it is better to have several small radiators instead of one large one in each room, and to place them in front of air inlets in order that the heat may draw in fresh air and at the same time warm it. Pipes running round the room at the bottom of the walls are dirty, and do not assist ventilation at all. In addition to hot-water or steam radiators, it is advisable to provide a fireplace in each room in order to have the assistance of the chimney as a foul-air outlet.

The best working temperature for a classroom is between 60° and 65° Fahrenheit, and there should always be a thermometer in each classroom and this should be consulted by the teacher from time to time during a class session.

Furnishing.—The most important articles of furniture in the classroom are the seats and desks. For the elementary school the *single seat and desk*—which is undoubtedly the best—is objected to because of its price and because it takes up a greater amount of space than the seat and desk for two or more pupils. Its advantages are that it can be adapted to the child who is to occupy it, and the desk portion can be adjusted for the various exercises to be performed at it. With the *dual* or other form there is no possibility of suiting the seat to the child; even though the desk be adjustable it can never be fitted, so far as height is concerned, to all the children working at it.

Fixed seats and desks are never quite suitable. In the case of the seat it is essential that the back and the seat should be capable of being moved up and down so that the feet of any child occupying it may be allowed to rest square upon the floor and his back be provided with support just below the shoulder-blades. In the case of the desk it is essential that alterations should be possible in height and in distance, *i.e.*, the space between the edge of the seat and the front edge of the desk. Seats and desks which have only one fixed distance may lead to eye strain and spinal curvature and other deformities.

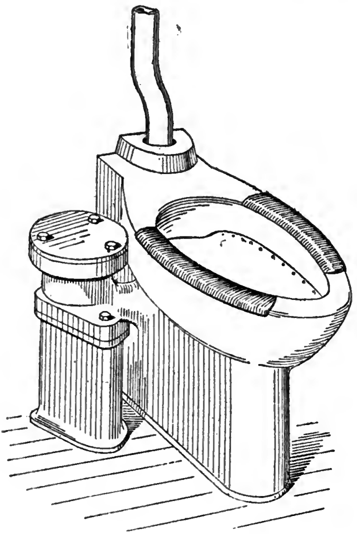

Fig. 97.—Form of wash-down closet recommended for use in schools.

Sanitation.—Only the most up-to-date sanitary appliances should be used in schools; the *drainage* should be properly constructed and water- and gas-tight. *Closets* of the most approved type should be used, and there should be a plentiful supply of lavatory basins, water, soap, and towels.

Formerly the sanitary convenience preferred was the *trough.* This form, however, is disappearing and its place is being taken by the separate *wash-down closet* with the separate flushing cistern.

The number of closets depends upon the size of the school, but the minimum should be one for every fifteen girls and one for every twenty boys. In addition, *urinal* accommodation is required for the boys, and white glazed stalls, not slate slabs, should be introduced.

The *lavatory basins* should be placed near the sanitary conveniences and should be as plentiful as, if not more plentiful than, the conveniences themselves. Towels should also be provided, and since roller towels may spread such conditions as skin diseases and eye affections, single towels should be used and frequently changed.

Fig. 98.—School Drinking Fountain. The water discharges upwards and the child drinks direct from the stream.

In addition to providing these conveniences, the advisability of introducing one or more plunge or shower *baths* may also be suggested.

Water.—No water from a doubtful source should be used. The *drinking fountains* should be conveniently situated and numerous, and if the children are to be allowed to drink out of metal cups, they should be taught, in order to avoid the spread of such diseases as diphtheria, to well rinse the cup before use, and to dip the lips into the water rather than grip the edge of the cup between the lips. Fountains in which the water is directed upwards from the tap into the child's mouth and no cup is required are recommended by some, but are not greatly favoured in this country.

Cleansing.—In order to prevent the spread of infectious germs by means of dust, cleansing should be regularly and thoroughly attended to, and damp dusting and washing and scrubbing of the floors of classrooms, corridors, cloakrooms, lavatories, etc., properly carried out. In certain quarters there is a tendency to recommend the use of disinfectants of various kinds in the school, but if plenty of soap and water are used and the washing, scrubbing, and dusting are thoroughly and energetically done day by day, the routine use of disinfectants becomes quite unnecessary.

The Existing School.—What has gone before refers mainly to new schools, but it should be remembered that many existing schools are far from hygienic. In some cases the defects may be remediable, *e.g.* in the case of overcrowding, defective sanitation, lighting, and ventilation, while in others they may be so bad that complete reconstruction is necessary. As with houses, so with schools, each must be considered on its merits, and unless conditions are incapable of improvement there will not be absolute condemnation.

School Work.—In a sketch of school hygiene such as this, it is only possible to refer to some classes of school work and a few of the school articles and arrangements that may affect the health of the children, and to indicate shortly some of the conditions that may be caused.

Apart from infectious diseases, already dealt with, the main risks are of injury to eyesight.

Eye defects are very commonly found amongst school children ; in London, for instance, it was recently noted that amongst children from eight to nine years of age about 15 per cent. and of those aged twelve about 16 per cent. required treatment.

Reading, writing, sewing, and other work naturally throwing a strain on the eyes because it is carried out close to them are blamed.

Reading and Print.—The print employed for school-books should be such as will ensure the book being held no nearer to the eye than between 10 and 12 inches. On the whole, in this country, there is little to complain of in connection with the size of the print, though occasionally, in the infant school, books are met with the print of which is too small for infant use. The letters should be clearly printed and there should be a sufficient space between the words in each line and between the letters in each word. The space between the lines should also be fairly wide, and the lines should not be too long. The colour of the paper should be good and the surface dull and smooth.

Writing and Writing Materials.—Slates and slate pencils should not be used. Paper and lead pencils or pens are more cleanly, and, because a better contrast is obtained, less strain is thrown on the eyes. For young children who cannot co-ordinate the fine muscles concerned with writing, crayons and brown paper, or chalk and a blackboard, are much better than pencils or pens and paper.

Since the attitudes taken up in writing may be answerable for visual troubles, as well as deformities such as curvature of the spine, writing lessons should be short.

Sewing as a producer of defective vision is very much condemned because the needle, the thread, and the material used may all induce approximation of the work to the eye and lead to strain. In infant schools sewing is now an optional subject until after the age of five.

Defective Children and Medical Inspection.—The ideal aimed at by the Board of Education, in relation to school medical inspection, is to ensure examination of each child at the time of entry and again just before the time for leaving school is approaching.

These children are commonly named *entrants* and *leavers*, and the ages at which the examinations are made are for the entrants five to six and the leavers twelve to thirteen, the age for leaving school being thirteen. Because the requirement as to examination is laid down in a code of the Board of Education, the groups are sometimes called *code groups*.

A third examination which it is desired to see carried out would be made at some period between the date of entering and that of leaving, *e.g.* when the child is from eight to ten years old. In quite a number of districts a practice is made of examining such an *intermediate non-code group*, and in the majority, even if the extra group is not examined, a considerable number of *special or selected cases* are seen and re-examinations are made of children sent for treatment or marked at the first inspection.

A very full record is made with regard to each child, showing medical and health history previous to entering school, condition at time of inspection, and so on.

Generally the routine examinations at least are made in the school, and very frequently the doctor has the assistance of a school nurse. Parents are invited to attend, and a fair proportion take advantage of the invitation.

In each case, height and weight are taken and note is made with regard to sight, hearing, cleanliness, clothing, nutrition, and the presence or absence of lesions in the heart and other organs. On an average about ten children per hour are examined. In the main, the conditions met with are such as can be comparatively easily remedied. The number of children it is found necessary to refer for treatment, however, is generally considerable.

Nose and throat conditions are very common amongst school children, and many of those referred for treatment are so dealt with on account of *adenoids* or *enlarged tonsils*. Much of the deafness met with in schools is the result of adenoids.

External eye disease is not at all uncommon; but apart from *otorrhœa*, ear disease is not often noted.

Probably the greatest amount of trouble is experienced with *teeth*, the elementary school child without carious teeth being the exception.

Tuberculosis is not particularly common, although opinions seem to differ with regard to the frequency of the pulmonary form amongst children of school age.

Of conditions affecting the nervous system *chorea* is perhaps the commonest, though it is not unusual for teachers to allege that children who are restless and jerky and highly strung, as a result of overwork at home or at school, are suffering from this condition.

Skin troubles are common, and *ringworm* particularly may be a source of worry and annoyance, and though in some cases if the scalp is affected the child is not excluded if a special cap is worn, the question as to whether or not infected scholars are to be allowed to attend school is often discussed.

In connection with the examinations into the *mental condition* of the children many interesting types are seen. Many children classed as "dull and backward" by teachers are proved to be so only because they suffer from defective hearing or defective vision. Others are so classed because they are *word blind* as a result of some defect in the connections between the receptive and perceptive centres in the brain.

Mentally defective children require special treatment as regards teaching, and quite a number of education authorities have established special schools for the purpose.

Treatment.—In some places arrangements have been entered into between the education authority and existing institutions, and children requiring treatment are sent to local hospitals. In other places special centres have been established and special officers appointed. *Dental clinics* particularly have been found necessary, and many authorities have now a school dentist carrying out treatment on their behalf. Special centres for the treatment of ringworm are not uncommonly established.

Special Schools.—In many districts in addition to special schools for mentally defective children, schools for children who are lame or otherwise physically defective have been found necessary and have been provided.

Open-air schools for children who are or are suspected to be tuberculous are becoming more and more common. In these, except in the worst of weathers, most of the teaching is given out-of-doors, and the time-table is so arranged as to allow of the pupils having certain periods of rest.

CHAPTER XXVI

PUBLIC HEALTH ADMINISTRATION

Broadly speaking, the authorities concerned with public health administration may be classed as Central and Local.

Central Authorities.—Of the *central authorities* probably the most important is the *Local Government Board*, though the Home Office, the Board of Agriculture, the Board of Education, and others of the large central departments have certain responsibilities, and must be classed as central authorities concerned with public health.

The *Local Government Board* consists of a number of high Government officials, presided over by a President, who is one of the most important members of the Government which happens to be in power at the moment. Mainly it is a supervisory body, and its chief *duties* in relation to public health seem to be the issuing of instructions to the local authorities or acting as a court of appeal in matters affecting housing of the working-classes and sanitation generally. In addition it is concerned with registration of births, deaths, and marriages, vaccination, administration of the poor law, local government, and other matters.

Organisation of Local Authorities.—The *local authorities* are the Councils of the various areas, Counties, Boroughs, Urban and Rural Districts of Counties, and Parishes into which the country is divided. They are mainly executive bodies charged with the duty of putting into operation such measures as are likely to protect the inhabitants from disease and generally to benefit their health. In preceding pages sufficient reference has been made to these measures, and the mode of carrying them out. In practice, for the reason that the authority has a vast number of other things to do on behalf of the community they represent—*e.g.* light the district, pave the streets, attend to the policing of the district, collect the rates for paying for these and other matters—it is unusual, in districts of any size, to find the whole council attending directly to the protection of the public health.

Most commonly the work is delegated to certain councillors who form a *committee* known generally as the "Public Health Committee," and endeavour to bring about the results aimed at by the local authority by means of certain provisions in Acts of Parliament, by-laws, and other measures which impose duties on individuals or certain classes of individuals, and the local authority itself.

Officers of Local Authorities.—That the council itself and its committee cannot themselves see that the requirements are complied with is recognised by the law, and they are empowered, therefore, to appoint certain *officers* to attend to the work on their behalf.

The Medical Officer of Health.—The *chief executive officer* is the Medical Officer of Health, a medical man who, in addition to the ordinary medical qualifications, possesses and is bound to possess *special qualifications* in sanitary science and public health. Appointed by the local authority, or, in the case of small districts united for the purpose, by each of the local authorities, the Medical Officer of Health belongs chiefly to them and his duties are performed almost entirely in the district for which he acts. At the same time, however, he is regarded as being responsible in many ways to the Local Government Board, who issue regulations relating to his duties and exercise control in connection with his *appointment.* The *duties* laid down by the Board refer to the inspections he must make; to matters regarding which he is to give advice to his local authority; to the action which he must take in connection with the prevention of disease, and the detection and removal of nuisances; to offensive trades and unsound food; and to the making of reports for submission to the local authority and the Local Government Board.

The making of reports, and particularly of an annual report, is one duty to which great importance is attached by the authorities. In the annual report the Medical Officer of Health is required to refer to the work done during the year, to set out the provision made by the authority for the protection of the public health and the action taken in respect of any advice given by him. Copies of this report are sent to the Local Government Board and to the Home Office. Medical Officers of Health of districts not counties must send copies to the County Council also. The payment of the Medical Officer of

Health's salary, which comes partly out of Government funds through the County Council, is made to depend to some extent on the annual report, and any failure to report or to send copies may be met by a refusal to contribute to the salary.

The majority of his more or less sanitary duties are not carried out directly by the Medical Officer of Health, but under his supervision by officers named *Sanitary Inspectors* or Inspectors of Nuisances. These officers, like Medical Officers of Health, are appointed by the local authority, but are also to some extent under the control of the Local Government Board, by whom their duties are prescribed.

For the carrying out of the more definitely medical duties the Medical Officer of Health is held responsible, though, if the district is at all large, special medical assistants are generally appointed, *e.g.* School Medical Inspectors, Tuberculosis Officers, etc.

The method of carrying out and *distributing the duties* imposed upon him depends largely upon the constitution of the staff of the individual Medical Officer of Health.

For the purposes of inspections the area is usually divided into districts which are entrusted each to an inspector who is expected to make himself thoroughly acquainted with it and to examine premises for nuisances, either after complaint or as a matter of routine.

The size of the district allocated to any one inspector depends almost entirely upon local conditions, but is, of course, affected by the size of the area and the number of inspectors upon the staff.

In addition to inspection work, each inspector, in his district, usually performs certain other duties in connection with infectious diseases, making inquiries as to source of infection, contacts, condition of the home, and so on, for the Medical Officer of Health, who determines the action to be taken when the results of the inquiry are reported to him. Removal of infected persons for isolation and disinfection of the premises may be carried out or arranged for also by the inspector. In large towns, however, this work, along with many other duties, *e.g.* in connection with the protection of the food supply, may be entrusted to special members of the staff acting under the Medical Officer of Health.

Treatment of infectious disease is carried out at a hospital or hospitals provided by the local authority. The staff of these hospitals consists of medical and nursing members who, in the largest of the large towns, are only indirectly under the Medical Officer of Health through a Medical Superintendent of the Institution. In the smaller of the large towns the Medical Officer of Health usually administers the hospitals of the local authority, in addition to carrying out his other duties.

Apart from the special staffs mentioned above, officers to carry out such work as may lead to the *prevention of phthisis* and of *infantile mortality* are required. Other officers to supervise the work of midwives and to inspect or assist in inspecting schools and school children are also necessary.

Some of these officers must be medically qualified, *e.g.* the *Tuberculosis Officer* and the *School Medical Inspector*; others may be lay. As lay workers in respect of the work mentioned, women are generally preferred, and appointments of tuberculosis nurses, of health visitors for infantile mortality work and work among midwives, and of school nurses, are usually made.

In some cases the women workers also have duties relating to the health of women employed in *factories and workshops*, and under the direction of the Medical Officer of Health see that conditions inimical to health are remedied in or removed from such places.

The *qualifications* required of women inspectors are similar to those called for in the case of their male colleagues, though preference is usually given to women who have had training or experience in nursing and midwifery.

More recently the place of the fully qualified woman inspector has been taken to a certain extent by what are known as *Health Visitors*. Generally the women appointed are not required to possess the sanitary qualifications of an inspector, but since their work is mainly directed to infant life protection, training and experience in health subjects, nursing, and midwifery are considered advantages.

School Medical Work.—Work in connection with schools and scholars, which receives a great amount of attention, has added considerably to the duties of the Medical Officer of Health. In most towns, indeed, he is the *School Medical Officer*, and may, if the district is small, carry out the school work himself in addition to the ordinary routine and other duties of his office. In the larger districts the routine work is generally left to more or less junior officers, male or female, who are known as Assistant School Medical Officers or School Medical Inspectors. These officers usually report to the Medical Officer of Health, by whom any powers directed by statutes or orders to be enforced by a school medical officer are carried out.

Tuberculosis.—In regard to tuberculosis the arrangement is much the same as that described in connection with school medical work. The Medical Officer of Health may himself carry out the duties of *Tuberculosis Officer*, which include a number performed under the *Insurance Act* on behalf of the Insurance Committee, a body not uncommonly distinct from the local authority. In large areas, *e.g.* counties and large towns, the Medical Officer of Health attends to the administrative part of the work of the Tuberculosis Officer, leaving the examination of patients and contacts, and clinical work generally, to assistants.

Clerical Work.—In addition to the more or less professional members, the Medical Officer of Health has, of necessity, a staff of clerks responsible for the purely clerical work arising out of the duties performed by him and his assistants and inspectors. This *clerical staff* is not the least important, and in some towns is very large.

Laboratory Work.—The *Laboratory Work* and the bacteriological and chemical investigations which play such an important part in modern public health work are usually carried out, the former by a distinct official, known as the *Public Analyst*, the latter by a bacteriologist appointed for the purpose.

The fact that such matters as *sewers and sewer construction*, *sanitation of new buildings*, *sewage disposal*, *water supply*, and *scavenging* of streets and *refuse removal* are not generally under the control of the Medical Officer of Health has already been stated.

The *sanitation of new buildings* is, with few exceptions, in the hands of an officer named the *City* or *Borough Surveyor*, who may attend to nothing else but new buildings, or may combine duties in connection with these with certain engineering or other duties.

Scavenging and refuse removal if carried out by the local authority, as is generally the case, are supervised by an officer named the *Cleansing Superintendent*.

Other very important duties with which the Medical Officer of Health has no concern are those relating to *vaccination*, which is and always has been entrusted to distinct bodies, viz. the Boards of Guardians of the Poor. The actual work of vaccination is done by Public Vaccinators appointed by the

Guardians, but placed, like the Medical Officer of Health, under the supervision of the Local Government Board.

In *Scotland* and *Ireland* the arrangements are very largely the same as in England and Wales. In each, the country is divided in the same way as England and Wales, and the councils of the various areas act as local authorities. Medical Officers of Health are appointed in the same way and work on lines similar to those followed by the officers in England and Wales. In the county areas in Scotland the Medical Officer of Health is to some extent an executive officer and, in addition to acting as county Medical Officer of Health, performs similar duties on behalf of some of the smaller districts within his county.

In *London* there are in addition to the County Council twenty-nine local authorities. These last are the Councils of the Metropolitan Cities and Boroughs, and in the Act relating to public health in the Metropolis, viz. *The Public Health* (*London*) *Act*, 1891, they alone are known as *Sanitary Authorities*, *i.e.* have executive powers under the Act.

One great difference between the arrangements in London and those existing in the remainder of the country is in respect of infectious disease. In the provinces the local councils themselves provide and have control over the hospitals intended for the isolation of infected persons. In London this is in the hands of a special body known as the *Metropolitan Asylums Board*, which consists of members elected by the Boards of Guardians and not the Councils. The money required for carrying on and maintaining the hospitals is, however, paid by the Councils and not by the Boards of Guardians.

CHAPTER XXVII

SANITARY LAW

To the group of Acts of Parliament, by-laws, and regulations, etc., containing the powers and imposing the duties referred to in preceding sections the name *Sanitary Law* is given. Together these measures form a very large volume of law, of the extent of which some sort of indication may be obtained from the following list of a few of the Acts:

The Public Health Act, 1875.
Public Health Acts (Amendment) Acts, 1890 and 1907.
Infectious Disease (Notification) Act, 1889.
Infectious Disease (Prevention) Act, 1890.
Vaccination Acts, 1867–1907.
Housing of the Working Classes Act, 1885–1903.
Housing, Town Planning, etc., Act, 1909.
Sale of Food and Drugs Acts.
Margarine Act, 1887.
Butter and Margarine Act, 1907.
Factory and Workshop Acts, 1901 and 1907.
Midwives Act, 1902.
Notification of Births Act, 1907.
Notification of Births (Extension) Act, 1915.
Education (Administrative Provisions) Act, 1907.

The Public Health Act, 1875.[1]—The foundation of all the work done in respect of public health in England and Wales is undoubtedly the Public Health Act, 1875. It is defined as an Act consolidating the law with regard to public health in England, and in it power to appoint Officers, amongst them the Medical Officer of Health and Inspectors of Nuisances, is

[1] This act applies only to England and Wales. London, Scotland, and Ireland have each a Public Health Act more or less resembling the 1875 act.

given to sanitary authorities who, as a matter of fact, owe their own creation to it as well. In addition it deals with a wide range of subjects, of which the most important are given under the general heading *Sanitary Provisions* and include sewerage and drainage; scavenging and cleansing; water supply; cellar dwellings and lodging houses; nuisances, including offensive trades, unsound food, etc.; infectious diseases and hospitals, etc.

Many of the matters referred to in this summary have been discussed in various parts of this volume, where also some indication has been given of the legal requirements in relation thereto. Indeed, most of the hints given and rules laid down in connection with various matters are based upon or are designed to show how compliance with provisions contained in this or other Acts is brought about.

The Public Health Acts (Amendment) Acts.—These Acts, as the name implies, have for their object the amending of the Act just dealt with in a number of respects. As always happens with Acts of Parliament, defects in that of 1875 became evident almost immediately it came into operation. Moreover, as time went on, and public health work came to assume greater importance, the fact that the powers given were too limited became apparent. The Amendment Acts were passed, the first in 1890 and the second in 1907, to remedy some of the defects and to provide some of the additional powers found to be necessary.

No very extended reference to the provisions in the 1890 Act is necessary here, though it may be noted that both it and the Amendment Act of 1907 are *adoptive Acts*, and do not operate in any district unless and until the local authority express a desire to see them in operation and adopt them in the manner indicated in the Acts themselves.

In the Act of 1907 there is a very important series of sections dealing with infectious diseases which deserves mention. In these provision is made for requiring *dairymen* to supply information as to sources of milk supply and upon *laundrymen* and *principals of schools* to supply lists of customers and of scholars respectively if the Medical Officer of Health considers such information would be useful in relation to the prevention of spread of infectious disease.

In addition, the use of *library books* is forbidden to infected persons, and local authorities are empowered to disinfect or destroy such as may have been used. Under this Act also *contacts* with infected persons may be provided with accommodation; the holding of *wakes* over persons dead of infectious disease is forbidden, and provision is made for *cleansing* and disinfecting premises which either the Medical Officer of Health or a medical practitioner certifies to stand in need of such treatment.

The Infectious Disease (Notification) Act, the **Infectious Disease (Prevention) Act** and the **Vaccination Acts**, the Acts next named in the list given above, have been sufficiently referred to in the chapters dealing with communicable diseases and their prevention.

The provisions contained in the **Housing of the Working Classes Acts** and the **Housing, Town Planning, etc., Act**, were designed with the object of improving the housing for members of the working-classes particularly, but not exclusively. In them power is given to local authorities to close and demolish houses unfit for habitation; to clear overcrowded areas; to remove premises that are rendering houses unfit for habitation; to provide houses for the working-classes, and to undertake schemes of town planning, *i.e.* lay out districts to the best advantage from the sanitary and health point of view.

In the section on food reference was made to the **Sale of Food and Drugs Acts**, the object of which is to ensure that only foods of proper quality shall be sold. Of all these Acts the first, passed in 1875, is still the most important. It is defined as "an Act to make better provision for the sale of food and drugs in a pure state." It forbids any one to sell articles of food or drugs which are mixed, stained, or coloured so as to be injurious to health or which are not of the nature, substance, and quality demanded by the purchaser.

The provisions of the Act allow of the Medical Officer of Health, Sanitary Inspectors, and certain other officers taking samples of foods and drugs for the purpose of having them analysed. No one but these officers may sample under the Act, and the analysis must be carried out by a specially appointed *Public Analyst*, if further proceedings are to be instituted with the object of having adulteration punished as the Act provides.

Acts passed subsequently to 1875 are largely amending Acts and designed to meet certain legal difficulties that arose in connection with the administration of the Act of that year.

The **Margarine Act** and the **Butter and Margarine Act** contain provisions relating to margarine and butter. The Butter and Margarine Act in addition deals with the substance known as *milk-blended butter*, which, as defined in the Act, is "a mixture produced by mixing or blending butter with milk or cream (not condensed milk or cream)."

To ensure that there shall be no risk of a purchaser receiving margarine when he desires to purchase butter it is required that all boxes containing this substance, as well as blocks exposed in shops and packages handed to customers, shall be plainly marked "margarine." Margarine, which has as its base fat other than that derived from milk, in order to close all loopholes against the food sophisticator is defined in the *Butter and Margarine Act* to be "any article of food, whether mixed with butter or not, which resembles butter and is not milk-blended butter."

In order to prevent adulteration of butter, margarine, or milk-blended butter with water, the *Butter and Margarine Act* limits the amount of moisture in the first two to 16 per cent., and in the case of milk-blended butter to 24 per cent.

The **Factory and Workshop Acts** have for their object the protection of the health of the workers from harmful influences that may exist or arise in the factory or workshop, from the work itself, or from the materials worked with.

The principal Act was passed in 1901, and is defined merely as "an Act to consolidate with amendments the Factory and Workshop Acts." It is divided into ten parts, of which only the following call for special mention, viz.:

Part I, which treats of health and safety, and has three heads: (1) *Health*, which deals with the sanitary condition of factories, workshops, and workplaces; ventilation, sanitary conveniences, etc. (2) *Safety in case of fire*, etc. (3) *Accidents.*

In *Part IV*, provisions relating to *unhealthy and dangerous industries* are given; notification of certain trade diseases (lead, mercury, arsenic, and phosphorus poisoning and anthrax) is required, and the Home Secretary is empowered to make regulations as to certain dangerous trades. Reference to these matters is made in the chapter on Industrial Diseases. Elsewhere, also, consideration is given to another matter dealt with in this part of the Act, viz. the provision of *ventilation and lavatories* in factories.

Sections relating to *bakehouses* and *laundries* are contained in *Part V*, and in *Part VI* provisions as to *home work* and outworkers, requiring that work, particularly on articles of clothing, shall not be carried on in unhealthy premises or where there are cases of infectious disease.

The **Midwives Act, 1902,** is "an Act to secure the better training of midwives and to regulate their practice."

Every woman desiring to practise as a midwife must be certified under the Act, and before a certificate can be obtained it is necessary for the candidate to produce evidence that she has passed an examination held by one or other of certain bodies, the chief of which is one created by the Act and known as the *Central Midwives Board.* Up till 1905 it was possible for a woman who had not passed an examination to be certified, provided she had had experience and bore a good character. Since then examination prior to certification has been necessary.

Before commencing practice in any area the midwife must give notice to the local supervising body, which in the case of Counties is generally the County Council or a District Council to whom the County Council has delegated its powers. In County Boroughs the local authority acts as the local supervising body.

Certain duties in relation to her practice are imposed upon a midwife by the Act, and compliance with certain regulations specified in rules made by the Central Midwives Board is required.

No woman unless certified may call herself a midwife or attend women in childbirth habitually for gain, otherwise than under a medical practitioner.

Certain conditions met with in her practice, *e.g.* inflammation of the eyes in babies, must be notified by the midwife, and she is required to call in medical assistance on the appearance of certain abnormalities.

Certain records must be kept and certain apparatus provided and always kept in proper condition. A midwife failing to comply with the various rules renders herself liable to censure or to be struck off the roll of midwives. The midwife is one of the parties responsible for notifying births and cases of ophthalmia neonatorum, the former under the Notification of Births Act, the latter under the order, to be referred to later, making this condition notifiable.

Notification of Births Act.—This Act, which was passed in 1907, required that information with regard to the event should be given to the Medical Officer of Health within thirty-six hours of the occurrence of the birth of a child, alive or dead, which has issued forth from its mother after the 28th week of pregnancy; by (*a*) the father of the child if actually residing in the house at the time of the birth and (*b*) any person in attendance on the mother at the time of or within six hours of the birth.

This notification is in addition to and not in substitution for registration of births, which must be carried out at a Registry Office within forty-two days (in Scotland twenty-one days) of birth.

The chief defect of this Act was that it was adoptive and only applied in districts in which the local authority took advantage of the power of adoption given to them by the Act. Quite a number of authorities neglected to do so, and eventually in 1915 the **Notification of Births (Extension) Act**, which made the system of notification universal throughout the country, was passed.

In order that proper use may be made of the information received, the Act provides that local authorities may exercise all powers granted by the Public Health Acts and other Acts, to promote the care of mothers and young children. In this connection the Local Government Board in a special circular have suggested the works they consider necessary to be done in respect of maternity and infant welfare. This contains reference to ante-natal, natal, and post-natal supervision and provides for the care of the woman during the expectant period, at the time of, and after the birth of the child, and of the child from birth till school age is reached, and it comes into the system of school medical inspection.

The Education (Administrative Provisions) Act, 1907.—The only section in this Act to which reference need be made is that which imposes on education authorities the duty of providing for medical inspection of school children. Instructions on this point are contained in Section 13, in which also power is given to provide play centres and vacation schools and such-like during holidays for children attending elementary schools.

Further reference is made to the subject of school medical inspection in the chapter on School Hygiene.

The National Insurance Act.—Though this Act is a public health measure, generally speaking sanitary authorities and their officers have comparatively little to do with its administration. Instead of centralising the working of the provisions in the Local Government Board, the Act provided for the creation of a new central body, the *Insurance Committee*, and in many local areas this example was imitated and a committee distinct from the existing local authority was formed and given the duty of attending to the administration of the provisions locally.

That this has been so accounts, largely, for the fact that practically only the sections making special reference to the sanitary authorities are regarded as of particular moment by these bodies.

Of these, Section 63, which relates to inquiries to be held in districts in which excessive sickness occurs, due or alleged to be due to neglect on the part of the local authority, may be mentioned.

Sections 16 and 22, which deal with tuberculosis and sanatorium benefit, are of some importance. The former relates to the administration of sanatorium benefit and the latter empowers councils of boroughs and districts to contribute to certain expenditure on medical and sanatorium benefit.

Section 17 provides power to extend sanatorium benefit to dependents, a power which in many places, London included, has not so far been made use of, for the reason mainly that funds are lacking.

The great bulk of the Act is made up of sections relating to contributions and finance generally, and the methods of administration to be adopted.

Provisions with regard to insurance committees, their powers and duties, and as to medical committees are given in Sections 59–62 inclusive. The practice in relation to the former varies considerably, but in a number of places the local authority is the committee, which is a convenient arrangement and works well.

The Acts shortly described above are only a few of the more important public health measures. Some others have been noted and summarised in preceding chapters in connection with matters referred to in these.

Apart from definite Acts of Parliament there are, as already indicated, certain other measures under which work is done, mainly by-laws, regulations, and orders. Examples of these have been quoted, and some of their contents noted; the following facts with regard to them may, however, be set down here.

By-laws.—A by-law is defined as "a law made with due legal obligations by some Authority less than the Sovereign and Parliament, in respect of a matter specially or impliedly referred to that Authority, and not provided for by the general law of the land."

In the case of by-laws relating to public health or sanitary matters, the authority who makes the by-law is the local authority, and it is made under powers or directions specially or impliedly given in Acts relating to public health.

The chief condition with which there must be compliance is that before by-laws can become operative in any district they must be approved by the Local Government Board. After approval they apply only in the district of the local authority making them and affect only persons within that area.

In order that these persons may have an opportunity of knowing what the by-laws provide and to object to them if they so desire, advertisements with regard to them must be made in the local papers and copies must be open to inspection in the offices of the local authority. After they have been approved any ratepayer is entitled to a copy on application.

Matters with regard to which by-laws may be made include drainage, common lodging houses, houses let in lodgings, slaughterhouses, and offensive trades.

In some cases the making of by-laws is optional; in others it is compulsory on local authorities. In order to ensure that there shall be more or less of uniformity in by-laws, the Local Government Board have issued "model by-laws." Copies of these are readily obtainable from various Government publishers, and it is mainly from the models that quotations have been made in dealing with the matters to which they relate in the preceding pages.

Regulations differ from by-laws in being somewhat less formal. They may be regarded as being rather rules and instructions than definite laws.

They may be, and are in some instances, made by the central bodies, in which case they apply to all local authorities; or by local authorities themselves for the guidance of all the inhabitants or some special class of the inhabitants of their district.

As examples of regulations made by a central authority, in these instances the Local Government Board, there may be mentioned the *Canal Boats Regulations*, the *Foreign Meat Regulations*, the *Public Health (Milk and Cream) Regulations*, the *Public Health (Shell Fish) Regulations*, and a number relating to the notification of certain diseases, *e.g.* the *Public Health (Tuberculosis) Regulations*, the *Public Health (Ophthalmia*

Neonatorum) Regulations, the *Public Health (Measles and German Measles) Regulations*, and several others.

Regulations of local authorities, like by-laws, are made under powers given in Acts of Parliament. Amongst the matters with regard to which they may be made the following may be named: as to the duties and conduct of *officers*; as to the management of *post-mortem rooms*; with respect to the *removal to hospital* of infected persons brought by ships; and as to *underground sleeping-rooms*. Reference has been made to the majority of these regulations in previous sections.

Orders.—Instructions to local authorities are issued from time to time by the Local Government Board and other central bodies in the form of *Orders*. The *Dairies, Cowsheds, and Milkshops Order*; the *Cholera Order*; and *Sanitary Officers Orders*, relating to appointment, duties, etc., of Medical Officers of Health and Sanitary Inspectors, may be quoted as examples.

The Medical Practitioner and Sanitary Law.—Apart from duties imposed upon him as a member of the public, the Medical Practitioner in his professional capacity has various others specifically imposed by certain Acts. Further, he has certain powers granted to him, on account of his qualifications, that are denied to members of the laity.

The most important of his *duties* are in respect of infectious diseases, and many of his powers refer to these also and are given with the object of obtaining his assistance in connection with prevention.

His primary duty as regards infectious diseases is *notification*, and by the *Infectious Disease (Notification) Act* he is required to notify certain diseases named therein to the Medical Officer of Health as soon as he becomes aware that any patient of his is suffering from one or other of them.

A similar duty is placed upon him by a number of regulations relating to particular diseases, *e.g.* Tuberculosis (all forms), Plague, Cerebro-spinal Fever, Polio-myelitis, Ophthalmia Neonatorum, Measles, and German Measles. With regard to special diseases made notifiable under Regulations it may be noted that before the requirement relating to them comes into operation notice will be sent to the practitioner by the Medical Officer of Health of the district in which he practises.

Under the Factory and Workshop Act certain *trade diseases*, (arsenic, phosphorus, mercury, and lead poisoning and anthrax) are notifiable by medical attendants. The notification in this case is to be directed to the Chief Inspector of Factories at the Home Office.

Another form of notification is that required by the *Notification of Births Act*; this, it will be remembered, is to be made to the local Medical Officer of Health within thirty-six hours after the birth has occurred.

The *powers* given to medical practitioners are, generally speaking, in the interests of the health of their patients, and are conferred by various Acts, chiefly the Public Health Acts, the Infectious Disease (Prevention) Act, and the Housing of the Working Classes Act.

Certificates by one or in some cases two medical practitioners will ensure that attention is given to *offensive trades*, to certain *nuisances*, to the *cleansing of houses*, and to *defective housing*. Certificates with regard to *disinfection* of houses may also be issued by qualified medical practitioners either requiring this to be done or stating that it has been satisfactorily carried out. On the strength of a certificate granted by a practitioner, a Justice of the Peace may order the removal of the corpse of a person dead of an infectious disease to a mortuary.

CHAPTER XXVIII

VITAL STATISTICS

In recognition of the fact, that only by studying the vital statistics of a country or district is it possible to estimate the effect of any sanitary measures put in force and to determine the directions which further efforts should take, a great part of the annual and other periodical reports of Medical Officers of Health is statistical and relates to the population of the district and the births, deaths, and diseases that have occurred in it during the period under review.

Of the figures, those with regard to population are fundamentally the most important because they form the basis of all the calculations.

The population figure is taken from the census returns, and in this country the census enumeration is made every ten years. The information obtained as a result of the census inquiries is supplied to Medical Officers of Health by the Registrar-General, who is responsible for the taking of the census.

In addition, each Medical Officer of Health receives returns of deaths and births and notifications of all cases of infectious disease that occur in his district.

Information as to births and deaths is sent weekly by the local registrars, and with regard to the former by persons attending the mother of each child born, or present at or within six hours of the birth.[1]

[1] All deaths and births must be *registered* with the registrar of the district in which they occur, the former within five days and the latter, in England, within forty-two days and in Scotland within twenty-one days of their occurrence. Notification under the *Notification of Births Act* must be sent to the Medical Officer of Health within thirty-six hours of the birth. Stillbirths are not registrable either as births or deaths, though the Notification of Births Act requires notification of every child, alive or dead, which has issued forth from its mother after the 28th week of pregnancy.

Stillborn children are allowed to be buried on a declaration signed

With these figures various rates are calculated, mainly the Death Rate, the Birth Rate, and the Death Rates from various causes.

Population.—The great difficulty is the population. Since the census is decennial, exact information is only obtained once in ten years, the figures for the intervening years being arrived at as a result of calculations. In connection with the making of these calculations the main difficulty is that the factors that lead to variations, viz. births and deaths, and *immigration* and *emigration*, do not occur regularly.

To overcome the difficulty several methods have been devised, each of them making its basis information obtained at the previous census and endeavouring, as far as possible, to take the various factors into consideration. The best-known methods are (*a*) the *Registrar-General's method*, (*b*) from the number of *inhabited houses*, and (*c*) from the *birth-rate*.

Method (*a*), *the Registrar-General's Method*, is usually employed. In it several assumptions are made : (1) that matters will proceed in the same way in the new intercensal period as in the ten years following the preceding census, and if the census figure was above or below its predecessor the increase or diminution will continue ; (2) that the total increase or diminution shown by the census was equally distributed over the ten years, each year being higher or lower than the one before by one-tenth of the total ; and (3) that equally in the succeeding ten years each year's population will find itself above or below that of the preceding year by such a tenth. Comparatively accurate in normal times, this method is apt to fail because it cannot foresee extraordinary variations in emigration and immigration, nor provide for the fact that in many districts the fluctuations of trade mean fluctuations in the population and in the number of births.

Such an influence as war too it cannot take into account, and in 1915 the Registrar-General abandoned his own method and based all his estimates of population upon the returns of births, deaths, and migration, working out the *actual increment* of the population by correcting the *natural increment*, *i.e.* the excess of births over deaths, for emigration and immigration.

In carrying out his calculation in his own method for con-

by one of the persons who would (if the child had been born alive) have been required to give information of the birth, to the effect that no medical practitioner was present at the birth, or that his certificate cannot be obtained, and that the child was stillborn.

venience of working the Registrar-General uses logarithms, a fact that has led to the classification of the method as the "logarithm method."

The mode of procedure adopted has been more or less indicated above. In the first place the increase that actually occurred in the preceding ten years is worked out, and this is done by subtracting the logarithm of the census population at the beginning of this period from that of the census population at the end of the ten years. The logarithm obtained is called the *logarithm of decennial increase.*

The next step is to distribute the total increase over the ten years and show it as an annual increase by dividing the result of the previous operation by ten. This logarithm is the "log. of annual increase," and during the next ten years the population of each succeeding year will be higher than that of its predecessor by the amount represented by this figure.

The exact number that will have to be added to the census population in any one year is obtained by multiplying the annual-increase figure by the number of the year in relation to that of the census; *e.g.* in 1916 five years have elapsed since the taking of the census in 1911, and the population of that year is the census population plus five times the annual increase.

For statistical work and the calculation of rates, it is regarded as more accurate to deal with the population as at the end of June, *i.e.* the "mid-year population."

The census, however, is taken at the end of March, and the method described above estimates the population in each year to that date. In order to meet the difficulty it is necessary to make an addition to the figure in respect of the months March to June. This happens to be exactly a quarter of a year, and all that is required is to divide the log. of annual increase by four and so obtain and add to the year's figure calculated as above the log. of a quarter year's increase.

The result is the log. of the mid-year population and the figure corresponding to this is then found in the table of logarithms.

Method (*b*): *From the Number of Inhabited Houses.*—In estimating the population by this method, the number of houses in the district, as shown on the assessment roll, is multiplied by the average number of persons per house as ascertained at the last census.

Method (*c*): *From the Birth-rate.*—In this method the assumption, not always justifiable, is made that the birth-rate year after year remains fairly constant. The figures used in the calculation are the number of births in the year under consideration and the birth-rate per 1,000 at the date of the last census.

With these figures the calculation becomes a matter of simple proportion, and if in a district the number of births were 2,454 and the birth-rate at the census 30·8, then :

$$30.8 : 2,454 : : 1,000 \text{ or}$$
$$\frac{2,454 \times 1,000}{30 \cdot 8} = 79,675$$

Neither of the two last methods is particularly satisfactory except in small communities where the increase in the population is *natural* and dependent upon an excess of births over deaths.

In large communities where movements of the population are continually going on, and the increase, if any, is *actual* and due to an excess of births and immigration over deaths and emigration, the results are apt to be inaccurate.

For most purposes the method generally employed is that first described; and with the population estimated as indicated, various rates, birth-rates and death-rates particularly, are calculated.

Birth-rate.—The *Birth-rate* is stated as the number of births per 1,000 of the total population, and is readily worked out from the number of births and the population.[1]

In order to make the rate as accurate as possible, the figure representing the births is corrected by excluding all births occurring in the district to persons not normally resident therein and including others that may have occurred to persons regarded as inhabitants but residing outside its boundaries at the time of the birth.

As is well known, the birth-rate has been steadily falling for a number of years. In 1876 it was 36·6 per 1,000; now the average is about 25 per 1,000 for the country as a whole, though it varies somewhat with the locality, mining and manufacturing districts having rates somewhat higher and agricultural rather lower than the average. In war time, and for a period after wars, the birth-rate is always low for obvious

[1] A more accurate method of calculating the birth-rate would be by estimating not on the total population, but on the number of females between the ages of fifteen and forty-five.

reasons, though it is not uncommonly found that the proportion of male to female births is higher than in peace times.

The steady *lowering of the birth-rate* is stated commonly to be due to a *dislike of marriage* on the part both of men and women, to *distaste for domesticity* and the ties of a family, and to the increased *cost of living.*

Limitation of families is widely practised, the more well-to-do classes favouring preventive measures, and only resorting to abortifaciants, which are the standby of the poorer classes, if the necessity for active interference arises.

In reports it is usual to find that though *illegitimate births* are included with the others in calculating the general birth-rate, a separate note is made with regard to them and a separate rate worked out on the total population.

Death-rates.—The rates in relation to deaths to which most prominence is given in reports are the *Recorded Death-rate*—usually erroneously called simply "The Death-rate" or the "General Death-rate"—and the *Corrected Death-rate.*

The death figure used in calculating the first-named rate is that in which are included only deceased persons who *actually belonged to the district,* no matter whether their death occurred within its boundaries or elsewhere in England and Wales. Equally it excludes the deaths of persons who belonged, at the time of their death within the district, to some other part of the country. The necessity for such a procedure is obvious. Hospitals, nursing homes, prisons, asylums, and other public institutions take in persons from many districts other than that in which they are situate, and persons in search of a cure often leave their own district and die away from home. No calculation that did not make allowances for these things could ever hope to be quite accurate.

To permit of the exclusions and inclusions being properly done, an elaborate system has been created whereby the Registrar-General collects and distributes institutional and other deaths. In some districts quite a marked change is made by the various additions and subtractions, this Recorded Death-rate being a very different thing from the *Crude or General Deathrate* in which *all the deaths* in the district are used in making the calculation. The working out of the rate is a matter of simple proportion, the population being the first, 1,000 the middle, and the number of deaths the end term.

In reports for shorter periods than a year it is usual to state the death-rate for the period, and in calculating this the number of deaths that occurred is taken and the calculation made not on the annual population, but on the population of the week, the month, the quarter, or whatever the period may be.

To find this figure it is necessary to divide the mean annual population by the number of weeks, months, or quarters in the year. In many places it is preferred to obtain the daily population by dividing the annual population by 365·24, the number of days in the year, and multiplying the result by 7, 28, 30, 31, or whatever may be the number of days in the period under consideration. With this figure and the number of deaths the rate per 1,000 is easily worked out. It is then set out in the report side by side with the number of deaths, and it is stated in the report that there were so many deaths and a death-rate equal to an annual death-rate of so many per 1,000 of the population.

The Corrected Death-rate.—In calculating this, allowance is made for the fact that the *constitution of the population*, particularly as regards sex and age, exerts a definite influence in relation to the number of deaths.

A population consisting largely of women has a smaller number of deaths and a lower death-rate than one in which the male element preponderates; districts, such as new and thriving industrial centres, which have many young adults have lower rates than those in which there are many old folks.

The difficulty of comparison created by these differences is overcome by *raising or lowering the Recorded Death-rate in a certain ratio.* What the ratio for each district shall be is stated by the Registrar-General, who calculates the factor, known as the *factor for correction*, by a method perfected some years ago and carried out as early as possible after the census enumeration.

The process of calculation is a long and somewhat complicated one, but the result is always somewhere in the neighbourhood of 1, which represents the factor for correction for the country as a whole. When the Recorded Death-rate is multiplied by this, a figure suitable for comparison with all other corrected rates is obtained, allowance having been made for any difference in the age and sex constitution of the populations compared.

Another figure prepared by the Registrar-General with the object of assisting in the making of comparisons is the *Comparative Mortality Figure.* This compares the Corrected Death-rate of the district with the Recorded Death-rate of the country as a whole. The latter is taken as being for 1,000 persons, then, by simple proportion, if the Recorded Death-rate of the country occurred amongst 1,000, amongst how many persons would the corrected death-rate of the district occur ?

The figure obtained will be more or less than 1,000 as the Corrected Death-rate of the district is higher or lower than the Recorded Death-rate of the whole country.

An example commonly quoted is that of Huddersfield, which at one period showed a comparative mortality figure of 1,210 as compared with the 1,000 of England and Wales, for the reason that its Corrected Death-rate was 18·58 when the Recorded Death-rate of the country was 15·36.

Infantile Mortality Rate.—Death-rates at various age groups of the population can be calculated on the census populations of these groups and, in the intercensal periods, on populations estimated by the Registrar-General's method from the two previous census populations of the groups.

In annual reports one age group rate always shown is what is known as the *infantile mortality rate*, which is *the number of deaths of infants under one year of age per* 1,000 *of the births per annum.* The figures on which the calculation is made are obtainable from the returns of the local registrars. As in the case of the Recorded Death-rate, only births and deaths actually belonging to the district are included, all others being excluded.

The Infantile Mortality Rate can always be regarded as fairly accurate, and it is generally considered as a very fair index of the condition of the district as regards health. Districts in which health work is well and thoroughly attended to almost invariable show a lower rate than those in which sanitation and hygiene are neglected.

The causes that contribute most largely to the Infantile Mortality Rate are (1) *Prematurity* (congenital malformation, *e.g.* cleft palate, which interferes with suckling ; premature birth ; and wasting, the result of improper and unhygienic or insufficient feeding) ; (2) *Diarrhœa and Enteritis* due to neglect, carelessness, or ignorance in relation to hygiene, food, and feeding ; (3) *Respiratory Diseases* such as Pneumonia and Bronchitis in many cases following neglect and exposure ; and (4) *Infectious Illnesses*, especially Measles and Whooping Cough.

All these conditions are now regarded as preventible, and the proper mode of prevention is, in addition to obtaining improvements in the surroundings of the infants and their mothers, to care for the mother before the baby is born, to assure for her proper treatment and attention when the birth takes place, and to teach her how to look after her baby as regards feeding and general nurture during its infancy and earlier years.

Improper feeding, neglect of breast-feeding particularly, is regarded as a most important cause of infantile mortality. As already explained, considerable efforts are made in the more progressive districts to induce mothers to nurse their children and to show them, if natural feeding is impossible, how artificial forms can best be carried out.

The great bulk of infant deaths occur in the earlier parts of the first year of life and in the hotter months of the year. Years in which the summer is cold and wet are usually attended by a low infantile mortality rate. This is taken to be due to the fact that infected dust and the number of flies are kept down, the former by the rain and the latter by the cold. Both dust and flies are capable of conveying contamination to the food of infants.

Though poverty of itself is not necessarily contributory to the infantile mortality rate, in most districts the figure is highest in the poorest areas where the population is most closely packed and overcrowding is marked.

Even in these areas, however, a great deal can be done on behalf of the infants by their mothers and through their mothers by the local authority.

Generally speaking, the infantile mortality rate in this country has been steadily falling for a number of years, and in 1915 was 109 and in 1916 91 per 1,000 births. In rural districts it is usually under 100.

In mining districts ordinarily it is above the average, and in some places reaches to between 150 and 200 per 1,000 births.

Purely residential districts have always fairly low rates. In industrial areas the rate is generally high even though the average rate of wages is high.

Disease Death-rates.—The rates of quite a number of diseases are always given in annual health reports, particularly if they can be regarded as affording any indication as to the general condition of the district in relation to sanitation. They are all calculated on the estimated population and the number of deaths from the disease dealt with, and are stated as per 1,000 of the population.

Zymotic Death-rate.—The zymotic death-rate is that from a group of infectious diseases including smallpox, diphtheria, scarlet, typhus, enteric, and other or doubtful fevers, measles, whooping cough, and diarrhœa.

In the country generally this rate runs from about 2 to 2·5 per 1,000, but variations occur as a result of epidemics.

The Zymotic Rate is considered by many to be helpful in forming an opinion as to the sanitary condition of a district. As a general rule, however, the whole rate is much less useful for this purpose than the rates of some of the individual diseases named, and in reports it is usual to find that in addition to grouping for the purpose of calculating the zymotic rate, the death-rate of each of the diseases is given, and in some cases even the death-rate from each at various periods of life.

What is known as the *attack rate*, which is the number of cases per 1,000 of the population calculated from the total number of cases occurring, is generally also shown, as well as the *case mortality.* This latter is the *number of deaths per cent. of the notified cases*, and indicates the fatality of the disease under consideration. In discussing the various diseases in the chapters relating to infectious and other diseases the case mortality was always quoted and referred to at length in any case in which further reference seemed to be called for.

Other diseases with regard to which death-rates are worked out are Pulmonary Tuberculosis and Cancer. These rates are calculated from the population and the number of deaths, and if, as is generally the case, the rates for males and females and at different age periods are shown in addition to the total death-rate from the cause, similar data and methods are employed.

As explained in the section on *Tuberculosis*, the death-rate from the Pulmonary form is showing a marked tendency to decline in the country as a whole. At present it is between 1 and 1·5 per 1,000 of the population, and few districts have rates much higher than this. To some extent the records as to Tuberculosis are helpful in judging as to the healthiness or otherwise of a district, though it is necessary generally to inquire as to the existence of factors such as trades carried out in the locality before condemning the district as a whole.

The Cancer Death-rate, as already noted, is on the increase, and the reasons to account for this have been given. In reports it is usual to show the figure for males and females and also for different age periods. A table showing the situation of the disease as indicated on the death certificates is generally introduced also.

The cancer figure for the country as a whole is ordinarily just below 1 per 1,000, though amongst females it is practically always higher than amongst males.

Death Certification.—As already explained, the information with regard to deaths is obtained from returns submitted by the local registrars, who send an exact copy of the death certificate in each case.

Speaking generally, *death certification* is fairly well done in this country, though occasionally most unsatisfactory specimens are encountered. It is quite common to find a physical sign, *e.g.* " double aortic," set down as a cause of death, and sometimes the certificate merely gives a list of the symptoms presented by the deceased. In these cases the Medical Officer of Health engaged in classifying the deaths must either exercise his discretion or write to the certifying practitioner for further information.

Where two or more causes of death are shown, the general rule is to accept the first; and where one of the diseases is a zymotic disease always to take it. For example, if a certificate states that a person died of " kidney disease and cardiac failure " the death would be put down to kidney disease, and if the certificate showed " broncho-pneumonia and measles " as the causes, measles, being a member of the zymotic group, would be taken as the cause.

Occupational Mortality.—Reference to deaths due directly or indirectly to occupation is not frequently made in the ordinary annual reports of Medical Officers of Health, and the chief source of information on this subject are the reports of the Registrar-General. The figures in these relate to the period of life during which occupation will be most in evidence as a factor, viz. twenty-five to sixty-five, and all the calculations are made on deaths occurring in that period and on the numbers of males living at that period and following the same occupation. The calculations required to be made are rather numerous and somewhat involved and need not be discussed.

The figures obtained are known as *Comparative Mortality figures*, and relate to males following certain definite occupations, occupied as well as unoccupied and retired, and to all males, occupied males, occupied and retired males, and unoccupied males. The table shown below contains a few of the figures given by the Registrar-General in the supplement to his report on the census of 1901.

With the object of obtaining more detailed information the comparative mortality figure, which represents deaths from all causes, is further subdivided, to produce a comparative mortality figure for each one of the twenty-four common causes of death. These figures serve to show the diseases most prevalent in any occupation and how the various occupations stand as regards the prevalence of any of the twenty-four diseases.

The method of obtaining the figures need not be described; the following table, which shows them for all males, for labourers, and for clergymen, may, however, be of interest.

OCCUPATIONAL MORTALITY

Comparative Mortality Figures

Diseases.	All Males.	Occupied General Labourer.	Occupied Clergyman.	All Occupied Males.
All causes	1,000	1,987	515	925
Influenza	23	41	33	23
Alcoholism	16	40	2	16
Rheumatic fever	7	10	4	7
Gout	2	3	5	2
Cancer	68	111	48	63
Phthisis	186	450	53	175
Diabetes	10	9	13	9
Diseases of the nervous system	105	154	63	78
Valvular disease of heart	36	76	20	33
Aneurism	7	17	2	7
Other circulatory diseases	101	201	62	95
Bronchitis	57	123	6	53
Pneumonia	90	224	32	87
Pleurisy	6	13	6	6
Other respiratory diseases	21	35	3	19
Hernia	3	5	..	3
Liver diseases	27	34	14	25
Other digestive diseases	27	39	35	26
Bright's disease	35	59	28	32
Other urinary diseases	17	29	11	16
Plumbism	1	..	..	1
Accident	59	120	9	58
Suicide	19	31	6	19
All other causes	77	163	57	72

Life Tables.—A life table may be constructed for a whole country or for a district, and, 1,000,000 persons supposed to come into existence at the same time are followed throughout their lifetime, the number likely to be alive at the end of each year or period of years being estimated.

From a life table, amongst other information, may be obtained the probable duration of life of any member of the life-table population and the expectation of life of any member at any age.

The *probable duration of life* is the age at which exactly half the million will have died. The *expectation of life* is the average number of years which any person in the population at any age is likely to live. These figures are rarely shown in annual reports, and the calculations involved being highly complicated are only very exceptionally carried out by Medical Officers of Health.

Statistical Pitfalls.—This chapter is specially designed with the object of assisting in the better understanding of the reports of Medical Officers of Health, and generally speaking the figures given there and the conclusions based upon them may be regarded as sound and accurate. It should be pointed out, however, that errors are easily made, and it is easy to go wrong both in relation to methods employed and conclusions drawn.

In connection with the working out of rates per 1,000 of the population it must not be forgotten that, practically always, the population figure is only *calculated* and few populations increase or diminish at exactly the estimated rate. Quite commonly, when the census comes to be taken, it is found that for several years a figure much lower or higher than the actual has been used and that therefore the death- and birth-rates for these years have been wrongly stated. Such errors as these are practically unavoidable.

Such a rate as the infantile mortality rate, which is based on the number of deaths of infants under one year of age and the number of births, are comparatively quite accurate, since very few of the births and deaths go unregistered.

In the case of disease death-rates, apart from the fact that there must always be some uncertainty as to the accuracy of the population figure, there is the further possibility that the cause of death has not been correctly stated on all death certificates.

As to these disease death-rates, probably the most important point to bear in mind is that caution must be exercised in regard to conclusions drawn.

Quite commonly the figures given in the reports are comparatively small, and conclusions based upon small numbers are peculiarly liable to be erroneous. If, as may easily happen, the figures, besides being small, relate only to a short period, the liability to error is increased.

The error in this case arises from the paucity of data and is the "fallacy of small numbers." It is one which, it would almost seem, members of the medical profession are particularly liable to make.

Another error very commonly made is in regard to *comparisons*. The fact that correction of death-rates for age and sex constitution is necessary to allow of the making of comparisons between districts has been pointed out. As a matter of fact, before comparisons can be made on any rates, corrections are necessary in order to meet differences in constitution and circumstances. These it may be said rarely are made, and districts different in a vast number of ways are compared one with the other through one or more rates, greatly to the detriment of one of them.

An error occasionally made appears when it becomes necessary to *combine the death-rates* of two or more separate and distinct areas and to state them as one.

In such a case it is not sufficient to take the average death-rate by adding together the rates and dividing by the number of areas. It is essential first to find the population of each area, and from the death-rate per 1,000 to discover the number of deaths. All the populations must then be added together and the total population found. The total number of deaths must be obtained in the same way. With these figures the death-rate per 1,000 is then calculated.

Example.—If, in a town, district A, with a population of 160,000, has a death-rate of 17 per 1,000, and an adjacent district, B, a death-rate of 14 with a population of 20,000, what is the death-rate of the whole area ?

The answer is not $\frac{17 + 14}{2} = 15{\cdot}5$ per 1,000, but 16·6, obtained thus :

160,000 people at	17 per 1,000	yield	160×17	= 2,720	deaths
20,000 ,,	14 ,,	,,	20×14	= 280	,,
180,000 people yield .		.	total deaths .	= 3,000	and

$$180{,}000 : 1{,}000 :: 3{,}000 \text{ or } \frac{1{,}000 \times 3{,}000}{180{,}000} = 16{\cdot}6 \text{ per } 1{,}000.$$

APPENDIX

The following copies of leaflets and cards are introduced for the purpose of illustrating certain remarks in the body of the book. In addition to serving as examples of the forms commonly used, they may be found instructive also since they contain a number of hints on hygiene.

INFANT FEEDING LEAFLET[1]

ADVICE TO MOTHERS DURING PREGNANCY AND NURSING

Keep yourself in good health. The health of your baby depends upon your own.

Take good and wholesome food at regular meals only.

Do not take spirits, beer, stout, or much tea, but rather milk or cocoa.

See that your bowels act every day.

When possible take exercise in the open air every day, and keep your window open night and day.

1. Feed your Baby Regularly, by the Clock, and not by Guesswork or Whenever it Cries. Babies get indigestion, feel uncomfortable, and cry if they are not fed at regular times.

2. Never Give your Baby a Dummy Teat. It is simply a bad habit, and dirty and dangerous.

3. As babies sometimes cry because they are thirsty, sips of warm water may be given.

RULES FOR DAILY USE

Let the baby sleep in its own cot and lie in it during the day. A banana crate, box, basket, or drawer serves equally well. If the child cries, see if its napkin wants changing or if the baby is cold and not properly covered up. Never rock the baby. Wake the baby up at the proper time for feeding during the day only.

Clothing.—Give the baby a warm woollen vest with long sleeves, a soft knitted or flannel binder, a long flannel nightdress, and an outer dress. Do not use a tight or stiff binder. Never use flannelette.

[1] The contents of this leaflet are based on information contained in a leaflet published by the National League for Physical Education and Improvement.

"Shorten" at two to three months old. Keep to the vest and one flannel petticoat and dress, but now put on warm stockings instead of socks.

Bath the baby once a day, and wash it once a day as well, using very little soap. Dry thoroughly, especially in ears and all folds of skin.

Undress and dress the baby quickly so that it does not catch cold. Babies must always be kept warm.

The windows of the bedroom and living-room, except at bath time, should always be kept open at the top, as wide as the weather will allow. The baby should be kept out-of-doors in the daytime as much as possible, and may sleep out-of-doors in mild weather in a sheltered place.

Do not give soothing syrups, teething powders, or purges without the doctor's orders.

Babies should be weighed regularly.

If a baby cries often,
does not increase in weight,
does not sleep,
is frequently sick,
is constipated,
has diarrhœa,
snuffles,
has cold feet,
has a discharge from the eyes,
or has a rash on the body or under the napkin,

it is not well, and should be seen by the doctor.

BREAST FEEDING

Mother's milk is the best, cheapest, and safest food for infants

1. Get your baby into good and regular habits of feeding. Babies form bad habits just as easily as grown-up people.

2. Keep the child at the breast about ¼ hour at each feed.

3. Do not feed more often than every two hours during the day and once between 11 at night and 6 in the morning. *Never let the baby feed too fast.* Wake the baby if asleep at feeding times during the day only.

The time between the feeds should be gradually increased until at the beginning of the third week the breast is given every three hours, and at the age of six months five times in the day and not at all between 11 at night and 6 in the morning. The best times are 6 a.m., 10 a.m., 2 p.m., 6 p.m., and at 10 p.m. In this way the mother gets a rest at night, and so does the baby's stomach.

If you think the baby is not thriving on the breast, do not give up breast feeding before the age of nine months without asking a doctor.

Weaning.—Keep the baby on the breast entirely for nine months if possible. Never wean during July, August, or September, if you can help it. Wean slowly, giving first one feed of cow's milk a day and then gradually increasing the number. Crusts of bread with butter or dripping and a lightly-boiled egg may now be added.

From One Year Upwards.—Do not give butchers' meat before the age of eighteen months. Children must have no tea or stimulants, and such articles as pork, shell-fish, fried fish, lobsters, baked pastry, new bread, and hot cakes are liable to cause illness, and must be carefully avoided. They should have three or four meals a day, and no food or sweets should be taken between meals. Beer and spirits are injurious to a child and must never be given.

BOTTLE FEEDING

NOTE.—These directions are not intended to apply to those babies who are ordered a special diet by a doctor.

Give only milk until the baby is about nine months old. Do not give condensed milk or any other infant food unless ordered by the doctor.

Never give separated or skimmed milk to a baby.

MILK.—Get good fresh milk twice a day. Boil it at once, pour it into a *clean* jug, cover with a *clean* cloth, and stand the jug in cold water. In hot weather the water should be changed often so as to be as cool and fresh from the tap as possible.

BOTTLE.—Bottles with long tubes should *never* be used. Wash the bottle and teat thoroughly in hot water after each feed and keep them in clean cold water until the next feed. When washing the teat turn it inside out and hold it under the tap.

FEEDING.—*Measure the milk carefully.* Give the same amount at each feed, not more one time than another. If the child does not finish the feed, what is left should not be given again to the baby. Give the milk warm.

From $\frac{1}{4}$ to $\frac{1}{2}$ teaspoonful of fresh cream should be added to each feed, and the same amount of white sugar. About $\frac{1}{2}$ teaspoonful of olive or cod-liver oil should be given twice a day if no cream is put into the bottle.

FROM BIRTH TO THREE WEEKS OLD.—Never feed more often than every three hours in the daytime, and once between 11 at night and 6 in the morning.

At first the baby does not want more than 1 tablespoonful of milk and 2 tablespoonfuls of water. By the time it is three weeks old it may be having 1 to $1\frac{1}{2}$ tablespoonfuls of milk and 2 of water.

FROM THREE WEEKS TO THREE MONTHS OLD.—Gradually increase the quantity at each feed up to 3 to 4 tablespoonfuls of milk and 3 of water. Feed every three hours by day and, if possible, not at all between 11 at night and 6 in the morning.

FROM THREE MONTHS TO SIX MONTHS OLD.—By the time the baby is six months old it should take 6 to 7 tablespoonfuls of milk and 2 of water at each feed. Do not feed more often than every four hours, and not at all at night.

FROM SIX TO NINE MONTHS OLD.—Gradually decrease the water until the baby is taking 8 to 10 tablespoonfuls of milk and no water at each feed. A little orange juice or stewed apple may now be given.

FROM NINE TO TWELVE MONTHS OLD.—Continue to give milk, but crusts of bread with butter or dripping and a lightly-boiled egg may be added to the diet.

FROM ONE YEAR UPWARDS.—Do not give butchers' meat before the age of eighteen months. Children must have no tea or stimulants, and such articles as pork, shell-fish, fried fish, lobsters, baked pastry, new bread, and hot cakes are liable to cause illness and must be carefully avoided. They should have three or four meals a day, and no food or sweets should be taken between meals. Beer and spirits are injurious to a child and must never be given.

DIARRHŒA LEAFLET

SUMMER DIARRHŒA

Every summer, during the warm weather, many hundreds of babies suffer from sickness and diarrhœa, and very many die.

This illness is nearly always caused by dirt getting into baby's mouth in some way, from dirty feeding bottles, dirty teats, dirty dummies, and dirty hands.

Wrong feeding makes it worse, and bottle-fed babies are more likely to suffer than breast-fed babies.

With care mothers can keep babies from catching the disease.

1. What to do to keep Sickness and Diarrhœa away

(1) Feed baby on the *Breast*, and keep the nipples very clean.

(2) Do *not wean* baby during the hot weather.

(3) If baby must be fed on the bottle, *do not use a long-tube bottle.*

(4) Only use a clean *boat-shaped bottle.*

(5) *Boil baby's milk* as soon as it is taken from the milkman, and *keep it covered.*

(6) Only make one feed at a time.

(7) *Do not use old feeds.* If baby does not finish all there is in the bottle, the rest may be used for cooking purposes.

(8) *Wash out the bottle and teat* in hot water directly baby is fed, and keep them in cold water till the next feeding time.

(9) Always have the *bottle and teat* quite *clean* before putting in the feed.

(10) *Do not use a dummy teat.*

(11) Special care should be taken as to the cleanliness of floors and bedding.

(12) Keep all food covered from flies and dust, which spread the disease.

2. What to do if baby catches the disease.

(1) Remember that the illness is serious. Even if baby is teething, send for the doctor at once.

(2) As soon as sickness and diarrhœa begin, *stop* giving baby milk and food, and give only *pure hot water*, sweetened with a little sugar, every half-hour.

(3) *Keep baby warm.* Put on a flannel binder, and put a hot-water bottle to the child's feet.

(4) Open all windows at the top.

(5) Remember that the illness is catching. Always wash the hands after changing baby, and disinfect all soiled clothing by boiling.

(6) If the house drains get stopped up, or the supply of water gets low, tell your landlord and write to the Medical Officer of Health.

SCARLET FEVER LEAFLET

Precautions to be observed to prevent the spread of infection, when patient is treated at home

(1) One room must be set apart for the patient, all unnecessary furniture, books, ornaments, and other articles being previously removed from it. A sheet should be nailed outside the door of the room, and should be kept wet with a solution of a disinfectant.

The sick-room should be light, airy, and well ventilated, but the patient must be protected from draughts.

(2) The patient is to remain in the sick-room until certified free from infection. The patient should be attended by one person, an adult, who should not do any other work about the house or elsewhere, and under no circumstances mix with other persons without first changing the outer clothes and washing the face and hands.

A linen overall, reaching from the neck to the feet, is a very useful garment for the attendant, who should put it on when entering, and take it off when leaving the sick-room. The overall when not in use should be turned inside out and kept quite away from all garments worn by other members of the household.

The attendant should not, if possible, sleep in the same room as the patient.

(3) All food brought into the sick-room and not taken by the patient must be destroyed. Solids are to be burned and liquids thrown down the drains. All food, except that for immediate use, should be kept outside the sick-room.

Nothing from the sick-room, except ashes from the grate, may be put into the dust-bin.

(4) Bed and body linen used by the patient should be steeped in disinfectant for 24 hours, or else boiled, before being washed. If any linen used by the patient or attendant be sent to a laundry, proper notice of the fact that it has been used by such person, or persons, must be given to the proprietor of the laundry. *In any case the laundry should be informed of the presence of illness in the house.*

No books, toys, crockery, cutlery, etc., used by the patient should be removed from the room without first undergoing disinfection and cleansing.

(5) The patient should be frequently and regularly bathed, as may be ordered by the doctor in attendance.

(6) No member of the patient's family should attend any public or private gatherings until after the necessary disinfection shall have been effected. No children residing in the same house as the patient will be received at school until the Head Teacher, or Proprietor, shall have been notified by the Medical Officer of Health that the necessary disinfection has been performed to his satisfaction.

(7) When the doctor has certified the patient to be free from infection, the patient should have a complete bath and put on fresh clothes which have not been in the sick-room or otherwise exposed to infection. The sick-attendant is to observe the same rule as to bath and clothes. All infected clothes, books, etc., are to be left in the sick-room, the windows of which should be opened, and the

door locked. The room should be left thus until the Council's Officers come to do the disinfection.

(8) Should the case terminate fatally, the funeral should be held with the utmost dispatch. The body should be coffined and the coffin screwed down within 48 hours. The dead body shall be kept in a room apart by itself. The Council's Mortuary Chapel is available (free of charge) for the reception of the bodies of persons dying from infectious diseases. The Mortuary Keeper should be informed of the nature of the illness.

(9) After the room has been disinfected by the Council's Officers, it should be left with the windows open (top and bottom) for several hours (24, if possible). At the end of that time all woodwork, including furniture, floor boards, doors, etc., should be washed with a disinfecting solution, and the wall-paper cleaned or stripped off. For cleaning wall-paper, use crumb of bread, and burn the dirt and crumbs. Every article in the room, not removed by the Council's officials, should be washed, or, if washing is impossible, wiped over with a cloth damped with disinfectant.

Very special care should be given to remove all dust from the room, using plenty of water for the purpose, not dry sweeping and dusting.

Books, clothes, bedding, toys, and many other articles may retain the infection of scarlet fever in an active condition for many years. All such must, therefore, be placed at the disposal of the Council's officials to undergo disinfection or destruction.

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