GRIFFIN'S SCIENTIFIC TEXT-BOOKS

PRACTICAL SANITATION.

PRACTICAL SANITATION:

A Hand-Book for Sanitary Inspectors and others interested in Sanitation.

BY

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WITH AN APPENDIX ON SANITARY LAW

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With Numerous Diagrams.

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PREFACE TO FIRST EDITION.

THE question of sanitation is one which is now attracting the serious attention of the general public. People are beginning to enquire for themselves into matters which, hitherto, they have closed their eyes to. The necessity for no longer allowing grave sanitary defects to exist in our houses and their surroundings is now generally acknowledged, and this has led to a demand that plumbers shall possess a sound knowledge of their work. The action of the Sanitary Institute in encouraging a desire on the part of Inspectors of Nuisances, or as I generally designate them in this book, Sanitary Inspectors, to acquire a practical and scientific knowledge of their duties, supported in many instances by Sanitary Authorities, who make it a condition that such Officers shall hold a certificate of qualification, has greatly helped on the cause of Sanitation.

In the autumn of 1890 I delivered a course of lectures on Sanitation, in Stafford, under the auspices of the County Council. The course was principally intended for Sanitary Inspectors in the county, but others, including Members of Local Authorities, builders, plumbers, and a section of the general public interested in the subject, availed themselves of the invitation to attend.

This lecture scheme attracted the attention of the Sanitary Institute, who, the following year, in conjunction with the County Council, organised a second course of lectures in

Stafford, the lecturers being well-known specialists. At the termination of this course, an open examination was held at Stafford by the Sanitary Institute, for which, in addition to candidates from other parts of England and Scotland, twenty-five Staffordshire Inspectors entered; of these, twenty-three satisfied the examiners, and obtained the certificate of the Institute,—by far the largest percentage of passes that had been recorded since the institution of the Examination about ten years ago.

Hitherto, such Lectures have been delivered in London only, but, recently, the example set by Staffordshire has been followed in other counties and towns, for example, Derbyshire, the West Riding of Yorkshire, Cardiff, and Newcastle-on-Tyne, and it is likely that the movement will extend still further.

On the termination of the first Course of Lectures, I was requested by those who attended the Class to publish them, but this I could not do, as they had been delivered from notes only. It occurred to me, however, that a Hand-Book on Practical Sanitation, arranged specially for Sanitary Inspectors and others engaged in the work, although written in a form which would be useful to the general reader, and, possibly, to Students of Technical Instruction Classes, would fill what would appear to be a vacant corner in the literature of the subject.

With this object I have compiled these pages, which include descriptions of insanitary as well as sanitary work and appliances, illustrated by numerous diagrams.

As the end for which sanitary appliances are designed may be entirely defeated through the ignorance or culpability of the workmen employed in fixing them, attention has been paid to the details of plumbing and drainage work,—sufficient, it is hoped, to enable Sanitary Inspectors to recognise faulty work, and appreciate the dangers that may arise from it.

The subjects of Sanitary Law, Model Bye-laws, and other matters which are not of such general interest, are introduced in the form of an Appendix, which has been carefully compiled by Dr. Herbert Manley, Medical Officer of Health for the County Borough of West Bromwich, with a view more especially to meeting the wants of the Sanitary Inspector. This Appendix also deals with the duties of Sanitary Inspectors and their relations to the Sanitary Authority and the general public.

G. R.

STAFFORD, *June*, 1892.

PREFACE TO SECOND EDITION.

THE fact that the First Edition of this work has been exhausted within a few months of publication indicates that it has supplied a want among Public Health Officers and Students. Beyond a few slight corrections which were overlooked in the first edition, and one or two omissions which are now introduced in the form of an Appendix, the matter is unaltered.

G. R.

STAFFORD, *March*, 1893.

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CHAPTER I.

INTRODUCTORY.

Before discussing the details of sanitary work, time will not be wasted if we take a brief glance at the past history of sanitary science or Hygiene.

According to the late Prof. Parkes, hygiene is a science which aims at rendering growth more perfect, decay less rapid, life more vigorous, and death more remote. Our conditions of life are unnatural. Commerce brings us together into densely populated areas, too small to admit of cleanly surroundings; by reason of this, we breathe unwholesome air, and drink contaminated water; our food, either from our poverty or over indulgence, is not fitted for our requirements; vice and drink play their parts in the production of disease; and all these combined have resulted in the transmission of enfeebled constitutions less able to withstand the hardships to which they are exposed.

To correct the defects of our surroundings and habits is the aim of hygiene, and although it may not be possible, owing to the necessities of the times in which we live, to arrive at an ideal state of existence, much may be done, as indeed much has been done, towards that end, and, in time, the influence of heredity, which, through our own faults, has hitherto told in a deleterious direction, will act as an all-powerful ally in improving the stamina of the race.

In recent years more especially, the attention of eminent scientists has been devoted to the study of hygiene in its various branches. Our knowledge regarding the nature of contagion, for example, has thus advanced by leaps and bounds, and this has led to greater precision in the measures adopted to combat it. Where formerly we were groping in the dark and guessing at conclusions, we are now able to work on more or less definite lines. Again, improved methods of compiling and studying vital statistics, combined with a better knowledge of disease generally, have been instrumental in the advancement of sanitary legislation; yet, notwithstanding the evidence in favour of this, there are people still to be found who ask "what good has all this done;" it may be well, therefore, to review the past, and see what light history can throw upon the question. Most people are aware that to filth, in the broad sense of the term, must be attributed the pestilence and death of the dark ages, when whole armies were destroyed, when cities were depopulated, when gaols were death holes, and when the general annual death-rate exceeded 80 per 1,000.

In 1844, the Health of Towns Commission, which had been appointed mainly owing to the energy and work of Mr. Chadwick, Dr. Farr, and others, presented their report, and four years later, owing to a cholera scare, the Public Health Act of 1848 was passed.

By this Act, power was given to local authorities to borrow money for sanitary purposes, but in it, as in many of the Acts that followed, the word *may* too often took the place of *shall*; in fact, its adoption was optional in place of being compulsory. In this instance it was perhaps a fortunate circumstance that it was so, for, in those days, architects and engineers did not know their work, and in place of the surface channels then generally to be found, badly constructed and ill ventilated sewers were laid down, which were directly connected by untrapped and unventilated drains with the houses. Much of this work is to be found at the present time, and, had we but a portion of the money that was thus originally misspent, as well as what has since been expended in correcting these mistakes, we might well afford to place every district in the Kingdom in thorough sanitary order. No real progress was made until Urban and Rural Authorities were established by the Public Health Act of 1872.

The Privy Council still remained the central Authority, but in 1875 an improved Act was passed—the last Public Health Act—by which the control of sanitary affairs was transferred to the Local Government Board.

It is sometimes said that figures may be made to prove anything, but the following plain statement tells an unmistakable tale, to whatever causes the improvement may be attributed :—

TABLE SHOWING PROGRESSIVE IMPROVEMENT IN DEATH-RATE.

	Period of Years.	Mean Annual Death-rate per 1,000 living.
	Ten years, 1862-71,	22·6
Public Health Act, 1872, .	Four years, 1872-75,	21·8
" " 1875, .	Five years, 1876-80,	20·8
	" 1881-85,	19·3
	" 1886-90,	18·6

This table speaks for itself. Starting with an average death-rate per 1,000 of the population, of 22·6 for the ten years ending 1871, it falls to 21·8 for the four years subsequent to the passing of the 1872 Act, to 20·8 for the five years period following the passing of the 1875 Act, and so on, step by step, until the low figure 18·6 is recorded for the quinquennial period ending 1890. This is the picture when viewed from the broad standpoint of general results, but let us go a step farther and see whether, and to what extent, we can particularise as regards cause and effect. In the year 1866, Dr. Buchanan conducted an enquiry, with a view to discovering whether any benefit to health had followed the carrying out of sanitary works in certain districts. The places selected were those in which the improvements had been longest established, and this was the only consideration that influenced the selection. In the following table the results are given as regards the general mortality, and as regards the mortality from typhoid fever and phthisis, diseases that are well-known to be influenced by sanitary surroundings.

It is not always possible in sanitary work to demonstrate that good results follow each individual act of improvement, and the public are slow to recognise the broad fact that they derive a very substantial return for the money expended in this direction; yet from the above tables there can be no doubt that the death-rate has steadily decreased in recent years; and when we consider that for each life saved there is also a saving of many weeks of sickness to others, the financial gain to the community must be enormous.

To quote Dr. Parkes:—" It has been proved, over and over

Effect of Sanitary Works on the General Annual Death-rate and on the Mortality from Typhoid Fever and Phthisis.*

	Death-rate per 1,000 of Population.		Degree of change in Typhoid Death-rate.	Degree of change in Phthisis Death-rate.	Influence of Sewage Works on Subsoil.
	Before construction of works.	After construction of works.			
	1	2	3	4	5
Alnwick, . . .	26·2	24·7	- 36 p.c.	+20 p.c.	No drying.
Ashby, ...	21·6	20·2	- 56 ,,	+19 ,,	Some drying.
Banbury, . . .	23·4	20·5	- 48 ,,	- 41 ,,	Much drying.
Bristol, ...	24·5	24·2	- 33 ,,	- 22 ,,	Some drying.
Brynmawr, . .	27·3	23·2	- 56 ,,	+ 6 ,,	No notable change.
Cardiff, ...	33·2	22·6	- 40 ,,	- 17 ,,	Much drying.
Carlisle, . . .	28·4	26·1	- 2 ,,	+10 ,,	Drying with local effects.
Chelmsford, . .	19·6	21·5	+ 5 ,,	± 0 ,,	Slight drying.
Cheltenham, . .	19·4	18·5	- 37 ,,	- 26 ,,	Some drying.
Croydon, . . .	23·7	19·0	- 63 ,,	- 17 ,,	Much drying.
Dover, ...	22·5	20·9	- 36 ,,	- 20 ,,	Local drying.
Eley, ...	23·9	20·5	- 56 ,,	- 47 ,,	Much drying.
Leicester, . . .	26·4	25·2	- 48 ,,	- 32 ,,	Drying.
Macclesfield, . .	29·8	23·7	- 48 ,,	- 31 ,,	Much drying.
Merthyr, . . .	33·2	26·2	- 60 ,,	- 11 ,,	Some recent drying.
Morpeth, . . .	26·2	24·7	- 40 ,,	- 8 ,,	No change.
Newport (Mon.), .	31·8	21·6	- 36 ,,	- 32 ,,	Local drying.
Penrith, . . .	25·3	25·0	- 55 ,,	- 5 ,,	No change.
Penzance, . . .	22·1	22·2	+ 6 ,,		
Rugby, ...	19·1	18·6	- 10 ,,	- 43 ,,	Some drying.
Salisbury, . . .	27·5	21·9	- 75 ,,	- 49 ,,	Much drying.
Stratford-on-Avon,	21·7	20·2	- 67 ,,	- 1 ,,	Some local drying.
Warwick, . . .	22·7	21·0	- 52 ,,	- 19 ,,	Some drying.
Worthing, . . .	15·5	15·3	+23 ,,	- 36 ,,	Some drying.

* Compiled from the *Ninth Report of the Medical Officer of the Privy Council*, 1866.

again, that nothing is so costly in all ways as disease, and that nothing is so remunerative as the outlay that augments health, and in doing so augments the amount and value of the work done."

Again, as Dr. Lyon Playfair says—"The record of deaths only registers, as it were, the wrecks which strew the shore, but it gives no account of the vessels which were tossed in the billows of sickness, stranded and maimed as they often are by the effects of recurrent storms."

At present we have no means of arriving at an accurate estimate of the amount of sickness in a community, and although this information would prove of the greatest interest and value, it is doubtful whether it can ever be obtained. It may be taken for granted, however, that a high death-rate means a high sick-rate, and that the one bears a fairly constant ratio to the other.

So far, we have considered the effect that improved sanitation has had on the death-rate of the community as a whole. We will now go a step farther, and consider the death-rate, and, consequently, also the health-rate, as influenced by condition and surroundings.

The first point that strikes one is the great difference between the death-rate of rural as compared with urban districts. Take Staffordshire, for example, and we find that the average rural annual death-rate is 15·4 per thousand of the population, as compared with 18·9, the urban rate; or, more striking still, Stafford rural district proper, where the figure is 12·0, as against 17·0 in the case of Stafford urban district. It is true that the age and sex constitution, which greatly influences the death-rate, differs, as a rule, in urban and rural districts; but the advantage, so far as this is concerned, is certainly in favour of towns with their large industrial populations containing a greater proportion of young adults, among whom, other things being equal, the death-rate is low.

Among the conditions that influence the death-rate, to occupation must be given an important place, and, without going too fully into the question, the following table shows in a striking manner how this operates, particularly in the case of two classes of disease—viz., phthisis and diseases of the respiratory organs:—

Comparative Mortality of Males in Certain Dust-inhaling Occupations from Phthisis and Diseases of the Respiratory Organs.

	Comparative Mortality Figure (1880-1-2) that of Males being 1,000.	Phthisis.	Diseases of the Respiratory Organs.	The two together.
Coal Miner, . .	891	126	202	328
Carpenter, Joiner, .	820	204	133	337
Baker, Confectioner, .	958	212	186	398
Mason, Builder, Bricklayer, . .	969	252	201	453
Wool Manufacturer, .	1,032	257	205	462
Cotton ,, .	1,088	272	271	543
Quarryman, . .	1,122	308	274	582
Cutler, . . .	1,309	371	389	760
File Maker, . .	1,667	433	350	783
Earthenware Manufacturer, . .	1,742	473	645	1,118
Cornish Miner, . .	1,839	690	458	1,148
Fisherman, . . .	...	108	90	198

We must not stop to discuss the process by which these trades exercise their baneful effects; why in a given number of coal miners only 126 deaths occur from phthisis, whereas, among a corresponding number of Cornish miners, 690 deaths occur from that disease—more than five times as many—the figures are given merely to show that occupation does influence the death-rate, and to a very large extent. In recent years much has been done in the case of some of these trades, as well as in others, to diminish this wholesale sacrifice of life, but much still remains to be done, as apparently our present legislators are aware. The responsibility is a serious one; for the prostration of the bread-winner of a family for months, by an illness which in the end proves fatal, must involve an amount of misery, poverty, and distress beyond conception.

Certain of these trades operate injuriously upon those engaged in them by reason of their nature, but, on the other hand, there are some trades which need not cause injury, provided they are carried on under conditions less unfavourable to health than is frequently the case.

The two following tables give the mortality in Glasgow in 1885 from all causes, as well as from certain classes of disease that are especially liable to be influenced, both as regards prevalence and fatality, by insanitary surroundings. Of course the conditions of life in other respects of the occupants of small, as compared with large towns, are not comparable, but apart from this, there can be no doubt that cleanliness of the atmosphere, as affected by density of population, is an all-important factor in the result:—

GLASGOW, 1885.

INCIDENCE OF ANNUAL DEATH-RATE PER 100,000 ON POPULATION INHABITING HOUSES OF—

	1 and 2 Rooms.	3 and 4 Rooms.	5 Rooms.
All Diseases, ...	2,650	1,950	1,100
Zymotic Diseases, . . .	478	246	114
Lung Diseases, . . .	985	689	328
Diseases of Nutrition in Children under 5 years, . .	480	231	91

GLASGOW, 1885.

OVERCROWDING AND DEATH IN A GROUP OF TEN FAMILIES OF FIFTY PERSONS IN HOUSES OF—

	1 and 2 Rooms.		3 and 4 Rooms.		5 Rooms.	
	One Person dies in every					
	Yrs.	Mths.	Yrs.	Mths.	Yrs.	Mths.
All Diseases, ...	0	9	1	0	1	10
Zymotic Diseases, . . .	4	2	8	1	17	6
Lung Diseases, . . .	2	0	2	10	6	1
Diseases of Nutrition in Children under 5 years, . .	4	2	8	6	22	2

To put it shortly, nearly two and a-half times the number of people die from all causes who live in houses of one and two rooms, as compared with those who live in houses with five rooms and upwards; and in the case of zymotic diseases three times, lung diseases four times, and diseases of nutrition in children five times the number die in the small, as compared with the large houses.

In the second table, the same point is exemplified in a different manner. Both these Tables deserve careful study; the figures they contain are taken from a large district, and, therefore, the operation of chance is less likely to invalidate the conclusions one may draw from them.

The following little table is taken from the report for 1889 of Mr. Farrow, the Sanitary Inspector of Leek. It is introduced here because it has reference to the question of overcrowding, and also because it is an excellent example of what may be accomplished in a comparatively small district by an enthusiastic worker:—

Class of Houses.	Number of Houses.	Population.	Number of Deaths per year.	Mortality per 1,000 Living.
Houses with 1 bedroom, .	275	748	28	37·43
,, 2 ,, .	1,695	7,418	140	18·87
,, 3 ,, .	574	3,094	43	13·89
,, 4 or more, .	353	2,148	25	11·63

As already pointed out, from such statistics one is not justified in attributing the excessive mortality entirely to overcrowding. The conditions of life as regards occupation, food, and general surroundings have an important bearing on the question, as well as the fact that the population living in houses of five rooms and upwards includes domestic servants, a class in which, by reason of sex and age, the mortality is low.

The following table, although compiled on different lines, illustrates the same point, and is not open to the same objection. In this case, owing to the character of the localities selected, the inhabitants of each may fairly be compared with each other as regards condition and surroundings, so that any difference in the rate of mortality may be attributed to the one circumstance in

DEATH-RATE AND BACK-TO-BACK HOUSES* (SALFORD).

		POPULATION.	Annual Death-Rate per 1,000 Living from				
			All causes.	Pulmonary Diseases, excluding Phthisis.	Phthisis.	Seven chief Zymotic Diseases.	Diarrhœa.
		1	2	3	4	5	6
Greengate Sub-District.	GROUP 1.—No back-to-back houses,	8,713	27·5	6·6	2·8	4·5	1·42
	GROUP 2.—Average proportion of 23 per cent. of back-to-back houses,	11,749	29·2	7·8	3·3	4·8	1·55
	GROUP 3.—Average proportion of 56 per cent. of back-to-back houses,	11,405	30·5	7·9	3·6	6·2	2·12
Regent Road Sub-District.	GROUP 1.—No back-to-back houses,	54,264	26·1	5·7	2·7	4·9	1·54
	GROUP 2.—Average proportion of 18 per cent. of back-to-back houses,	8,773	29·1	7·5	2·7	4·9	1·85
	GROUP 3.—Average proportion of 50 per cent. of back-to-back houses,	4,380	37·3	8·6	4·5	7·6	2·83

* Compiled from Joint Report to the Local Government Board by Dr. Barry and Mr. P. Gordon Smith on Back-to-Back Houses, February, 1888.

which the localities differ—viz., the proportion in each of back-to-back houses, and, as this feature, in its result (by reason of less possibility of free ventilation), corresponds to overcrowding, to that cause must the difference in the mortality be attributed.*

The foregoing tables of statistics have been introduced, in the first place, to show that already some good has resulted from sanitation, and, therefore, inspectors need not be discouraged if they fail to see any immediate result from their work, and, in the second place, to demonstrate that much still remains to be done.

These, then, are some of the questions in which an intelligent Inspector must take an interest, but they are not by any means all. He must make himself familiar with the principles of Sanitation, and acquire a practical knowledge of the various dangers to health met with from day to day, in order to be in a position to protect the public from the effects of their own ignorance and carelessness, as well as from ignorance, carelessness, and fraud on the part of workmen.

In the following pages the principles that ought to guide him in the discharge of his duties will invariably precede detailed description; for it is a common experience that ignorance of the principles with which all details must comply not infrequently results in a useless expenditure of money, and brings discredit on the Sanitary Authority and their officials. It does not follow that the structural alterations called for in one case are equally necessary, or indeed suitable, in all; what may be necessary under certain circumstances, may under others be inexpedient. Again, more than one sanitary appliance may be admissible in a given case, and unless the Inspector appreciates the object that is to be attained, he may condemn a perfectly suitable appliance, simply because, in detail, it does not correspond with what he has seen used under similar circumstances before.

It will not infrequently be the duty of an Inspector to point out to the owner of a property who, it may be recently, has spent a considerable sum in sanitary (?) work, that, through faulty work, things are no better than they were before, but, in doing so, he must be perfectly confident of his ground, a confi-

* The two following papers will be read with profit by those who are interested in the housing of the working-classes:—1. *The Vital Statistics of Peabody Buildings and other Artisans' and Labourers' Block Dwellings.* By A. Newsholme, M.D., D.P.H. (read before the Royal Statistical Society, Feb. 17, 1891). 2. *Model Dwellings in London and Overcrowding on Space.* By Louis C. Parkes, M.D., D.P.H. (read before the Sanitary Institute, Feb. 11, 1891).

dence that can only be the outcome of a sound knowledge of the principles of Sanitation.

Inspectors may learn much by extending their field of observation to other districts than their own, when opportunity offers, and it is most desirable that they should form societies (branches of the Society of Sanitary Inspectors) for the discussion of sanitary questions, from time to time, among themselves. Such discussions will tend to keep alive an interest in work which is daily growing in importance, and promote that efficiency which alone, in future, will insure success.

It is important that Inspectors should take a comprehensive view of what is expected of them, and remember that they are workers in a wide field of labour. In order that they may successfully contend against the ignorance that prevails on all sides, they themselves must possess a knowledge of the general laws in operation in Nature, with which man's action must comply if health is to be maintained. Nature is a vast laboratory in which chemical change is in perpetual operation; there is no new formation of matter. What exists simply assumes a variety of shapes and conditions in accordance with the circumstances under which it is placed—so growth and decay go on; what are living cells of one animal to-day form the food of other animals or plants to-morrow, or, it may be, become for a time constituents of the inorganic world, to be redissolved and again appropriated by organic matter. These changes involve death and decomposition, and, under certain circumstances, danger to neighbouring life, a danger, however, against which we often possess a remedy in Nature herself, if we study her laws and take advantage of them.

CHAPTER II.

WATER-SUPPLY, DRINKING WATER, POLLUTION OF WATER.

Water a Prime Necessity of Life.—Water is one of the prime necessities of life, and that all should be provided with a pure supply is by no means the least important of the health requirements. It is a vital element of our food, and assists in the building up of our tissues, of which it constitutes one hundred parts in each hundred and fifty; it preserves the fluidity of the blood; aids in the excretion of effete matter;

and assists in maintaining our bodies at a uniform temperature under varying conditions of heat. It is also essential for drinking purposes, for cooking, and for personal and household cleanliness. By the community at large it is required for public baths, for water-closets, for flushing sewers, for the cleansing of streets, for use of animals, and for manufacturing and various other purposes. It is important, therefore, that the supply should be plentiful as well as pure.

Sources of Supply.—From whatever source our water-supply may be obtained, it is dependent for replenishment upon the rainfall. From the surface of the land, rivers, lakes, and oceans, evaporation takes place through the agency of the sun's heat, and the atmosphere has the power of retaining moisture, in the form of invisible vapour, in quantities varying with the temperature. The higher the temperature, the greater capacity the atmosphere has for retaining moisture in this invisible form. Should the temperature fall, which it may do from a variety of causes, a point is at length reached which is called **saturation point,** when the atmosphere contains as much moisture as it can possibly hold in the form of vapour; and if the temperature should be further reduced, a portion of the moisture is condensed into fine globules, and becomes visible as mist. Clouds are simply mist, and their circumscribed and apparently solid appearance is the result of their being viewed from a distance.

By the cooling of the atmosphere still farther, the globules of moisture coalesce into larger particles, until a point is reached, at which, by reason of their weight, they can no longer be retained in suspension, and are deposited in the form of rain. If the point of saturation of the atmosphere should not be reached—that is, if condensation should not occur—until the temperature is below freezing point (32° F.), then the deposit occurs in a solid form, and falls to the ground as snow.

The average annual rainfall in Great Britain is about 30 inches, varying from 20 inches on the East Coast to as much as 70 inches, or more, on the West Coast of Scotland and Ireland. At certain localities in the English lake district 150 inches is not an unusual amount. One inch of rainfall a day, or even more, is not an infrequent occurrence in this country; in some countries there may be much more, and in these the annual fall may amount to 400 inches or more.*

After having fallen, a certain portion of the rain water is lost by evaporation, another portion runs off the surface and the re-

* For a fuller account of the causes of the rainfall, &c., see *Elementary Meteorology,* by R. H. Scott (International Scientific Series).

mainder penetrates into the soil, the extent to which each takes place being regulated by a variety of circumstances, such as the amount of the rainfall, the temperature, the slope of the surface, and the porosity—that is, the openness of the soil. In winter a larger quantity penetrates or runs off the surface in the direction of the natural drainage than in summer, when, by reason of the increased temperature, evaporation is very rapid, and when it requires a heavy shower of rain to overcome the absorbent properties of the warm dry surface, so as to enable any portion to reach the water-courses, especially in flat districts.

Subsoil Water.—That portion of the rainfall which penetrates the surface continues to descend until, sooner or later, it meets with an impervious stratum, where its downward course is diverted in one direction or another, in accordance with the natural fall of the stratum in question. This fall is usually in the direction of the general surface fall—that is, towards the natural water outlet of the area. It must be remembered that the pace at which this subsoil water travels is very slow indeed, by reason of the obstruction offered to its progress by the soil through which it has to travel, and, for this reason, it varies with the density or looseness of the soil in question. Now it is this subsoil water which we tap in sinking what we call our **surface wells**; it, therefore, contributes largely to our domestic water-supply. As regards its qualities for this purpose, more will be said presently.

It will be understood from the above description that the depth of a surface well will vary according to the distance from the surface of the impervious stratum upon which the subsoil water rests.

It may here be stated that this has an important bearing upon the dampness of a locality, and for this reason it is of the utmost importance, especially in the case of low-lying districts, that no obstacle should be offered to the natural flow of the stream or water-course, which is the ultimate outlet of the water in question. The placing of weirs along the course of rivers, for the purpose of back-pounding the water, in order that it may be used as a motive power for mills, is a custom which, unfortunately, still prevails throughout the country.

Deep Water.—Beneath the impervious stratum just mentioned, we come upon other porous strata, and in them supplies of water which have percolated downwards from distant points where these strata reach the surface (Fig. 1). By sinking deep wells into such a stratum at its lower part we tap this supply, and, if the surrounding country should be much higher than the spot selected for the well, the pressure may be so great as to raise the water to the surface at the site of the well or even above it. Hundreds of feet may have to be pierced to reach this source of supply, and this plan is adopted by many large towns.

Springs.—These, which are outflows of water from the earth, are divided into two classes, **surface springs** and **deep springs**—the former are found mostly on the face of slopes, and their presence is dependent upon the fact, that at this point the impervious stratum, say of clay, which supports the subsoil water, rises to the surface and thus opposes a barrier to its onward progress. Deep springs, on the other hand, are due to the presence of a fissure in the impervious stratum, which enables the water below it to rise to the surface. The fact that surface springs are liable to become dry after a long interval without rain, while deep springs are nearly always permanent, will, therefore, be easily understood. The following sketch will assist the reader in understanding the above somewhat curtailed description:—

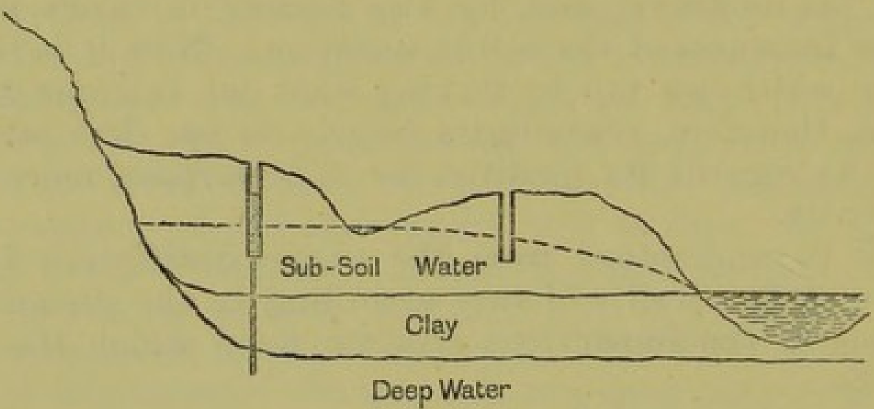


Fig. 1.

Character of Different Waters.—The sources of our water supply then may be from the rainfall, rivers, lakes, springs, and wells (superficial and deep). It does not come within the province of an inspector to say which of these yields water best suited for domestic purposes; his attention ought more especially to be directed to the risks of contamination to which water may be exposed during storage and distribution. The natural characteristics of the water from each of these sources may be shortly summarised as follows:—

Rain water, by reason of its want of aeration, is flat and insipid, and in towns it takes up so much impurity from the air during its transit, and from the various collecting areas, that it can hardly be looked upon as a satisfactory supply. In some districts in the country, where well supplies cannot be obtained, rain water, with proper storage and filtration, may be used for drinking purposes, but, as all soft waters possess considerable solvent powers, and as, owing to the intermittent character of the water supply, it is necessary to provide considerable storage room, great attention must be paid to the precautions to be observed in the construction of tanks (see p. 20).

Hard and Soft Water.—Rain water is excellent for washing purposes, as, being soft, less soap is required than in the case of hard waters. By a "hard" water is meant a water which contains a large quantity of saline constituents, of such a kind as to interfere with the formation of a lather with soap. Before a lather can be formed, in the case of such a water, the saline ingredients must form with the soap a curdy material, so that a quantity of soap, varying in amount with the hardness of the water, is thus wasted. There are two kinds of hardness, temporary and permanent. The former is owing to the presence of certain salts (chiefly lime-salts) that are deposited on boiling, and not redissolved, and the latter to others that are not so deposited.

Water-Supply of Towns.—Some large towns are provided with excellent water from lakes, which are simply large natural reservoirs, supplied by mountain-streams. Other towns construct reservoirs by damming up mountain-streams in their passage along valleys, and thus obtain good and plentiful supplies of water. Rivers and streams, on the other hand, which pass through cultivated land and populous districts, are unsafe, partly because of the manure which is applied to the land, and, in too many instances, because of sewage pollution. *Water from surface wells must always be viewed with suspicion by reason of the danger of pollution from similar sources.* Deep wells, on the other hand, as a rule yield excellent waters, although, in some instances, the various salts they contain in solution are present in such quantity as to be objectionable by causing deposits in boilers. By reason of their hardness, also, such waters are not convenient for washing purposes, and in some instances, from the same cause, they may be injurious to health; the latter consideration, however, is purely a medical one.

The following condensed summary of the broad characteristics of waters from different sources is given by the Rivers' Pollution Commissioners :—

Wholesome	1. Spring water.	Very palatable.
Wholesome	2. Deep-well water.	Very palatable.
Wholesome	3. Upland surface water.	Moderately palatable.
Suspicious	4. Stored rain water.	Moderately palatable.
Suspicious	5. Surface water from cultivated land.	Palatable.
Dangerous	6. River water to which sewage gains access.	Palatable.
Dangerous	7. Shallow well water.	Palatable.

Quantity of Water Required.—The quantity of water required by towns for all purposes varies with circumstances, such as the general presence or absence of water-closets, manufacturing processes, &c The average supply per head for the London districts in 1884 was 28 gallons in the 24 hours, varying from 25 to 37 gallons. Some towns exceed this amount, while others do not reach it; in Glasgow, for example, the daily supply is 50 gallons, while in Sheffield it is only 20. Dr. Parkes has calculated the amount used per head in a household of fairly cleanly people at 12 gallons; in this calculation, 2½ to 3 gallons are allowed for a daily sponge bath, and it includes clothes-, utensil-, and house-washing, but not a water-closet supply.

	Gallons daily for each person.
Cooking,	·75
Fluids, as drink (water, tea, coffee),	·33
Ablution, including a daily sponge-bath, which took 2½ to 3 gals.,	5
Share of utensil- and house-washing,	3
Share of clothes (laundry) washing, estimated,	3
	12

The same writer states that if from scarcity of supply the amount must be limited, 4 gallons is the least that ought to be allowed, and that with this amount there cannot be daily washing of the whole body, and there must be insufficient change of underclothing. This question is of importance to Sanitary Authorities of rural districts in determining, for example, whether the yield of certain wells is sufficient.

A double system of water-supply has been suggested; pure for drinking and less pure for washing purposes in cases in which difficulty has been experienced in obtaining a sufficient supply of pure water for all purposes; but there are two objections to this plan—first, the cost in providing duplicate pipes, and second, the danger that, through carelessness, the one supply might be substituted for the other.

Collection and Storage.—Allusion has already been made to the plan adopted for the collection of water on a large scale by taking advantage of Nature's reservoirs in the shape of large lakes, or by constructing an artificial lake by damming up a stream in a valley. Under such circumstances the amount of storage necessary is dependent upon the rainfall of the district and the extent of the collecting area. In the case of deep-well supplies the water is pumped into service reservoirs large enough to contain several days' supply, but the collection and storage of water on a large scale is an engineering question outside the province of a sanitary inspector. On the other hand, the construction of wells for local supplies (which are simply small reservoirs), and cisterns, is of vital importance, and the details ought to be familiar to all inspectors.

Wells are of two descriptions—surface and deep. The former, as already mentioned, tap the subsoil water, while the latter pierce the impervious stratum upon which this water rests, and tap the water-bearing stratum below. The distinction between the one and the other is not, strictly speaking, a matter of depth, for what is known as a "surface" or shallow well in one district may be deeper than a deep well in another, from the fact that, in the latter case, the impervious stratum of clay or rock may be near the surface. Also, what is, strictly speaking, a deep well may be very shallow, provided it is sunk at a spot where the stratum which yields the deep water crops up close to the surface. The ordinary surface well which one meets with throughout rural and small urban districts is constantly liable to pollution from various sources, unless certain precautions are observed as regards its position and construction. Filth from a leaking cesspool, privy-midden, manure heap, or faulty drain, will find its way into such a well from a considerable distance off. Such percolation is sometimes demonstrated by the fact that well water may smell of disinfectants that have been thrown down the drains.

A surface well drains an area which varies in accordance with the depth to which the water in the well is lowered by pumping, and the nature of the ground in which it is sunk. The more porous the ground, the greater is the distance from which the water travels towards the well, and, from experiment, this distance has been stated to vary from 15 to 160 times the depression which results from pumping.

Whether these figures be accurate or not, there is no question that surface pollution does find its way into wells, from points that one might consider a safe distance off (it is, therefore, of vital importance to observe every precaution in their construction).

Well Making.—The precautions to be observed in making a well are as follows:—In the first place, the spot selected for a surface well ought to be as far removed from all sources of pollution as possible, and in the opposite direction to the natural fall, so as to tap the water previous to its reaching the polluting source, and not after it has travelled past it. The importance of this will be understood from the description already given of the course that the subsoil water takes (see p. 13). In addition to this, the lining of the well must be so constructed as to be quite impervious to soakage from the surface immediately surrounding it.

In place of the brick work being loosely laid around it, which is the usual practice, it ought to be set in cement down to the water level, and, as an additional precaution, it is well to interpose a layer of puddled clay all round, between the brickwork and the adjoining soil. Every well ought to be provided with a pump, and be covered over by means of stone slabs, carefully adjusted and sealed with cement. By reason of such precautions, in place of entering the well direct, all surface water must percolate through the intervening stratum, and, in doing so, become more or less purified.

In the "Rivers' Pollution Commissioners' Sixth Report" the following remarks appear, which are given here because they express very forcibly what one often finds to be the case:—

"Twelve millions of country population derive their water almost exclusively from shallow wells, and these are, so far as our experience extends, almost always horribly polluted by sewage and by animal matters of the most disgusting origin. The common practice in villages, and even in many small towns, is to dispose of the sewage and provide for the water supply of each cottage, or pair of cottages, upon the same premises. In the little yard or garden attached to each tenement, or pair of tenements, two holes are dug in the porous soil; into one of these, usually the shallower of the two, all the filthy liquids of the house are discharged; from the other, which is sunk below the water line of the porous stratum, the water for drinking and other domestic purposes is pumped. These two holes are not unfrequently within 12 feet of each other, and sometimes even closer. The contents of the *filth-hole*, or cesspool, gradually soak away through the surrounding soil, and mingle with the water below. As the contents of the *water hole*, or well, are pumped out, they are immediately replenished from the surrounding disgusting mixture, and it is not, therefore, very surprising to be assured that such a well does not become dry even in summer. Unfortunately excrementitious liquids, especially after they have soaked through a few feet of porous soil, do not impair the palatability of the water; and this polluted liquid is consumed from year to year without a suspicion of its character, until the cesspool and well receive infected sewage, and then an outbreak of epidemic disease compels attention to the polluted water. Indeed, our acquaintance with a very large proportion of this class of potable waters has been made in consequence of the occurrence of severe outbreaks of typhoid fever amongst the persons using them."

Norton's Abyssinian tube well is constructed by driving tubes into the soil, one length being screwed on to another, and the lowest segment having a series of perforations at the free end. When the subsoil water is reached, a pump is attached to the tube, and after pumping for some time, the water, which at first is dirty, becomes clear and remains so, as a cavity which corresponds to the ordinary well is formed at the end of the pipe owing to the gradual removal of the soil by pumping.

This is an excellent plan of obtaining a water-supply for villages situated on gravel, provided the water is not very far from the surface.

For precisely the same reasons as are stated above, it is equally necessary, in the case of deep wells, to protect the surface by carrying the impervious brickwork down as far as the impervious stratum. A very striking example of the effect of not doing so was met with some years ago in the Stafford Rural District, in the case of a deep well belonging to a school. The water in this case was highly polluted, so much so that it had a most offensive odour, and in the absence of any local insanitary surroundings, it was at first difficult to account for it; on opening the well, however, and introducing a light, the cause was at once apparent. Down to a distance of 12 feet from the surface, the brickwork was perfectly clean, but at this point a well defined line was formed by the entrance of a filthy, slimy-looking fluid, which stained the bricks down to the water-level 50 or 60 feet below. In this case, the only source of pollution was from a manure heap in a farm yard 70 or 80 yards away, from which, no doubt, percolation had occurred through the surface gravel, along an impervious bed of clay. Had the brickwork of the well in question been built in an impervious manner down to this clay, no such pollution could have occurred.

The quality of cement used is very important, the best

Portland cement being alone admissible for this, as for all sanitary work. The proportions of added sand ought, for this particular purpose, to be two of sand to one of cement, and the two ought to be thoroughly well mixed before the water is added. The sand selected must be clean and fine, and quite free from any dirt or clay, otherwise the cement will not set. Builders and workmen require careful watching as regards these points.

In all cases in which well-pollution is suspected, it is advisable to open the well in order to ascertain whether there is any evidence of the penetration of sewage matter above the water level. If such be the case, at one point or another, the brickwork, in place of presenting a clean, red surface, will be discoloured in a manner which, when once seen, will never be mistaken. Apart from this, it is highly desirable that wells should be **opened periodically** for the purpose of being cleansed, as, however well constructed they may be, with time impurity may arise.

Pumps.—There are two kinds of pumps, the ordinary **suction pump** and the **forcing pump.** The former will answer the purpose so long as the distance the water has to be raised does not exceed from 30 to 33 feet; in fact, as a rule, taking imperfections of mechanism into account, 25 feet may be looked upon as the limit. In the case of deeper wells, it is necessary to fix the more elaborate and expensive forcing pumps; hence it is that in practice one so often finds open wells with a bucket and windlass for raising water. In such cases, the danger of surface pollution is increased, and if the arrangement be allowed to continue, as in the case of small cottages probably it will, the greatest care must be taken to see that the top of the well is so situated with regard to the surface as not to permit of drainage into it. A good fitting cover ought to be insisted upon, otherwise dead leaves and other decaying matter will find their way into the well.*

Cisterns.—In cases where cisterns are necessary certain precautions must be attended to in their construction.

(1) *They should be constructed of a material that will not impart any injurious quality to the water.* Galvanised iron and slate both answer the purpose well; the latter, however, although the best in other respects, is heavy and it is difficult to avoid leakage through the joints; these should be carefully made with cement. Lead and wood are bad materials for use in the construction of cisterns. The risk of metallic contamination in the case of the

* For a full and simple description of the construction of pumps see *Well Sinking*, Weale's Rudimentary Series.

former has often been demonstrated, and, as regards the latter, sooner or later decay takes place and organic contamination results.

(2) They should be easily accessible, and, while the sun's rays ought to be excluded, the place where they are fixed must not be dark. These requirements are essential so as to afford every facility for inspection and cleansing. It is not unusual to find cisterns placed under floors, in situations quite unknown to the occupants of the house, until, by reason of the foul condition of the water, a search is made, and the cause, in the shape of dead and decomposing rats, is discovered.

(3) They ought to be covered in and ventilated, otherwise dirt of all descriptions will enter.

(4) The overflow pipe ought to be carried to the outside where it should either be cut short or discharge on to an open gully. It is a very common practice to connect it direct with the soil pipe or drain, in which case it simply acts as a ventilator, and foul gases are conducted direct to the drinking water. In some instances in which this is done a syphon trap is introduced, but as the overflow pipe is only in use when the ball-tap which regulates the supply of water is out of order, this trap owing to evaporation must stand empty, and, therefore, be absolutely useless. Some years ago the author found an illustration of this fault in the case of an hospital, where, to make matters still worse, the cistern overflow pipe was connected direct with the drain from the fever wards.

(5) The supply pipe for the water-closet *must not pass direct from the cistern*, but a smaller cistern (water waste preventer) ought to be interposed (see p. 120).

Distribution.—In public water-supplies there are two systems of distribution—the **constant** and the **intermittent.** The former is very much the better, for a variety of reasons, although the latter is the system in operation in some towns.

Constant and Intermittent Systems.—In the case of the constant system, the taps of the houses deliver water direct from the service pipes, without the intervention of a cistern, except in the case of water-closets, which have what are termed "water waste preventers"—small cisterns that deliver, at one time, only the requisite quantity of water for flushing purposes—and kitchen boilers, which cannot be supplied direct, but must be provided with small supply cisterns. The necessity for having large cisterns for storing water on the premises is thus avoided, while, with an intermittent supply, these are essential, otherwise, from time to time, houses would be entirely without any water. The chief objection to the storage of water in houses is the danger of pollution, which may occur from various causes already noticed. Another objection to the intermittent system is that, by periodically shutting off the water from the mains, a vacuum is liable to be created in the pipes, from gradual leakage at faulty joints, and this vacuum is replaced by foul air, or even sewerage, from leaking drains, an occurrence which in more than one instance has led to an outbreak of typhoid fever. The mains, in the case of a constant supply, are always full, therefore this risk is to a large extent avoided. In addition to this, pipes running full are less liable to rust than those that are occasionally empty, as air in the presence of moisture has considerable corroding power.

Besides these advantages, in the constant system there is always an abundant supply of water in the case of fire. The disadvantage of a constant supply is that the waste from leaking pipes is greater, as the water is always at pressure in the mains; also, by reason of the great pressure in the service pipes, the various fittings must be of more perfect make, and therefore more costly. For this reason, much waste of water has resulted in cases in which a constant has been substituted for an intermittent supply without replacing the old fittings. On the other hand, in some cases where the change has been made, and the necessary fittings substituted, a diminution in waste has resulted.

Charges.—The system of charges for water may be by rate or by meter. The former is much the better for domestic supplies, as, by making a charge in accordance with the quantity consumed, an inducement is offered to economise, and economy in the legitimate use of water is certainly not what one would wish to see.

Indirectly, there is another important reason for placing no obstacle in the way of a generous use of water, and that is the cleansing effect that it has on the drains and sewers. By limiting the supply, we diminish the flushing power, and thus add to the risk of deposit, which is so highly objectionable as will be explained in a later Chapter. Of course, in special cases, such as manufactories, it may be necessary to charge by meter.

Pipes.—Iron, with a coating of some protective material, such as Angus Smith's varnish, is what is used for mains. Lead is most generally used for house pipes, but in the case of certain waters its use is dangerous, for reasons already stated. Galvanised iron pipes are now often used, as they are not so liable to rust as plain iron pipes. The temptation to use lead pipes is very great, as they can be carried anywhere round corners by simply bending them; whereas in the case of iron pipes, joints have to be inserted at frequent intervals, not only where angles have to be passed, but also where one length has to be joined on to another.

Many materials have been suggested as a protective coating for both lead and iron pipes, but most are either unsatisfactory or too expensive for general use.

Glass-lined iron pipes are manufactured, and answer the purpose well.

Tin is used as a protective coating for both iron and lead pipes, but in this form it is hardly satisfactory.

Composite pipes, consisting of a block tin pipe enclosed in a lead pipe and solidly united together, are not so liable to be acted upon by water, and they may be bent in any direction like an ordinary lead pipe; these answer excellently.

Iron pipes treated by the Barff process are recommended by some. The process consists in raising the temperature of the pipes to a white heat (about 1200° F.) in a chamber into which superheated steam is passed. After being exposed to the action of the steam for several hours the metal becomes coated with a protective oxide.

Impurities.—The chief impurity, in fact the only one that need be considered from an inspector's point of view, is that which comes from an organic source, either vegetable or animal, the latter being much the more objectionable of the two.

Both may be present in a solid form or in solution; in the former case, the water is distinctly discoloured, the colour varying in depth in accordance with the amount or nature of the contaminating material; while in the latter, notwithstanding the presence of considerable impurity, the water may be perfectly clear and wholesome looking. The absence of colour, therefore, is no sign that the water is pure; but neither is its presence a sign of dangerous pollution, for peat imparts a considerable colour to water which need not be injurious. The important point to remember is, that a clear water need not mean a pure water, but that danger may exist even though it is beautifully sparkling and perfectly clear. Here, then, we are brought face to face with a problem which can only be solved by the chemist, but as the inspector ought to appreciate the significance of what the chemist tells him, we must go a step farther, and explain shortly the reason why water which contains organic matter is dangerous from a health point of view.

Presence of Organic Matter—What it means.—In the first place, then, even from an ordinary point of view, it is, to say the least of it, objectionable, to drink water which contains matter in a putrefying state ; but, in addition to this, evidence exists which points to the conclusion that it is directly injurious to health to do so. The real danger, however, lies in the fact that any contaminating source—for example, human excreta and refuse—may contain the poison of a disease which may be communicated through the medium in question. We know a great deal more now than we did a comparatively short time ago of the nature of the poisons which cause diseases of the infectious class, and the belief that all such diseases are associated with minute living germs is universally accepted. Many circumstances which formerly we did not understand are now explained ; it is no longer difficult to realise that a water, known to be bad, may be consumed for a long period with apparent impunity, and then suddenly, typhoid fever may attack several of the consumers. We know now that the poison reaches the well by the same channel which all along has conveyed the polluting matter.

It is obvious from what has been said that a standard of purity cannot be arrived at simply by fixing a chemical limit of admissible impurity, because, beyond stating that a certain amount of organic contamination is present, chemistry cannot go—its exact nature cannot thus be indicated. Were a standard to be fixed on such evidence as this, it would amount, in some cases, to saying that a limited number of typhoid fever germs may be admitted with impunity, which, of course, is absurd.

How to Estimate Purity of Water.—The only safe way of arriving at a conclusion with regard to the quality of a water is to consider the analyst's report *together with the possible sources of pollution*, and, for this reason, it is most desirable to send a full account of the surrounding conditions with the sample.

The following history of an outbreak of typhoid fever, which the author investigated about two years ago, illustrates very forcibly what has just been stated. The cases were directly connected with a farm-house in which a person had died from the disease twelve months previously. Immediately on the occurrence of the cases in question, a sample of water from the well belonging to the house was sent to a chemist for analysis, with the result that it was pronounced to be perfectly wholesome. The fever attacked three occupants of the house, and three people living in different parts of the scattered district (two of whom lived over a mile away), but all of those patients worked at the farm in question, and drank the water from the said well ; in fact, after an exhaustive enquiry, the details of which need not be given here, the *contagion was unmistakably traced to the farm-house well.* In the course of this enquiry, a second analysis of the water was made, and by way of comparison the water from two other wells in the immediate neighbourhood was also analysed, with the result that, although the amount of organic matter present in the case of the farm-house well came within the chemical limit of purity, it exceeded by nearly four times the quantity present in the two wells that were selected for comparison. Where, then, did this increase of organic impurity come from? There need be no difficulty in answering this question, for within four yards of the well was situated a large foul privy cesspit.*

Purification of Water.—In the case of a public supply direct from a deep well, the water may be pumped direct into the reservoir, but when the source is a river or mountain stream, it is necessary to pass the water through a filter-bed after it has been received into reservoirs and subsidence of a great portion of the suspended impurities has taken place.

The Filter-Bed.—Such a filter is constructed of sand, which ought to be sharp and angular (not too fine), and gravel of various degrees of coarseness. The sand is placed on the top, and under it is the gravel which increases in coarseness, until, at the bottom, where the outlet pipes are situated, it consists of small stones. The efficiency of the filter is dependent upon the time which the water takes to percolate through, and this is regulated by the depth of the sand, which ought to be from 1½ to 2 feet, the gravel being 3 feet. Each square foot of such a filter will allow 70 to 75 gallons to pass in the 24 hours. The effect of such a filter, although chiefly mechanical, is not altogether so. Particles of mineral and organic matter adhere to the sand, so that the filter has to be periodically cleansed by the removal of the surface sand. Such a filter will remove dissolved organic matter to some extent. This is due to the oxygen of the air contained in the interstices of the sand and gravel mixing with the water in a finely divided state as it passes downwards, hence the reason for conducting the process slowly. It is this property of air which also mainly accounts for the increasing purity of a water, so far as dissolved organic matter is concerned, as it passes onward in rivers.

Rain-Water Filter.—For the filtration of rain-water it is a common practice to construct a filter under ground, in which case certain precautions are necessary. The arrangement ought

* See *British Medical Journal*, April 2nd, 1892.

to be similar, on a small scale, to that just described, but as, in this case, the filter is sunk in the ground, it is essential that the brickwork which contains the sand and gravel should be built in cement, so as to render it impervious to soakage from the surrounding soil. Sometimes, in addition to sand and gravel, charcoal is introduced, but this is objectionable, because the water has afterwards to be stored, and charcoal imparts to water a material which favours the growth of organisms. Such filters as these are apt to be neglected, on account of their inaccessibility, so, in order to facilitate regular cleansing, a convenient means of gaining access to them ought to be provided. This rule is applicable to all sanitary appliances. It is not easy, even if every facility is offered, to induce the public to systematically cleanse and inspect them, but if any difficulty stands in the way of doing so, it is hopeless.

Domestic Filters.—Great ignorance prevails regarding the efficacy of domestic filters. The general opinion is that, however foul the water may be to start with, all deleterious matter is removed by their use. One is constantly told that "the water must be all right, because every drop that is used is filtered." Filters are excellent things in their way, but they must not be regarded as specifics against all dangers, and their use ought to be confined to cases in which the water-supply, from unavoidable circumstances, is liable to be contaminated. Some exceptionally careful people, on the principle that it can do no harm, and may do some good, go to endless trouble in cases in which the water-supply is of the purest character, in passing it through filters previous to use. This is a mistake, for unless filters are **periodically cleansed,** and the filtering medium **renewed,** they may be the means of contaminating in place of purifying the water.

The effect of filtration on a small scale is to remove, more or less completely, all solid matters, both organic and inorganic. In this respect their action is mechanical; but, in addition to this, some filtering materials have the power of acting chemically upon decomposing organic matter, and upon organic matter in solution, as well as upon certain saline constituents. It would appear, however, that their effect upon fresh organic matter is *nil*—an important consideration in view of what is now known of the nature of disease-poisons. The material most frequently used is **charcoal,** or a combination of charcoal with silica (silicated carbon filters), animal charcoal being much more efficacious than vegetable. It may be used either loose or compressed into blocks, but the latter form is not so convenient for cleansing purposes.

The "Filtre Rapide" of Maignen is largely used in the army, and is an excellent contrivance, in which the water is rapidly passed through a large surface of charcoal in the form of granules, asbestos cloth being used as a straining material. The great advantage in this filter is that the charcoal can be easily removed—an important consideration; for in nearly all filters organic matter previously removed may be given back again in time, particularly if the water is very impure. This is more likely to take place if the filtering process be slow, and the water is thus left long in contact with the charcoal, so that, in this respect also, this form of filter has an advantage.

Dr. Frankland has proved experimentally that water which has been in contact with charcoal, if kept, decomposes more rapidly than it otherwise would do. The suggested explanation of this is that the water takes up phosphate of lime from the charcoal—a material which favours the growth of low forms of life. Allusion has already been made to this in describing a rain-water filter. In order that a charcoal filter may retain its power of acting chemically upon water, it must be periodically exposed to the air.

Spongy Iron—a substance obtained by roasting hæmatite iron ore—is also largely used as a filtering material. By reason of its porous nature, it allows the passage of water through it, while, at the same time, it arrests the solid matters. It also acts chemically on the water, without imparting any material to it which afterwards encourages decomposition. Spongy iron retains its filtering power longer than charcoal, and, therefore, need not be renewed so often; and it differs from charcoal in that it does not require to be periodically exposed to the air in order to enable it to act chemically upon the water; indeed, it ought not to be so exposed. Other materials, such as **magnetic carbide of iron** and **polarite,** are also used with success as filtering media.

All organic substances, such as sponge, flannel, cotton-wool, and tow, should not be used as filtering materials, either alone or combined with charcoal, &c. Any action they possess is purely mechanical, and sooner or later they decompose and add impurity to the water.

Filters permanently fixed in cisterns are objectionable, as their existence is liable to be forgotten, and, consequently, they are little likely ever to be renewed or cleansed. Small filters attached to service pipes are useless for the purpose for which they are intended, as the medium is in such small bulk, that the water is not long enough in contact with it to allow any purifying effect to take place. It has been stated that such filters, if the filtering material be animal charcoal, will remove lead from water to some extent.

A tap filter ("the gem") has recently been brought out by a firm at Leeds, which consists of a small chamber containing finely-divided quartz. It can be fixed to most taps easily, and it is reversible, so that when the water has passed through it for some time in one direction, it can be turned round, the object being to remove the deposit that has occurred in the meantime, by reversing the direction of the current. This little filter is said to answer the purpose for which it is intended very well, but it must be remembered that the only effect it can have is purely a mechanical one, and for that reason, it is a question whether its use ought not to be discouraged, on account of the false security it may convey to the minds of the public.

A good Filter; Essential Points.—Prof. Parkes enumerates the essentials of a good filter as follows:—

"1. That every part of the filter shall be easily got at, for the purpose of cleaning or renewing the medium.

"2. That the medium have a sufficient purifying power, both as to chemical action on organic matter in solution, and arrest of organisms and their spores in suspension, and be present in sufficient quantity.

"3. That the medium yield nothing to the water that may favour the growth of low forms of life.

"4. That the purifying power be reasonably lasting.

"5. That there shall be nothing in the construction of the filter itself that shall be capable of undergoing putrefaction, or of yielding metallic or other impurities to the water.

"6. That the filtering material shall not be liable to clog, and that the delivery of water shall be reasonably rapid."

Cleansing of Filters.—It is necessary before a filter is used that from 10 to 20 gallons of water should be passed through it, as all in the first instance yield a certain amount of foreign matter to the water. The most difficult to cleanse are the block carbon filters—but this may be accomplished by first carefully brushing the surface and pumping air in the reverse way, and afterwards allowing a mixture of dilute Condy's Fluid with a little hydrochloric acid to pass through it, until it comes out of a distinct pink colour. It is obvious that the cleansing can only be properly done by the maker, to whom it ought to be sent for the purpose. When the filtering medium is loose charcoal, it may be cleansed in the same manner with Condy's Fluid and acid, but the simplest plan in this case is to renew the carbon.

In both cases, after cleansing or renewal, it must be remembered that clean water should be passed through the filter before it is again used. This cleansing process must be conducted at intervals, varying in accordance with the amount of impurity present in the water filtered, but the interval ought not to be longer than six months.

In the case of spongy iron filters Condy's Fluid and acid must not be used, but the material may be cleansed by burning it, although in this case also, the best plan is to renew it. As spongy iron retains its filtering power longer than charcoal, this process need not, probably, be gone through oftener than every twelve months.

From the above, it is obvious that all filters in which the medium is permanently sealed up ought to be discarded, and it must be remembered that all so-called self-cleansing filters are a myth.

Various chemical substances, such as lime and alum, are used for the purpose of water purification. The effect that such produce is a mechanical one, the various matters in suspension, both organic and inorganic, being thrown down with the precipitate which is formed on the addition of the material. The organic matter in solution remains unaffected by the process.

Boiling as a means of Purification.—One excellent and simple method of water purification on a small scale has not yet been mentioned, and that is boiling.

The effect that boiling has, is to cause certain salts to be deposited (as mentioned in referring to the hardness of waters), and matters in suspension in the water are carried down with them, but the all-important effect of boiling is that as the organisms of disease cannot withstand a moist temperature, even for a short period, of 212° F. (the boiling point of water), the great danger of infection by water may thus be removed. Filtration after boiling is an additional precaution. Inspectors, therefore, in all cases in which suspicion attaches to water as the carrier of disease, ought to bear this in mind, and do all they can to encourage the public to take advantage of this simple safeguard.

Taking of Samples.—It is the inspector's duty, when he has reason to suspect that a water-supply is likely to be contaminated, or when he is requested to do so by the medical officer of health, to procure a sample for analysis by the medical officer or analyst. In doing so, the following instructions ought to be attended to.

It is hardly necessary to say that the bottle in which the sample is taken, which should be a Winchester quart, must be scrupulously clean; before being filled, it should be rinsed out two or three times with the water that is to be analysed. The bottle ought to have a glass stopper, and it is well to cap it with leather, the string being sealed with sealing-wax. If for any reason a stoppered bottle cannot be obtained, an ordinary cork may be used, but it must be a clean new one, and it also ought to be capped as described.

The following particulars, when applicable, ought to accompany each sample :—

1. Date on which the sample was taken.
2. If from well, stream, town supply, or other source?
3. If from well, how deep, approximately?
4. What is the distance from the nearest midden, drain, or cesspool?
5. How far from stable or farm-yard?
6. Is there any other possible source of pollution?
7. Is the water drawn from pump or tap?
8. If from a pump, is it one of wood, iron, or what?
9. If from a tap, are the pipes of lead, iron, or galvanised iron?
10. What is the special reason (sickness, &c.) for requiring analysis?
11. Are there any other particulars to which it is desirable that attention should be called?

One is sometimes asked by an inspector whether any simple test can be applied by him to determine roughly whether a certain water is good or bad, with a view to assist him in deciding whether or not a sample should be taken for analysis. The question must be answered in the negative. He must be guided by the existence of anything in the local sanitary conditions that may operate injuriously in contaminating the water in question.

Inspector's Duty with regard to Water-Supply.

Among the numerous duties an inspector is called upon to perform, there are none to which greater importance can be attached than that of enquiring as to whether the conditions upon which a pure water-supply is dependent are violated. These conditions vary in accordance with the nature of the supply. In the case of large urban districts with public water-supplies, the enquiry, so far as the inspector is concerned, will be directed mainly to the house connections, while in rural and small urban districts, which are dependent upon local supplies from wells, springs, &c., the chief circumstances to be noted are the house surroundings.

Summary.—From what has already been said, the details which in each case should receive attention will be appreciated, but perhaps it may be well to repeat the more important of these, by way of summary.

1. The water-supply of a household ought to be within a convenient distance, *plentiful* and *pure;* but if from any cause the supply should be limited, the smallest quantity admissible for houses without water-closets, is 4 gallons per head per day, an amount, however, which would not admit of perfect cleanliness, or proper flushing of the drains.

2. That upland surface water and water from springs and deep wells is usually of good quality, while that from cultivated land, rivers, and surface wells must be viewed with suspicion.

3. That the site selected for a well ought to be as far removed as possible from all sources of pollution, and that the well should be so constructed as to be absolutely impervious to surface pollution, by building the brickwork in cement, sealing the surface with stone slabs, and attaching a properly constructed pump.

4. That in the case of deep wells, the brickwork ought to be built in the same manner, at any rate down to the impervious stratum of clay or rock.

5. That in all cases in which surface leakage is suspected, the well ought to be opened and examined.

6. That while storage in a house is objectionable, in cases in which it cannot be avoided, the cistern should be constructed of a material which will not impart any injurious matter to the water, and be placed in an accessible situation, to facilitate inspection and cleansing. It should be covered, ventilated, and have an overflow into the open apart from any drain. The supply-pipe to the closet ought to be intercepted by a second small cistern.

7. That the supply ought to be constant, and that, except in special cases, the charge ought to be by rate.

8. That lead pipes cannot always be used with safety.

9. That although the water may be perfectly clear it does not follow that it is not dangerously polluted.

10. That none of the filters in the market can be trusted to render harmless any disease-poison the water may contain.

11. That all filters require cleansing.

12. That nothing of an organic nature ought to form part of

a filter, and that it should be so arranged that it can be taken to pieces with ease.

13. That after filtration through charcoal, the water must not be stored for any length of time.

CHAPTER III.

VENTILATION AND WARMING.

Pure air is as essential to health as pure water, although the public are very ignorant of the fact. Unfortunately, the air of our rooms may be loaded with impurities without any visible sign being apparent that such is the case, and although, fortunately, some of us have timely warnings of evil, in the shape of headaches and feelings of depression, others seem to possess an unfortunate immunity from any such indication of danger. Probably children helplessly suffer in like manner, but, reared in homes almost hermetically sealed against the entrance of fresh, or the exit of foul air, to be transferred later in life, for certain periods of the day, to schools and workshops that may be similarly described, their constitutions, if they withstand the strain that is thus placed upon them, become blunt to all impressions—nature ceases to sound the warning note which for so long has been disregarded.

Although, to the uninitiated, it would appear that air does not come into such direct contact with our internal economy as water, this is a mistaken notion. We inhale in the course of twenty-four hours, while at rest, 480 cubic inches per minute (twice this amount or more when at work), which is brought into intimate contact with the blood in the microscopical cells of the lungs, around which the blood-vessels ramify. It is here that the air performs its function by giving up oxygen to the blood, and receiving from it moisture and various effete matters. The number of air-cells has been estimated at between 5 and 6 millions, with a combined area of from 10 to 20 square feet.

These figures will give some idea of their minute size, and of the extent of the absorbent surface presented to the air.

The presence of impurity in water is in some cases indicated by its turbid appearance, but the air of our rooms, however impure it may become from overcrowding, presents no visible evidence of the fact. This may be looked upon as an unfortunate circumstance, for few people would be so callous as to continue to breathe air that is obviously foul, if the fact was apparent to them.

The composition of the atmosphere varies in different situations. In the following table the proportions of the various ingredients of an average sample are given :—

Composition of Atmospheric Air (*Parkes*).

Oxygen, ...	209·6 per 1000 volumes.
Nitrogen, ...	790·0 ,,
Carbonic Acid, ...	0·4 ,,
Watery Vapour, ...	varies with temperature.
Ammonia, ...	trace.
Organic matter (in vapour or suspended, organised, unorganised, dead or living,	Variable.
Ozone, ...	Variable.
Salts of Sodium, ...	Variable.
Other mineral substances, . . .	Variable.

Oxygen is the all-important element. It is the gas to which the air owes its purifying power, and it is the great supporter of combustion. If the proportion present were much diminished, a light would cease to burn, and life would become impossible.

Ozone is another form of oxygen, possessing similar, but more active properties. As a rule, it is only to be found in the purest atmospheres, and is absent in populous districts.

Nitrogen acts as a diluent of oxygen, which, in its pure state, is far too potent. Unlike oxygen, it does not support combustion, but, like carbonic acid gas, if present in excess, it extinguishes a light.

The quantity of **carbonic acid** present varies from ·2 to ·5 part per 1,000 of out-door air; the former may be the proportion in mountainous districts, and the latter in some densely populated parts of towns.

In rooms without proper ventilation, ten times the above amount of carbonic acid may be present, but although large quantities of this gas are discharged into the atmosphere as the result of the combustion of coal, respiration, &c., the quantity present in the air varies very little, owing to the diluting action of the winds, and the power possessed by plants in absorbing and appropriating the carbon.

In addition to carbonic acid, a large quantity of **organic matter,** the result of tissue waste, and also **impure vapour** are given off from the lungs and skin, and it is to these that injury must in a large measure be attributed. Carbonic acid in itself may be present in considerable quantity without any ill effects being apparent, as is demonstrated in the case of workers in aerated water manufactories. It has been ascertained by experiment, that the ratio of carbonic acid added to the air *as the result of respiration*, corresponds very closely with the amount of organic matter from the same source, and for this reason it is taken as a standard of purity. It is the presence of effete organic matters from our bodies that causes the disagreeable odour and sensation of stuffiness experienced in occupied rooms that are unventilated.

In addition to impurity, the result of respiration, the air is liable to be contaminated by materials, both solid and gaseous, from a great many sources. Among the former may be mentioned particles of dust of all descriptions, too numerous to mention, pollen of plants, germs of various sorts (including, it may be, some that we know to be instrumental in the production of disease), and fragments of carbon and tarry matters from the imperfect combustion of coal. Among the latter are special gases evolved in certain trades, and others the result of combustion, as well as effluvia from badly constructed sewers, and from collections of excreta, manure, and refuse of all descriptions.

The use of gas in rooms and factories adds greatly to the impurity of the air. One cubic foot of gas will, in burning, consume the entire oxygen of 8 cubic feet of air, and also impart certain noxious compounds of sulphur and carbon to the air. In spite of this, we find that people not only use gas for lighting purposes, but also, in the shape of a naked flame, as a means of heating rooms, shops, and factories. An oil lamp with a good burner will consume 3·2 cubic feet of oxygen in an hour, so that, it may be said that one gas burner of ordinary size is ten times worse, as regards the injury it does, than a lamp giving an equal light.

From what has been stated, it will not appear surprising that the air of towns should compare unfavourably with that of country districts; the wonder is rather that the difference is not greater, and this can only be explained by the purifying power possessed by the oxygen of the air itself, and the action of the winds in distributing the impurity over a large area; it is important, therefore, that the former should not be overtaxed, and that the latter should have full play.

Diseases Produced by Impure Air.

The effect of impure air on the health of the people is illustrated by the various tables given in the first chapter. The excessive mortality from lung diseases in the case of those engaged in certain dust-producing occupations, as well as the influence on the death-rate of overcrowding, and of the back-to-back arrangement of houses, is there proved by statistics. In addition to this, however, there can be no question that foul air is highly conducive to a general lowering of the vital functions, which renders illness more frequent, and recovery more uncertain and prolonged.

The success which attends the medical and surgical treatment of cases in hospitals, as compared with the results of similar treatment at home, in overcrowded and badly ventilated cottages, is recognised by all medical men, and, that fresh air is a factor which largely contributes to the good result in the former case, is generally admitted. Again, there can be no question that the severity of infectious disease, as well as the risk of infection, is greatly increased by atmospheric impurity.

Enough has been said to indicate the importance of fresh air. We must now pass on to consider the amount that is necessary, and the means at our disposal for obtaining a proper supply.

Quantity of Air Required

As the amount of carbonic acid gas present in the air of a room corresponds with the degree of impurity caused by effete matters given off from our bodies, that gas, as already stated, is taken as the standard in estimating the condition as regards ventilation. Up to a certain point, one can detect different degrees of impurity by the sense of smell, and the sensation of stuffiness experienced on entering a room from the open air, but the power of discrimination as to degree ceases after a certain amount of foulness is exceeded. The figures in the following table, prepared by Dr. de Chaumont, and which have been carefully tested, indicate the point at which impurity becomes first apparent to the senses, and also when the power of discrimination as to degree of impurity ceases.

It is not desirable to burden the memory with many figures; but, from a ventilation point of view, it is important to remember that when respiration has added 0·2 vol. of carbonic acid per 1,000 to the air of a room, the effect begins to become apparent to the senses; consequently, it may be concluded that an amount beyond this is not compatible with a properly ventilated room.

It must be remembered that these figures do not represent the actual amount of carbonic acid gas present in the air, but only that which is *added*, so that from 0·3 to 0·4 (the amount naturally present in the air itself) must be added in each case to show the total amount. This applies also to the remarks that follow.

The amount of carbonic acid given off per hour by a person at rest, is 0·6 cubic feet;* it follows, therefore—if the air of the room is to be kept at the above standard of purity—that 3,000 cubic feet of fresh air must be introduced for each person during that time. This brings us to the consideration of the amount of cubic space required for each person.

	1. Fresh, or not differing sensibly from the outer air.	2. Rather close, Organic Matter becoming perceptible.	3. Close, Organic Matter disagreeable.	4. Very close, Organic Matter offensive and oppressive: limit of differentiation by the senses.
Mean Carbonic Acid per 1,000 volumes of air, the result of respiratory impurity, . .	0·19	0·41	0·67	0·91

Cubic Space Required.

It is obvious from what has been said that the question of space is one which is entirely dependent upon the facility that exists for changing the air of a room, and, granting the possibility of doing so to an indefinite extent, it becomes quite immaterial how limited the space allowed for each person may be. Were it not for one consideration, this theory would be perfectly applicable in practice, but it is found to be unworkable on account of the draughts that result from the rapid movement of the cold air.

Temperature, then, influences the pace at which air may travel without causing a feeling of draught. Air at 55° to 60° Fahr. travelling at 1½ feet per second is not perceptible, at 2 to 2½ feet it is imperceptible to some persons, at 3 feet it is perceptible to most, while at 3½ feet it is perceptible to all, and anything above this causes a feeling of draught. If the air be warmed to 70° Fahr., a greater velocity is not perceived, but if the temperature be as high as 90° Fahr., it again becomes

* This is an average—men give off more, and children less.

more perceptible; this also happens if it be lowered, say to 40° Fahr.

Experience teaches that, in this country all that can be borne is a change of the air of a room three times an hour; it follows, therefore, that in order to retain the standard of purity, viz., 0·2 of added carbonic acid gas, as each person contributes 0·6 cubic feet of the gas per hour, the space allowed per head ought to be 1,000 cubic feet. In practice, this amount is very seldom met with, indeed, in cottages it too often does not exceed from 200 to 250. The amount provided in barracks is 600 cubic feet, and that usually required for common lodging-houses is 300.

Theoretically, from the amount of impurity added to the atmosphere by **animals,** such as horses and cattle, the amount of space required by them, on the above calculation, would be from 3,000 to 7,000 cubic feet, but this amount in their case is neither requisite nor attainable. The conditions are altogether different, as much greater liberty may be exercised in the direction of free ventilation. In practice, 1,000 cubic feet per head is a satisfactory amount. The Regulations under the Dairies, Cowsheds, and Milkshops Order, usually require 800 cubic feet, although in some cases the amount is only 600, or even less, which cannot be said to be sufficient.

Fallacy concerning Large Rooms.—It is a popular idea that plenty of space does away with the necessity for ventilation, but this is a mistake. Even with a space of 10,000 cubic feet occupied by one person, in the absence of ventilation, the limit of impurity would be reached in a little over three hours, after which time the same amount of fresh air would have to be introduced as in the case of a smaller room, in order not to exceed the standard of impurity.

The **height** of a room is an important consideration in a ventilation enquiry. The respiratory impurities tend to accumulate about the occupants of the room, and beyond a certain point *loftiness will not take the place of floor-space.* The air of a space enclosed by high walls, but uncovered by a roof, would soon become very foul if the space were overcrowded. There is no objection to a lofty room, but it must be remembered in estimating the capacity in a ventilation sense, that a height of 12 feet only should be considered, as this may be taken to be the maximum useful height for a room.

Ventilation and Warming of Schools.

Some years ago the author conducted an investigation with regard to the conditions of warming and ventilation of the

School.	Contents in cubic feet.	Average Attendance.	Cubic feet per head.	Ventilation.	Warming.	No. present when taken.	Outside Temperature.	Time when taken.	Impurity in volumes, Carbonic Acid per 1,000 air.	Amount over admissible impurity.
1. Seighford, . .	11,528	50	231	Two openings through ceiling but not through roof.	Two fire places in side wall.	37	33°	12·0	1·483	·883
2. Ellenhall, . .	8,160	40	204	Two ventilators, one at each end; both closed.	Stove in middle of room.	34	33°	1·0	1·534	·934
3. Salt, ...	10,880	50	218	Nil.	Two fire places in side wall.	53	49°	12·0	1·742	1·142
4. Hyde Lea, . .	5,712	40	143	Nil (practically).	Fire place in wall.	40	51°	12·0	1·894	1·294
5. Great Haywood (National),	10,368	34	305	Both ends and roof.	Fire place at each end.	30	37°	12·0	1·987	1·387
6. Fradswell, . .	6,095	40	152	Nil.	Fire place in side wall.	38	37°	11·50	2·039	1·439
7. Weston, . . .	13,230	45	294	Nil.	" "	40	49°	12·0	2·041	1·441
8. Stowe, . . .	5,776	63	93	Two ventilators, one at each end; both closed.	" "	33	37°	12·0	2·106	1·506
9. Gayton, . . .	5,970	43	139	Two ventilators, one each end.	" "	30	37°	11·50	2·273	1·673
10. Tixall, . . .	9,750	44	222	Nil.	" "	24	35°	12·0	2·273	1·673
11. Great Haywood (Catholic),	7,344	38	198	Nil.	Stove in room.	37	33°	12·0	2·298	1·698
12. Ranton, . . .	11,036	26	424	Two small openings, one at each end.	Two fire places in side wall.	26	33°	12·0	2·465	1·865
13. Hixon, . . .	12,096	36	336	Three ventilators in gable ends.	Open fire place.	36	37°	11·30	2·529	1·929
14. Colwich (Infant),	6,912	40	173	Nil.	Fire place in wall.	26	49°	11·30	2·841	2·241
15. Haughton, . .	6,446	50	128	Nil.	Fire place in wall at end of room.	40	42°	12·0	3·030	2·430
16. Rickerscote, .	7,718	53	145	Two ventilators through ceiling but not through roof; not open.	Fire place in wall, also stove.	35	39°	11·45	3·201	2·601
17. Bradley, . . .	7,290	36	203	Nil.	Fire place in wall.	36	42°	12·0	3·252	2·652
18. Berkswich, . .	4,044	38	106	Two small ventilators in wall, only one open.	Fire place in wall, also stove.	38	35°	11·45	3·708	3·108

elementary schools in the rural district of Stafford, and for that purpose it was necessary to make analyses of the air.

As the question has an important bearing on the subject at present being discussed, the foregoing table, giving the result of the analyses, with condensed remarks as to other circumstances, will prove of interest. The significance of each heading of the table will be understood from what has already been said. The samples were taken during the winter months, about the same time of day in each case, and after the schools had been occupied for about three hours.

One cannot expect that the air of schools should come within the standard of purity, considering the present small amount of space required by the Education Department (100 cubic feet per head), and for this reason, it is the more essential to adopt all reasonable measures in order to approach that standard as nearly as possible. In the cases given in the table which, in all probability, may be taken as types of the condition of school ventilation throughout England, the amount of impurity in the atmosphere of the best school is more than twice what it ought to be, while in the worst, the standard is exceeded by six times.

The figures also represent a better all round condition of ventilation than would generally be found, for the number of children present at the time of taking the sample of air was, in several instances, considerably below the average attendance.

To properly ventilate a school, or any other public building in which the space per head is so small, is a matter of great difficulty, and unless mechanical means are adopted, it amounts to an impossibility.*

The bearing that cubic space has upon the condition of the air in occupied rooms, is well illustrated by the figures of the table, which show that the greatest capacity is by no means always associated with the greatest purity.

Measurement of Cubic Space.

The estimation of the capacity of a room of ordinary shape is a simple matter, all that is necessary being to multiply by each other, the length, breadth, and height. It is more convenient to express the measurements in feet and decimals of a foot than in feet and inches.

* For an account of the difference in cost between mechanical and natural ventilation in the case of schools, and the comparative results obtained by the one and the other, see a Report by Prof. Carnelley for the information of the School Board of Dundee, 1889.

The following table gives approximately the proportion in decimals that inches bear to feet :—

Inches.	Decimal Parts of a Foot.	Inches.	Decimal Parts of a Foot.
12	1·00	6	0·50
11	0·92	5	0·42
10	0·83	4	0·33
9	0·75	3	0·25
8	0·67	2	0·17
7	0·58	1	0·08

For example, if a room measures 12 ft. 6 in. in length, 10 ft. 3 in. in breadth, and 10 ft. in height, the calculation will be as follows :—$12·5 \times 10·25 \times 10 = 1281$. The capacity of the room in question, then, is 1,281 cubic feet.

Any recesses that exist must be measured separately, and added to the total; and projections, in the shape of walls or cupboards, must be deducted from it.

In the case of rooms of irregular shape, it is necessary to measure portions separately, in order to arrive at the true capacity.

The following are the rules to be followed in the examples most frequently met with :—

Area of a triangle = base multiplied by half the height.

Suppose, in the figure given (Fig. 2), the base measures 12 feet and the height 4 feet, the area would be 24 feet. This rule applies in the case of rooms without ceilings; the section of the space within the slope of the roof, representing the triangle, is measured by multiplying the breadth of the room (base of triangle) by half the height from the roof angle to a line corresponding with the height of the walls, and this figure multiplied by the length of the room will give the cubic capacity of that part of the space embraced by the roof slope.

In the case of a room the walls of which are irregular as to length, corresponding, for example, to the figure represented (Fig. 3), the area may be obtained by dividing the floor space into triangles, and taking the sum of their areas—this figure multiplied by the height from floor to ceiling will give the cubic capacity.

In the case of a circle, the area is obtained by multiplying the square of the diameter by ·7854, and this figure multiplied by the height of the room will give the capacity.

The area of a segment of a circle (Fig. 4) is obtained by adding the cube of the height, divided by twice the chord, to two-thirds of the product of chord and height $(\text{Ch.} \times \text{H} \times \frac{2}{3}) + \frac{\text{H}^3}{2\,\text{Ch.}}$.

The figure obtained, if multiplied by the height of the room, in the case of a circular recess, or the length of the room, in the case of a circular roof, will give the capacity of the space enclosed.

The cubic capacity of a dome is ascertained by multiplying two-thirds of the product of the area of the base by the height (area of base × height × $\frac{2}{3}$), the area of the base being simply that of a circle.

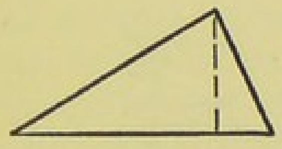


Fig. 2.

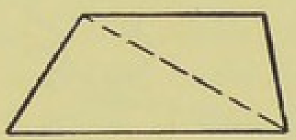


Fig. 3.

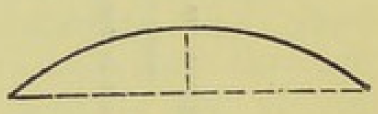


Fig. 4.

By applying these rules most spaces usually met with may be measured, and by dividing the total capacity by the number of persons occupying the room in question, the cubic space per head is obtained.

Ventilation.

By ventilation is meant the dilution and removal of all impurities which collect in the air of inhabited rooms. The process may be the result of forces constantly acting in nature—**Natural Ventilation**; or it may be the result of forces set in action by man—**Artificial Ventilation.**

In order to understand the operation of the various ventilating appliances in use, it is necessary first to understand the principles with which they must all comply to insure success. Although many difficulties are met with in devising ventilation schemes, these arise not so much, perhaps, from want of knowledge on the part of the person engaged, as from the impossibility of the task he is asked to perform. By the use of artificial means, a large volume of air may be passed through a room; but, as already explained, if the rate at which the air travels exceeds a certain pace, a feeling of draught is the result.

Natural Ventilation.

The chief forces acting in nature which encourage ventilation are—(1) *Diffusion;* (2) *the action of the winds;* and (3) *the movement produced by unequal weights of air*, upon which principle the wind itself is dependent.

Diffusion is the term applied to the power which gases of different densities possess of mixing with each other. This intermixing may take place through porous substances, such as dry brick, but it is slow under all circumstances, and, therefore, it assists in ventilation only to a slight extent.

The Wind is an active agent in ventilation, but it is open to the objection that, while at one time it is practically almost stagnant, at another it may be blowing with great force, and for

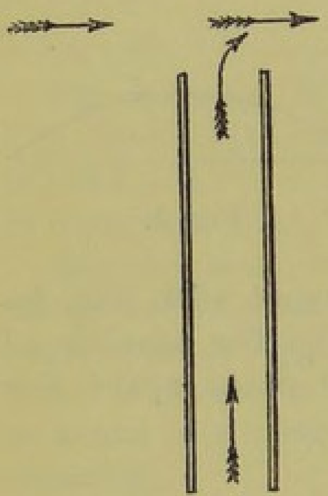


Fig. 5.

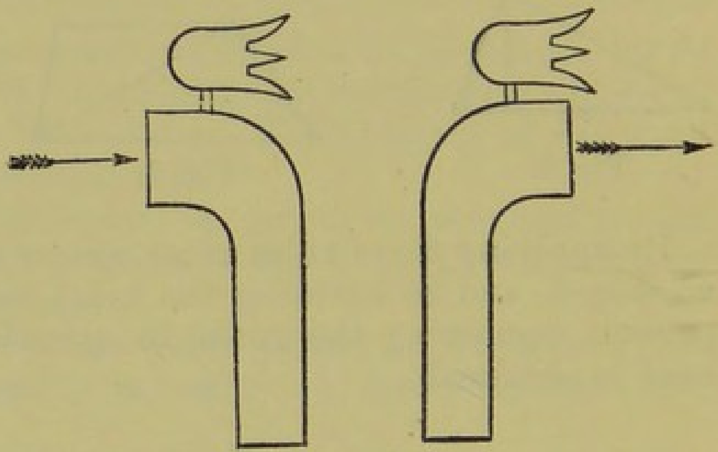


Fig. 6.

this reason it is difficult to regulate its effect. When the weather will admit of it, the action of the wind may be taken advantage of, by opening windows on opposite sides of a room, as a free cross current of air will thus be produced; this practice ought invariably to be followed, at intervals, when rooms are unoccupied, for example in the case of schools, as by such means a rapid renewal of the air is effected.

The action of the wind is also of great assistance in encouraging an upward current in ventilating shafts, by reason of the aspirating effect that one current of air has when passing at right angles across another, in the manner indicated by the arrows in the sketch (Fig. 5).

The action of the wind has been taken advantage of in house ventilation by fixing movable cowls at the top of shafts, with vanes so fixed as to direct the mouth of the one towards the wind, and of the other in the opposite direction. The effect is that the wind enters the cowl which has its mouth turned in the direction in which it is travelling, when it can be conducted by pipes to the various rooms, and returned to the reverse cowl by other pipes (Fig. 6).

So far as house ventilation is concerned, this plan has not been found to answer, as the great variation in the pace at which the wind travels renders it difficult to regulate the amount of air introduced. The system answers well, however, in the case of ships, where the cowls can be adjusted, by hand, in a position in accordance with the rate at which the ship is travelling, and the direction of the wind.

The movement produced by **unequal weights of air** is a potent factor in ventilation, particularly in our climate where the external air is, as a rule, colder than that of our rooms. It operates in the following manner:—When the temperature of a room is raised, the air in it expands, and, by reason of its increase in volume, the room cannot contain the same quantity as before, a portion, therefore, is discharged through any opening that may exist. But if the outside air is not correspondingly raised in temperature, an inequality is at once established between the one and the other, and as the cold air outside is heavier than the warm air inside, the result is that, by the law of gravitation, it will enter the room through various openings, and continue to do so until such time as the point is reached when the temperature of the one and the other (and, therefore, their gravity or weight) is precisely the same. Now, if the cause which led to the raising of the temperature of the inside air continues to operate, either in the shape of a fire, or other artificial heating means, or by reason of the room being occupied by people, the same constant inflow of colder air will continue, and the rate of entrance of this cold air will be exactly in accordance with the depth of the heated column, and the difference of temperature between the one air and the other. The greater the depth of the heated column, and the greater the difference between the two temperatures, the more rapid is the inflow. It does not follow that the direction of the current is always from the outside into the room, because, if from any cause the air of the room is colder than the outside air—which it may be in summer—the reverse action takes place. In winter, when our houses are artificially warmed, this process is in active operation, and if the direction of the inflowing current of cold air be regulated by artificial appliances, it may be turned to excellent account as a means of ventilation, as will presently be explained.

Artificial Ventilation.

Under ordinary circumstances, if rooms are not overcrowded, and it is not, therefore, necessary to change the air very often, natural ventilation is sufficient, but in the case of crowded public rooms some artificial means of renewing the air ought to be employed. There are two systems of artificial ventilation—viz., *Extraction* and *Propulsion*. By the former system the foul air is extracted from the room, and is replaced by pure air; and by the latter, pure air is forced into the room, the foul air giving place to it.

The various appliances in use in both natural and artificial ventilation will presently be described.

Position and Size of Openings.—It is obvious that, in order that air may enter a room, an exit must be provided for that which is at present in the room, so that two openings are necessary. Theoretically, the size of the outlet ought to be larger than that of the inlet, because warm air has a greater volume than cold; but the difference is so slight that it may be disregarded, and both openings may be of the same size.

Again, although the total area of the inlets ought to correspond with that of the outlets, their number should be greater, and they should be placed in situations as far as possible removed from the outlets, so as to ensure as complete a circulation of air as possible. If they are placed close together, the air will enter and pass out without mixing with that of the room, and so the object for which they are intended—viz., the dilution of the impure atmosphere—will not be accomplished.

Warm air, being lighter than cold, has a tendency to rise, therefore the most suitable position for the outlet ventilator is in or near the ceiling; it by no means follows, however, that the proper position for the inlet ventilator is near the floor, for, were it so placed, as the air that enters is usually much colder than the air in the room, a draught would at once be felt. The position of the inlet ought to be either near the ceiling or some 5 or 6 feet from the floor; but in the latter case some plan must be adopted that will give the entering air an upward direction.

Practically speaking, then, it amounts to this—that in natural ventilation both outlet and inlet ought to be placed high up, and for absolutely opposite reasons; in the former case, because warm air rises, and in the latter, because cold air falls. By this arrangement draughts are not so likely to be experienced, because by the time the incoming air reaches the level of the occupants of the room, its temperature has been raised by mingling with the warm air to a point at which movement is less perceptible. In cases where it is possible to warm the air before it is introduced, the inlet may be at the floor level, but such a plan, strictly speaking, comes under the head of artificial ventilation.

The Chimney is a very efficient outlet ventilator; and in rooms it is usually the only one. This really is an example of artificial ventilation, as its action is greatly dependent upon the fire, but, as it is so commonly found, one may almost look upon it as being natural.

Mechanisms Employed in Ventilation.

From the account just given of the principles upon which the movement of air is dependent, the action of the various mechanisms in use as aids to ventilation will better be understood. In warm summer weather ventilation is an easy matter, for then a perfect change of the air of a room may be accomplished by opening windows; but in cold weather this cannot be done, and it becomes necessary to devise schemes for changing the air of rooms without inducing draught.

Natural Ventilation.

Tubes or shafts are employed as both inlets and outlets, and in their construction certain rules must be followed.

Friction greatly influences the rate at which air travels along a tube, and for this reason, especially in the case of natural ventilation, it is important to limit its effect in every possible way by reducing the causes of it to a minimum. The following are the more important considerations under this heading:—

1. That as in the case of two openings of similar area, the one circular and the other square, the friction surface in the former case is only $\frac{7}{8}$ of that in the latter, circular are to be preferred to square tubes.

2. That the smaller the opening the greater is the friction. In the case of openings of similar section the friction is inversely as the diameter. For example, with an opening of 6 inches diameter, the friction will be twice that of an opening of 12 inches; the diameter of the one being twice that of the other. It follows from this, that by dividing an opening of 1 square foot into four

openings of $\frac{1}{4}$ of a square foot, the friction will, theoretically, be exactly doubled, because the respective diameters of the smaller openings are only one-half that of the larger.

3. That angles increase the friction greatly. It has been shown by experiment that a right angle will diminish the current by one-half; so that a ventilating pipe with two right angles in its course will only have a quarter the ventilating power of a straight pipe of a similar length and calibre. This fact is very generally disregarded. One frequently finds ventilating pipes with many angles, by reason of their being carried round, in place of through, various projections.*

To modify friction from this cause as much as possible, in cases in which it is absolutely necessary to deviate from the direct line, the angles ought to be well rounded and as obtuse as possible.

4. That the longer the tube the greater is the friction.

5. That the smoother the interior of the tube the less is the friction, not only on account of the diminished surface thus exposed to the air, but also because there is less chance of the accumulation of dust, which, besides being in itself objectionable, offers an additional obstacle to the current.

The length of the outlet tubes or shafts ought not to be greater than is necessary, for, in addition to the increase of friction with length, there is a danger of the current being checked entirely, by reason of the air in the tube being cooled to an extent which will render it so heavy as to overcome the upward tendency of the warm air from the room. To diminish this risk of cooling it is a common practice to place outlet shafts close to flues.

Joints of ventilating pipes must be air-tight, otherwise the upward current will be greatly lessened by the entrance of cold air. Very commonly, in making such pipes, whether of sheet-iron or zinc,† the joints are formed by simply inserting one length of pipe into another; but by this means an air-tight joint is not secured. All such joints ought to be soldered, and, in order that the integrity of the joints may not be endangered through any strain, the shaft ought to be secured by stays at frequent intervals.

One often finds, particularly in the case of schools, that outlet openings are made in the ceiling, and are not continued up by a shaft carried through the roof. In such cases an opening is

* This applies very generally in the case of soil-pipe ventilators (see p. 127).

† These remarks have reference to room, not to soil-pipe, ventilators, which latter ought to be constructed of more durable material (see p. 126).

usually made in the gable wall which communicates with the roof space. The effect of such a plan must be a more or less constant down-draught into the room—particularly if the wind chance to be blowing in the direction of the outer opening—which compels the permanent closure of the inner opening. In such cases, the remedy consists in attaching a pipe to the ceiling opening, and continuing it through the roof.

Wire gauze or perforated zinc is often used to cover outlet openings, so as to diminish any down-draught that may occur. This practice is to be condemned, for, although it may remedy the occasional evil, it permanently interferes with the extracting power of the shaft by greatly diminishing its calibre. A far better precaution against a down-draught being perceived is to fix a circular disc under the opening, and of larger diameter than it, within a few inches of the ceiling, as is represented in section by sketch (Fig. 7). By this means any down-draught, in place of descending upon the heads of the occupants of the room, is directed to the side.

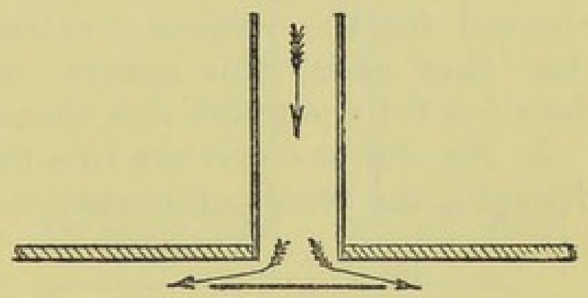


Fig. 7.

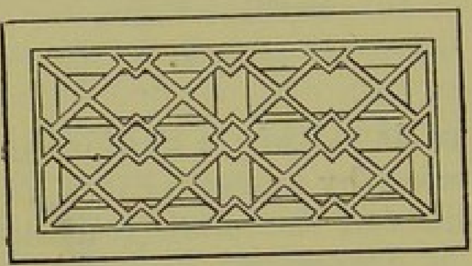
Cowls are placed on outlet ventilating shafts with the object of (1) preventing the entrance of rain, (2) increasing the extracting effect of the wind, and (3) checking the tendency to down-draught.

1. The entrance of rain into a ventilating shaft diminishes the upward current of air, by reason of the cooling effect on the air of the evaporation which follows. The custom of damping surfaces, with the intention of reducing the temperature, is one which is generally practised ; for example, the watering of the floors of larders and dairies in warm weather. The reason of the cooling which follows is explained by the fact that in the conversion of water into vapour heat is necessary, which heat is supplied by the neighbouring surfaces, with the result that there is a local reduction of temperature, the heat that has been appropriated being rendered "latent" so long as the moisture is retained in a vaporous state. Now, as already explained, the weight of a given volume of air is increased as its temperature is reduced, and applying this knowledge to the case in point, it will be understood that the weight of air in a ventilating shaft may, by a process of cooling, be so increased as to overcome the upward tendency of the warmer, and, therefore, lighter air below,

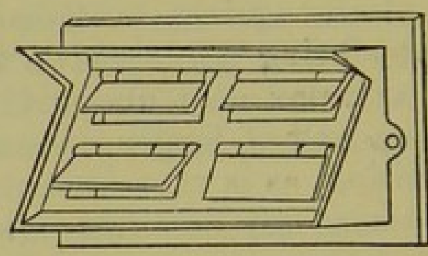
and thus the shaft in question may cease to act as a ventilator. The tendency to down-draught in damp weather in the case of a chimney of a fire-place, which for some time has not had a fire in it, is a familiar example of the effect of the process just described; and if such may occur, notwithstanding the presence of a fire to encourage the draught, still more must it do so under similar circumstances in the case of a ventilating shaft which is not artificially warmed.

2. The aspirating effect of the wind on the air of an upright shaft is considerable, irrespective of any apparatus, but it is claimed for the various "extractors" (as their name implies), that they assist this natural tendency; experiment, however, does not fully support this claim.

3. No doubt cowls are to a certain extent preventers of down-draught, the result of downward gusts of wind.



View from room.



View from chimney.

Fig. 8.

From what has been said, it will be understood that cowls do not exercise any very wonderful power, but simply aid to a certain extent, the natural upward current that takes place through a shaft which communicates with a room, the temperature of which is higher than that outside.

The Chimney, which in itself is a powerful extractor, may be utilised as an outlet for air on a level with the ceiling, by tapping it at that point, and introducing a form of ventilator which will allow of the passage of air from the room without permitting a reverse current.

Boyle's Mica-flap Ventilator, which is represented in the accompanying sketch (Fig. 8) is designed for this purpose. Back-draught is almost entirely prevented by means of valves in the shape of thin talc plates suspended on cross-bars behind an iron-grating; these move backwards by reason of the pressure of the out-draught from the room, and are immediately closed should any tendency to down-draught—and the consequent entrance of smoke into the room—occur. A certain amount of noise is produced by the flapping of the valves, particularly when there is much wind, but apart from this objection (which is much lessened in the more recent appliances), these outlets into the chimney are of use in diminishing the tendency to draught in the neighbourhood of the fire-place, and in removing the warm air from the upper part of the room, where it is vitiated by respiration and the foul products of the combustion of gas. In the case of new houses, as already mentioned, it is better to construct a second flue alongside the chimney flue, with which the upper and lower rooms may be connected without the intervention of any special apparatus.

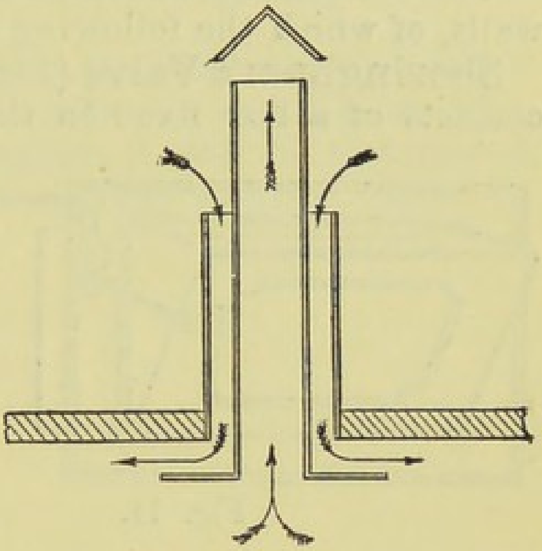


Fig. 9.

M'Kinnell's Ventilator is a combined outlet and inlet ventilator which is applicable in the case of upper rooms or rooms in single-storey houses. It consists of two tubes, the one encircling the other as represented in the sketch (Fig. 9). The area of both tubes is the same, and the inner one, which acts as the outlet, is continued for some distance above the outer, and is fitted with a cowl. The lower end of the inner tube is prolonged a little distance into the room, and has a flanged rim some inches in width which extends beyond the area embraced by the outer tube, and thus prevents the incoming air from descending at once into the room, by causing it to radiate to the side for some distance parallel to the ceiling.

Windows may be fitted with various ventilating appliances which will admit of the entrance of fresh air without causing a draught.

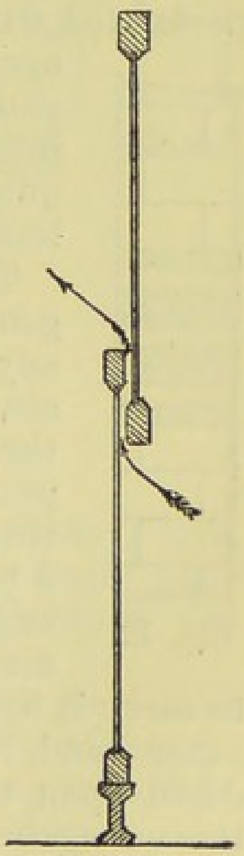


Fig. 10.

Hinckes-Bird's Window Ventilator (Fig. 10) consists of a piece of wood, or what is more cheerful in appearance, plate-glass, the width of the window, and 2 or 3 inches deep, introduced under the lower sash so as to leave an opening where the upper rail of the lower sash and the lower rail of the upper sash meet. The air enters at this point, and is directed upwards by coming in contact with the elevated top of the lower sash.

Louvred Panes, taking the place of one of the squares of glass, and arranged so as to admit of being opened and closed, is another plan of window ventilation by which an upward direction is imparted to the incoming air.

Various plans are adopted of introducing air through the house walls, of which the following are examples :—

Sheringham's Valve (Fig. 11), which is frequently employed, consists of a box fixed in the wall near the ceiling. The air enters through an iron grating in the outer wall, and is directed upward by an inner valvular opening which is movable, being attached to the lower side of the box by means of a hinge.

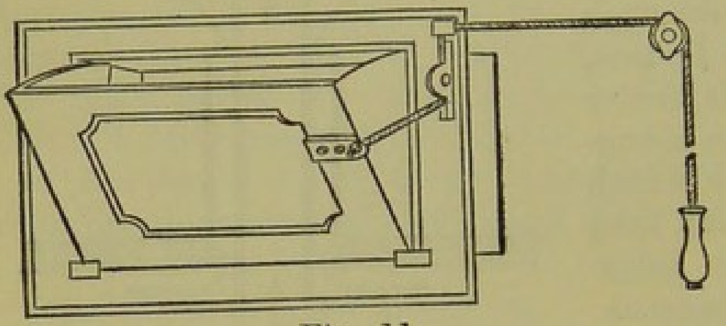


Fig. 11.

The valve is opened and closed by a balanced weight, and the extent of the opening can be regulated by means of a string and pulley.

Ellison's Ventilating Bricks (Fig. 12) consist of bricks perforated with conical holes, and are fixed in the wall with the apex of the cone on the outside. By reason of the expansion of the openings towards the room, the air is introduced in a less circumscribed current, consequently it diffuses more readily, and thus draught is less likely to be felt.

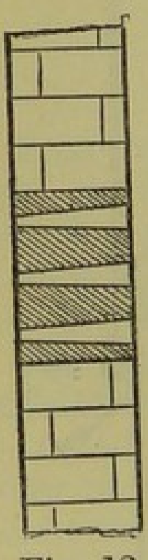


Fig. 12.

Tobin's Tube Ventilator (Fig. 13, A), now very generally in use, is perhaps the most satisfactory of any of the present aids to natural ventilation. The air, in this case, is introduced at the floor level, through an iron grating connected with a tube which passes through the wall into the room, where it is continued at right angles up the wall to a distance of from 5 to 6 feet. The height, in the case of ordinary rooms, ought not to exceed this, as the impetus given to the air in its upward passage along the tube is sufficient to carry it beyond the point where draught may be felt; on the other hand, if the tube be much longer, the air may be driven down upon the heads of the occupants of the room by its being thrown against the ceiling. Workmen in constructing tubes on this principle are very apt to carry them some 8 or 9 feet up the wall, in order, as they suppose, to avoid a draught—this is a mistake which ought to be avoided. Another fault which is not unfrequently found in a ventilator of this description, is its position being under a recess or overhanging shelf; the result of this is that the air on entering is at once thrown down by being directed against the obstruction. Under these circumstances the system gets blamed for what is really an error in its application.

From what has been stated regarding the influence that difference of temperature between the outside air and the air of a room has on the rate at which air enters, it will be understood that some means of regulating the amount admitted must be available. This is accomplished by means of *a plate within the ventilating tube*, which is capable of being adjusted to any angle by a handle. By turning this handle so that the plate lies at right angles to the axis of the tube, the opening is closed; and by turning it so that the flat surface of the plate is parallel with the axis, the tube is opened to its full extent; while, if fixed at any point intermediate between the two the opening is curtailed to an extent which increases the nearer the plate approaches the right-angle position. The accompanying sketch (Fig. 13, B) will assist the reader in understanding this description.

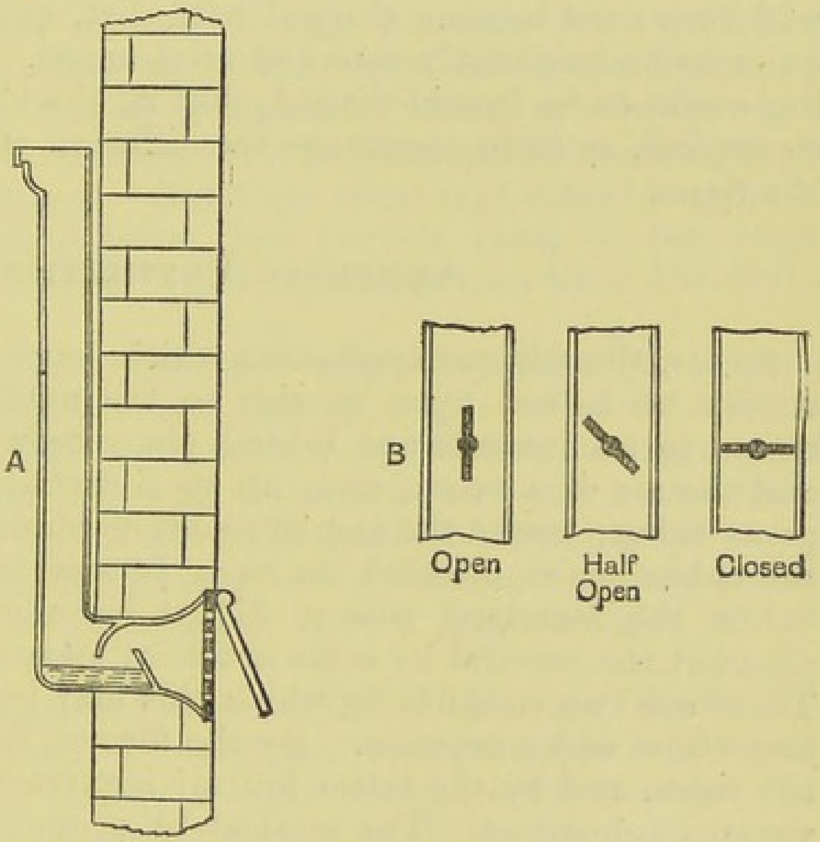


Fig. 13.

As the external opening of a Tobin's ventilator is protected by an iron grating, its calibre is thus reduced; it is necessary, therefore, in order to counteract this, that this opening should be of greater diameter than the tube itself (see Fig. 13, A).

An overhanging hood attached to the wall at an angle, and prolonged to about an inch below the lower margin of the opening, will counteract to a considerable extent the tendency to an excessive inrush of air at times when the wind is blowing against the face of the wall in which the opening is situated.

A water-trough may be placed on the floor of the inlet on to which the air is directed by means of a plate, as represented in the drawing. By this means a certain portion of the floating particles present in the air of towns is arrested. It is a question, however, whether such a plan as this is of much practical use, by reason of the fact that the water must be periodically renewed—a condition which is not likely to be complied with.

A diaphragm of gauze inserted at the inlet will filter the air very effectively, but it must be remembered that the material will very soon become clogged with dirt, and will, therefore, require to be frequently renewed or cleansed. The internal opening ought to be funnel-shaped, that is, the tube at the top ought to expand, so as to encourage the diffusion of the air on entering the room.

Artificial Ventilation.

So far, the various appliances which have been described may simply be looked upon as aids to the natural tendency which exists to an interchange taking place between the outside air and the air of a room, and, up to a certain point, they are of great value; but in the case of rooms or public buildings in which the cubic space allotted to each person may be considerably below the standard (see p. 37), it becomes necessary to supplement the natural by some artificial means of renewing the air. There are two methods by which this may be accomplished—viz., *propulsion* and *extraction*. By the former, fresh air is forced into the room, and by the latter foul air is extracted from the room by various appliances. The method by propulsion is usually to be preferred, as the air discharged into the building may be taken from any selected situation, and directed—after treatment, it may be, by filtering, warming, cooling, or moistening—to any particular locality. There are circumstances, however, favourable to extraction being the system selected, but the advantages, under varied conditions, of the one or the other will be better appreciated after the mechanisms employed in each case have been described.

Fans consist of a series of vanes fixed in an oblique direction to a revolving axis enclosed in a chamber which has an opening on two sides. By the rapid revolution of the fan within the chamber, the vanes set the air with which they come in contact in motion, and thus a current is produced which passes in at one opening and out at the other, at a speed which is regulated by the rapidity with which the apparatus is made to revolve. These fans act as propellers or extractors, according to whether they are fixed in connection with the inlet or outlet ventilating shaft. Steam or electricity may be used as the motor power, or, what may be more convenient, as requiring little attention, a gas engine.

Heat is capable of being utilised as a means of ventilation by *extraction.* The assistance in this direction afforded by the ordinary fire-place, and the various methods by which it may be taken advantage of, have already been referred to, but special shafts are sometimes connected with furnaces for ventilating purposes. Mines are frequently ventilated in this manner. A furnace is lit at the foot of an up-shaft, which draws air which has entered by a down-shaft, after it has been distributed throughout the various workings. Ships are often ventilated in a similar way by the ventilating pipes from various parts of the vessel being conducted to a shaft which communicates with the boiler furnace.

Gas used for lighting purposes may be utilised as a very efficient ventilating power, and, indeed, ought to be so utilised. What are known as sun-lights are a series of burners congregated together near the ceiling, and connected with an outlet shaft. The heat generated by the gas is thus taken advantage of as an extracting power, and all noxious fumes, the result of combustion, are at once carried away, together with a large amount of foul air from the room.

If the plan of connecting all gas-lights with outlet shafts was more generally adopted, it would add immensely to our health and comfort. In old houses it is not always easy to adopt this plan, but in new houses no gas burner ought to be fixed except on this principle. Many improvements in gas burners have recently been introduced with the two-fold object of improving the lighting power and assisting in the ventilation of rooms.

The accompanying sketch (Fig. 14), which represents the "Globe" light of Mr. Hammond, is reproduced, together with the description, from *Our Homes,* edited by Shirley F. Murphy, and will assist the reader in understanding the principle of construction of a gas burner of this description.

"The air of the room in which the light is fixed enters near the top of the globe at A, and, passing between the interior of the globe and the exterior of the chimney-glass, descends to supply oxygen to the burner, B. The products of combustion ascend to the top of the chimney-glass at D, under the aperture of the hollow pendant, up which they are impelled by the sharp draught of the heated current. Having reached the upper part of the pendant, the heated products are turned by the elbow at the top into the horizontal pipe, A, A, and are carried into the chimney of the room in which the light is fixed.

"The pipe, A, A, is surrounded by an outer pipe, C, C, which affords—where the draught in the chimney is sufficiently good—a means of gently and imperceptibly changing the atmosphere of the room by the steady current which is produced by the heat of the inner pipe.

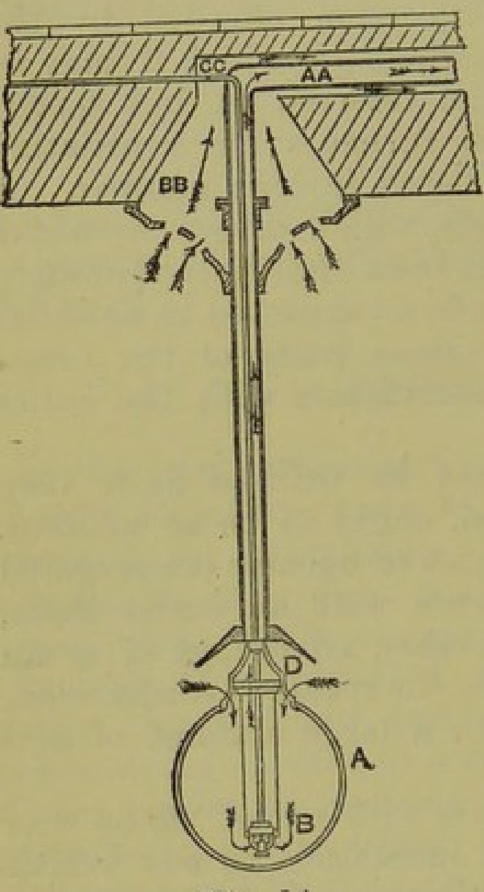


Fig. 14.

"The openings, B, B, provided in the ceiling-rose for the purpose, communicate through the cone with this pipe, so that the temperature of the room is equalised by the constant gradual rise of the comparatively cool air from below as fast as the upper portion passes into the pipe. This action is self-regulating, the current being more rapid when gently heated, and less so as the cooler air ascends."

Gas brackets when fixed on a wall in the neighbourhood of a fire-place may be ventilated by an overhanging pipe communicating with the flue; this arrangement need not necessarily be unsightly. In connecting such ventilating pipes, it is important to notice that the flue in question is not common to two rooms. It is by no means an unusual custom, although it is a highly objectionable one, to connect a fire-place on the first floor with the flue coming from one on the ground floor, and, under such circumstances, if the gas ventilator belonging to the down-stairs room is carried into the flue, the offensive fumes are likely to be discharged into the room above. Far too little attention is paid to the method of lighting rooms by gas.* What in itself is injurious when burned in the room as a naked flame, owing to the impurity which is added to the atmosphere as the result of combustion, may, by an arrangement

* For a description of various gas burners, see *Our Homes*, Chaps. xlii. to xliv.—*R. Brudenell Carter.*

such as has been described, not only be rendered harmless, but actually turned to account as an excellent aid to ventilation. In all new houses especially this fact ought not to be lost sight of.

A small jet of gas burning in an outlet ventilating shaft—apart from any consideration of lighting—will greatly facilitate the upward current of air.

Steam may, when available, be used as a means of ventilation by extraction, by being discharged in the form of a jet into the outlet shaft. By this means a volume of air is set in motion which is said to exceed by 200 times the volume of the steam.

The following is a summary of some of the chief points that have to be borne in mind in connection with ventilation :—

1. That in order to keep the air of a room within the recognised standard of purity, it is necessary that 3,000 cubic feet of fresh air should be introduced every hour for each occupant.

2. As in this country it is not possible, without producing a feeling of draught, to change the air of a room oftener than three times an hour, it follows, in view of the first condition, that each person should be provided with 1,000 cubic feet of air space.

3. It is a mistake to suppose that cubic space can take the place of ventilation, for, however much space may be available for each person, unless the requisite quantity of fresh air be introduced, a period is ultimately reached when the limit of impurity will be exceeded. The height of a room also, beyond a certain point, does not count as space in a ventilation sense.

4. That although, theoretically, animals, such as horses and cattle, ought to be provided with a larger space than people, in practice, by reason of the greater liberty that may be taken as regards the introduction of fresh air, the actual space need not exceed 1,000 cubic feet.*

5. That in every case it is necessary to provide inlets for fresh, and outlets for foul air, although in most ordinary rooms the chimney answers the purpose of an outlet.

6. That the best position for an outlet is the ceiling ; that the inlets ought to be more numerous than the outlets, and placed as far as possible apart from them, and that they ought to be so constructed as to impart an upward direction to the incoming air and diffuse it as much as possible.

7. That in order to minimise the effect of friction in ventilating shafts, they ought to be large in diameter, circular in shape, smooth in the interior, and not longer than is necessary.

*Probably no more than 800 cubic feet can be insisted upon in "Regulations under the Dairies, Cowsheds, and Milkshops Order," but nothing less than this ought to satisfy a Sanitary Authority.

All angles, if possible, ought to be avoided, and, where essential, they ought to be as obtuse as possible. Covering the room opening with gauze ought to be avoided, and as regards ceiling openings a plate fixed within a few inches of the ceiling, and of larger diameter than the opening, should be substituted, so as to direct any down-draught that may occasionally occur to either side.

8. That the entrance of rain ought to be guarded against by means of a cowl, which, also, in itself, will limit the effect of gusts of wind in causing down-draughts, and possibly assist the upward current of air.

9. That means ought to be provided for regulating the quantity of air admitted, in accordance with varied conditions of temperature, &c.

10. That ventilating tubes ought to be connected with all gas lights, to remove the noxious fumes of combustion, and assist in the general ventilation.

11. That, in the case of crowded rooms, some artificial means of ventilation is necessary, and that, under these circumstances, the air before entering the rooms ought to be warmed during cold weather, otherwise a sensation of draught will be felt.

Warming.

As the question of warming is closely connected with that of ventilation, it is convenient to deal with it in this chapter.

There is perhaps no department of domestic economy about which greater ignorance is displayed than the warming of houses. Among the poorer classes more especially, this ignorance, combined with more or less carelessness, leads to the most reckless waste in the consumption of coal, even when poverty necessitates its being purchased at the cost of considerable deprivation in other directions. The people are not alone to blame for this waste, for they are obliged to live in houses with fire-places so constructed as to afford a minimum amount of heat from a maximum amount of coal. Of recent years, in the case of better class houses, a certain amount of improvement has been apparent, but even in these we have not yet by any means seen the last of the hideous hollow-backed iron grates.

Heat may be communicated by *radiation*, *conduction*, and *convection*. The open fire-place is an example of the first, and although it is an extravagant method, with certain precautions to be presently noticed, this fault is capable of considerable modification. From a health point of view, radiant heat is certainly to be preferred to the system of heating by convection as one usually finds it carried out, for ventilation is a necessary condition of an open fire-place, and the air of the room being thus continually renewed, is not dried as it is in the case of warming by stoves or hot pipes.

On the other hand, a room cannot be uniformly warmed by an open fire-place, and draught is likely to be felt in the neighbourhood of the fire, owing to the air rushing from distant parts of the room, and from ventilators, &c., towards the fire-place. The heating effect of an open fire-place diminishes rapidly the farther one is removed from it, the loss increasing exactly as the square of the distance, so that the heat at a distance of 4 feet from the fire is sixteen times less than it is within 1 foot. Under these circumstances, it will readily be understood that, in the case of long rooms especially, an open fire-place is not an efficient method of warming.

Conduction is the term applied to the passage of heat from one particle to another; and **convection,** to the conveyance of heat by moving masses of air. The latter is the principle which is chiefly operative in the case of rooms heated by stoves and hot-water or steam pipes, and although greatly superior to the open fire-place as a means of warming, there are great objections to the plan as one usually finds it carried out in practice; but as these objections are all capable of being overcome, the fault lies not in the principle itself, but in the ignorance of those who put it into practice. From what has been said, the necessity for reviewing the conditions of warming usually met with, will be apparent.

Open fire-places, as usually constructed, possess one or all of the following important faults :—

1. The grate is placed so far back under the flue opening, that great loss of heat necessarily takes place up the chimney.

2. The flue passes backwards and upwards from immediately behind the grate, and thus volumes of unconsumed smoke are drawn up the chimney, and much heat is wasted.

3. The back and sides of the grate are constructed of iron, and there is a large space behind, which causes unnecessary loss of heat by radiation.

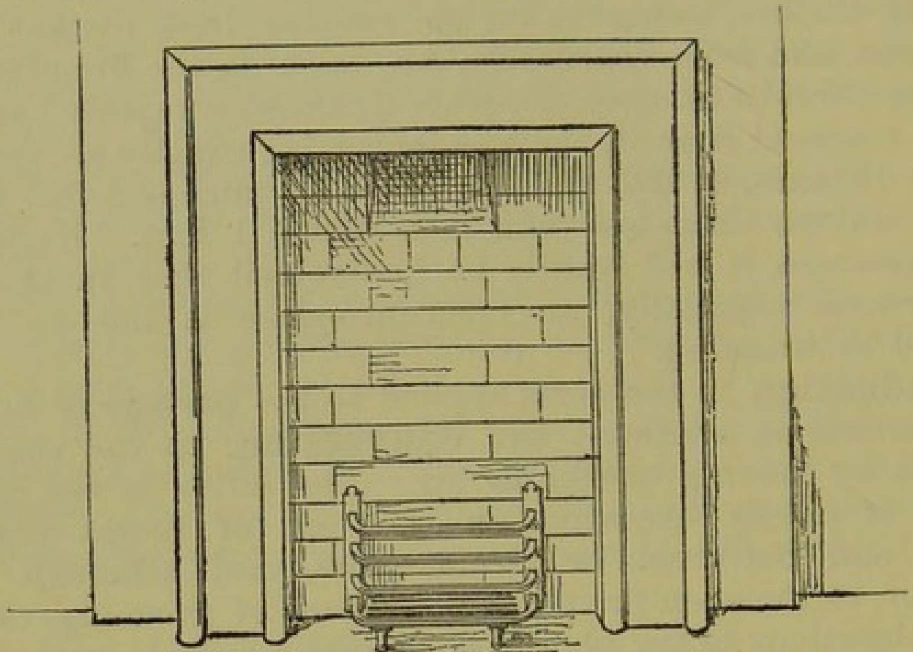
4. The front and bottom bars are constructed so wide apart, that the coal falls through in unconsumed pieces, and as the grate is open from below as well as in front, combustion is needlessly rapid, and therefore wasteful.

The important points to remember in the construction of an open fire-place are :—

1. That it should be brought into the room as much as possible, so that the heat may have a chance of radiating in all directions.

2. That the connection with the flue ought to be arranged so as not to cause an immediate back-draught and consequent loss of heat.

3. That fire-clay should take the place of iron as much as



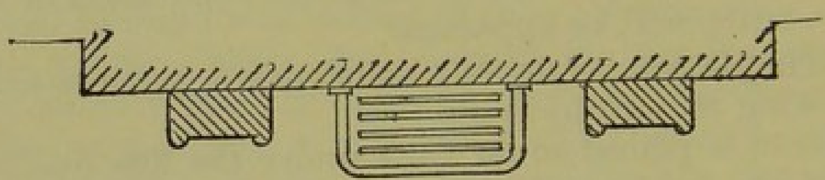


Fig. 15.

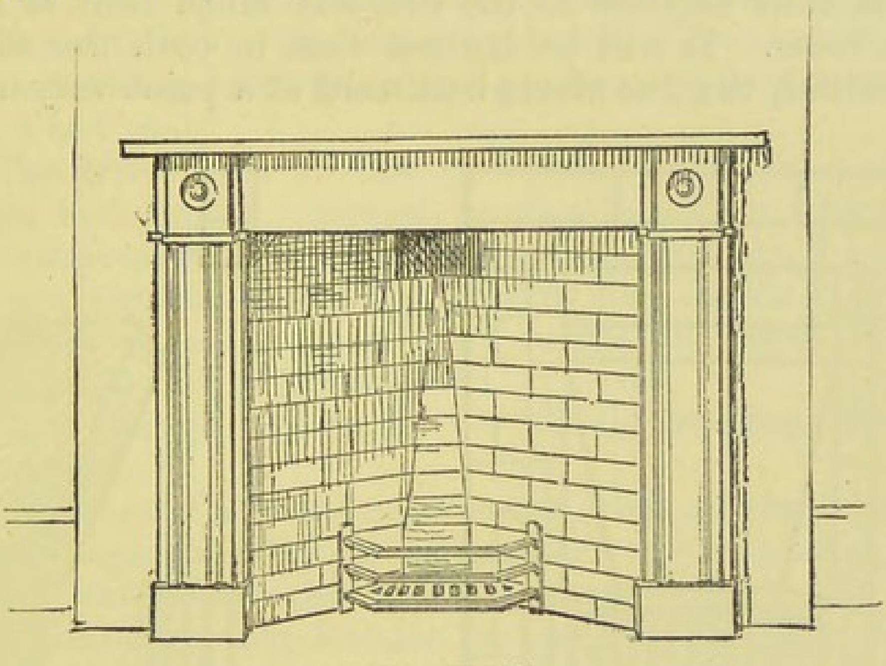
possible in its construction, so as to prevent the waste of heat by radiation from the back of the grate.

4. That the bars, both underneath and in front, ought to be so close together as only to admit of the smaller ash passing through.

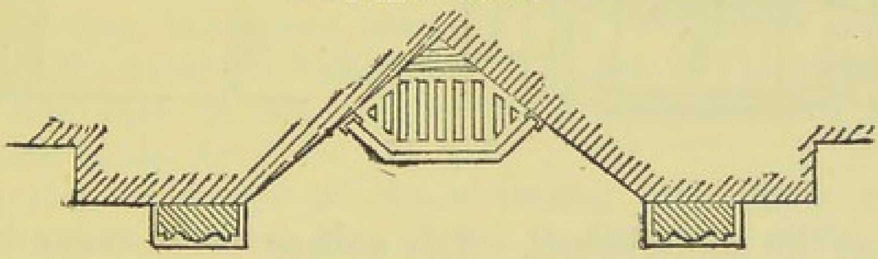
5. That no air ought to be allowed to pass under the fire, the space between the lower bar and the hearth being closed by a movable box for receiving the ashes.

The **ordinary iron grate** is familiar to all, and need not therefore be described, but with the assistance of the accompanying sketches (Figs. 15–18) the reader will be able to appreciate the advantages, both as regards heating power and economy, of fire-places constructed in accordance with the rules just laid down.

The Staffordshire fire-place (Fig. 15) is sometimes met with in old houses, although in many cases they have been abolished in favour of the modern and singularly inartistic cast-iron, hollow-back grate. Where in use, the combustion



—ELEVATION.—



—PLAN.—

Fig. 16.

and heating power is excellent, and the economy in coal, as compared with the wasteful consumption of the cast-iron grate, is sufficient soon to repay the very moderate outlay that is entailed in substituting the one for the other. The appearance presented by the plain fire-brick sides, which to some may be objectionable, can easily be overcome by their being faced with tiles. It will be noticed that the bars project some distance in front, and thus a larger radiating surface is exposed. In the old pattern of this grate the fire stands at a distance of some

9 or 10 inches above the hearth, and the bottom bars are exposed, but by lowering the fire to within 4 inches of the hearth and introducing an ash-box with closed front, the heating power is increased, and the consumption of coal lessened.

The old Leamington grate (Fig. 16) is of somewhat similar design, and, as regards heating power, it is probably as efficient. In this case the fire does not stand quite so far forward, and as the sides, which are constructed of fire-brick, form an angular opening, the apex of which is at the back, a large surface is thus exposed to the fire, and much heat is radiated into the room. It will be noticed that in both the fire-places just described, the flue starts backward at a point very nearly as

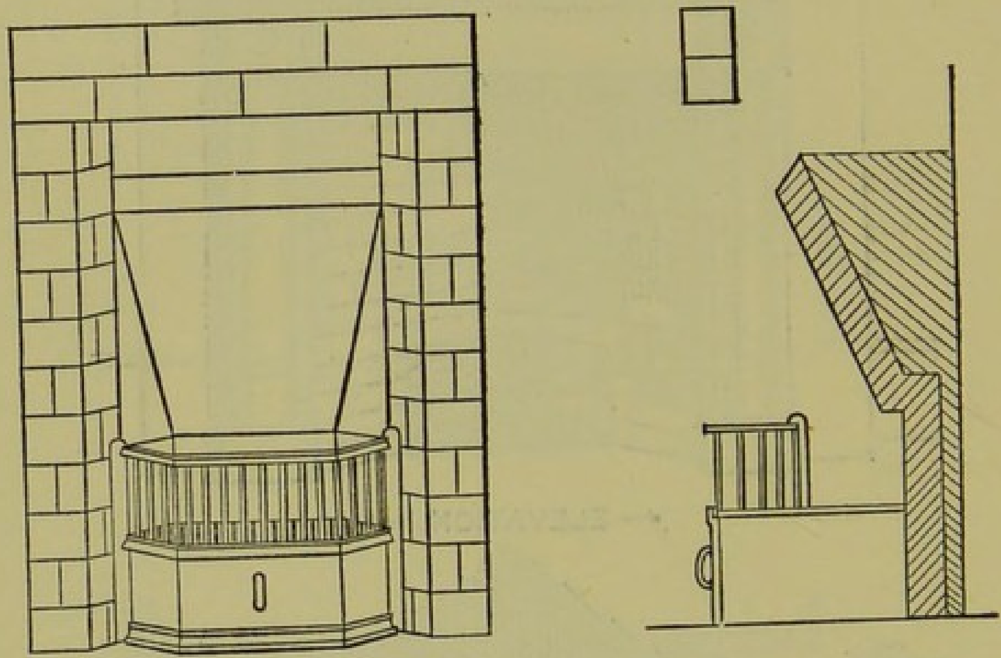


Fig. 17.

high up as the mantel-shelf. The author has in many instances induced householders to adopt one or other of these grates, and has usually had some trouble in convincing them that it would "draw," owing to the distance which separates the fire from the flue, but in no instance in which the suggested change has been made has the verdict been other than highly satisfactory.

The Teale fire-place (Fig. 17), which is constructed upon the principles advocated by Mr. Pridgin Teale of Leeds, in a paper read before the Architectural Society, London, on December 3rd, 1886, possesses all the features essential to economy and efficiency in an open fire-place. The following rules of construction are laid down in the paper in question :—

1. "As little iron as possible."

2. "The back and sides of the fire-place should be of brick or fire-brick."

3. "The fire-brick back should lean over the fire, not lean away from it."

4. "The bottom of the fire or grid should be deep from before backwards, probably not less than 9 inches for a small room, nor more than 11 inches for a large room."

5. "The sides or 'covings' of the fire-place should be vertical, but inclined to one another as the sides of an equilateral triangle."

6. "The 'lean over' at the back should be at an angle of 70°."

7. "The slits in the grating or grid should be narrow, perhaps $\frac{1}{4}$ inch for a sitting-room grate and good coal, $\frac{3}{8}$ inch for a kitchen grate and bad coal."

8. "The front bars should be vertical, that ashes may not lodge and look untidy; narrow, perhaps $\frac{1}{4}$ inch in thickness, so as not to obstruct heat; and close together, perhaps $\frac{3}{4}$ inch apart, so as to prevent coal and cinder from falling on the hearth."

9. "There should be a rim $1\frac{1}{2}$ inches in depth round the lower insertion of the vertical bars."

10. "The chamber under the fire should be closed by a shield or 'Economiser.'"

11. "Whenever a fire-place is constructed on these principles, it must be borne in mind that a greater body of heat is accumulated about the hearth than in ordinary fire-places. If there be the least doubt whether wooden beams may possibly run under the hearthstone, then an ashes pan should be added with a double bottom, the space between the two plates being filled with artificial asbestos, 'slagwool,' 2 inches in thickness."

12. "See that no woodwork comes within 10 or 12 inches of the back of the fire."

With the assistance of the sketches, the above rules will convey a tolerably clear idea of the construction of the fire-place in question. That it is a very great improvement on the cast-iron grate, there can be no question. The great feature of it is the construction of the back. By its projecting forward over the fire, heat, which is otherwise largely lost up the chimney, is reflected back upon the fire as well as into the room, and thus, among other things, the consumption of smoke is much more perfect.*

The "Lionel Teale" Front Hob Fire-place (Fig. 18) is a recent adaptation of the one just described. The only ironwork

* For a full description of the Teale fire-place see *The Economy of Coal in House-fires* by T. Pridgin Teale, published by J. & H. Churchill, price 3s. 6d.

connected with it is that which forms the bottom bars or grid, and the ash-tray, the front bars being abolished, and the fire sunk below the level of the hearth, which is raised some 5 inches above the floor level. The air which supplies the oxygen for combustion is introduced through the front of the ash-tray, and, therefore, enters from below the fire only, and the activity of combustion is regulated by a provision for increasing or diminishing this aperture. The appearance of the raised hearth and the sunk fire is by no means unsightly. Still further economy is claimed for this fire-place, by reason of the fire being surrounded on all sides with fire-brick.

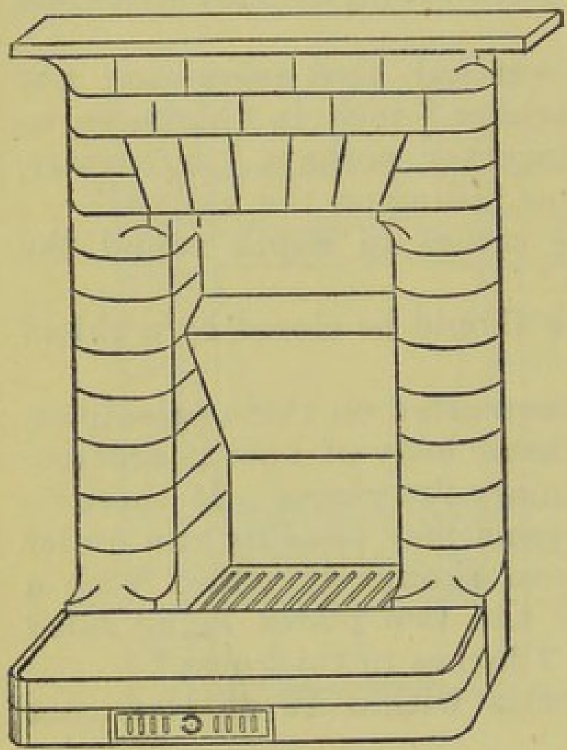


Fig. 18.

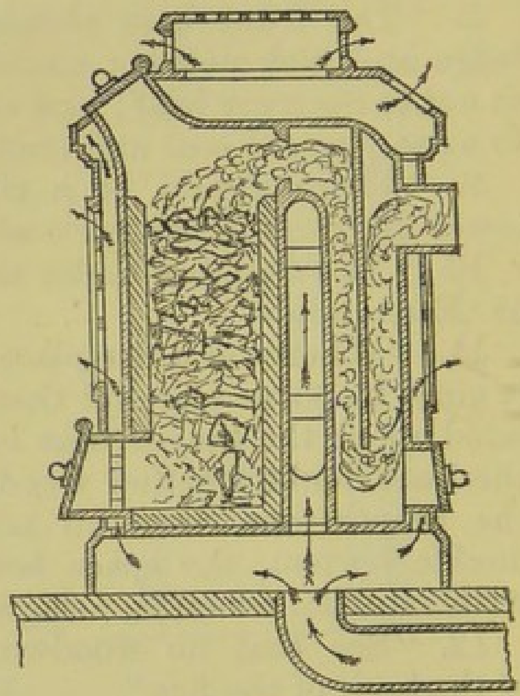


Fig. 19.

Stoves, as a means of warming rooms, have their advantages and disadvantages. There is less loss of heat, and the room is more uniformly warmed. In place of the air of the room being drawn up the chimney after having been warmed by the fire, as is the case with an open fire-place, it comes in contact with the outside of the stove, and, as it is thus warmed and rendered lighter, it immediately ascends, its place being filled by colder air from other parts of the room, which follows the same course. By this process the air of all parts of the room is gradually warmed.

The *disadvantages* of stoves as a means of warming rooms are:—

1. The ventilation of the room is not so perfect as in the case of open fire-places with large flues.

2. The air itself being raised in temperature by passing over the stove is thus rendered too dry. The actual amount of moisture present is unchanged, but the relative humidity, which from a health point of view is important, is greatly diminished, because warm air is capable of holding more moisture before the saturation point is reached than cold. To obviate this it is a common practice to place a tin vessel containing water on the top of the stove.

3. The external surface of the stove may be so hot as to scorch the floating organic particles in the air and thus cause a disagreeable odour.

4. Carbonic oxide (carbon monoxide), an extremely noxious product of combustion, may pass into the room through imperfect joints or fissures, or, it is believed, through the pores of the metal in the case of cast-iron stoves when superheated. The headaches and feeling of discomfort, so often experienced by the occupants of rooms heated in this manner, are sometimes attributed to the presence of this gas. The production of this gas, which undoubtedly is found in stove-heated rooms, is attributed by some to the imperfect combustion of particles of carbon in the air, the result of coming in contact with the superheated surface of a stove.

The first fault, namely, that of imperfect ventilation, may, to a large extent, be rectified by a special arrangement, by which fresh air is introduced by a pipe opening underneath the stove, and is discharged into the room after being warmed by passing through chambers in the interior of the stove. The accompanying sketch (Fig. 19) represents, in section, one of Musgrave's stoves, which are constructed on this principle. Many stoves of this description are now made, and no others ought to be fixed.

To diminish the risk of superheating, every portion of the stove ought to be lined with fire-clay, which ought periodically to be inspected, and replaced when worn out. Such a precaution will prove economical in the long run.

By increasing the heated surface, and thus exposing a larger area to the cooling process of contact with the air of the room, the risk of superheating is also reduced, as iron is an excellent conductor of heat. This may be accomplished by the addition of vertical metal flanges projecting from the top and sides of the stove.

Gas fires are now very much used for warming rooms, particularly bedrooms. Cleanliness and economy in servants' time are the chief arguments in their favour. In all cases they should be provided with means of ventilation, by a pipe carried into a flue or to the outside. The ordinary fire-place may be adapted for warming by gas by filling the grate with asbestos blocks which are heated by means of a Bunsen burner. In this case there is no necessity for any special flue, as the ordinary chimney answers the purpose, and the ventilation is as perfect as with an ordinary fire. With this particular arrangement the loss of heat is very great, and to remedy this, gas stoves are now frequently fixed in front of the fire-place, with a short pipe leading into the flue to carry off the offensive fumes. It is essential for ventilating purposes that the opening of the fire-place proper should be quite free, and not filled up with sheet iron as is so often done, otherwise the ventilating effect of the chimney will be greatly lessened, particularly when the fire is not actually burning. The air in bedrooms in which gas stoves have been fixed in the objectionable manner just described, is very foul in the morning if the stove has not been burning all night, and in the absence of any special outlet ventilator.

Ventilating gas stoves are a great improvement upon the ordinary kind, from an economical as well as from a health point of view. They are constructed much on the same principle as ordinary ventilating stoves, fresh air being discharged into the room after it has been warmed by passing through a tube which is enclosed in a chamber in which the gas burns; this outer chamber is connected with the chimney by a pipe which carries off the foul products of combustion.

Hot-water and steam pipes are frequently employed for warming the halls and passages of houses, as well as offices and public buildings. This system, if properly applied, is an excellent one, but one usually finds, in cases in which it is in operation, that all principles of ventilation have been completely disregarded. One has only to enter an office, for example, in which a number of clerks are engaged, and in which the ordinary open fire-places have been abolished in favour of hot-water pipes simply run round the walls, to realise the effect that such an arrangement has on the atmosphere of the room. The whole-some influence of the ordinary fire-place in changing the air of the room is lost, with the result that the same foul air, which has been breathed for hours on end, is circulating in warm currents round the room in question.

No system of warming by hot-water or steam pipes is admissible, unless both inlets and outlets are provided for ventilation. The best method of introducing air into a room warmed in this manner, is by so arranging the openings that the incoming air must first circulate over the hot pipes (see Fig. 20). By this means its temperature is raised, and thus, as already explained (p. 36), a more frequent change of the air of the room may be effected without causing a sensation of draught. This is easily accomplished by conducting the pipes to coils enclosed in flat boxes, or cases of wood or iron, which have openings along the top, and communicate below direct with the open air, the room openings being of larger area than those below through which the cold air enters. Means of closing the openings at such times as the pipes are not in use must be provided, as the incoming air would cause a feeling of draught, by being introduced so near the floor level. Other inlets must be available, such as Tobin's tubes or Sheringham's valves, for use on such occasions. The pipes employed in heating by hot water may be of large or of small diameter. In

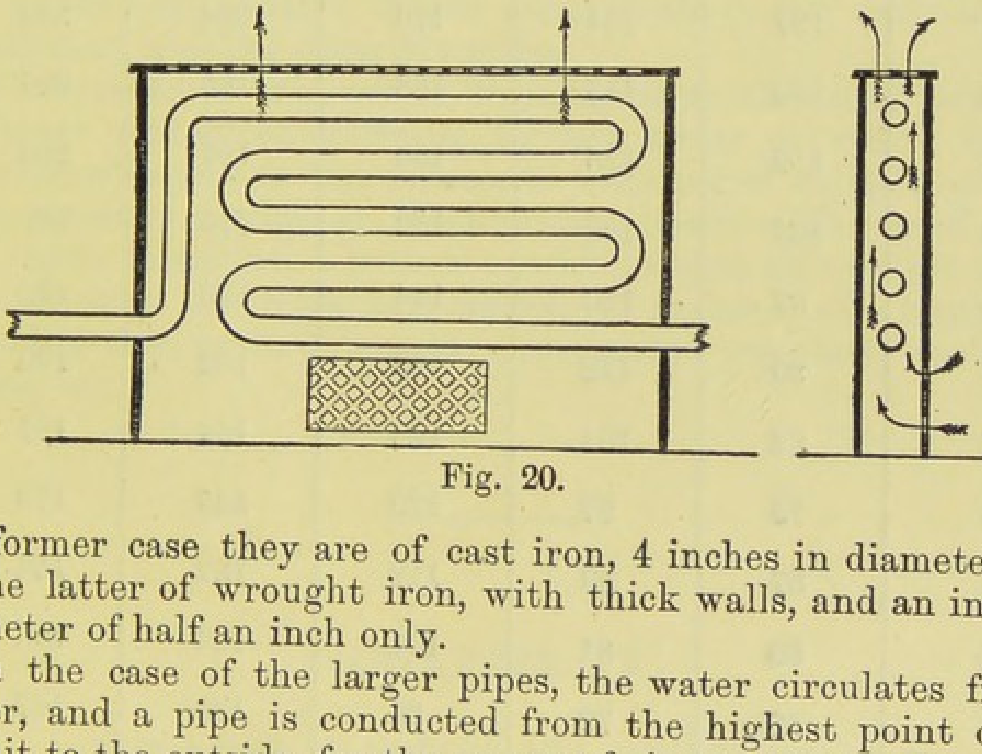


Fig. 20.

the former case they are of cast iron, 4 inches in diameter, and in the latter of wrought iron, with thick walls, and an internal diameter of half an inch only.

In the case of the larger pipes, the water circulates from a boiler, and a pipe is conducted from the highest point of the circuit to the outside, for the escape of air or steam. The water in this case, not being under pressure, does not as a rule raise the temperature of the pipes above 200° F., and 12 feet of such piping for every 1000 cubic feet of air space will maintain the temperature of the room in cold weather at about 50° F.

Rain water, by reason of its softness, is the best for heating purposes. Hard water causes a deposit in the boiler and pipes. This sometimes takes place to an extent that may absolutely close the circuit and thus lead to an explosion.

In the system of warming by small pipes (Perkin's) no escape-pipe is provided, and they are not connected with a boiler, but

Table showing the Quantity of Pipe, 4-inch Diameter, which will Heat 1000 Cubic Feet of Air per Minute any required number of Degrees. Temperature of the Pipe being 200° F.

Temperature of External Air.	Temperature at which the Room is required to be kept.				
	50°	55°	60°	65°	70°
	Feet.	Feet.	Feet.	Feet.	Feet.
10°	150	174	200	229	259
12	142	166	192	220	251
14	135	159	184	212	242
16	127	151	176	204	233
18	120	143	168	195	225
20	112	135	160	187	216
22	105	128	152	179	207
24	97	120	144	170	199
26	90	112	136	162	190
28	82	104	128	154	181
30	75	97	120	145	173
32	67	89	112	137	164
34	60	81	104	129	155
36	52	73	96	120	147
38	45	66	88	112	138
40	37	58	80	104	129
42	30	50	72	95	121
44	22	42	64	87	112
46	15	34	56	79	103
48	7	27	48	70	95
50	...	19	40	62	86

are simply coiled within the furnace. Under these circumstances the water circulates under pressure, and, therefore, the temperature of the pipes may reach to from 300° to 350° F.

About 8 feet of such piping will correspond, as regards heating power, to 12 feet of the 4-inch piping. According to Wynter Blyth, this system is not to be recommended for the purpose of warming houses, owing to the liability to overheat the air, and also because of the sudden variation in temperature that is likely to result unless the fire is constantly kept up.*

Steam, as a rule, in this country is only used for heating purposes in the case of factories, where it is necessarily on the spot as a motive power. In America it is largely employed for heating dwelling-houses. A very elaborate system of heating by steam is in operation in the Houses of Parliament. On the whole, perhaps the best system of warming houses is a combination of the low pressure 4-inch pipes, with proper provision for ventilation, and the open fire-place.

It is well to be cautious in deciding as to who shall carry out whatever system of warming by hot water or steam may be determined upon, as the successful working of all is dependent upon so many conditions, the non-compliance with one of which will result in failure. It does not follow that all who are willing to undertake the work are capable of satisfactorily completing it, and in this, as in all cases, experienced workmen are worth paying for. †

CHAPTER IV.

PRINCIPLES OF SEWAGE AND REFUSE REMOVAL.

An intelligent appreciation of the subjects dealt with in this and the following three chapters is perhaps the most essential element in the education of a sanitary inspector. Hardly a day can pass without his knowledge of the subjects being put to the

*For a description of the process of calculating the quantity of pipe necessary to raise the temperature of a given space, under various conditions of temperature, see *Manual of Public Health*, by A. Wynter Blyth, from which the above table is taken.

†For a full description of various means of warming, see *Our Homes*, section on "Ventilation and Warming," by Sir Douglas Galton.

test, and upon its thoroughness, the health and, it may be, the lives of many are dependent. The ignorance that still prevails, even among the educated public, regarding the most elementary facts connected with the drainage of houses, is indeed surprising. To them the whole question appears mysterious and complicated, but in reality it is not so.

In this chapter the **principles** of sewage and refuse removal will alone be dealt with, and if these are once understood, the appreciation of the details which follow will present no difficulties.

Without going minutely into the **composition of sewage**, it may be said to consist of water containing certain refuse substances in solution and in suspension. These consist of urine and fæces of men and animals; house waste-water, containing grease, soap, and foul matters from the surface of the body and from clothes and general house washing. The sewage may also contain special pollution from manufacturing processes.

Human fæcal matter is sometimes excluded from the drains, and when it is so, it is popularly supposed that the sewage is comparatively innocuous, but this is certainly not the case. An estimate of the difference between the sewage of *water-closet* towns and of towns where the fæcal refuse is dealt with by the *midden or pail systems*, may be arrived at by comparing the value as manure of the sewage in each case.

According to the first report of the Rivers Pollution Commissioners, the value for agricultural purposes of 12 tons of sewage from towns without water-closets is equal to 10 tons of sewage from towns with water-closets. This fact is important, as showing how essential it is to provide some means for treating all sewage, irrespective of its nature, before allowing it to enter a stream.

House-refuse consists of ashes, dust, food scraps, both animal and vegetable, waste paper, &c.; in fact, all waste material from a household which does not enter the drains. Under certain circumstances this mixture is likely to become a source of nuisance; it is necessary, therefore, that measures should be taken to prevent this as far as possible.

Ordinary sewage and refuse, when fresh, are comparatively harmless; but, as all dead organic matter must necessarily undergo change (in the process of which it is split up into its simpler elements) and, as during this process of *decomposition* (unless it takes place under favourable conditions) nuisances are likely to arise, it is essential that precautions should be taken to prevent these. By reason of the artificial conditions of our existence, then, art must assist in these natural processes; but we may rest assured of this, that if man does his part of the work, Nature will do hers.

Putrefaction is, in all cases, the result of an attack upon dead organic matter by *minute living germs* or *bacteria*, ever present in the air; the process is similar to, in fact it is, *fermentation.* Under favourable conditions, these germs multiply with enormous rapidity, until in time complete dissolution of the material is accomplished, and during this time a continual discharge of fœtid organic matter and foul gases takes place, which contaminate the atmosphere, and tax to a great extent the purifying effect of the oxygen it contains. This alone must seriously affect the health of the inhabitants, and if it is not in itself directly responsible for the production of disease, there is no question but that it greatly favours the extension of diseases of the infectious class. Under these circumstances, it is of the utmost importance that all sewage and refuse should be disposed of in a manner that will least contribute to the injurious consequences just described. The great principle then to keep in view is the *immediate and thorough removal of all fluid refuse, and the retarding of decomposition in all solid refuse until it can be completely removed;* it is necessary, therefore, to consider what are the conditions which favour decomposition or putrefaction.

Warmth and moisture are the great agents that encourage putrefaction, and for this reason it is essential that all refuse matter, while it remains on the premises, should be kept dry and not exposed to the sun, and that all sewage should at once be removed. Dry fæcal matter, comparatively speaking, does not decompose rapidly, but when mixed with water, or, what is worse, urine, the change almost immediately takes place. Garbage and all organic refuse are also likely to give rise to a nuisance during decomposition, and the same conditions favour the process in this case also.

The important points then to determine, in judging of the efficiency of any system of sewage and refuse removal, are, with regard to the former—is it immediate and complete? and with regard to the latter—are precautions taken to check decomposition, and is the removal conducted at sufficiently short intervals?

Methods of Sewage Removal.

Having considered the broad principles with which all perfect methods of sewage removal must comply, we must now go a little farther and apply these principles to the different methods now recommended, leaving the consideration of the structural details to another Chapter.

The present systems of sewage removal may be considered under two heads—viz., the **water-carriage system** and the **conservancy system.** In the former, solid fæcal matter is introduced into the sewers, while in the latter it is excluded.

Great difference of opinion has hitherto prevailed as to which ought to have the preference, but the water-carriage system is now pretty generally admitted to be the better one, except, perhaps, in the case of scattered populations dependent for their water-supply upon local wells. The arguments in favour of the water-carriage system seem unanswerable.

If it were possible to get rid of the ordinary slop water by some other means than sewers, then it might become a matter for consideration whether the necessity for the removal of excreta alone would warrant their introduction, but, as sewers must exist for ordinary waste-water purposes, the only point to determine is whether the addition of excreta is expedient or not. Now, so far as the composition of the sewage of water-closet towns is concerned, as compared with that of towns in which the dry method is in operation, the difference, as already pointed out, is very little, but the volume in the one case as compared with the other is considerably greater. Six gallons per head per day increase of volume in the case of water-closet towns (*Parkes*) makes a considerable difference in the sum total of sewage that has to be disposed of; and in the case of inland towns, particularly where the absence of sufficient fall necessitates the pumping of every gallon, for the purpose of land or other treatment, before it is discharged into a stream, such an addition may become a matter for serious consideration. Then, again, it may be that the water-supply is limited, and cannot be supplemented without considerable expenditure, in which case the saving of 6 gallons per head per day must not be overlooked.*

To obviate these objections, various plans for utilising the ordinary house waste-water as a flush for water-closets have recently been devised, and some towns have, to a large extent, overcome the difficulty in this way. These will be described in detail later on.

There can be but little question that the water-carriage system is the cleanest, most rapid, most convenient, and cheapest method of sewage removal.

The dry system, or the **conservancy system** as it is

* The estimate of 6 gallons is, probably, much in excess of the actual figure.

termed, has been adopted in many towns, but, even where carried out on the most approved principles, it must necessarily give rise to nuisances in densely populated areas. On the ground of expense, also, it is found to be a mistake, and were it not on account of the outlay that has been incurred, it is probable that most authorities who have adopted the system, would abandon it. It is only in scattered rural districts where there is land enough attached to each house, on which the excrement can be disposed of, that the system is really admissible; the difficulty in dealing with the excreta in populous districts necessitates an annual expenditure, which is not by any means recouped by the sale of the manure. The mistaken idea that the addition of excrement to the ordinary sewage of a town greatly increases the difficulty of treatment, is probably answerable in all cases for the adoption of the conservancy method of sewage removal, and the sooner the true state of the case is understood by authorities the better.

Privy-middens and **ash-pits** ought undoubtedly to be abolished, particularly in populous districts, and if excrement is permitted to remain on the premises, it must be under conditions least harmful to health. The **earth-closet,** if it were possible to provide the necessary labour, is perhaps the best dry system of removal, but the expense entailed in attending to essential details is too great to admit of its adoption, except in better-class houses. The **pail system,** with frequent and regular removal, may perhaps be permitted, but it would be well if authorities of populous districts would come to the determination to encourage the substitution of water-closets for all insanitary privies, and their introduction into new houses.

The term **separate system** is applied to a water-carriage system in which separate channels are provided for the rain-fall. The addition of surface water to the sewage of inland towns greatly taxes the efficiency of all methods of sewage treatment, and although it may be useful as a flush for sewers, it is too irregular and uncertain to be admissible, in cases in which flushing is specially necessary.

Towns without a proper system of sewers are to be congratulated as regards this point, for they are in the position of being able to make use of what sewers exist as storm-water carriers, and to start *de novo* to construct sewers on the separate system.

In the construction of a **water-closet,** attention ought to be paid to the following points:—

1. It ought to be placed next an outside wall, and, if possible, separated from the house by a passage with cross window venti-

lation, the closet itself being provided with a window for ventilation.

2. A perfect water flush must be provided. This must not be taken from any cistern for supplying drinking water, nor service water-pipe, and should be sufficient to entirely remove the excreta, and nothing in the construction of the closet should tend to interfere with this complete removal.

3. The soil-pipe should be outside the house, a water-seal being interposed between it and the closet, and it ought to be so constructed as to allow of the free passage of air through it.

4. The drain that removes the water-closet waste ought not to be directly connected with the sewer or cesspool, as the case may be, but an opening to admit air, with a water-seal between it and the sewer or cesspool, must in all cases be provided.*

Water-troughs may be said to be a series of water-closets placed alongside each other, with one receptacle, common to all, which contains water, and is periodically and automatically flushed by means of a special flush-tank. They are intended for use in the case of factories, schools, or groups of cottages. The same general principles apply as regards ventilation, flushing, trapping, &c., as in the case of water-closets, although the details of construction must necessarily differ, as will be explained in the chapter devoted to sanitary appliances.

Waste-pipes, whether they are intended for house-slops, lavatory-, bath-, or sink-wastes, must all be constructed in accordance with the general principles laid down in the case of water-closet connections. There must be perfect disconnection between these and the drains, and a water-seal must be provided at the house end in all cases. It is a mistake to suppose that disconnection of the drain does away with the necessity for trapping the waste-pipe and *vice versâ; both must be regarded as essentials, not alternatives.* Waste-pipes must not be longer than is essential, and they should be so placed as to allow of easy access in the event of any fault arising. They must not be concealed within walls, and if, by reason of their position, it is necessary to incase them, provision for inspection, in the shape of hinged openings or movable boards, must not be omitted—no such covering should be permanently screwed down.

* Some sanitary engineers now advocate the direct connection with sewers, without the intervention of a trap, of all house drains, in which case the soil-pipe and drain ventilators assist in the ventilation of the sewers, but it is only where these are constructed on the most approved principles that such a plan is admissible ; it would be a dangerous proceeding in the case of old and badly constructed sewers (see p. 106).

The same remarks apply with regard to **rain-water pipes** so far as their connection with the drains is concerned.

Traps, in order to be effective, must comply with certain conditions. They must impose a sufficient and constant barrier or seal against the passage of sewer gas, and they must be self-cleansing. The first condition necessitates a depth of water-seal of at least 1½ inches, and the second, the absence of all angles, projections, or cavities that may interfere with a free flush, and lead to the deposit of solid matter, which would immediately decompose and cause a nuisance. All drain-traps must be outside the house, and so connected with the drain that in the event of sewer gas forcing its way through, it would escape into the open air, and not into the house.

The erroneous belief, among the public and ignorant workmen, that perfect safety is afforded by a trap, is responsible for many grave defects in house drainage. These defects will be noticed in detail when the different kinds of traps in use are described; but there are certain dangers, against which all traps, however perfect in design, are more or less inoperative.

1. A trap may cease to be a trap by reason of disuse, owing to the evaporation that takes place from the surface of the water. This is a consideration that has to be thought of in connection with any drain that is only in use at intervals, and some provision should be made for renewing the water in the trap.

2. A trap may cease to be a trap by the water it ought to contain being sucked out by syphon action. This is a danger that can be guarded against by connecting an air pipe with the top of the trap, beyond the seal, and by other means to be presently noticed.

3. Pressure of foul gas within the drain may force the water-seal. This danger may be guarded against by proper ventilation of the drain, sewer, or cesspool, as the case may be.

4. Sewer gas may be absorbed by the surface of the water on one side of the trap, and discharged from the surface on the other. The more perfect the self-cleansing action of the trap, and the better the drain, sewer, or cesspool ventilation, the less likely is this to occur.

5. As all traps necessarily impose a certain amount of obstruction to the flow of sewage in the drain, they tend to cause stoppage, and for this reason ready means of access to them should be provided.

Drains and Sewers must be so constructed as to comply, in every respect, with the principle of immediate and perfect sewage removal. There is considerable confusion with regard to what is a drain and what a sewer. The definition, as laid down by the Public Health Act, is that a "drain" is a channel which receives the drainage of one building or set of premises, and a "sewer," that which receives the drainage of two or more buildings or premises, occupied by different persons (see Appendix).

Drains and sewers should be water-tight, smooth in the interior, and not larger than is necessary; they should, if possible, follow a straight course and have a sufficient fall, varying in accordance with the diameter, and, as far as possible, of the same uniform rate; where curves are unavoidable, they should not be abrupt, and at such points, as well as where tributary sewers join, a manhole ought to be provided. Ample provision should exist for ventilation, so that sewer gas may not stagnate but have free outlet into the open air. There ought to be no direct connection between drains and sewers, but a trap should be inserted near the junction of the one with the other, with an air outlet on the house side (see footnote, p. 72).

Drains are very often needlessly large, and thus the flush is very much reduced. For example, given two drains of equal fall, carrying the same volume of sewage, the one 4 inches in diameter and the other 6, the rate of travel, and, therefore, the flushing power, in the former case will be greater than in the latter, because the depth of fluid in the smaller pipe is greater than in the larger. The accompanying sketch (Fig. 21) shows the comparative difference in depth of the same volume of fluid in a 4-, 6-, and 9-inch pipe. As a rule, the diameter of house drains need not exceed 4 inches, except in the case of very large establishments. Far too often, even now, a 6-inch pipe is used when a 4-inch would answer all requirements, and, in the case of old houses, one frequently finds that even the tributary drains are constructed of 9-inch pipes.

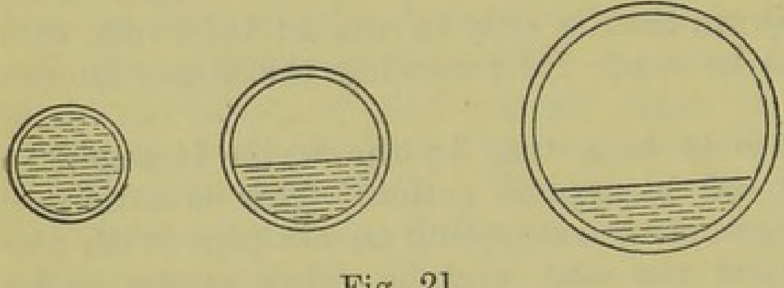


Fig. 21.

SEWERS AS A DANGER TO HEALTH.

One often hears it stated that certain towns were perfectly healthy, and experienced no nuisance from the disposal of their sewage, until the introduction of a general system of sewers. Such a statement must be received with a considerable amount of qualification, although it contains an element of truth. Many examples of the old order of things are to be found even now in small towns, where the fluid refuse is simply discharged from the houses on to open channels communicating with street gutters along which it travels to the nearest ditch or stream; although sometimes it is conveyed there in brick sewers with which the street gutters are connected, the whole being periodically flushed with storm water. Now, no doubt, such a system is extremely unsightly, and the danger of well-pollution, from the saturation of the soil with sewage which percolates freely from numerous stagnant pools along the course of the rude channels, is very great; but that there is perfect "disconnection" and free "ventilation" there is no question, and, when compared with an arrangement which connects each house direct with an unventilated and possibly badly-constructed sewer, it is certainly to be preferred, especially if the people are not dependent upon local wells for their water-supply. This, however, is no longer a true comparison; we now appreciate the importance of flushing, trapping, disconnecting, and ventilating our drains and sewers. The only instances (three out of twenty-four), in Dr. Buchanan's enquiry (p. 4), in which the deaths from enteric (typhoid) fever had increased since the introduction of sewers, &c., occurred in towns where, undoubtedly, the sewage arrangements were imperfectly carried out. In the case of the other twenty-one towns, an average reduction of 45·4 per cent. took place. That enteric fever can be conveyed by sewer air, is a question about which there is little doubt, although the specific poison must first be introduced into the sewers.

That the air of sewers is the cause of certain throat affections, diarrhœa, anæmia, and general ill health, particularly among children, is also admitted.

Principles of Sewage Disposal.

The practice of discharging sewage in its crude state into streams, although contrary to law, is by no means an uncommon one, and, at the present moment, the question of sewage disposal is occupying the attention of sanitary authorities throughout the country. The Local Government Act of 1888 imposes the duty on County Councils of enforcing the provisions of the Rivers Pollution Act, and already this power is making itself felt.

Authorities who, hitherto, have failed to realise their responsibility as guardians of streams, are seriously considering what is to be done. That the question is no easy one to settle has been demonstrated over and over again by failures on the part of many authorities in obtaining good results notwithstanding large outlays of money.

It must be understood at the outset that treatment to be effective must accomplish more than simple clarification. It is possible by many methods so to treat sewage as to remove practically all the solid or suspended matters, leaving a clear fluid which, in appearance, may differ only slightly from potable water, but this treatment alone will not render the sewage fit to be discharged into a stream, for it still contains *in solution* an immense amount of *organic matter*, which, as decomposition proceeds, will become turbid, and give rise to nuisance from deposit on the bed of the stream of putrefying solid matter. The process, to be complete, must go farther than this; the soluble organic matter must undergo a chemical change, which so alters its nature as to convert noxious *organic* into harmless *inorganic* substances. So far as our present knowledge goes, undoubtedly the best means of accomplishing this is by submitting the sewage, after precipitation of the suspended matter, to **land treatment,** and those authorities whose districts are so situated as to allow of this plan being adopted are certainly to be congratulated.

In order to appreciate the importance of certain conditions indispensable to successful land treatment, it is necessary to understand the operation of the process.

Sewage when brought in contact with land in a fresh state is immediately attacked by the minute living germs (*bacteria*) universally present in the upper strata, and by these its organic matter is split up into various simple constituents, which, with the assistance of the oxygen and carbonic acid gas present in the ground air, unite with certain mineral bases present in the soil, and thus are transformed from organic, unstable compounds, liable to putrefactive changes, into more fixed inorganic salts of an innocent nature. These salts are partly discharged with the effluent water into some water-course, and partly appropriated by vegetation, by which they are reconverted into living organic matter.

The chief requirement, therefore, essential to success, is land which is permeated throughout by microscopic life, and of such a consistency as will allow of the free penetration of air. A rich loose loam is best for the purpose; gravel and sand, on the other hand, are of little use, and act simply as a mechanical filter, exercising little chemical effect on the sewage.

A profit must not be expected from any system of sewage treatment; if the returns cover the expenses and a reasonable rental for the land, that is all that can be looked for, but so much they certainly ought to do. It must be remembered that the first consideration is the effectual treatment of the sewage; if this can be accomplished at a profit, well and good, but no profit will justify any sacrifice of efficiency in this respect. Failure, in many instances, arises from too much thought being given to what is best for the crop, little consideration being paid to efficient sewage treatment. For this reason, it is important that sewage farms should be under the direct management of the Sanitary Authorities, in place of being let to farmers, whose interests are not, or may not be, in conformity with the principles of sewage treatment.

Artificial filtration may be a necessary expedient in cases in which land is not obtainable, or as an adjunct to land treatment where sufficient land cannot be acquired. Except under such circumstances, however, it would appear from our present knowledge of the subject, that such treatment, in most cases, in addition to being expensive, is far from satisfactory.

Sand and **charcoal** have mostly been used hitherto as filtering media, but these must now be discarded in favour of more efficient substitutes to be described later; the former simply acts mechanically, and the latter exercises but little chemical action on the sewage, so that the effluent, although it may thus be clarified, still contains the greater part of the soluble organic matter, and is, therefore, for reasons already stated, not in a fit state to be discharged into any water-course.

In conclusion, the principle that no sewage, however small in quantity, may be discharged into any stream or water-course without first being rendered as far as possible harmless, must be recognised, and, whatever system may be adopted, no return can be looked for, beyond what will cover the working expenses.

So far, we have been dealing with the methods of sewage disposal applicable to large communities; we must now consider how the sewage of **villages** and **individual houses** may be dealt with.

In the neighbourhood of villages, land as a rule is plentiful, and the question need present no difficulty if Local Authorities would only give their attention to it. At present, they seem to look upon it as a monstrous imposition to be called upon to deal with the sewage of a few hundred houses in any way beyond turning it into a stream, and no argument will convince them that any injury will result from such a proceeding. The prevailing argument, that the absence of water-closets warrants such a conclusion, is the plea brought forward, and it is not until strong pressure is brought to bear that any steps are taken.

In order to insure success in dealing with the sewage of small communities by land treatment, the same preparation with regard to land drainage as is described in the next chapter in reference to larger populations is necessary, and although one cannot expect that the preliminary treatment of the sewage will receive that attention which is called for in towns, still some supervision is necessary.

It may not be out of place to give here a few examples of what has been done in this direction in small districts.

The following particulars are taken from a paper by Mr. C. S. Read, which was published in the Journal of the Royal Agricultural Society of England. It would appear that owing to the frequent occurrence of fever in various parishes in the Brixworth Union, a special investigation was conducted by Dr. Thorne Thorne, of the Local Government Board, and, as a result, in the case of six villages in the Union, drainage operations were carried out on a system which had been previously approved of by Sir Robert Rawlinson. The following table shows the cost in the six parishes where a complete system of sewers has been adopted :—

Name of Parish in the Brixworth Union.	Population in 1881.	Date of Works.	Cost, including land.	Extent of land irrigated.	How cropped.
Brampton Chapel, .	233	1880-1	£407	Half an acre.	Osiers.
Brixworth, . .	1,183	1876-8	822	One acre.	,,
Harlestone, . . .	569	1878	750	,,	Ashpoles.
Moulton, ...	1,483	1874-8	980	,,	Osiers.
Spratton, ...	817	1886	810	,,	Ashpoles.
Walgrave, . . .	603	1874-8	673	,,	Osiers.

Dr. Parsons, in a later report to the Local Government Board, alluding to the improvement of the health-rate of these villages, ten years after the above drainage operations were completed, as compared with the ten antecedent years, says that information from the Registrar-General's Annual and Quarterly Reports "shows a gratifying decline of mortality, amounting on their present population to an annual saving of about twenty lives, or, reckoning five severe cases of illness to one death, of one hundred severe illnesses with their attendant sufferings and expense." The sewering of Whissendine, a village in Rutland, containing 734 inhabitants, was recently completed at the following cost:—

Sewering Whissendine village (including £140 for outfall and osier bed, 1 acre, . . .	£849	0	0
Engineer and Clerk of Works, ...	126	0	0
Compensation to occupiers of land crossed by sewers to outfall, about	25	0	0
	£1,000	0	0

The cost of the sewerage of East Dereham, Norfolk, which contains 6,000 inhabitants, was as follows :—

Contract for pipes, manholes, excavating, and laying, ...	£3,454	14	3
4 acres 1 rood 2 poles land for irrigation, surveyors, and arbitration, ...	794	12	1
Draining and preparing the ground, . .	473	10	8
Compensations for disturbance, . . .	88	7	10
Engineer's commission, ...	100	0	0
	£4,911	4	10

The above examples are introduced in order to assist those interested in the subject to form an idea of what expenditure is necessary; but in considering the question, this expenditure must not be looked upon as money entirely out of pocket, for the resulting diminished sick-rate, which may reasonably be looked for in return, must necessarily lead to diminished local expenses.

Principles of Refuse Disposal.

In **Rural Districts** where land on which it may be utilised is plentiful, the removal of house refuse is a comparatively simple matter, and in such cases the important consideration is that while it remains on the premises, it shall not give rise to nuisance. To insure this, it is essential that the receptacle should be placed at a reasonable distance from the house, that it should be covered in, and built in non-porous material, the floor being above the surface of the ground, and that the size should be limited, so as to necessitate tolerably frequent emptying. The old privy-midden, as commonly met with, does not comply with any of these requirements, and ought unquestionably to be condemned. It is a common practice to construct two pits, the one for the reception of excrement, the other for ashes and house refuse; this is a mistake, for the ashes may be turned to excellent account by being thrown on the excrement, provided rain water is excluded.

In **Urban Districts** in which, unfortunately, the conservancy system of sewage removal is in operation, much greater restrictions must be placed on the construction of receptacles for excreta and refuse. The capacity should be very much reduced, and removal at least once a week ought to be insisted upon. It is a common practice in such districts to contract for the removal of all refuse, but this practice is invariably unsatisfactory. Authorities, in all cases, should undertake the work themselves, otherwise it will be badly done. It is but reasonable to expect that the contractor will economise labour so as to increase his profit—the more inefficient the work, the more profitable the undertaking.

In some districts the owner or occupier is held responsible for the cleansing of privy-middens; this is both unreasonable and unworkable.

In some towns fixed receptacles are not allowed, the excreta and the ashes, either separately or combined, being deposited in pails, and removed weekly, or oftener, when the refuse is disposed of as manure, either in its natural state, or after being dried by artificial means, and reduced to a powder, which, as a manure, is worth about £5 a ton. The system of pail collection and drying was first introduced at Rochdale, where it is still in operation.

A modification of the Rochdale system is adopted by some authorities, the pails being emptied on the spot in a collecting cart, a proceeding which is far from satisfactory. Fresh pails, which have previously been cleansed and disinfected, should, in all cases, be substituted for those containing the excreta, which should be removed with their contents from the premises, to be subjected to a similar cleansing process previous to again being made use of. Unless this plan be adopted, the pails soon become very filthy, and cause serious nuisance. With regard to the conservancy system for urban districts, as compared with the water-carriage system, it cannot be said, even allowing that the system is efficiently carried out, that it is other than dirty, clumsy, and expensive; but when carried out as it usually is at present, the system becomes distinctly dangerous. It is impossible that the presence of so many centres of decomposing fæces and urine in thickly-populated districts can be other than insanitary.

Mr. Berrington, the Borough Engineer of Wolverhampton, a town of under 100,000 inhabitants, where the pail system is in operation, has published an interesting account of its cost, in which he estimates the saving that would be effected by the substitution of the slop-closet system. His pamphlet, from which the following extract is taken, is well worthy of perusal*:— ". . . supposing it were possible to abolish the pan system altogether (say in one year), then I contend that in twenty years from now (say in 1910), Wolverhampton would be pecuniarily benefited to the extent of £115,320. Of course it would cost something to alter the system. Supposing it cost £2 per house, and if there are 13,000 pans, that represents £26,000. Then how do the figures stand for 1910?

Saving by an immediate change of the pans in use to-day, ...	£111,920
Saving by the adoption of waste water-closets from 1890 to 1910, ...	29,400†
	£141,320
Deduct cost of changing present pans, . . .	26,000
Credit amount realised to sale of appliances, &c., .	...
Net saving in twenty years, ...	£115,320‡"

In water-closet towns, and in towns where the pail system is in operation, the mixture of ashes and other house refuse still remains to be dealt with. As regards collection, in this case also it should take place, at least weekly, from movable receptacles, and the ultimate disposal ought to be destruction by fire.

Destructors for town refuse should certainly be looked upon as essential requirements in all well-regulated districts. The common practice of disposing of such refuse on waste land in densely-populated localities is a dangerous one, particularly if it is intended afterwards to use the land for building purposes.

* *A Short Account of the Wolverhampton Sewage Works, with some Remarks on the Pan System.* September, 1891.

† By abolishing the necessity for providing new pans.

‡ In arriving at this figure, the probable increase in the population during the period is taken into account.

In these days, it is much to the discredit of authorities to find placards posted intimating that certain spots may be used as "free tips for refuse," and still more discreditable is it that in course of time this placard should be replaced by a notice to the effect that "this eligible site" is for sale for building purposes. The danger to health that the occupiers of houses built on such sites, possibly by the jerry builder, are exposed to must be very great. Disposal of refuse by fire is the only safe proceeding, and the apparatus now available for the purpose—a description of which will be given in the next chapter—enables this to be accomplished with little or no nuisance, and at small cost. It is important also to remember that the people themselves may render great assistance to the authority by burning the house refuse, as far as possible, by means of the kitchen fire, in place of consigning it to the dust-bin, a fact which ought to be impressed upon them whenever opportunity offers.

CHAPTER V.

DETAILS OF DRAINAGE, SEWAGE, AND REFUSE REMOVAL AND DISPOSAL.

In the previous chapter, the *principles* upon which efficient sewage and refuse removal are dependent were alone considered. It now becomes necessary to apply these principles to the various conditions usually met with, and so arrive at an opinion regarding their efficiency.

Drains, whether they are intended to convey the ordinary waste-water only, or in addition, the excreta and urine of a household, must be constructed with equal care and attention to detail.

Socketed glazed stoneware pipes are alone admissible, and, for ordinary establishments, as already stated, these need not exceed 4 inches in diameter. They should be laid, as far as possible, in straight lines, with the socket end directed towards the sewage flow, as is represented in Fig. 22 (A), not as is shown in the same Fig. (B); the fall ought to be uniform, of not less than 1 foot in from 40 to 60. If such a fall cannot be obtained, then some artificial means of flushing, which in all cases is desirable, becomes essential, in order to insure perfect cleansing of the channel.

Before proceeding to lay the pipes, each one should be carefully examined, and any that are imperfect should be rejected. In outline they should be perfectly round, otherwise the spigot will not fit accurately into the socket; the internal surface must be smooth and thoroughly well covered with glaze; and they must be entirely free from cracks or flaws of any description, otherwise the drain will not be water-tight.

The trench in which the pipes are laid should be dug, not piece by piece, but in lengths, and it is important not to interfere with the solidity of the floor by excavating, in the first instance, to a greater depth than is necessary, as this necessitates the replacement of soil and thus causes a risk of after subsidence. If it should happen, in the process of digging, that more soil has

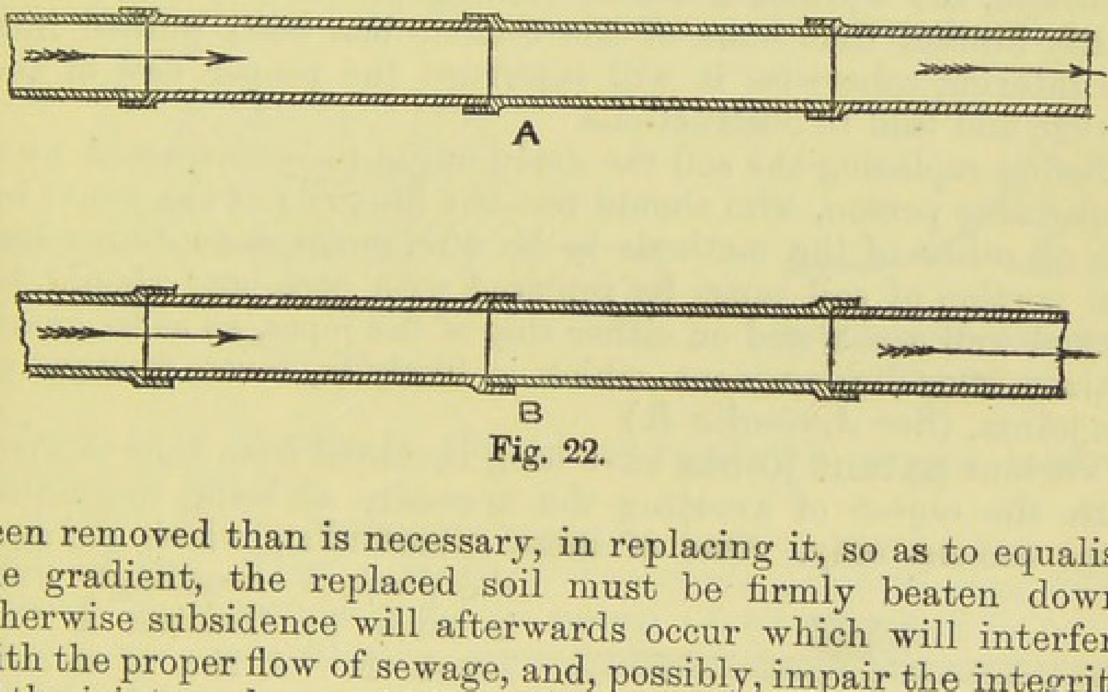


Fig. 22.

been removed than is necessary, in replacing it, so as to equalise the gradient, the replaced soil must be firmly beaten down, otherwise subsidence will afterwards occur which will interfere with the proper flow of sewage, and, possibly, impair the integrity of the joints and cause leakage.

Unless the ground is naturally solid, all drains should be laid on a bed of **concrete** 4 inches in depth, and, if it should be found necessary to carry a drain under a house, it should be entirely imbedded in concrete of at least the same thickness. The latter precaution ought to be observed in all cases where it is necessary that a drain should be laid in close proximity to a well, although, if circumstances permit, it is better to select another route for the drain.

In laying the pipes, a point of the utmost importance to remember is, that they should rest on their bodies on the bottom of the trench, and not on their sockets, a portion of soil being removed at points corresponding with each socket to allow of this. It is the usual practice of inexperienced drain layers to disregard this precaution, with the result that, when the trench is covered in, in place of the weight of soil being uniformly distributed along the entire length of the pipe, the pressure is concentrated upon each joint, and, in all probability, causes the recently introduced cement to be expelled from the sockets.

Joints must be made with the utmost care, the best Portland cement being alone admissible. Even in these days it is by no means an uncommon practice to use *clay* for the purpose. An ignorant workman may, possibly, be excused for following past custom in this respect, but builders and architects are greatly to blame if they countenance such a proceeding.

Having carefully cemented the joint, not only at the top, but all round, the workman, before making the next joint, should satisfy himself that none of the cement has been pushed into the interior, otherwise it will interrupt the proper flow of the sewage and lead to obstructions.

Before replacing the soil the drain ought to be inspected by a responsible person, who should test the integrity of the joints by one or other of the methods to be afterwards described. The first portion of soil must be replaced with care, and should be packed well under and on either side of the pipes, so as to guard against after-displacement, which is likely to cause fracture of the joints. (See *Appendix B.*)

Various **patent joints** have been invented from time to time, with the object of avoiding the necessity of being dependent upon cement only. One of these (Stanford's), which answers the purpose exceedingly well, is made by Doulton & Co., Lambeth. A rim of smooth and durable material is cast on to the spigot end of the pipe, and to the interior of the socket, so as to insure a tight fit, and a space is left to allow of cement being introduced as an additional precaution. More recently this joint has been further improved, the composition which is cast on the spigot of the pipe being made convex on the surface, as shown in the sketch (Fig. 23). The advantage claimed for this arrangement, although it is a doubtful one, is, that if from any cause after-subsidence should occur, a certain amount of displacement of

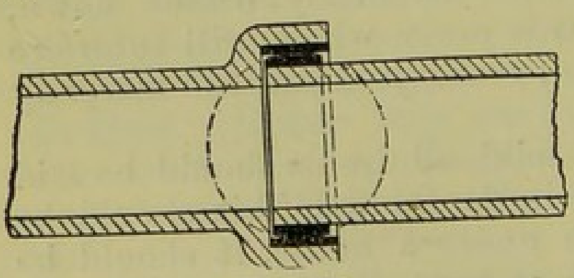


Fig. 23.

the pipes may take place (on the same principle as a ball-and-socket joint) without the integrity of the joint being impaired.

The process of laying these pipes is very simple. Having carefully wiped the spigot and socket, a small quantity of specially-prepared lubricant is applied inside the socket of the one pipe, and round the spigot of the other; they are then pressed home, and the joint is complete. These pipes are made in various sizes from 4 to 18 inches.

As regards the question of the durability of these joints, time alone can decide, but it is claimed for the composition, that it has shown no evidences of deterioration in pipes that have been taken up after having been in use for fifteen years.

Another joint, the **Archer patent** (Fig. 24), is constructed so as to allow of the joint being made by liquid cement being poured in at an opening at the top of the socket, after the pipes have been adjusted, a luting of clay being first introduced, to act simply as a barrier to the entrance of the cement into the interior of the pipe.

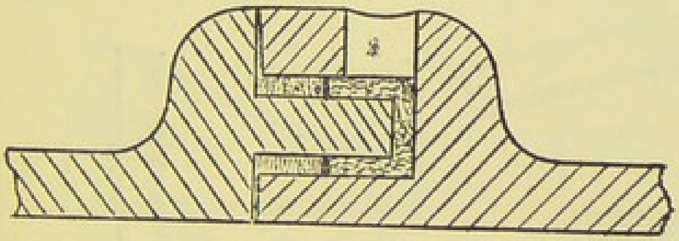


Fig. 24.

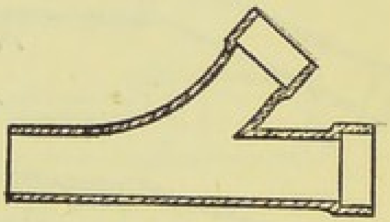


Fig. 25.

Patent joints, however, have not by any means come into general use. From a sanitary inspector's point of view, therefore, it is important that the points to be attended to in the making of an ordinary cement joint should be thoroughly appreciated.

Junctions must always be in the form of a **V**; no tributary drain should join at right angles. The figure (Fig. 25) represents a **V**-shaped junction pipe. Such pipes are made in all sizes. It is important to remember, that unless tributary drains join main drains obliquely in this manner, so that the sewage enters in the direction of the flow, splashing will occur, and this, in time, is likely to lead to obstruction, owing to a deposit being gradually formed from the drying of the sewage that has been driven against the sides of the pipe, above the water-line. It is needless to remark that it is a wrong proceeding to connect a tributary drain by knocking a hole in the main drain, although the practice is by no means an uncommon one.

Bends in drains should, as far as possible, be avoided; when they are unavoidable, the curve ought to be an easy one. Pipes with easy bends are made, and should always be used when bends are necessary (Fig. 26, B), although it is a common practice to use straight pipes for the purpose. The effect of such a proceeding is shown by the accompanying sketch (Fig. 26, A). Not only are objectionable angles formed at the junctions of the pipes, which tend to interfere with the easy flow of sewage; but what is still more important, the impossibility of accurately adjusting the spigot end of one pipe into the socket of the next, in the case of straight pipes laid otherwise than in a straight line, necessitates an imperfect joint being made.

In connecting a branch drain with a main drain easy bends should be used (Fig. 27), but, when it is necessary to depart from the straight line in the case of the drain itself, or in the case of sewers, by far the best proceeding is to construct a **man-**

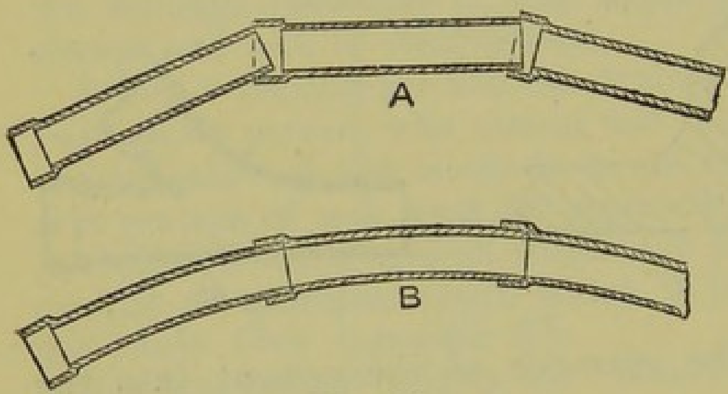


Fig. 26.

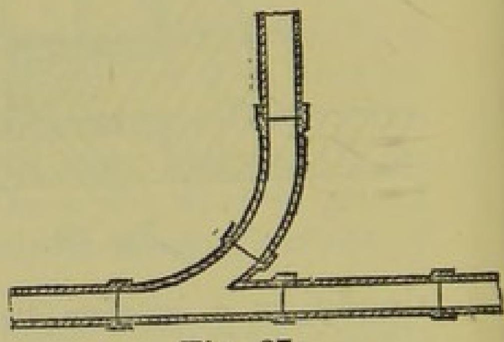


Fig. 27.

hole at the point where the **curve** occurs, in a manner to be presently described. Indeed, whenever practicable, all tributary drains and sewers should join the main drain or sewer, as the case may be, at a manhole, so as to facilitate inspection and cleansing.

Inspection pipes of various kinds are made, and ought to be introduced at the top end of all branch drains, particularly when they are laid in concrete. The necessity for breaking into a drain, should it become obstructed, is thus avoided, as the clearing rod may be introduced at the opening provided.

Perhaps the simplest method, and one which does not entail any disturbance of the surface, is to introduce what would correspond to a V-shaped straight junction with the opening directed upwards (Fig. 28), to which a pipe, leading from the surface of the ground is connected, and along which a rod may be passed. The top end of this pipe must be sealed, either by a special cap or by a piece of slate fastened with clay, a small movable stone slab with ring attached being placed so as to mark the situation and allow of easy access to the opening.

Another method of inspection (Fig. 29), is by means of a pipe divided longitudinally into two segments, the upper of which may be removed by means of a chisel.

Sewers are constructed of pipes or of bricks according to their size. In the former case the same rules have to be observed as have been described in the case of drains.

The proper *size* and *fall* for a sewer is a question for engineers, and both are dependent upon the amount of the sewage flow. The following concise summary is given in *Hygiene* by Dr. Louis C. Parkes:—"To prevent deposit, sewers should be rendered self-cleansing by being constructed with a sufficient gradient, and of a size suitable to the volume of sewage which they will ordinarily be required to carry. According to Mr. Baldwin Latham, sewers of from 12 to 24 inches diameter should have a

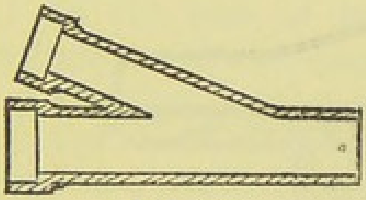


Fig. 28.

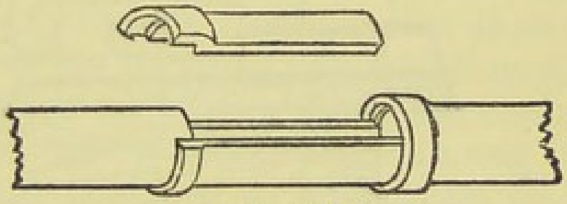


Fig. 29.

gradient sufficient to produce a velocity of not less than 2½ feet per second, and in sewers of larger dimensions in no case should the velocity be less than 2 feet per second. For large sewers a less gradient is required than for small sewers to produce the same velocity; but the volume of the sewage to be conveyed must be very much greater for the large than for the small sewer. A sewer 10 feet in diameter having a fall of 2 feet per mile; a sewer of 5 feet in diameter having a fall of 4 feet per mile; a sewer of 2 feet in diameter having a fall of 10 feet per mile; and a sewer 1 foot in diameter with a fall of 20 feet per mile, will all have the same velocity of flow, but the volume of sewage in the 10-foot sewer must be 100 times, in the 5-foot sewer 25 times, and in the 2-foot sewer 4 times the volume of sewage in the 1-foot sewer."*

Circular stoneware pipes should be used for all sewers up to 18 inches in diameter, but sewers of larger capacity should be

* For an excellent description of the method of calculating the flow of water through pipes see the volume on *Water Works*, Weale's Rudimentary Series.

egg-shaped, with the small end of the egg downwards, and constructed of good impervious bricks laid in the best Portland cement (see p. 20). The advantage of an egg-shaped sewer is the resulting increase in the depth of flow and consequent diminution of friction.

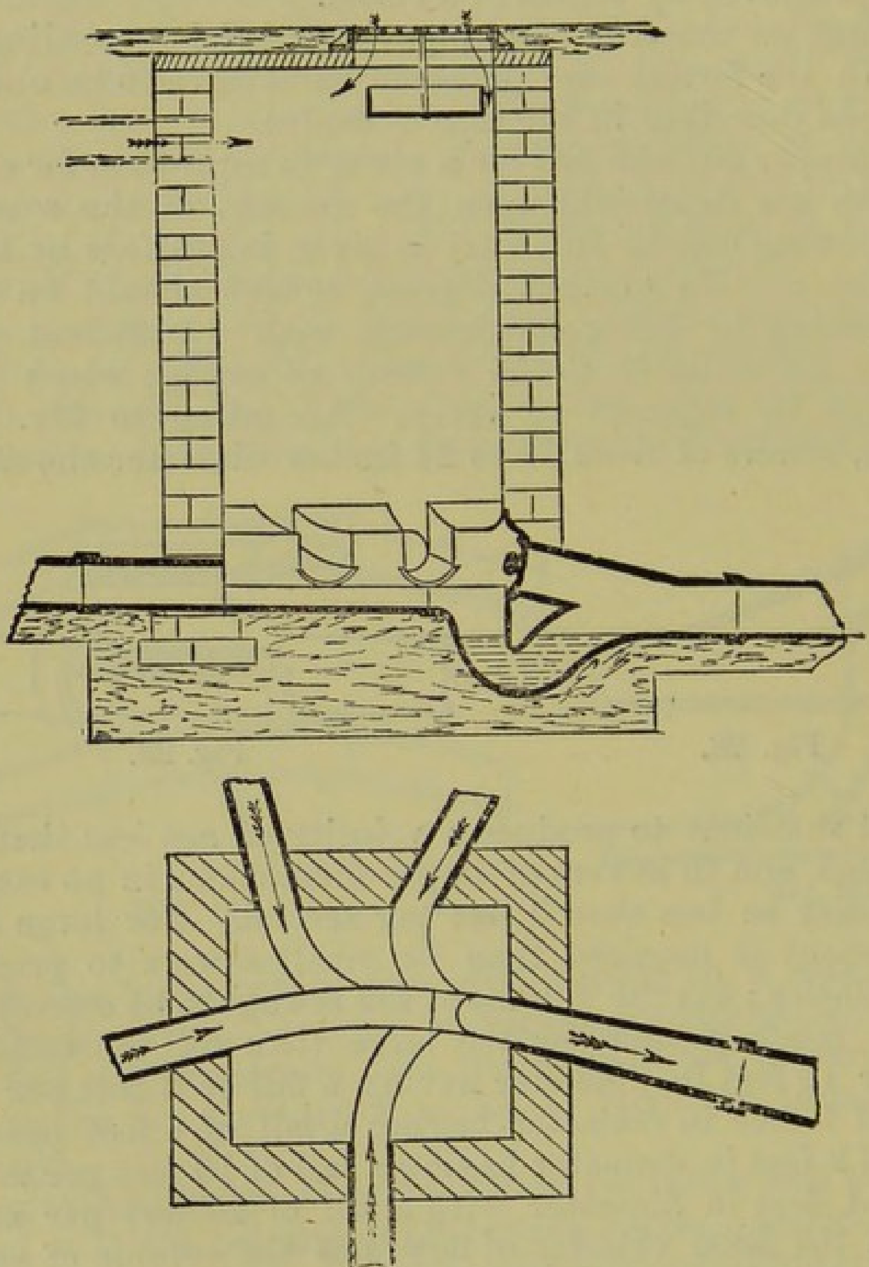


Fig. 30.

Manholes ought to be introduced at intervals of not less than 100 yards, and the convenient sites for these are where tributary sewers join, but, as already stated, it is essential to construct one at each point where the sewer has to alter its straight course. The same holds good in the case of the drains of all well-drained establishments; the satisfaction of being able to look through, and to pass a rod through from one end to the other of the drains and their tributaries, amply repays the extra outlay.

A manhole chamber (Fig. 30), is built of brick-work set in cement, and the drain or sewer is continued along the floor of the chamber by means of open half-channel pipes set in a bed of concrete. The surface of the concrete should be raised some inches above the edges of the half-channel pipes to prevent the sewage from overflowing on to the floor of the chamber, and it should be *floated* with cement all over so as to present a smooth and impervious surface. At points along the main channel tributary drains are connected by means of *curved* half-channels similarly laid in concrete, the junctions being formed by special half-channel junctions being introduced in the course of the main channel at these points. All street manholes should be fitted with a perforated iron lid to allow of the free circulation of air in the sewers (see p. 74), a bucket or tray being suspended under the perforations to catch any dirt that may enter from the road. In the case of private drains, the manhole lids should be air-tight, with the exception of the terminal one which ought to be perforated for the admission of air to pass along the drains and up the ventilators at the top ends of the main drain and its tributaries, a syphon trap being introduced at the outlet from the manhole into the sewer or cesspool as the case may be.

So much for the points that have to be attended to in connection with the laying of drains and sewers. A description of the various forms of traps has purposely been omitted at this stage, as they may more fitly be described when sanitary appliances come to be considered.

Methods of Sewage Disposal.

The methods of sewage disposal have next to be considered, and these, like drainage construction, have to be viewed in the light of the *principles* laid down in the former Chapter, always remembering that, although the details must necessarily vary with circumstances, none are right which do not comply with established rules.

To give anything approaching a detailed account of the various recognised plans of sewage treatment would far exceed the limits of this elementary treatise; those who wish, therefore, to follow the subject farther will do well to read a recent work on the subject by Mr. Santo Crimp, entitled *Sewage Disposal Works.*

The following short description, however, of the systems most in favour may prove of interest:—

The methods at present in use are *precipitation*, *artificial filtration*, *land filtration*, and *broad irrigation*. The question as to which is to be preferred is one which does not admit of a simple answer, but can only be determined by carefully considering the local conditions—a duty which belongs to engineers.

Precipitation consists in collecting the sewage in tanks arranged in a series, the top water being allowed to pass from one to the other in a shallow stream over a weir extending along the entire width of each tank, thus enabling a large volume to remain comparatively quiescent, so that the solid particles subside. This process may be greatly assisted by the previous addition of some **precipitant,** in the shape of lime, alum, salts of iron, or other substances, either singly or in combination. The fine particles of lime, and the flocculent particles which form from the salts of aluminium and iron, by reason of their density assist in the subsidence, the solid sewage particles being entangled and carried to the bottom of the tank in the form of **sludge,** leaving a comparatively clear fluid above. The process is purely a mechanical one except when certain reagents are used in addition, in which case dissolved organic matter may to some extent be acted upon; it is a useful, and in most cases a necessary, preliminary to further treatment, but in itself *it does not sufficiently purify the sewage to warrant its being discharged into a stream.* At intervals, the sewage in one of the tanks is allowed to remain for a time absolutely quiescent, to enable the solid matter to subside as much as possible, and provision exists for allowing the whole of the clearer portion to be drawn off, leaving the sludge behind.

Methods of Dealing with the Sludge.—The sludge is dealt with in a variety of ways. In the case of small towns conveniently situated in agricultural districts, farmers will usually undertake to remove it without further treatment, free of charge, and in some cases they will even pay a small sum for the privilege. This method of disposal of the sludge is not usually satisfactory, as it is often allowed to remain on the spot for a long period while decomposition is going on, until it may suit the convenience of the farmer to remove it.

In other cases, as in Birmingham, the sludge is deposited on land, and when it has become comparatively solid, through percolation into the soil and evaporation, it is dug into the ground, which is afterwards cropped. In some cases the sludge is pressed into cakes in filter presses, and sold or given away as manure, or burned and manufactured into cement. The question of dealing with the sludge is not the least difficult one in relation to sewage disposal.

Having so far clarified the sewage, the effluent has now to be dealt with, and where the surroundings will admit of it, there is no doubt, so far as our present knowledge goes, that land treatment is the most satisfactory.

Intermittent downward filtration is the term applied to that form of land treatment in which the effluent drains are laid at considerable depth, 5 or 6 feet below the surface, and in which the sewage (after precipitation) is turned on for a certain number of hours (8 hours), with intervals (16 hours), during which it is entirely kept off to admit of free aeration of the soil. The clarified sewage is conveyed in open carriers along the surface, and by a system of sluices it can be directed on to any part of the area which has previously been specially levelled and underdrained. The great object is to bring the sewage at regular intervals in contact with the soil, irrespective of any vegetation, but, by an arrangement of ridges and furrows, certain root crops may be cultivated, and in this way the process of purification may be assisted, while at the same time a small return is obtained from the sale of the produce. By such a system, properly attended to, and where the soil is particularly suitable, it is said that the sewage of from two to three thousand inhabitants (if previously thoroughly clarified by precipitation) may be dealt with on 1 acre of land.

Broad land irrigation is very similar to land filtration, with the difference that greater attention is paid to the cropping of the land. The area of land used is very much larger, and the sewage is discharged from surface carriers at such times and in such quantity as vegetation requires, or will admit of. The carriers are cut about 30 feet apart, along ridges, with a gentle slope on each side to admit of uniform distribution of the sewage. Constant attention is required to insure that the sewage is thoroughly distributed and not allowed to discharge on to a small area, as this would cause waterlogging, and thus prevent the proper aeration of the soil. The land, in this case, is drained at a depth of from 3 to 4 feet, and the quantity of land required is said to be 1 acre for each hundred of the population, provided no previous treatment beyond straining is in use; with preliminary precipitation, however, the sewage of twice as many people, if not more, may be dealt with on 1 acre of suitable land. Irrigation without previous precipitation usually ends in failure.

Italian rye-grass is the most suitable for sewage-farm cultivation, as it grows very rapidly and absorbs a large quantity of moisture. As many as three or four excellent crops may be cut during the year, and it yields a good return as a food for dairy cattle.

Perhaps the best system of **artificial filtration** is one which is in operation at Acton. It would seem from the analysis of this effluent that the process is worthy of more extended trial in cases in which suitable land is not attainable. The precipitant in this case is a material called "*ferrozone*," which acts rapidly, and is also credited with possessing a considerable chemical power of disintegrating the dissolved organic matter. The filtering medium is a substance called "*polarite*," a specially-prepared iron ore, which seems to have the power of rapidly oxidising organic matter without in itself undergoing any change. The effluent from the precipitation tanks is passed through a layer of this material after having gone through sand and gravel placed on the top of it, thus effectually removing any suspended matter which may remain after the first part of the process. It is necessary to remove the surface layer of fine sand periodically, as in time, notwithstanding the previous chemical precipitation, a considerable deposit of solid matter takes place.

On the whole this process, so far as it has been tried at present, seems to promise better results than any of the methods (with the exception of land treatment) in general use or recommended, such as alumino-ferric, black ash, lime, iron, electric, &c.

The **Amines** process, which was introduced some short time ago, and was in operation for a time at Wimbledon, consists in adding to the sewage, previous to its entering the precipitation tanks, lime and herring-brine. The lime acts simply as a precipitant, and the herring-brine, owing to its containing certain sterilising ingredients, is supposed to retard decomposition for a sufficient period to enable the sewage to reach the sea without giving rise to any nuisance. This process has not sustained the reputation which it at first acquired.

With regard to **villages**, the chief points to be considered in deciding upon a plan are simplicity and easy management, for without these failure is certain to follow. Land is generally to be had, and the crop which requires least attention, and perhaps answers the purpose best, is osiers. It is necessary to drain the land properly in the first place, and the osiers ought to be so arranged as to allow facilities for the regular removal of the sludge from the surface, as any process of previous precipitation, in the case of villages, is not as a rule practicable. This plan of sewage disposal has been adopted by several villages, and in the author's opinion with excellent results (see p. 78).

Another process of dealing with sewage in small quantities is by **sub-irrigation.** By this is meant the discharge of the sewage along ordinary agricultural drain-pipes, laid within 1 foot of the surface, so as to allow of its being purified by land and appropriated by vegetation. This plan is open to certain objections which render it unsuitable for cottages, singly or in small groups. The drain-pipes, unless periodically renewed, are liable to clog, and there is a danger of the sewage not being uniformly distributed over the whole area unless it is first passed into a tank which will periodically and automatically discharge it in considerable volume along the drains. These are conditions which may be practicable in the case of villages and large establishments, and in such cases the plan is a good one.

In certain villages where this system has been successfully adopted, the sub-irrigation drains have not required renewal for from five to seven years.

It may be well, however, to caution those who propose to give it a trial, that, as success is dependent upon the nature of the soil, and upon the manner in which the scheme is carried out, it is essential that it should be entrusted to one who has had experience in such work; indeed, the services of an engineer, whatever the scheme may be, are distinctly advisable, and in the end will prove economical.

Cesspools, without overflows, properly constructed and ventilated, and placed a safe distance from house wells, will probably be found to answer best for small houses and cottages in the country, where no system of sewers exists. The cesspool must have a pump attached to it, to allow of the contents being regularly removed and placed on the land. In the case of larger houses, with land available, an overflow-pipe for irrigation purposes may be connected with the cesspool, which ought to be of small capacity. Means of easy access must be provided to admit of frequent and regular removal of the solid deposit.

Cesspools constructed of porous brickwork, which allows of percolation through the bottom and sides, ought in all cases to be condemned.

In cases in which cesspools are admissible, that is, when other and better means of dealing with sewage—such as by sub-irrigation—are not practicable, they must be constructed so as to be absolutely water-tight. This may be accomplished by building the brickwork in cement, rendering it with cement, and surrounding it on all sides with puddled clay from 6 to 9 inches deep, for which, of course, it is necessary to allow in making the excavation. The puddled clay is first laid on the bed of the hole, and upon it the floor of the cesspool is built; the walls, one brick in thickness, are then carried up a certain distance, and, having carefully removed all dirt from the surface of the clay-bed outside the walls, the interval between the outside of the brickwork and the soil is filled up with the clay, which must be thoroughly well rammed down; another few lines of bricks are then laid, and the interval similarly filled up, and so on until the whole is complete. To avoid disturbing the brick-work while the process of ramming the clay is going on, care must be taken to "stay" the walls across from side to side, and the "struts" should not be removed until the cement, to some extent, has set.

An arched roof has next to be built, in which three openings must be left; one for the purpose of gaining access to the cesspool, in order to periodically cleanse it, the second for connecting a ventilating-pipe, and the third for fixing a pump. A properly-constructed manhole-cover is best for the first purpose, although a movable stone slab will answer. It is a common, though objectionable practice, in fixing the ventilating-shaft of a cesspool, to take advantage of a neighbouring tree for a support, with the result that the swaying of the tree ultimately injures the connections, and, if an iron pipe (which, however, ought not to be used for the purpose, see p. 126), breaks the joints. Some stationary object, such as a post or, if possible, a wall, must be made use of.

For the purpose of emptying the cesspool a chain pump is most suitable, as the mechanism is simple and does not get out of order.

A syphon intercepting trap, with an air inlet on the house side (pp. 104, 105), must invariably be placed between the cess-pool and the house, and near to the former.

The size of the cesspool must be regulated in accordance with the size of the establishment for which it is intended, but the smaller it is the better.

Methods of Refuse Disposal.

As in the case of sewage, so with regard to refuse, no plan of disposal applicable under all circumstances can be laid down. This has already been pointed out in the previous Chapter; the details applicable in each case have now to be considered.

Privies are constructed on different plans, according to whether it is intended they should receive the fæces and urine only, or also the ashes and general refuse of a household.

The drawing (Fig. 31) represents the section of a privy built for a *movable* receptacle, and for excreta only, in accordance with the requirements of the model bye-laws. In this case, the seat of the privy is hinged so as to allow of the pail being removed from the inside, but if it is found desirable to remove it from the outside, a modification, in the shape of a door at the back or side, is quite admissible.

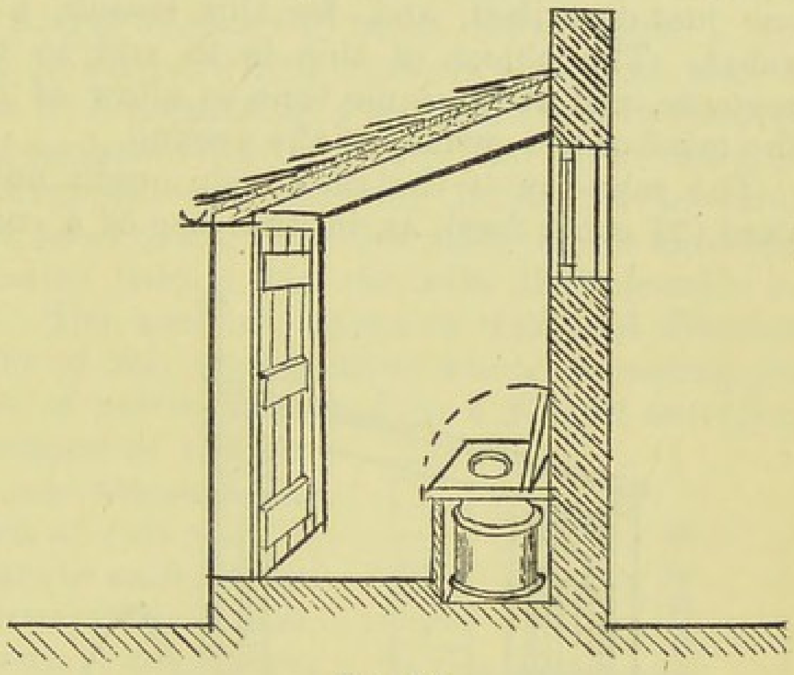


Fig. 31.

In order to provide for ventilation, an opening, communicating directly with the external air, should be constructed as near to the top of the privy as possible.

The floor ought to be flagged, or paved with hard tiles, or other non-absorbent material; every part of it should be at least 6 *inches* above the level of the surface of the ground adjoining, and it should have a fall towards the door of the privy of half an inch to the foot. Beneath the seat, the floor on which the receptacle rests must be at least 3 *inches* above the level of the surface of the ground, and it also should be flagged or asphalted; the sides of this chamber must be constructed of flagging, slate, or good brickwork, 9 inches thick, *rendered* in cement. The receptacle itself is limited by the model bye-laws to a capacity not exceeding 2 *cubic feet.*

In the case of a privy with a *fixed* receptacle for refuse, it is essential that the ashes and dry refuse should be regularly mingled with the excreta, consequently the capacity of the receptacle must be greater than 2 cubic feet. The limit of the capacity in this case is fixed at 8 *cubic feet* in the model bye-laws. In other respects, the structure of the privy is practically the same as that just described. The great object in limiting the capacity of the receptacle, is to necessitate weekly removal of the contents. As this is hardly possible in rural districts, the above limit must there be exceeded. The following sketch (Fig. 32) represents an arrangement which, in the author's experience, answers admirably in rural districts, and it has this advantage that in most cases it is possible to adapt it to existing privies. It will be noticed that the seat of this privy is higher than the one just described, and, for this reason, a step has to be provided. The object of this is to add to the depth of the receptacle, and at the same time to allow of its floor being above the level of the surface of the ground.

The capacity of the receptacle ought not to exceed 1 cubic yard (27 cubic feet), as, in the case of a cottage, with ordinary economy in the consumption of coal, this space is ample for three months' storage. By economy is meant the absence of wasteful consumption. It is a remarkable fact that the poorer classes, who can ill afford it, are most reckless in this respect. One too often sees large quantities of half-consumed coal thrown into the privy cesspit, a practice which renders the refuse useless as a manure, and for that reason the farmer, who otherwise would willingly remove it free of charge, declines to do so.

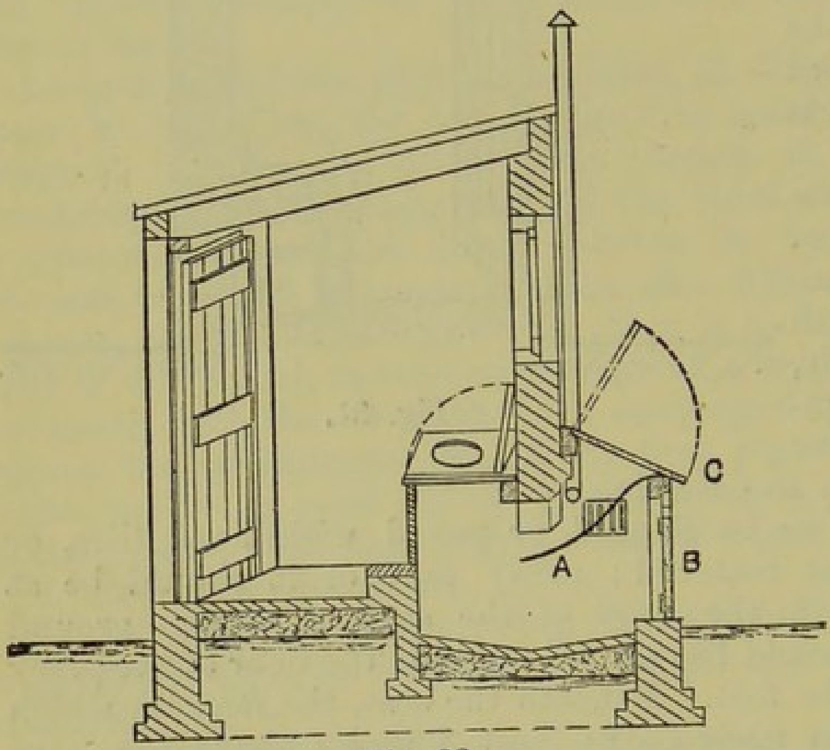


Fig. 32.

In this arrangement of privy, the ashes are thrown in from the outside at a door (C) which covers a part of the receptacle built out behind, the back wall of the privy being cut short in the form of an arch, the top of which is a little below the seat of the closet. Immediately under the lid, and fastened to the top of the back wall of the receptacle, is a shoot (A) made of sheet iron, the sides of which are slightly turned upwards, and which is adjusted by two stays connected with the arch of the closet wall, at such an angle as to direct the ashes on to the excreta. Below this shoot there is an opening (B) in the back wall of the receptacle, which is provided with a door, through which the refuse may be raked along the slightly curved floor on to a stone slab, from whence it is carted away.

Various contrivances, connected with privies, have been introduced for the purpose of screening the ashes, but it is seldom, if ever, found that the poorer classes will make use of them.

There is one plan, however, which answers well, and that is the old fashioned one of constructing a small pit on the hearth under the kitchen fire-place—the only one that need be considered in cottage property—and covering it with a movable screen with close bars, so as to allow the finer ash to pass through, while the coarser remains behind, and can with little trouble be replaced on the fire. The author's attention was first directed to the practical utility of this arrangement when inspecting, on one occasion, a series of privies attached to a row of cottages, where the small character of the discarded ashes in each case attracted his attention. The reason of this was explained by the existence in each cottage of one of the contrivances just described. In constructing such an arrangement, it is important that the pit should not be too large, and it is an advantage to provide a tray as a receiver, which can easily be slipped out, and in which the ash which passes through the bars can be carried to the ashpit. The above sketch (Fig. 33) represents the contrivance in section. The sloping bottom, deep at the back and shallow in front, allows of the removal of the ash-tray, and admits of the pit being readily swept out.

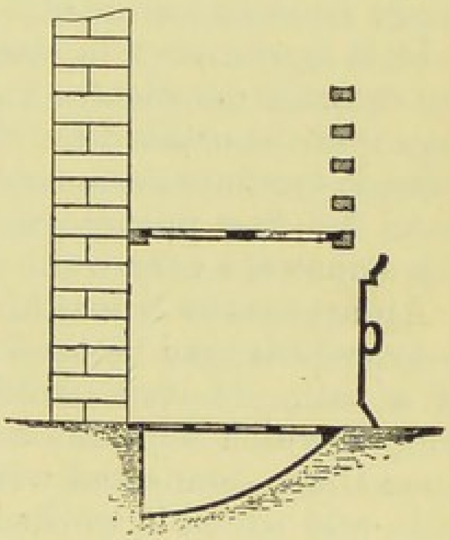


Fig. 33.

Moule's earth-closet is an excellent contrivance, but, unfortunately, it is hardly practicable for use on a large scale. In better class houses in the country, in the absence of water-closets, if soil is easily obtainable, and servants can be held responsible for the management, no better system for dealing with excretal refuse can be adopted. Ashes have little or no effect on excreta beyond keeping them dry, and so retarding decomposition; it is very different, however, with dry soil, which not only answers a like purpose, but also gradually disintegrates the organic matter, converting it into the condition in which it naturally exists in fertile soil.*

* See Dr. Buchanan's Report to the Privy Council, 1869.

After the earth has remained in contact with the excreta for a certain length of time (six weeks), it may be used again, provided it is dried; indeed, it has been so used over and over again (as many as a dozen times) with perfect success.

A loamy soil is by far the best for the purpose, although clay answers very well; sand, gravel, and chalk are practically useless.

A pint and a half of earth is the necessary quantity to be applied each time the closet is used.

All of the following conditions are essential to successful treatment:—

1. The earth must be suitable for the purpose, perfectly dry, and finely sifted.

2. It should be distributed over the excreta each time use is made of the closet.

3. All moisture, beyond that contributed by the excreta and urine, must be excluded.

It is convenient to store a sufficient quantity of soil during the summer months for use during the winter, as the sun's heat may then be utilised for the purpose of drying it. If this is not done, it becomes necessary to use artificial heat, and a convenient stove for this purpose may be obtained, although the kitchen-stove answers very well.

An apparatus is manufactured by Moule's Earth-Closet Company, which may be used in connection with a fixed receptacle or a pail. It consists of a seat, above and behind which is a hopper which contains a sufficient quantity of soil to last for some time; connected with this is a valve into which the earth falls, and which is worked either by means of a handle, or by a lever connected with the seat; so that when the plug is raised, or the person rises from the seat, the soil resting on the valve is distributed over the excreta, and when the plug is pressed down again, or the seat is again sat upon, the valve is re-charged.

If the closet be out of doors (it is hardly fitted for indoor use), there is no reason why the receptacle should not be large enough to contain three months' accumulation, and, provided a supply of earth is kept in the closet, the person using it may apply the necessary quantity by the hand, by means of a trowel or other convenient implement.

From the above description, it will be perfectly apparent that dry earth-closets are not admissible either for cottage property or for densely-populated towns; in the former case, the necessary details will not be attended to, and in the latter there is no facility, either for obtaining the earth, or for disposing of the manure.

The ultimate disposal of refuse, so far, has not been considered in detail, neither will space permit of the question being discussed in any other than a superficial manner.

In Rural Districts, provided ordinary care is observed in excluding from the refuse heap all but the fine ashes, excreta, and garbage of the household, little difficulty will be experienced, as neighbouring farmers will willingly remove such refuse free of charge. It is not, however, easy to insure that removal will be effected at sufficiently short intervals, and, until rural sanitary authorities throughout the kingdom realise that it is their duty, not only to see that nuisances are corrected as they arise, but also to do their utmost to prevent their occurrence, the difficulty will still continue. The inhabitants of scattered districts must necessarily do more for themselves than those who live in towns; what is quite practicable in the former case, becomes an impossibility in the latter, but this circumstance by no means relieves such authorities from responsibility. Carefully considered bye-laws, in which only what is reasonable is required of the people, should be in force in all districts, for this, as for other purposes, and by their regular enforcement, when necessary, each individual must be taught that he is expected to do his share in work that is essential to the health of the community as a whole.

In Urban Districts, sanitary authorities ought themselves to be responsible for the removal of refuse, and at intervals not exceeding a week, although daily removal is most desirable; the method of disposal must vary in accordance with the nature of the privy accommodation.

In the case of towns with *fixed* receptacles, in which the ashes are mixed with the excreta, the services of the farmer are again in request. When the surroundings are agricultural, and particularly when the proximity to a canal permits of cheap transit, comparatively little difficulty will be experienced, although the rural population may reasonably complain of the nuisance that must arise from the conveyance of such offensive matter in large quantities about the country.

In the case of towns with *movable* receptacles, the best system is what is known as the *Rochdale system*, and this, or a modification of it, is in operation in several towns, although, from what has been stated in the former chapter, they probably all have cause to regret having adopted it.

In this case, the pails, which ought to be provided with tight-fitting lids, are removed weekly, in covered carts, to a central depôt, being replaced by others which have, in the meantime, been thoroughly cleansed. A certain quantity of sulphuric acid having been added, in order, as far as possible, to retain the ammonia—the important constituent from a fertilising point of view—the excreta are discharged into iron cylinders, in which they are reduced to a dry powder (poudrette) by means of steam. The cylinders now in use have a steam-jacket around the outside, and in the interior there are hollow revolving arms for the purpose of agitating the contents; into these arms steam is introduced in order to aid in drying the excreta. The fumes given off during the process of drying are conducted over the furnace so as not to give rise to nuisance.

By this system, provided ashes and other refuse are excluded from the pails, a manure is produced which has a ready sale at about £5 per ton.

The disposal of dry refuse, in water-closet towns, and in towns in which the pail system proper is in force, has recently received a great amount of attention, and authorities are beginning to realise that the practice of depositing such refuse on land must be looked upon as a thing of the past.

Destruction by burning is the only safe and efficient method. This is conducted in large furnaces, constructed so that the refuse may be thrown in at the top, and the indestructible, mineral part of it (clinker), removed at the bottom. When once the fire is well started, it is found that the organic matter, of which all town refuse is largely composed, suffices to maintain the fire until complete destruction is effected, and nothing but the non-injurious mineral portion remains. The heat thus generated may be utilised for a variety of purposes; for example, the production of steam-jets in connection with the flues for increasing the draught; the pumping of sewage on to land, when the level of the surface necessitates doing so; the generation of steam for the purpose of treating the excretal refuse, when the Rochdale system is in operation; as a power for generating electricity, for lighting or other purposes; for the generation of steam necessary for the disinfection of clothing and bedding; in fact, for any purpose for which steam-power is required.

The clinker which remains may be used for the manufacture of cement, or as a foundation for roads, for which it answers admirably.

Destructor at Chelsea.—A most ingenious plant for the disposal of house refuse may be seen at the works of the Refuse Disposal Company, Chelsea. The system consists in separating the component parts of the refuse, so that each may be appropriated to some useful end, and the company claims, not only that this can be accomplished without loss, but that a substantial profit may be made. The process is chiefly mechanical, nine-tenths of the material being sorted without handling, and the requisite steam-power is obtained by burning that portion of the refuse which cannot be more profitably disposed of. The following short account of the process is reproduced from *The Surveyor* of February 18th, 1892 :*—

"The dust-cart tips the contents into a large revolving cylinder 10 ft. in diameter and 12 ft. in length. This screen is fitted with hard-wood bars, so as to prevent bottles being broken, the spaces between being 12 in. in length and 3 in. wide, so as to retain large bottles, &c. The material which is retained in the cylinder is guided by a coarse wood worm so as to ensure that the material shall be retained in the screen a sufficient time to remove all dust and small objects. Large paper, rags, carpet, wood, mill and straw board, boxes, bottles, tins, boots, straw and other large articles are sorted as delivered either at the end of the screen or on a travelling table, each article being put into its own class or bin. The material which passes through the mesh of the screen is elevated into a second screen fitted with a spiral worm, so that all the material has to pass over a surface of about 270 ft. in length on a mesh 1⅛ in. square, and, falling from the cylinder, is met by a blast of wind which drives all paper into a special cage or cupboard. The material which falls through the blast is directed on to a continuously-revolving iron table, and is distributed in a thin layer of material, so that each article can be at once picked up and put into its own place. All vegetable and animal matters are left upon the table, and are deposited upon the ground by the grinding mill. The principal products sorted from the table are bones, large coal and coke, metals, glass and crockery.

"The material which falls through the 1⅜ in. mesh of this No. 2 screen is delivered into a third screen, which is fitted with two different-sized wires—viz., ½ in. square mesh and ⅜ in. square mesh; also an outer or fourth screen, with ⅛ in. mesh. The material that comes from the end of these screens, and also that through the ½ in. mesh, forms what the brick-makers call 'breeze,' and is used for burning bricks. That which passes through the ⅜ in. mesh is called 'ashes,' and is mixed with the clay that is formed into the brick. This material also forms the

* Extract from a paper read at the Sessional Meeting of the Sanitary Institute, held at the Parkes' Museum, Feb. 10th, 1892, by Mr. Joseph Russell.

fuel for the boilers to provide steam for the works; and although at first great difficulty was experienced to maintain steam, yet since the introduction of a patent steel fire-bar, with a forced draught, this trouble has been entirely overcome, and there is not the slightest difficulty in maintaining the steam pressure required. It has also been found that, on account of the very small surface of bar in contact with the fuel and the very large volume of air in numerous and fine streams, and that also heated, the combustion is practically perfect. Another great advantage is also obtained—the clinker (of which there is about 30 per cent.) does not adhere to the fire-bars, and can be removed with the greatest ease. The products of combustion can be finally passed through 'scrubbers' before discharging them into the air.

"A load, or ton, from the time it is shot from the cart will pass through and be sorted into its various places in from five to seven minutes.

"One very important feature to which I would call attention is the means by which it is made a perfectly healthy and sanitary occupation. The first screen into which the dust-cart delivers its contents is provided with a very powerful exhaust fan, which extracts 7,000 cubic feet of air per minute, drawing in any odour and all particles of dust that rise in the screen, and discharging these into closed ashpits under the boiler fires, so providing the forced draught, and at the same time burning the dust and vapours. At various points inlets from other screens and dust chambers are taken into the main tube, so that 'it prevents injury to the dust sorters, and the atmosphere in which the operations take place is kept pure.' No case of illness has occurred at the works.

"Having given a general description of the process, it will be well to point out the uses to which the thirteen classes of material can be put:—

"Paper and rags are made into a common brown paper or leather board.

"Straw and fibrous material and small pieces of paper into straw boards.

"Woollen rags are sold for shoddy.

"Large coal and coke, sold.

"Iron, sold.

"Bottles are sold for re-use, &c.

"Crockery has been sold for re-manufacture, samples of which are on view. Offers have also been made for it, if broken up and sorted into sizes, for use in tar paving instead of marble chips.

"Ashes and breeze into block fuel (as sample) for steam purposes, such as for electric lighting, or can be sold to brick-makers.

"The vegetable and animal substance with the fine dust and the bones for agricultural purposes, or as a basis for distributing strongly concentrated manures (such as nitrate of soda).

"Mineral, such as the clinkers, stones, &c., for concrete blocks or artificial paving stones.

"The clinkers, being very hard, are also suitable for mortar, or to use in lieu of sand on wood and other roads.

"Broken glass can be re-made into bottles, &c., or used for making glass-paper, or as a flux.

"Tins, these by a simple process can be cleansed from the fats adhering to them, and the solder run off and collected, whilst the plates are melted and run into sash weights or slabs, similar to the sample shown; or the plates can be bundled up and sent to the mills to be re-forged.

"There is, therefore, not only a use for every portion of the house dust, but when so divided and dealt with these products possess a commercial value, and will pay all the expenses of manufacture and leave a handsome profit on the outlay."

It is needless to observe that the process is admissible for house refuse only; it is impracticable for towns in which such refuse is mixed with excreta.

CHAPTER VI.

SANITARY AND INSANITARY WORK AND APPLIANCES.

The various appliances connected with the drainage of houses and premises have now to be considered.

In forming an opinion regarding the efficiency of any appliance, experience is the only safe guide, but one thing is certain, that no mechanism is satisfactory which does not comply with the principles laid down in Chapter IV. Many inventions, however ingenious at first sight they may appear, and however well they may answer experimentally, have to be discarded on account of unforeseen circumstances which interfere with their efficient working in practice.

In conducting an examination into the sanitary condition of premises, a familiarity with the errors that are likely to be met with is hardly less important than a knowledge of what is right and proper, and it is essential that the enquiry should be conducted systematically, step by step: nothing being taken for granted, otherwise, sooner or later, a mistake will be made.

As **traps** are met with in connection with most appliances, it is convenient that they should first be discussed. The purposes served by traps, and the conditions with which all must comply, have already been noticed in Chapter IV. The following are the common varieties met with in practice:—Syphon-trap, Gully-trap, D-trap, Bell-trap, Antill's trap, and Dipstone-trap. The two first-mentioned traps (or a modification of them) are the only ones admissible; all the others are more or less objectionable.

The simplest form of **syphon-trap** for use in the course of a drain is an ordinary pipe with a bend in it (Fig. 34, A); both those represented in the drawing, however, are faulty for various reasons. The first (A) because (1) the dip is not sufficient to provide a proper water-seal; (2) the bottom of the trap is rounded, consequently there is a risk of its being fixed out of the level; (3) there is no provision for the ventilation of the drain, in the shape of an inlet opening on the house-side of the water-seal; and (4) no means of access to admit of the trap or the drain beyond being cleared out, should either become obstructed, are provided.

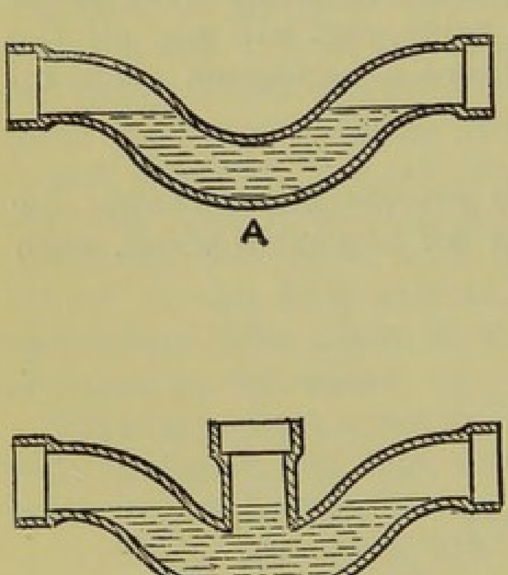


Fig. 34.

The second (B) is open to the same objections as far as the first and second points are concerned, and as regards the third, although means of access are provided, it is not at a point that will allow of ventilation, or the unstopping of the drain beyond. There is another objection to this, which is a form of trap one often meets with, and that is that floating matters are likely to accumulate in the central shaft.

The trap which is best fitted for the purpose (Fig. 35), and which is not open to any of the foregoing objections, has two openings, in addition to the inlet and outlet, one at A in the sketch, which is carried up by means of pipes to the surface of the ground, where it is covered by an open grating and thus acts as an air inlet, and the other beyond the seal, which may be used for cleaning the drain between the trap and the sewer or cesspool. It will be noticed that this trap has a deeper seal than the others; that the drain inlet is well above the outlet, thus affording a better flush; and that it stands on a flat bottom, which facilitates its being laid level.

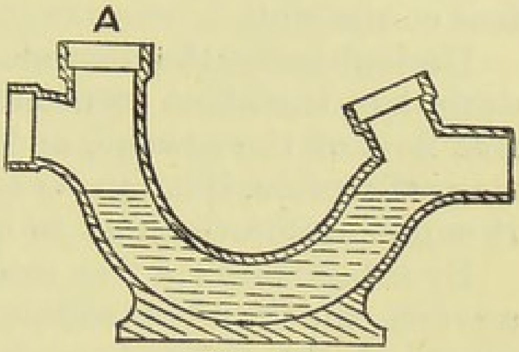


Fig. 35.

In the event of the drain terminating in a manhole, such as has been described on p. 88, previous to joining the sewer or cesspool, a special form of disconnecting trap, represented in the sketch (Fig. 30), with a **raking-arm** or by-pass to allow of the drain being cleared beyond the trap, should be used. In this case the inlet for ventilation is provided by means of openings in the manhole cover, or if, by reason of its position, there is an objection to this, by a special opening at the side, shown by dotted lines, which is carried up some distance above the ground level.

An improved trap (Fig. 36), has recently been introduced by Professor Corfield; the syphon is egg-shaped in section and curtailed in calibre; also, the raking-arm has a second inlet which is sealed by a movable plug with chain attached. This trap is more likely to be self-cleansing, and should the drain beyond the manhole become obstructed, the sewage which in consequence would collect in the manhole would be liberated by pulling the chain; without this contrivance it would be necessary to empty the manhole by means of a pump or with buckets before any one could enter it to unstop the drain.

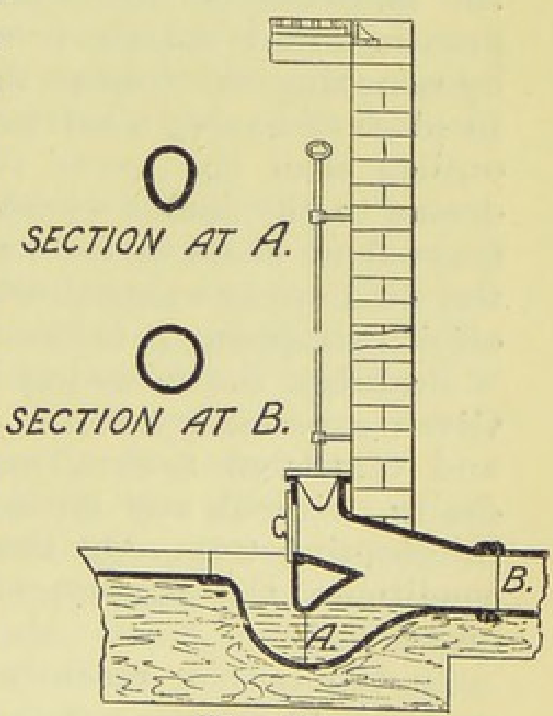


Fig. 36.

The question of the necessity for trapping a drain before it joins the sewer is at present the subject of discussion among sanitary engineers. While some maintain that it is desirable to adhere to the practice hitherto observed, others advocate the free connection.

Undoubtedly the introduction of a trap in the course of a drain has the effect of interfering to a certain extent, with the free flow of the sewage, and tends occasionally to cause obstruction; therefore, if it can be shown that the practice is unnecessary it ought unquestionably to be discontinued.

By establishing a free communication between the drains and sewers, the various soil-pipe ventilators, and the ventilators placed at the top ends of drains, would act as outlets for sewer air, the inlets being the open manhole covers in the streets. By this means the circulation of air in the sewers would be encouraged, and one would hear less frequently of nuisances arising from street ventilators. On the other hand, the opponents of the new system say that the abolition of the trap establishes a connection, through the medium of the sewer, between the various houses of the town, and so exposes unnecessarily the occupants of one property to the consequences of the misdeeds or misfortunes of other people. For example, granting that enteric fever may be conveyed by sewer air, by removing the trap at the entrance of the sewer, the germs, in place of having a barrier imposed against their exit by other outlets than the sewer ventilators, are conducted along the drains to the houses where the gully-traps and the water-closet traps alone stand in the way of their entry into houses through the windows or water-closets, although, with free ventilation and efficient trapping, it is hardly likely that this will occur.

Probably the following is the safe conclusion to arrive at. Given a perfectly-sewered town, with thoroughly self-cleansing and ventilated sewers, and efficiently-trapped and ventilated drains, without any blind ends, it may be safe to abolish the intercepting trap. On the other hand, in the absence of these conditions, the wisdom of abolishing the trap may well be questioned.

In the case ot recently drained houses which are not connected with sewers, one frequently, indeed usually, finds that a trap similar to that just described, is placed at the point where the soil-pipe joins the drain, notwithstanding that another and similar trap is placed at the terminal end of the drain. Under these circumstances, the soil-pipe cannot answer the purpose of a ventilator for the drain; consequently it is necessary to connect another ventilator with the drain beyond the soil-pipe trap, and carry it up parallel to the soil-pipe ventilator. In such a case it is undoubtedly best not to place a trap at the bottom of the soil-pipe, the one at the end of the drain being all that is necessary, apart, of course, from the various gully-traps. Not only does this do away with the necessity of going to the expense of providing a special drain ventilator in addition to the soil-pipe ventilator, but it entirely abolishes the risk of the occasional odour that may sometimes be detected coming from the air inlet at the foot of the soil-pipe, at the time when the contents of the closet are being discharged.

Gully-traps are used for the purpose of cutting off the various waste pipes of the house (bath-room, sink, &c.), and the rain-pipes from direct connection with the drain. They are also placed in yards, for the purpose of receiving the rainfall, and the water used for swilling purposes, carriage washing, &c. In fact, whenever it is necessary to make a connection with a drain, apart from the soil-pipe connection, some form of gully-trap must be employed.

In the case of yard gullies, evaporation during warm weather is apt to lower the water-seal, and so render the trap inefficient. For this reason it is advisable to regulate the incline of the surface, so as to utilise the waste-water gully for the purpose, as it is always properly sealed. Or if this plan is not convenient, the waste-pipe from some lavatory or bath-room may be connected with the yard gully.

Gully-traps must invariably be placed outside the house; under no circumstances whatever is it justifiable to fix one within the house—in the cellar, for example (see p. 73)—although one frequently finds that this is done. Indeed it is by no means uncommon to find one of these, or even a bad form of trap, fixed in a back-kitchen, larder, or dairy, and connected with the drain, simply as a convenience for floor washing.

A glance at the conditions upon which the efficiency of all traps is dependent (p. 73), will at once explain the reasons for this caution, but the most potent one applicable in this instance, is the risk of the trap becoming unsealed owing to evaporation. Especially is this the case as regards cellars, owing to the interval that is likely to elapse between each occasion of cleansing.

In the case of a laundry, where a considerable quantity of water must necessarily fall on the floor, the plan to adopt is to lay the floor with a slope towards a channel leading to an outside gully.

A gully-trap is an excellent thing in its proper place, but its place is not within a house.

The ordinary form of gully-trap (Fig. 37) is very simple and inexpensive, and it answers the purpose well, so far as the yard drainage and rain-pipe discharge is concerned. It is essential that it should be periodically cleaned out, but this applies to all alike. The grating, which may be of iron or stoneware, although the former is preferable, is surrounded by a cup-shaped arrangement of stoneware.

Street gullies, which of course are large, are similarly constructed, with the exception that the iron gratings are fixed by means of brickwork set in cement. Gullies are made with side inlets below the gratings, for the connection of waste-pipes; this arrangement, although unobjectionable, is not quite in accordance with the model bye-laws, which require

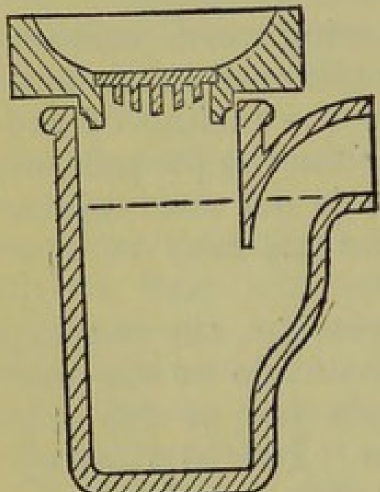


Fig. 37.

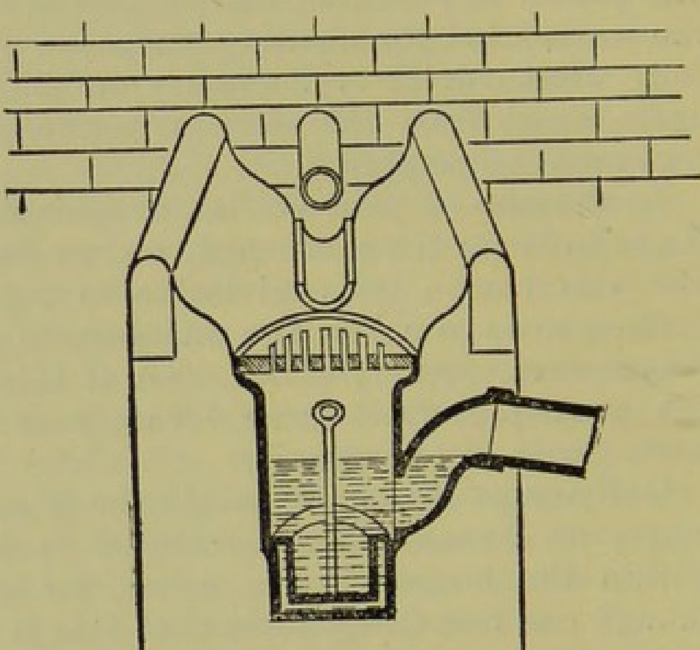


Fig. 38.

that waste-pipes shall discharge on to an open channel leading to the trap. The bye-law in question (No. 66, paragraph 4) reads as follows:—"He shall cause the waste-pipe from every bath, sink (not being a slop-sink constructed or adapted to be used for receiving any solid or liquid filth), or lavatory, the overflow-pipe from any cistern, and from every safe under any bath or water-closet, and every pipe in such building for carrying off waste water, to be taken through an external wall of such building, and to discharge in the open air over a channel leading to a trapped gully-grating at least 18 inches distant."

The accompanying sketch (Fig. 38) represents an arrangement which is in compliance with the bye-law in question. It will be noticed that this gully is fitted with a bucket, which can be lifted out by means of a handle, so that grease and sediment in the trap can be frequently and easily removed. It is important that this bucket should be provided with a flange round the top, fitting accurately to the sides of the trap, so as to prevent any dirt falling over the sides when it is being removed.

In connecting a sink placed in the basement story of a house, which has no area outside the external wall, a convenient plan is to lay pipes from the surface vertically down to the gully, which of course is necessarily a long way below the surface, and to extend the handle of the bucket so that it may be reached from the grating, which is fixed at the ground level. This is not strictly in accordance with the above bye-law, because the waste-pipe must, of necessity, discharge directly on to the gully, but no other arrangement under the circumstances is possible, and as all pipes ought to be trapped within the house, in addition to the outside disconnection, there can be little objection to the proceeding.

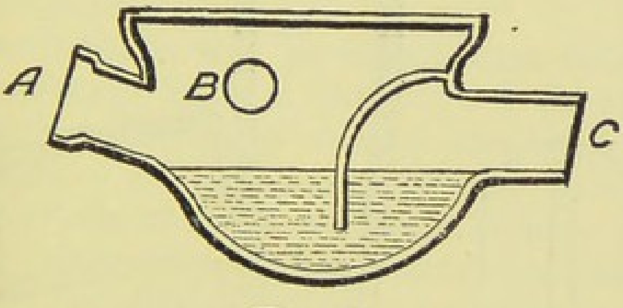


Fig. 39.

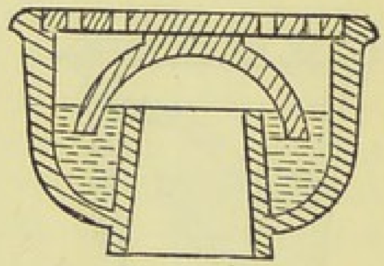


Fig. 40.

Various contrivances are made for the purpose of guarding against the trouble arising from grease being discharged into drains, and thus causing obstruction. The **grease trap**, represented by the drawing (Fig. 39), is recommended for this purpose by Dr. Louis Parkes, from whose book on *Hygiene and Public Health* the illustration (by permission) is taken. The sink water is cooled on coming in contact with the considerable volume of cold water in the trap, the fat is thus solidified, and, being lighter than water it rises to the top, the heavier matters, on the other hand, fall to the bottom. Connected with the inlet, A, is the discharge pipe from an automatic flush tank (see p. 112), which is constantly filling with water, the supply being regulated according to the frequency with which it is considered desirable the flush should take place. Of course the fixing of this appliance is only practicable in the case of large establishments. The effect of this arrangement is twofold; any sediment that may have formed is at once carried away, and the solidified grease, which has collected on the surface, is broken up, and, being solid, it is carried on by the flush of water in place of adhering to the pipes.

The bell-trap (Fig. 40) must be condemned whenever it is met with. Until comparatively recently this form of trap was almost invariably fixed within houses, and very often outside also, although the *dipstone-trap* was the favourite one for outside use.

The chief objections to the bell-trap are the following:—

1. The shallowness of the water-seal, which is no deeper than about $\frac{3}{8}$ of an inch, and in most instances even less. 2. The tendency to its becoming choked with grease, owing to the smallness of the space between the bell and the waste-pipe. 3. The fact that when the grating is removed (as it often must be, to clear away obstructions), the waste-pipe is untrapped. 4. The fact that the bell is frequently broken off, in which case it

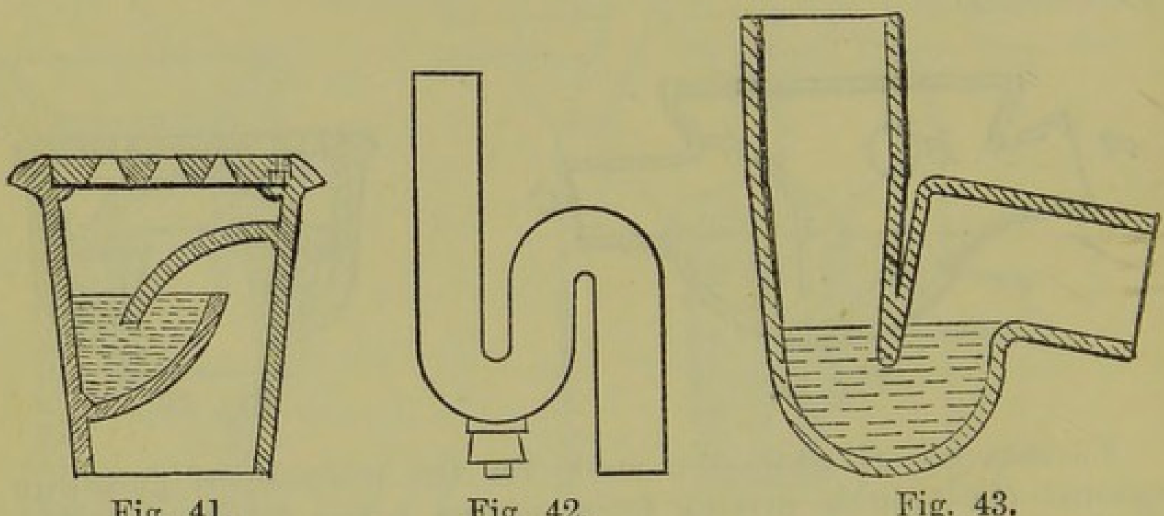


Fig. 41. Fig. 42. Fig. 43.

no longer constitutes a trap. It is astonishing how often the latter objection is found to apply, and it is by no means uncommon to find that the bell, when it is present, is not deep enough to reach the water in the trap.

Antill's trap (Fig. 41), although a great improvement on the bell-trap, because of the fact that the water-seal is not interfered with by the removal of the cover, cannot be said to be satisfactory, as it is very liable to get obstructed from deposit.

The syphon-trap, or, as it is termed, the **S-trap** (or a modification of it) (Fig. 42), is the only form of trap admissible for waste-pipes. To allow of unstopping it when necessary, an access screw-plug ought to be fixed at the bottom of the lower bend. These traps are not infallible, and in fixing them it is necessary to observe certain precautions, but these will be dealt with in the next chapter.

The anti-D-trap (Fig. 43), which was invented by Mr. Hellyer, is an excellent trap. It will be noticed that the part of it which forms the water-seal is smaller in diameter than the in-go and also that the out-go is enlarged and square in shape. This arrangement is most effective against syphonage.

The dipstone, or mason's trap, is a very objectionable one, in fact it is simply a cesspool on a small scale. The sketch (Fig. 44) shows it in section. It is only necessary to remind the reader of the essential conditions of a good trap, to prove why such a one as this must be condemned. It is not self-cleansing, neither is it easily cleansed, and probably it will be found that it leaks in all directions, for the workman who is capable of constructing such a trap at all is not likely to realise the importance of making it water-tight. The gully-trap is now so well-known, even in country districts, that, in the case of new work, it is usually employed in place of the above arrangement of bricks and mortar, still one occasionally does meet with such an objectionable form of trap even in new work, and very many may be found in work of an earlier date. The above sketch represents this trap as it is met with in the case of shallow drains, when frequently about one-half the area of the surface is left open, being fitted with a grating to receive the surface drainage of the yard; not unusually, however, the trap is completely covered, an arrangement which is still more objectionable, as the foul deposit which collects in it will rarely be removed.

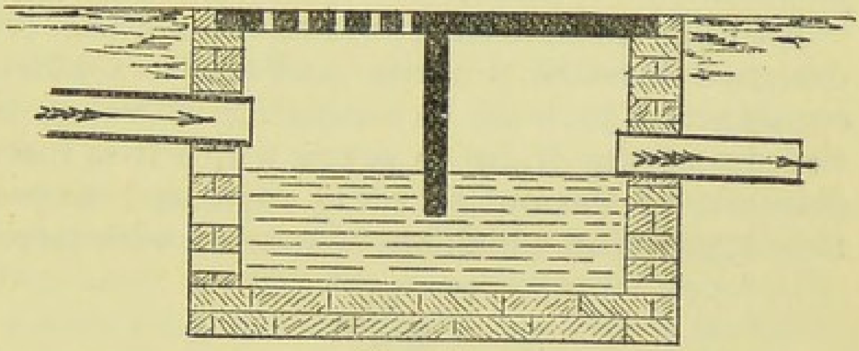


Fig. 44.

Another bad form of trap is the **D-trap** (Fig. 45). It is usually met with in connection with soil-pipes, although, now, the syphon-trap has entirely superseded it. Its defects are perfectly apparent, there are too many sharp angles and projections which prevent its being self-cleansing.

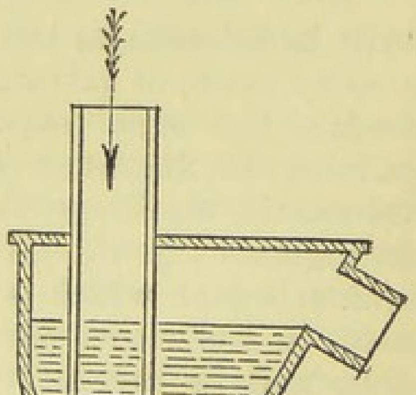


Fig. 45.

It will be necessary to refer to some of these traps again, in connection with the details of plumbing.

Automatic flush-tanks are excellent contrivances, by means of which drains and sewers may be regularly flushed, a proceeding which under all circumstances is desirable and often essential. Drains and sewers ought to be laid with a sufficient fall to be self-cleansing under the conditions of an ordinary flow of sewage, but this is not always possible, in which case the flow must be periodically supplemented by some other means.

Field's flush-tank, shown in section (Fig. 46), has been designed for this purpose, and answers admirably. It may be constructed to hold any quantity of water, in accordance with the size of the drain or sewer which it is intended to flush, the diameter of the outlet being regulated accordingly. Tanks of this description which are connected with large sewers are mostly

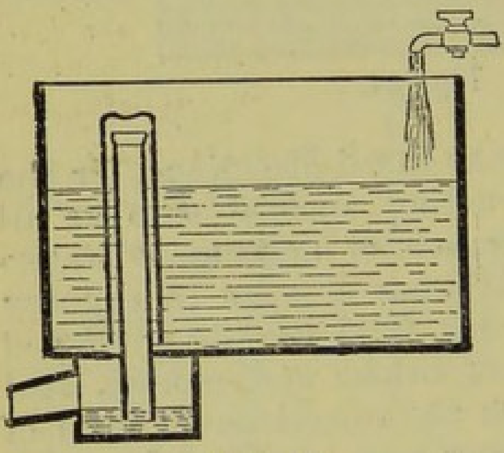


Fig. 46.

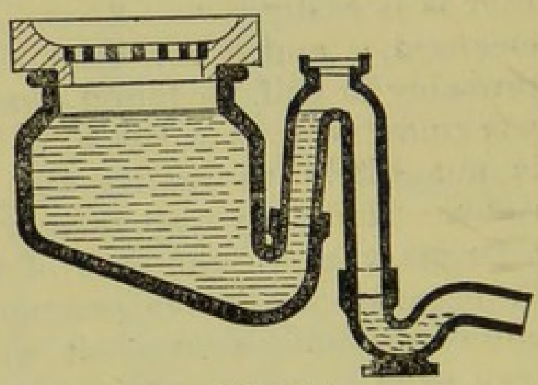


Fig. 47.

built in brickwork, but those for drains and smaller sewers are usually made of galvanised wrought iron. In the case of private drains, the usual capacity of such a tank is from 80 to 100 gallons, the diameter of the discharge-pipe being 4 inches. The automatic discharge is accomplished by means of the syphon arrangement in the interior. Passing through the floor of the tank is a pipe which is open at both ends; the lower end terminates in a chamber underneath, containing water into which it dips, and in the interior it is surrounded by a cap which does not reach quite to the bottom of the tank. This constitutes the syphon. A tap is connected with the tank, and the flow of water is regulated in accordance with the length of interval it is intended should elapse between each discharge. The syphon action is started in the following manner:—As the tank fills, the water ascends between the inner and the outer pipes, displacing the air down the central pipe, through the water in the lower chamber. When the water has risen to the top of the central pipe, it begins to fall down into the lower chamber, carrying with it a certain quantity of air; in time, by this process, a sufficient vacuum is established within the pipe to cause the pressure of the atmosphere to force the water from the tank into it, and thus, syphon-action being started, the tank is rapidly emptied through the outlet from the lower chamber which is connected with the drain. In order to encourage the formation of the vacuum, the top rim of the central pipe is curved inwards, so that the water, in place of trickling down the sides, falls freely down the centre. For this reason, it is important in fixing the tank to notice that the syphon is perfectly upright.

These tanks answer perfectly, however small they may be, for flushing with clean water, and the larger ones may be used for sewage water, in connection with the sub-irrigation treatment (see p. 93); but when used, as they are sometimes, for collecting and automatically discharging into the drains the sink or laundry waste of an establishment, they are very likely to fail from clogging.

A better form of flush-tank for the latter purpose, although it will not discharge by means of a drop feed, is **Adams' flushing gully** (Fig. 47).

There is one condition common to all syphon flush-tanks, and that is, that should there be a second trap in the line of drain with which the tank is connected, it must either be removed or an air-break must be introduced between it and the tank.

The following varieties of **water-closets** are met with:—**the valve, the wash-out** (four modifications), **the plug,** and **the pan.**

The following description of these forms has reference only to their construction, and in discussing their merits or demerits it must be remembered, that while a bad form of closet cannot by any process be made sanitary, a good closet may be rendered insanitary by errors in fixing. In other words, a bad closet cannot be made a good one, and a good closet may be made a bad one; the plumber cannot rectify the faults arising from a defective design, while he may defeat the objects aimed at in a good design. The details of fixing will be dealt with in the next chapter.

The valve closet (Fig. 48) is undoubtedly the best, provided economy is not considered; but, as there is a certain amount of mechanism in its construction, unless the best quality of workmanship is obtained, faults will very soon become apparent.

The simplest **wash-down** closet, of good design, is much to be preferred to a cheap valve closet.

The valve closet, apart from the fittings, consists of an earthenware enamelled basin, A, which is kept about two-thirds full of water by means of a valve, B, at the outlet. The water flush is connected with the rim of the basin, which is turned inwards upon itself, C, so that the discharge passes all over the surface, in place of being distributed over one side only, as is the case with the *fan spreader*. By means of a "pull" the valve is depressed within box D, which is connected with the basin above, and with the soil-pipe trap below, and thus the water and the contents of the basin are discharged through an opening 3 inches in diameter into the soil-pipe. The valve-box, which ought to be made of cast iron, enamelled in the inside, is connected with the trap by means of a short **conducting pipe,** E. A lead overflow pipe, F, with a properly-constructed syphon-trap, G, connects the basin with the valve-box below. Valve closets without overflows are now fixed not infrequently; in such a case, in the event of accident, the basin overflows into the safe-tray.

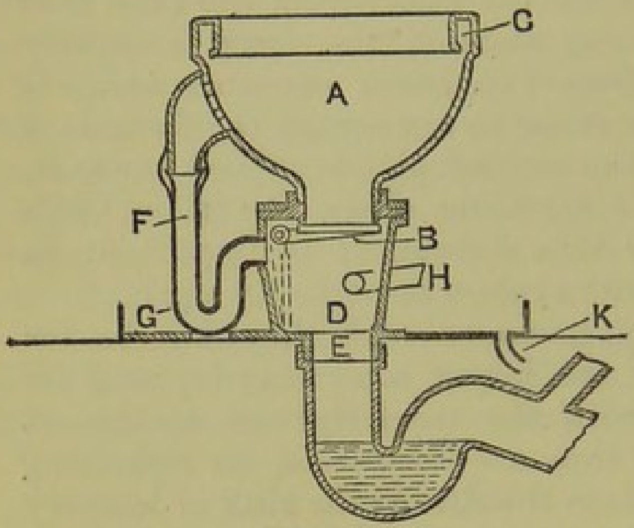


Fig. 48.

It is also important to ventilate the valve-box by a pipe, H, which should be carried through the wall at a convenient point a few feet away from a window, where it should be cut short and left open to the air. It is not necessary to continue this air-pipe upwards above the roof, the closet being self-cleansing, and the soil-pipe being ventilated. Unless the valve-box is ventilated in this manner, there is a danger that the syphon-trap of the closet overflow will be unsealed by the rush of water through the conducting pipe, E, when the closet is used, particularly if the pan has been filled up to the brim, with slop-water for example. In addition to this, it affords an escape for any foul air that may be generated in the closet-trap if the handle of the water-closet should be carelessly pulled so as not to allow of the free flush of the trap.

It is convenient to connect the overflow pipe with the valve-box ventilator, and there is no objection to such a proceeding.

Upon the floor under the closet, a *safe* or tray should be fixed to prevent injury to the floor, or the ceiling below (if the water-closet is on an upper floor), in the event of the overflow of the basin (if it has one), becoming stopped, and the supply-valve becoming defective, or any other accidental circumstance that might cause leakage. The construction of this safe, and the arrangement of its overflow, will be described in the next chapter.

The pan closet (Fig. 49) is a very different piece of mechanism to the above, and ought, when met with, to be unhesitatingly condemned.

The drawing shows it as it is almost invariably seen connected with a D-trap (see p. 111). A moment's reflection will make it apparent how thoroughly filthy the whole arrangement is. The basin, in this case, A, is fixed within a large cast-iron vessel called a **container,** or more properly receiver, B. The outlet of the basin is into a movable copper pan, from which the closet takes its name, and which sustains the water in the basin. By raising the "pull" of the closet, this pan describes a semi-circle within the container, until it reaches the point marked D within the dotted lines, and its contents are suddenly discharged into the trap underneath the floor, with which the container is connected, causing splashing all round the interior of the container, and on the under surface of the pan. To realise the disgusting effect produced, one must see the interior of such a closet which has been in use for some time, and it will then become apparent why a foul smell should be given off every time the closet is used, for at that time no water-seal exists between the basin and the container. Apart, therefore, from the usual insanitary conditions found in connection with this form of closet, in itself it cannot be otherwise than unwholesome.

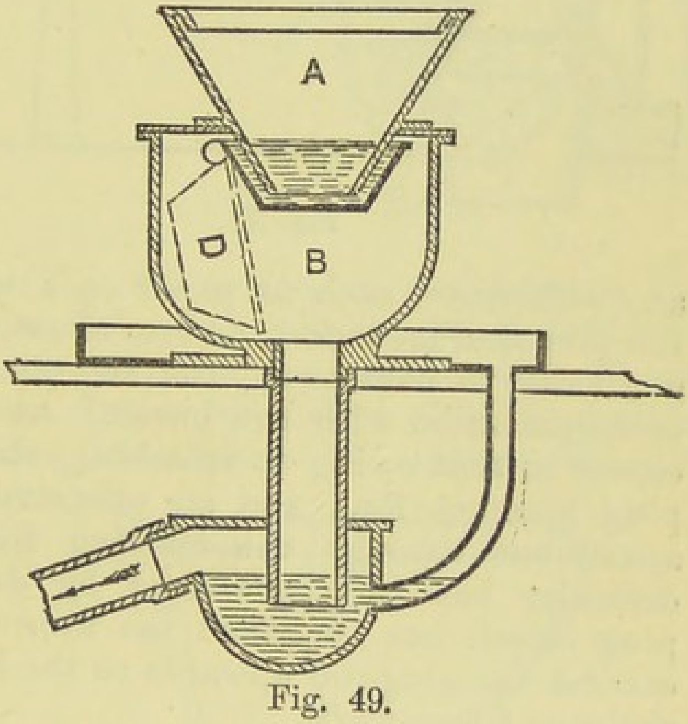


Fig. 49.

The plug closet, represented in section (Fig. 50), is also known as the **trapless** closet. The water-seal in this case is maintained by means of a plug, A, which is contained in a side chamber, B C, from the top of which an overflow passes down to join the soil-pipe below the plug, or, as is sometimes the case, the overflow, trapped by an S-trap, passes through the centre of the plug. It is not a safe proceeding to connect one of these closets direct with the soil-pipe, but, like the valve closet, it should discharge into a syphon-trap, otherwise, foul air will pass into the apartment from the soil-pipe when the closet is in use. Also, should any substance, such as paper or a match, get lodged between the plug and its socket, and so allow the water forming the seal gradually to pass away, the soil-pipe would then be in direct communication with the house. Another objection to the plug closet is, that owing to splashing, the plug chamber above the plug becomes foul, and an offensive smell may pass into the apartment through the opening for the plug handle. This difficulty has been overcome by Jennings, who, in his new plug closet, has abolished the upper part of the chamber, and carried the plug-rod upwards to the handle by means of an open skeleton frame-work.

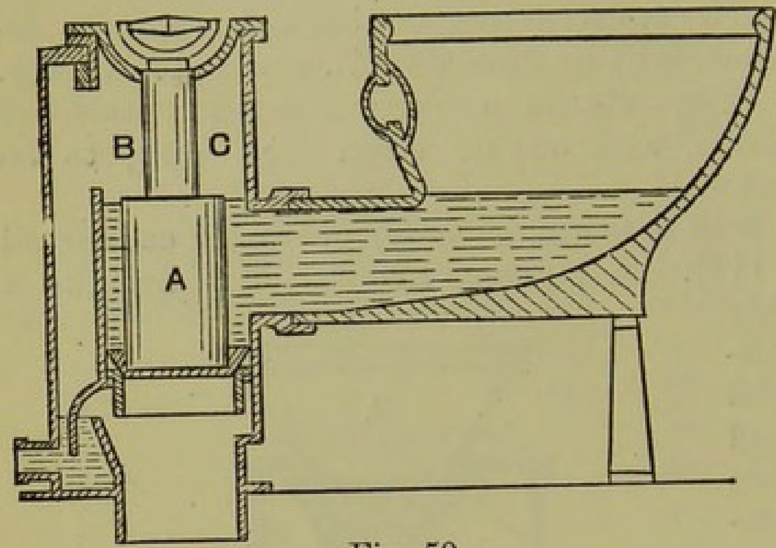


Fig. 50.

The **hopper** and the **wash-out** closets are all constructed very much on the same general principles, although they differ in important details. Both are made of stoneware, as is the S-trap, into which, in this case, the excreta fall direct. The sketches (Figs. 51 and 52), which represent in section the **long** and the **short** hopper, require little or no description, as they speak for themselves.

The short hopper is undoubtedly a great improvement upon the long one, by reason of the fact that it has a smaller area of basin to flush, consequently the contents are more thoroughly expelled, and fouling is less likely to occur. The short hopper is well adapted for an outside water-closet, or one on the ground floor, where it can be connected with the drain without the intervention of a lead soil-pipe; but for upstairs water-closets, there are difficulties associated with the junction of the stoneware trap and the metal soil-pipe, which militate against this particular design; these, however, will be dealt with more fully in the next chapter.

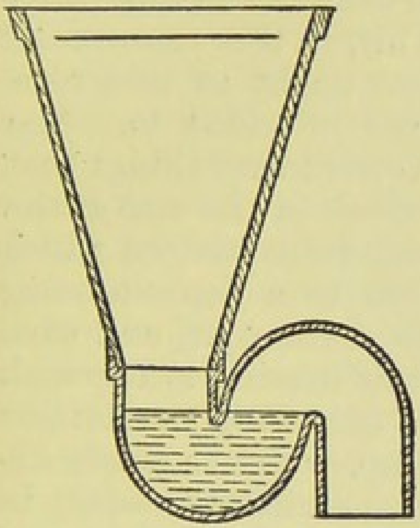


Fig. 51.

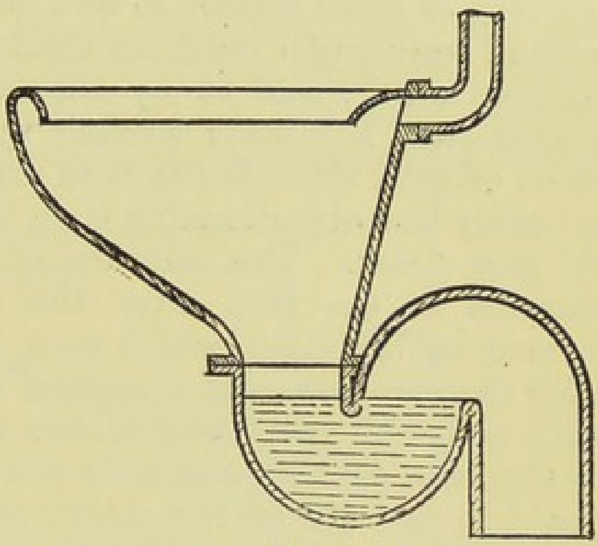


Fig. 52.

The **wash-out closet** (Fig. 53), which, in recent years, has been fixed in so many houses, differs from the short hopper chiefly in two respects—the basin and trap are constructed of one piece of stoneware, and the former is shaped so as to form a shallow container for water, into which the excreta fall and

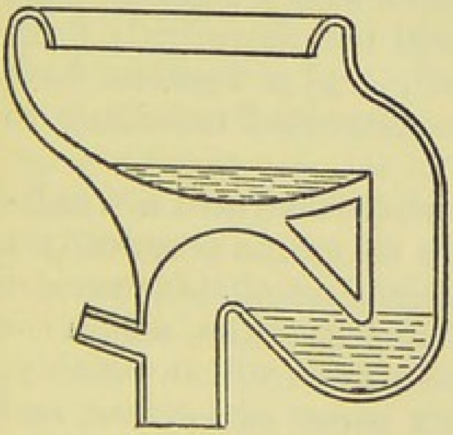


Fig. 53.

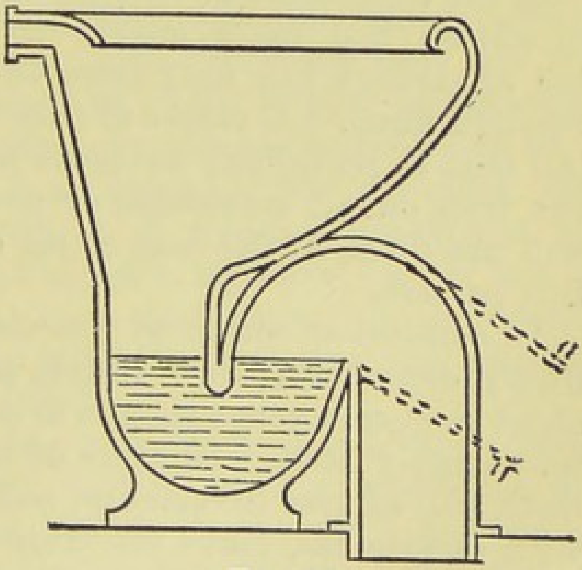


Fig. 54.

over the ledge of which they are discharged by means of the flush into the syphon-trap below. Of course the object of introducing this shallow dam of water is to prevent the fouling of the basin by excreta, but although it may have that effect, it is acquired at the expense of other and important requirements. In the first place, the interruption of the downward flush leads to the partial emptying of the trap only; and, secondly, the splashing of the water against the wall of the basin above the trap causes portions of fæcal matter to be deposited on the sides in a position beyond convenient reach for cleansing. This, in time, causes the glaze to crack, and so by converting what ought to be a non-porous into a porous surface the mischief is added to. The effect of both these faults is to produce a condition of things that is hardly less objectionable than that described in the case of the old pan closet. The mixture of urine and fæcal matter which remains in the trap after the flush leads to a deposit being formed on the sides, which soon begins to decompose, and each time the closet is used a certain area of this deposit is exposed, with the result that foul odours are given off. But, in addition to this, the part immediately above the trap, which is freely exposed to the air of the closet, and which, as already stated, in time becomes coated with filth, is alternately wet and dry, and constantly gives off offensive odours. Any one can satisfy himself with regard to the accuracy of these assertions, by lifting the closet seat and holding a lighted taper above the water-seal, and by placing his nose moderately close to the basin.

It is a fact that hundreds of these closets are removed yearly from London houses, on account of the nuisance arising from the conditions described, and the author has frequently had to advise the same course in the country, sometimes when the apparatus has only been in use for 12 months, and with a 3-gallon flush. A closet of this description with a 2-gallon flush (all that is permitted in most towns) will not thoroughly flush the trap on all occasions, or even usually, and a 3-gallon flush will not do so in the case of all closets constructed according to this pattern.

In contradistinction to the *wash-out*, what is termed a **wash-down** closet (Fig. 54)* which, as regards design, is practically a short hopper, except that it is made in one piece of stoneware, is now largely used. In some of these, of modern make, a 2-gallon flush will almost invariably, and a 3-gallon flush will invariably, with proper use, leave the trap free from paper or excreta, and they are not open to the objection arising from splashing. In fact, this design of closet, if properly constructed (not as is shown in the sketch which is not of recent design) and fitted in

* The drawing does not represent the best form of wash-down closet, as the area of water exposed is not large enough. The closet represented in Fig. 74, Chapter vii., is much to be preferred.

accordance with the rules laid down in the next chapter, compares favourably with any, including the valve closet, and it has the advantage over the latter that it costs less than one-half. There is still another water-closet belonging to this class that must not be forgotten, namely the Dececo (Fig. 55). The feature of this closet, which closely resembles the one just described, is that the ascending arm of the syphon-trap is continued upwards, so that the water in the basin stands at a higher level, and consequently a larger area is exposed, and a deeper seal is formed; also, the descending arm terminates in a second syphon before it joins the soil-pipe. It will be noticed that this arrangement practically corresponds with the construction of the automatic flush-gully described on p. 112, and, as a matter of fact, its action is identical. Syphon action is started with the inflow of water from the supply cistern, and the contents of the basin are rapidly extracted by that means.

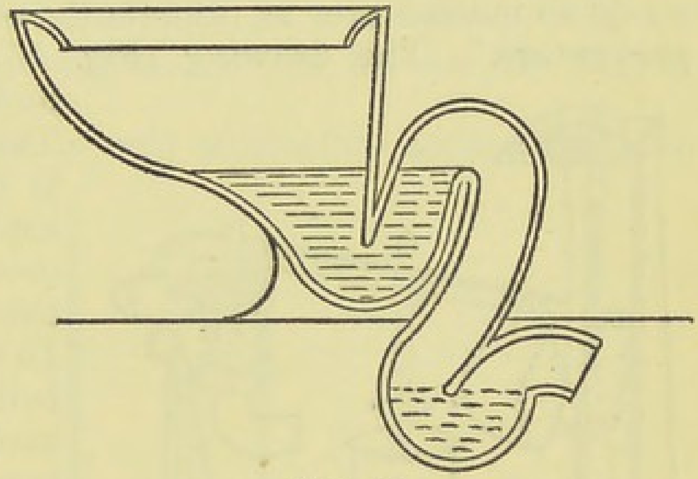


Fig. 55.

In selecting a closet it is important to remember the following points:—1. As regards the valve closet, only the best quality, and, therefore, the most expensive, is likely to give satisfaction. 2. The plug closet cannot be strongly recommended, but none are satisfactory that have the long chamber for the plug, and all must be fixed with a syphon-trap. 3. Avoid a closet with too long a basin. 4. On no account select a *wash-out*, but if one of that class be decided upon, let it be a *wash-down*. 5. Be careful to notice the plan for connecting with the soil-pipe, according to the cautions mentioned on pp. 131-3.

Special cisterns for supplying the water-closet flush must always be provided (see p. 21), and in most towns what are termed water-waste preventers, which discharge 2 gallons at a time, are insisted upon. From what has already been said, it will have been understood that this quantity is hardly sufficient even for closets of the best construction, and for any other it is far too little. Whenever possible, therefore, it is advisable to fix a cistern which delivers 3 gallons.

There are many such appliances in the market. One of the best for valve or plug closets is what is known as the **supply-valve and bellows regulator,** but it is not what is termed a **water-waste preventer.** By turning the stop-cock on the bellows regulator, the rate at which the air escapes may be controlled; and as it is upon this that the amount of water delivered depends, it is possible to adjust it for a large or a small flush. Another advantage is that with this apparatus several flushes may be given in rapid succession, and this is why water companies object to it, although, according to Mr. Hellyer, "a good supply-valve and regulator is not likely to waste so much water as nine-tenths of the so-called water-waste preventers." The drawing (Fig. 56) will assist the reader in understanding this appliance. The regulator in this instance is fixed on a cast-iron frame separate from the closet, but closets are to be obtained with the whole apparatus attached. In the figure, A represents the bellows regulator, which is made of copper. The small tap at the top is for the purpose of regulating the pace at which air can pass out of the bellows, and it is this which determines the amount of water that is discharged into the basin. By turning the tap so that the air passes through slowly, the weighted lever, C, takes longer to descend and close the supply-valve, B, and until this is closed water will continue to be delivered from the cistern. If the cistern is placed as high as 4 feet above the closet, a 2-inch pipe, connected with a 1½-inch supply-valve, will supply a sufficient flush, but if the height is only a foot or two, then a larger valve is necessary.

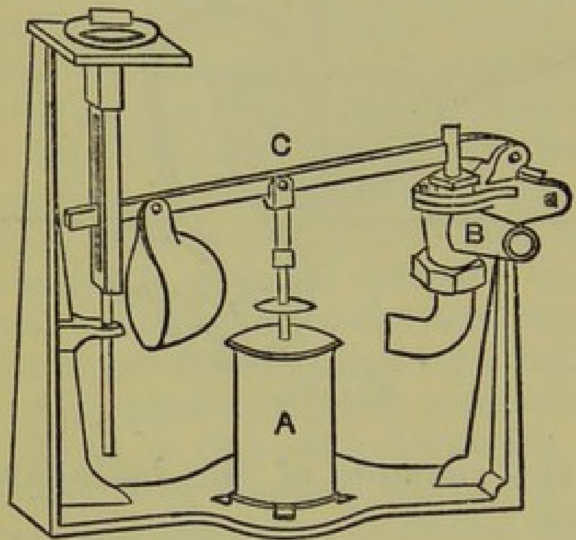


Fig. 56.

The kind of waste-preventer mostly used for wash-out and hopper closets discharges by syphon action, which is started by pulling the handle, and the whole of the water in the cistern is syphoned off for the closet flush. (See *Appendix B.*)

The **trough closet** (Fig. 57) is exceedingly well adapted for manufactories, schools, public buildings, and blocks of houses. It may be said to be a combination of wash-out closets with a common flush. It consists of a trough, usually of stoneware, which extends from one end to the other of a series of closets, which are simply compartments formed by partitions, each having an opening into the trough, and the whole being under one roof, and freely ventilated. The trough is slightly inclined towards the outlet, where the floor is turned upwards, forming a weir which contains a certain quantity of water in the bottom. Connected with the top end of the trough, and 5 or 6 feet above it, is an automatic flush-tank, similar to that described on p. 112, and at the other end is a syphon-trap, which is protected by bars with intervals large enough to admit of the passage of all ordinary matter, although sufficiently close to prevent any articles wrongly introduced from entering the drain. The size of the flush-tank depends upon the number of closets on the system, and the frequency of the flush is regulated by the tap on the supply-pipe.

The trough-closet system is only admissible on a large scale

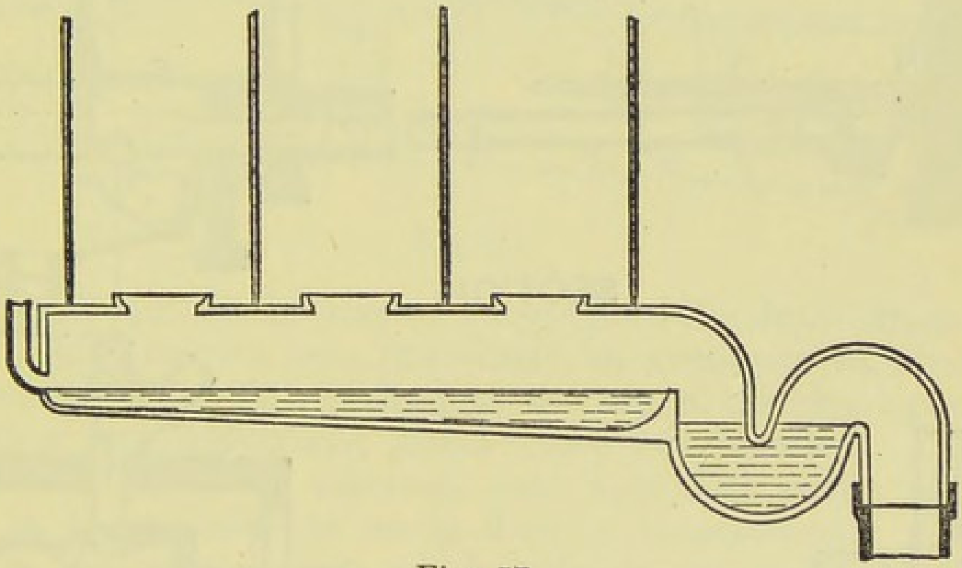


Fig. 57.

in towns with ample water supplies and favourably situated for dealing with the sewage. It may be essential, however, to exercise economy in the consumption of water, owing to its scarcity, or because the surroundings necessitate a pumping scheme, or because ample land is not available, in which case the slop-closet system, referred to on p. 70, answers admirably.

In many districts **slop-water** has long been used as a flush for the old hopper closet, the waste-water being simply collected in buckets, and tilted by hand into the pan. The more approved system now in use was first introduced some years ago by Dr. Alfred Hill, of Birmingham, and since then hundreds have been fixed in that town.

Recently considerable improvements have been effected in their design, and other towns have adopted the system with success.

There are several varieties of slop closets, but Duckett's and Allen's are those usually met with.

Duckett's closet (Fig. 58) consists of an oval pan, which reaches from the wooden seat to the drain, the depth varying in accordance with the distance of the drain from the surface.

Immediately under the pan is a chamber, the floor of which has an annular arrangement for retaining a certain quantity of

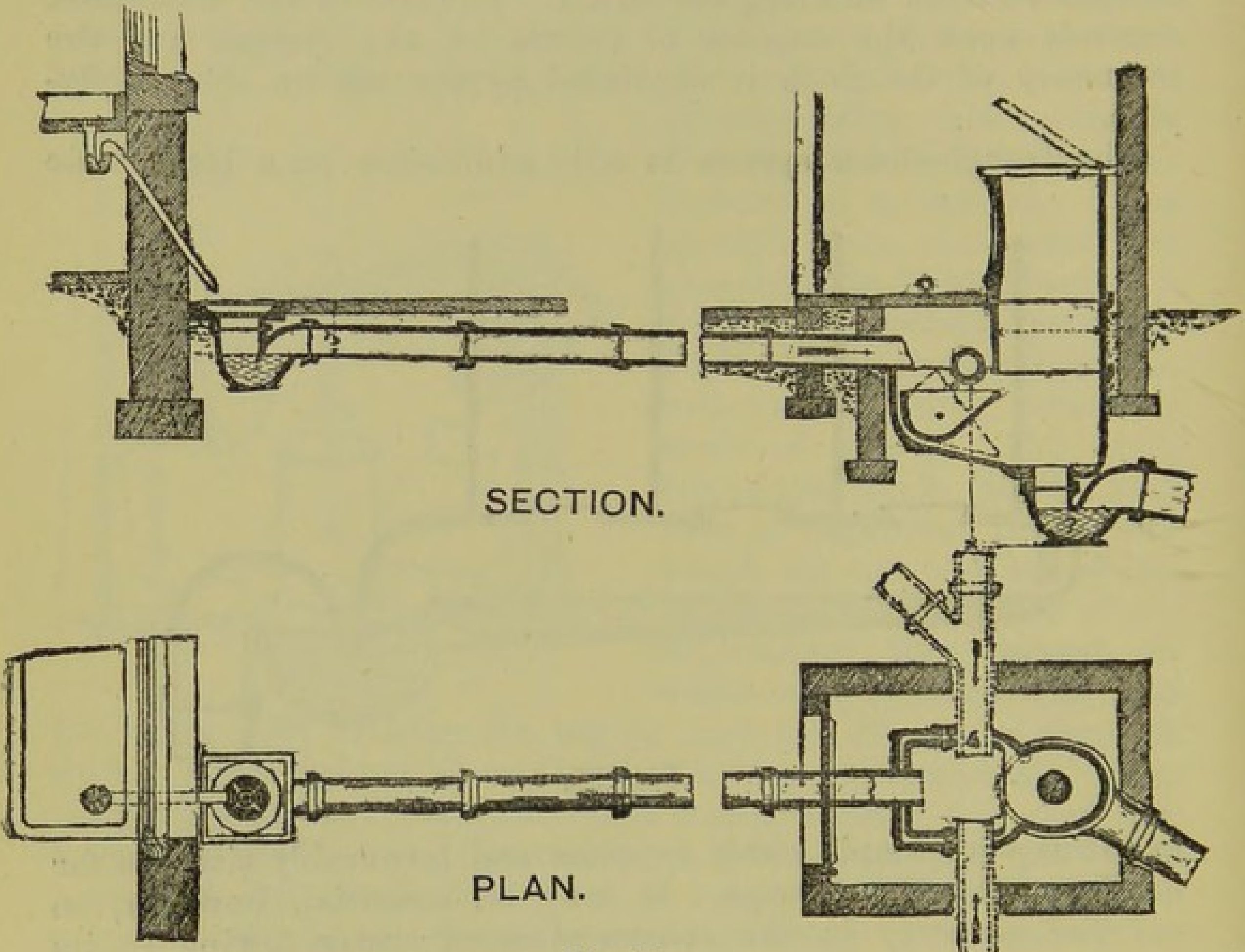


Fig. 58.

water. This chamber opens below into a syphon-trap which is connected with the drain. The sink pipe discharges on to a gully in the usual manner, the outlet from which is connected with a **tilting vessel** or **tipper** holding 3½ gallons. This tipper, which may receive other house connections, if necessary, is balanced on brass bearings, so as to cause it to tip over when full, and discharge the whole of its contents suddenly into the closet-trap.

Allen's closet (Fig. 59) is constructed much on the same principle, except that the closet-pan is connected with the top of the drain or sewer (see Appendix A), without the intervention of a syphon. Several closets may thus be connected, the flush being supplied by tippers on each premise, and a manhole, with syphon-trap and raking-arm (see p. 88), is placed at the outlet into the main sewer. The manhole cover is open, and the top end of the drain, or tributary sewer, is ventilated by a 4-inch pipe carried up above the roofs of the houses ; a ventilating pipe is also carried from the top of each of the closet-pans.

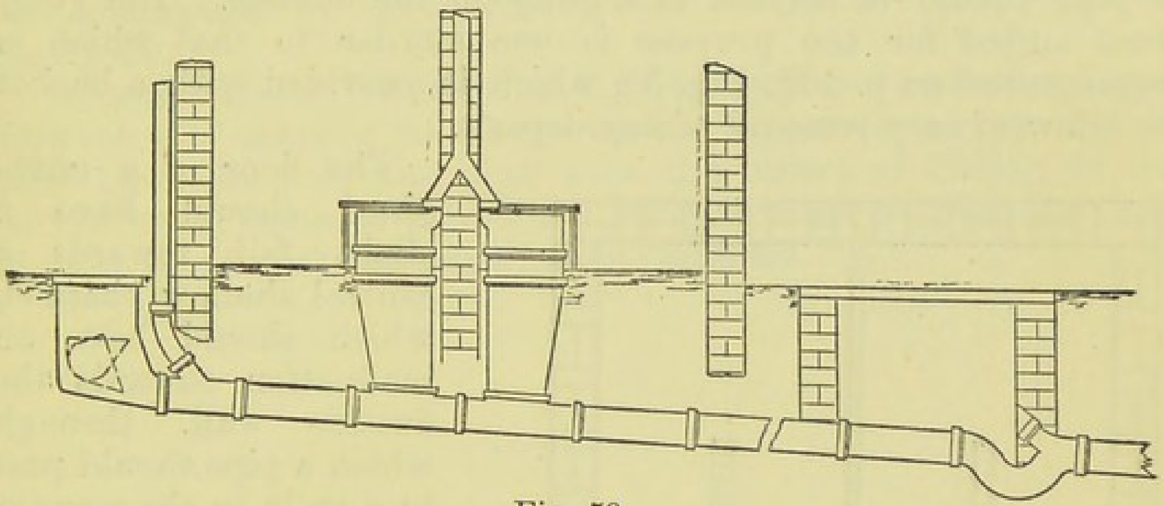


Fig. 59.

To guard against the risk of stoppage of the drain, from large articles being thrown into the closet, an arrangement, shown in small section (Fig. 60), is fixed on the top of the closet-pan. It consists of two converging plates which are directed downwards for some distance, and approach each other in the middle, so as to form a longitudinal opening, the long axis of which extends across the pan from front to back, the transverse measurement of the opening being about 2½ inches. There are other forms of slop closets, but the two that have been described may be considered typical of the rest.*

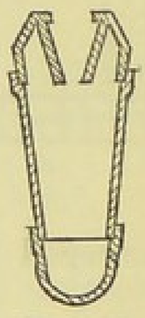


Fig. 60.

Drainage of Slaughter-Houses, Cowsheds, Stables, and Piggeries.

The general requirements in these buildings are defined in the model bye-laws (see Appendix), but it may be well to describe a little in detail how they should be drained.

* See report on slop-closets and trough-closets by Dr. Parsons, "Twentieth Annual Report of the Local Government Board" (Supplement), 1890-91.

All slaughter-houses, cowsheds, and stables should be disconnected from the drains—that is, no trap should be placed within the buildings. The floors should be laid in impervious material, such as brickwork set in cement on a bed of concrete, and a plentiful supply of water should be available for cleansing purposes.

The floor of a **slaughter-house** should have a slight fall from all sides towards one point close to the wall, through which a pipe should be carried to a gully on the outside. The gully best suited for the purpose is one similar to that which is represented on p. 108, Fig. 38, which is provided with a bucket to allow of easy removal of any deposit.

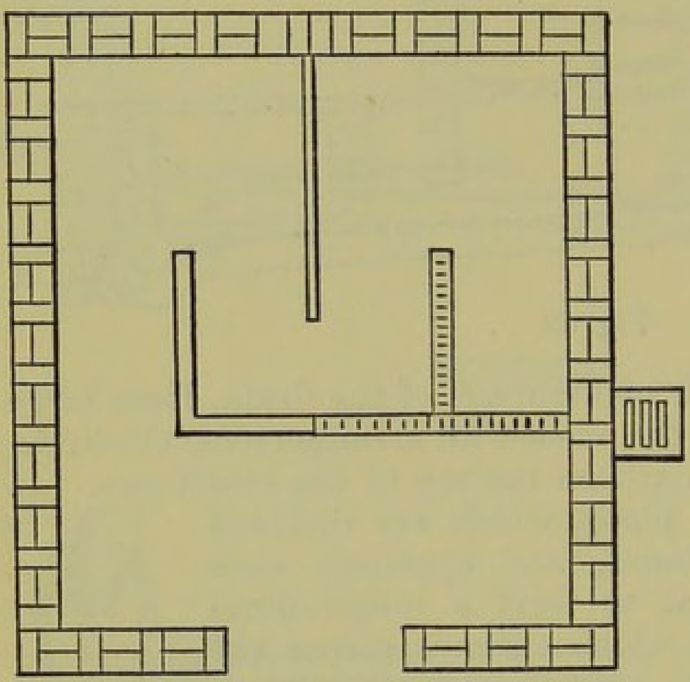


Fig. 61.

The floor of a **cow-shed** should have a slight fall towards a central shallow channel, which should have an inclination towards the outside wall, through which a pipe should pass to a gully in the manner just described.

Stables should be drained in the same manner, except that the surface channels should be constructed of half-channel iron pipes, coated with a protective coating, such as Angus Smith's preparation, and covered with movable, perforated iron-plates, as is represented in the drawing (Fig. 61). These plates should be periodically removed for the purpose of washing out the channels. For the sake of appearances, the gully, in place of being fixed on a level with the surface of the ground, may in all these cases be sunk a little distance, so as to admit of the pipe which passes through the wall discharging underneath an additional grating, placed above that which covers the gully, on brickwork laid in cement, in the manner shown in section in the drawing (Fig. 62).

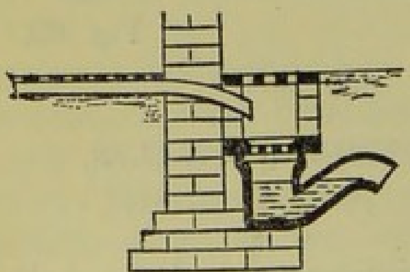


Fig. 62.

Piggeries, as they are usually constructed, give rise to great nuisance, but this may at least be considerably modified if the styes are properly built, and ordinary attention is paid to cleanliness. Wood is frequently used for the flooring, and it soon becomes saturated with decomposing filth. The floors should be properly paved with impervious bricks or asphalt, and although, in this case, the drain may be connected with a gully placed within the enclosure, it is more cleanly to make the connection in the manner described in the case of cow-sheds, &c.

It is a common practice among pig-keepers to allow a large collection of manure to remain within the enclosure, so that it may be trodden by the pigs, with the object of adding to its virtue as a manure. This not only creates a nuisance, but it must also injure the health of the animals.

CHAPTER VII.

DETAILS OF PLUMBER'S WORK.

THE connection of the various sanitary appliances with the drains—that is, the plumbing work—has now to be considered, and it is here we meet with the most glaring defects. The appliances themselves may comply in every respect with the principles laid down in Chapter IV., and yet the useful purposes for which they have been designed may be entirely defeated through the ignorance or culpability of the workmen employed in fixing them. The public are greatly to blame for this. So long as plumbers are employed whether they can show any evidence that they possess a knowledge of their work or not, so long will scamped work be turned out, money wasted, and health endangered. The best way to correct this is to refuse to employ all unregistered plumbers, and only engage those who possess certificates of registration. If there is one branch of work in which the maxim efficiency before economy is specially applicable, it is that of plumbing. *All cheap plumbing is bad, and good plumbing must be paid for.*

Water-Closet Connections.

The **soil-pipe,** as already stated, must be placed outside the house, and in a situation where it is screened, as far as possible, from the direct rays of the sun, so as to avoid its becoming bent from expansion; it ought not to be larger than 4 inches in diameter, and for the purpose of ventilation it should be carried upwards, full size, to above the eaves of the house, and terminate at a spot well removed from all windows or chimneys. It is by no means unusual to meet with soil-pipes 5 or even 6 inches in diameter, placed inside the house, and, if ventilated at all, only by an inch pipe terminating at a point where the foul gases it emits may enter rooms, or even contaminate water supplies. Examples of such arrangements will be given later.

The objection to a large soil-pipe is, that it presents a larger surface to be flushed, and a greater area on which deposit may take place, in addition to the fact that it costs more. A 3-inch soil-pipe will really answer all requirements, the only objection to it being the greater risk of syphonage of traps, an accident, however, which may be guarded against; if several closets are connected with one soil-pipe it is safer to use a $3\frac{1}{2}$-inch pipe.*

Drawn-lead soil-pipes are by far the best; **seamed lead pipes** are absolutely inadmissible, and **iron pipes** are not satisfactory, as the interior is not smooth, they corrode very readily, and unless they are strong enough to allow of the joints being caulked in with lead, a tight joint cannot be made. The only iron pipe that may be used is a water main or "underground" pipe (coated with Angus Smith's solution), as it is strong enough to allow of a caulked lead joint (see p. 129) being made. Another objection to iron soil-pipes is the difficulty of making a good joint between them and the lead junction or trap, and an iron trap must not be used.

The objection to a soldered seam-pipe is, that it may become faulty along the seam from corrosion having weakened the union, and from variations in temperature causing expansion and contraction of the pipe. An old seamed soil-pipe that is absolutely perfect is seldom met with, although if the workmanship is very good, such a pipe may last for a long time.

Drawn-lead pipes ought to be of uniform thickness throughout, and of at least 7 lbs., or, still better, 8 lbs. weight per superficial foot.

With regard to the **ventilator,** or air-pipe, which is simply

* *The Plumber and Sanitary Houses*, Hellyer.

a continuation upward of the soil-pipe, all bends in it should, as far as possible, be avoided, but when necessary to introduce an angle it ought to be an "easy" one. It is a very common practice to carry the ventilator round, in place of through the eaves of the roof, thereby greatly interfering with the current of air (see p. 46). It is not essential, however, to pierce the eaves at all, as the ventilator may be carried through the wall, and upwards inside the roof, until its exit at the highest point. This arrangement is less unsightly than when the soil-pipe is continued along the outside of the roof, only, in this case, it is absolutely essential that it should be a drawn-lead pipe, with perfect joints.

Cowls are usually placed on the top of the ventilating pipe to encourage an upward current of air. Except in wet weather it is a question whether anything is gained by their use, and there

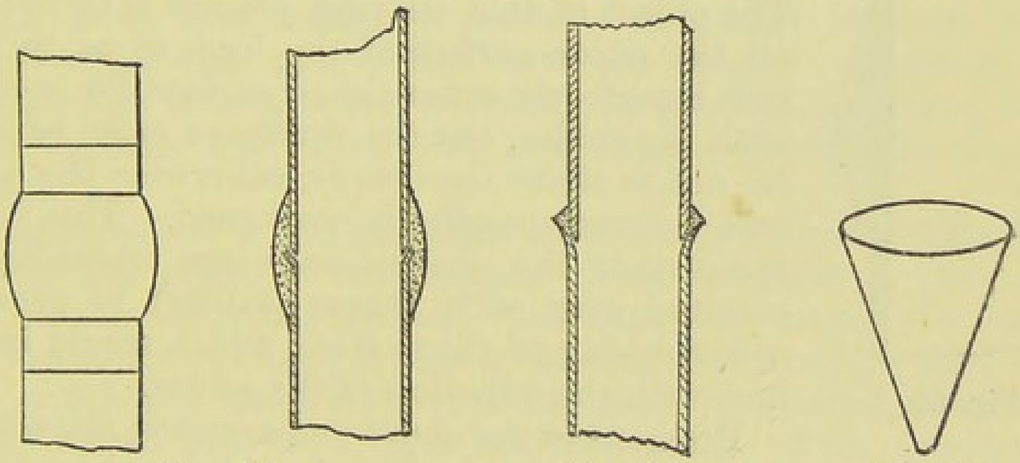


Fig. 63. Fig. 64. Fig. 65.

is a risk that birds will build in them. The same risk applies when the end of the pipe is left free, so it is advisable to cap it with wire netting of large mesh, fixed so that it projects upwards in a semi-spherical form.*

Joints.—The best joint for a lead soil-pipe is a **wiped-joint** (Fig. 63), but, unfortunately, it is not by any means always met with, even in recent work. What is known as a **copper bit-joint** (Fig. 64) is the joy of the plumber, because it requires less skill to make; as regards strength, however, it will not compare with the wiped-joint.

Wiped-joints are made as follows, whatever the size of the pipe may be:—First, what is called a "tan pin," which is a pear-shaped block of box-wood (see Fig. 65), is introduced into the upper end of the lower length of pipe, and by means of a

* For the result of experiments on the efficiency of various cowls, see *The Plumber and Sanitary Houses*, Hellyer.

mallet it is hammered into the pipe, so as to produce a slight bulging of the edge, to allow of the introduction of the lower end of the upper segment, which has been rasped down so as to fit accurately, without presenting any edging which would interfere with the flow of sewage. The accompanying section (Fig. 66) illustrates what is meant. The proper distance for the upper pipe to enter the lower is from ½ to ¾ inch. Having thus adjusted the ends so as to insure an accurate fit, the next proceeding is to apply a paint composed of lamp-black, glue, and whiting to the outside of the two abutting ends, for about 4 inches along the pipes in the case of a 4-inch pipe, and when this is dry the surface of each for a distance of 2 inches is "shaved" with a special hooked blade (shave-hook), care being taken not to remove more than the paint and the finest surface of lead. The object of this shaving process is to remove all the outer surface of the lead, so as to present a perfectly untarnished surface for contact with the solder, but the workman must be careful not to shave too deeply, otherwise the joint will be correspondingly weakened. This being completed, the shaven ends are immediately smeared over with grease (tallow) to prevent re-tarnishing of the surface, which would interfere with the adhesion of the solder.

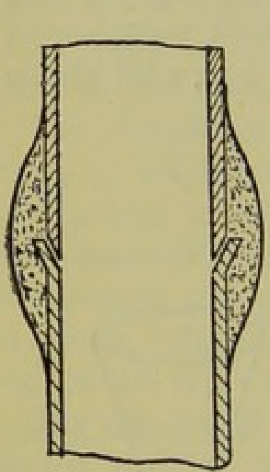


Fig. 66.

Previous to the above preparations, the solder-pot, with the necessary quantity of solder, has been got ready for melting—a process which has to be carefully conducted, so as not to overheat the metal, in which case it would not afterwards admit of wiping. Plumbers usually ascertain when the proper temperature is reached by applying a piece of paper to the molten metal, and the moment the heat is sufficient to ignite it, the pot is removed from the fire.

The solder is now poured on to the accurately adjusted pipes, and wiped round into the shape represented in the drawing by means of a "soldering-cloth," which must be smeared with grease to prevent the solder from adhering to it. It is never necessary to use a soldering-iron in the case of small pipes, but if the joint has to be made in an upright 4-inch pipe, the soldering-iron will be required to heat the surface. Plumbers endeavour, as far as possible, to make joints "under hand"—that is, on the bench—in which case the soldering-iron is seldom required, but of course "upright joints" (that is, when the pipe is in position) have very often to be made. The best material for a soldering-cloth is moleskin, four or more folds in thickness, but strong linen will answer the purpose. The solder that is used for making this joint consists of tin and lead, in the proportion of one of the former to three of the latter.

Copper bit-joints (Fig. 64), although far inferior to wiped-joints, are still frequently made, but no plumbing work of this description can be passed as other than third-rate. So far as the first part of the process is concerned, it is very similar to that in the case of the wiped-joint, except that the bulging outwards of the upper end of the lower pipe is carried farther. The solder is not melted in a pot, but is used in the form of a stick, and run into the space between the two pipes by means of a heated copper-iron (copper-bit), hence the name. In this case, the proportion of tin to lead, in place of being one to three, is three to one, that is, three parts tin and one of lead, the reason for this being that in this proportion it retains its heat long enough to enable it to float into the space. A glance at the drawings will indicate, without any further comment, how greatly superior the wiped-joint is as compared with the copper bit-joint.

What is called a **blown-joint** is made as follows:—Having prepared the pipes in the manner already described, they are adjusted; the abutting ends are then heated by means of a blow-pipe flame, for which purpose a candle is generally used, and when sufficiently hot, a stick of solder is applied, which is melted by the heated pipe and runs into the joint. This process is continued round the circumference of the joint until it is completely sealed. It is obvious that such a joint will bear very little strain, and it is only found in plumbing work of the worst description.

If **iron** is the material used for soil-pipes, the joints must be **caulked with lead,** and to allow of this, as already stated, the pipe must be stronger than the ordinary rain-pipe. The upper pipe is first adjusted into the socket of the lower, and then, in order to prevent the molten lead from running into the pipe, a few rings of spun yarn are well rammed down into the socket; the lead is now run in, and afterwards it is thoroughly caulked (see Fig. 67). The depth of lead forming the joint should not be less than 2 inches.

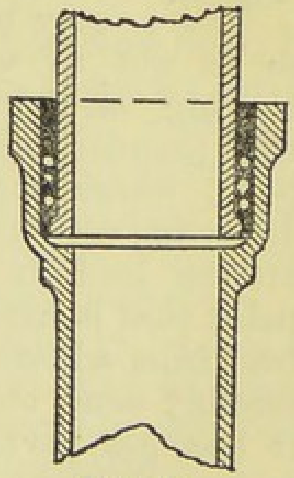


Fig. 67.

It is by no means an uncommon practice, indeed, it may be said to be the usual practice, to make the joints of iron soil-pipes of putty or cement, but this ought never to be done. There are other good forms of joints, for example the **block** and **astragal,** each adapted for special circumstances—the former when the soil-pipe is let into a chasing in the wall, and the latter when the appearance of the wiped-joint is objected to; space, however, will not allow of a further detailed description; those that have been described are what are usually met with.

It is important that the soil-pipe should be fixed firmly on to the wall, and this is accomplished by means of "tacks," which are square plates of thick lead, measuring about 9 or 10 inches, soldered on to the back of the soil-pipe, and fixed to the walls by screws, to receive which wooden plugs have been let in. For a 4-inch soil-pipe, it is necessary to have three tacks for every 10 feet, although plumbers usually make two answer the purpose.

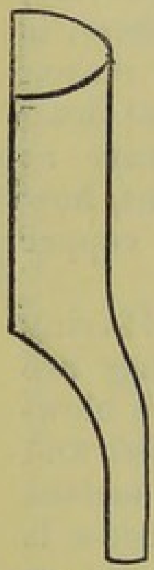


Fig. 68.

Lead pipes may be bent out of shape and dented in transit, and before being fixed they must be **straightened.** This is done by driving a "mandril" through the pipe. This is a round piece of wood about 2 feet in length, and of the same diameter as the interior of the pipe. While this mandril is being driven along by an assistant, the operator is engaged in hammering out the surface irregularities by means of a "dresser," which is a wooden implement of the shape represented in the sketch (Fig. 68).

Bends.—A good workman can bend a drawn-lead pipe, whatever its size may be, into any angle that may be necessary. To do so, however, requires skill, so as not to weaken the pipe, or alter its circular form. Having straightened the pipe, and removed all dents, in the manner already described, it must be heated at the point where the bend is desired to be made. This may be done in various ways, but the most usual is by applying molten lead to the exterior, having first coated it with the paint that is used in making wiped-joints, to prevent the molten lead from adhering firmly to the pipe. The next process is to forcibly bend the pipe to a limited extent, and as in doing so it becomes partly flattened at the bend, its circular shape has to be restored. This is done as follows:—While an assistant hammers the interior of the bend, by means of a "dummy," which is an elliptical, flattened block of lead on a basis of iron, fixed at a slight angle to the end of a stick, with a handle at the other end (Fig. 69), the operator hammers the outside of the pipe on either side, the blows being directed towards the "throat" (that is the larger curve of the pipe) with a dresser. This is continued until the circular form of the pipe is completely restored. The whole process is again repeated, until the necessary amount of bending has been accomplished.

It is obvious that in bending a pipe there is a tendency to diminish its thickness at the throat, but the process of dressing, if the bending is not carried too far at one time, will counteract this tendency.

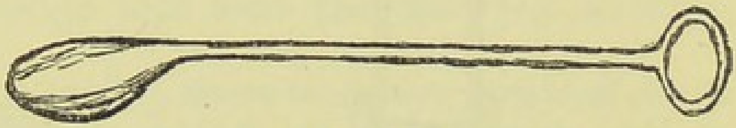


Fig. 69.

Bends to suit various angles may be purchased, but their use necessitates extra joints, and for that reason it is far better to mould the pipe itself to the requisite angle, in the manner described.

In the case of pipes which are too small to admit of a dummy being introduced, the circular shape of the bend may be restored by using a series of "bobbins," which are oval-shaped blocks of wood with somewhat flattened ends (Fig. 70). A small-sized one is first introduced, followed by larger ones, and they are driven through the bend until its circular shape is restored.

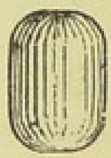


Fig. 70.

The **soil-pipe connection** is one of the most important of the water-closet fittings, especially since the introduction of the wash-out earthenware closets, between which and the lead soil-pipe it is difficult to make a perfectly tight junction.

In the case of a wash-down closet fixed on the ground floor, it is a comparatively easy matter, as there is no necessity for a lead connection; the closet pipe may be connected with the drain itself. In such a case it is better that the joint should be above the floor, so that it may readily be seen, and in order that this may be managed, the downward curve of the S must stop short of the floor, so as to allow the socket of the drain-pipe to be brought up to it (Fig. 71). Such a joint ought to be made with good Portland cement, and in order that this may be done, the end of the outlet-pipe from the closet (the spigot) is left free from glaze for about 2 or 3 inches. If it is intended to fix a closet of this description on an upper floor, it is better to select one, the outlet-pipe from which, in place of passing downwards to the floor, is directed backwards, as is represented by the dotted lines on Fig. 54, p. 117. In this case the outgo is flanged, and the joint is made by screwing it tightly against a similar flange, which is formed by tafting back the abutting end of the lead connection, an india-rubber ring being interposed, as is represented in section by the drawing (Fig. 72).

The drawing (Fig. 73) represents one of Dent & Hellyer's pedestal "Hygienic" closets, with a flanged outgo, as shown in the large section.

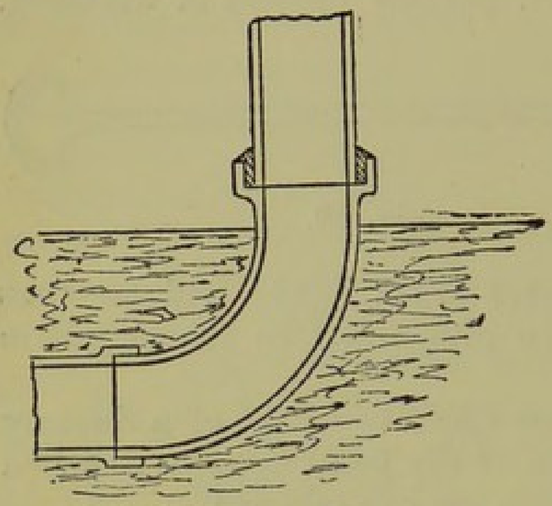


Fig. 71

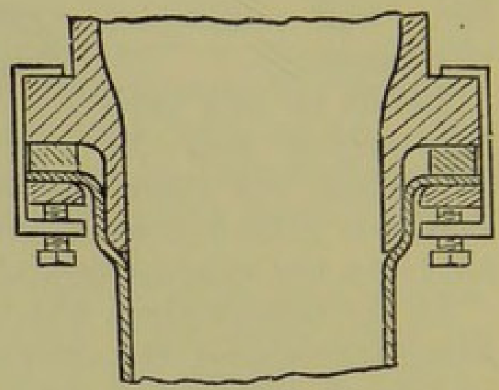


Fig. 72.

It is by no means easy to hammer out a flange on the lead connection which will perfectly adjust itself to the flange of the closet, and it is obvious that unless the adjustment is perfect, and the surface of the lead flange is smooth and uniform, tightness of the joint, which is entirely dependent upon the rubber

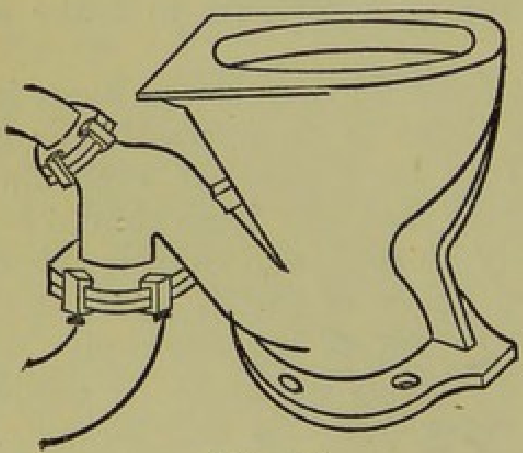


Fig. 73.

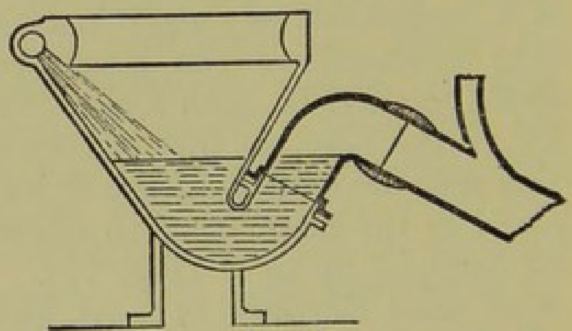


Fig. 74.

washer, will not be attained. With care, however, all this can be accomplished, and a good joint made.

Another joint may be made, which some prefer to that which has just been described, provided a lead-pipe outgo is bolted on to the closet, for then the junction being between lead and lead, a thoroughly good wiped soldered joint can be made.

The drawing (Fig. 74) represents such an arrangement fixed to the "Vortex" closet of Dent & Hellyer. It will be noticed that the lead outgo is connected to the earthenware trap below the level of the water, so that if any fault should occur, it will immediately be noticed, owing to leakage occurring (see p. 288).

In fixing a **valve closet,** the opening into the trap, the fixing of which will presently be described, is smeared round with red lead, and the outgo pipe from the valve-box is introduced into it.

As already pointed out (p. 73), there is always a risk of traps of the **S** pattern becoming **unsealed by syphonage,** and to avoid this it is essential to fix an **air-pipe** close to the top of the outlet of the trap. All stoneware closets of the wash-down kind have now an opening provided for this purpose, and it is not unusual for ignorant workmen to suppose that this is intended for a soil-pipe ventilator, although it is only 2 inches in diameter. If one closet only is connected with the soil-pipe, it answers the purpose perfectly to carry this air-pipe from the top bend of the syphon upwards through the wall, and connect it with the soil-pipe ventilator, but if two or more closets are connected, a special ventilating-pipe must be carried up to above the highest closet, where it may then unite with the soil-pipe ventilator, having, on the way, received the various air-pipes from each closet trap. Lead is the best material for this, as for other air-pipes, and all the joints ought to be wiped. Here the difficulty again arises of making a tight joint between lead and earthenware, in the case of the wash-down closet, unless it has a lead outgo, or unless it has a flanged vent-arm, as is shown in Fig. 73. For this reason it is best to connect the air-pipe to the lead branch beyond its junction with the closet, and seal up any opening that may be provided for the purpose in the earthenware part of the apparatus—that is, with the above exception, when a rubber-ring joint may be made.

The **valve-box** of a valve closet ought also to be ventilated, but in this case, all that is necessary is to carry it through the wall direct, where it may be cut short. The chief object of this ventilating pipe is to prevent syphonage of the trap connected with the pan overflow, which otherwise may occur, particularly when slop-water is thrown into the closet, and thus a large quantity of water is suddenly discharged.

The **service-pipe** to the closet, which, as already pointed out, must on no account be connected direct with a cistern that supplies drinking water, or with a general service-pipe, ought to be of sufficient size to insure a good flush. The diameter must never be less than $1\frac{1}{4}$ inches, and this is too small unless the flush-tank with which it is connected is fixed more than 5 feet above the rim of the closet. Any elevation under this requires a service-pipe of at least $1\frac{1}{2}$ inches to insure a good flush. The usual method of connecting the service-pipe with the closet-basin is by means of putty or red lead, but rubber caps are now made which answer the purpose well, and they last for a long time.

In the case of a valve closet which is provided with an **overflow** (see p. 114), frequent trouble arises owing to its being wrongly constructed.

All overflow-pipes, wherever they may come from, must be carefully followed up in investigating into the sanitary condition of a house, as it frequently happens that work, which would otherwise pass muster, has to be condemned because of faulty overflows. One method of dealing with the closet overflow is to connect it with the valve-box, as shown in Fig. 48, a syphon-trap being interposed in all cases. Another method is to carry it into the ventilator of the valve-box (see Fig. 76).

In case any leakage should occur, it is necessary to fix a **safe** under valve closets, and here again the overflow from the safe is often a source of danger, owing to errors in fixing. The safe itself should be made of lead (4 or 5 lb. to the superficial foot), the sides being formed by turning up the edges to a depth of about 4 inches,

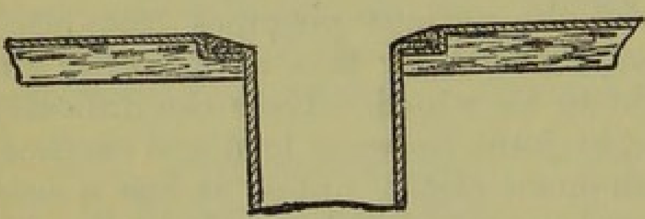


Fig. 75.

and soldering each angle. If the closet-trap is below the floor, which is generally the case, the edge of the opening in the floor of the safe, through which the outgo-pipe passes from the valve-box, ought to be carefully soldered to the trap in the manner represented in the sketch (Fig. 75). Round the opening in the floor through which the outgo-pipe from the valve-box passes, a sunk ledge, about an inch or so wide, is formed, by chiselling out the wood, and the floor of the safe is hammered down into this ledge. The inlet to the trap is then introduced a sufficient distance to allow of its being tafted over the edge of the ledge, and the solder is applied, all round, as is represented. In order that this safe may serve the purpose for which it is intended, it is necessary that its overflow-pipe should be large enough to carry off all possible overflow water, should any accident happen to the closet. The $\frac{3}{4}$- or even the 1-inch pipe that is usually fixed is useless for this purpose, the proper size is 1½ or 2 inches. Plumbers are apt to think that if a trap is fixed on this overflow-pipe it may be taken anywhere with safety, but this is a gross mistake, for, as it will only be in use when the closet is out of order, the trap will invariably be dry, and, therefore, not a trap. It used to be a common practice to connect this overflow to the old D-trap, but, from the account given of that appliance, it is needless to say that this was a wrong proceeding. It is equally wrong, of course, to connect this overflow with the soil-pipe, as is often done. The **proper outlet** is into the open air, direct through the wall, where it should be cut short, and in order to prevent wind blowing through the pipe or birds building in it, a copper hinged flap ought to be fixed on the discharge end.

The accompanying sketch (Fig. 76) shows the proper method of connecting two or more closets with a common soil-pipe. In this case two closets are shown, the upper one a valve closet, and the lower one a wash-down closet with P-trap.

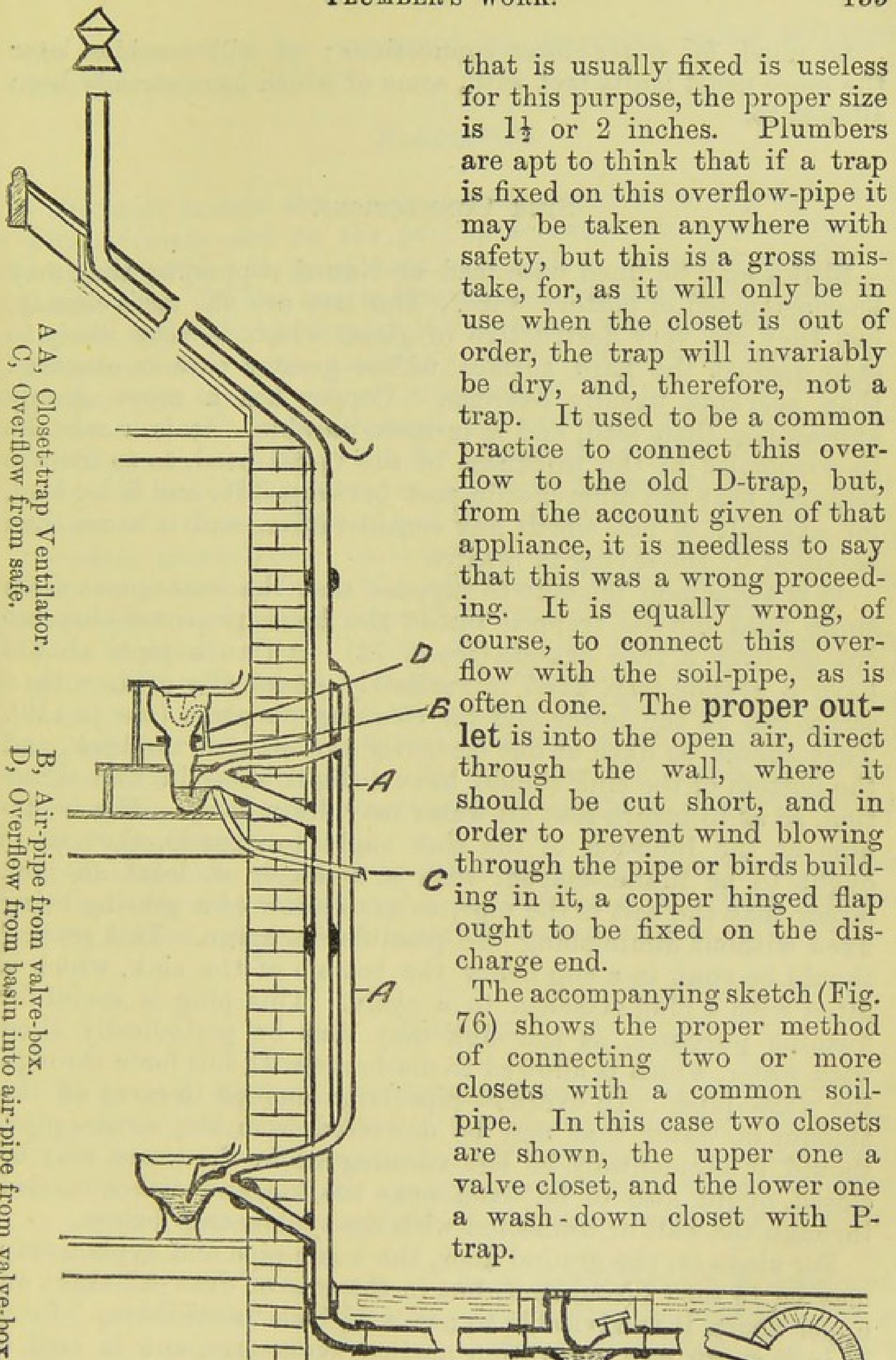


Fig. 76.

So much for water-closet connections; we will consider later the more usual faults met with, some of which have already been alluded to.

Sink Connections.

Sinks may be lined with lead or tinned copper, or they may be constructed of pottery ware. The last are the most cleanly, but they are very destructive of glass, which is very likely to chip against the hard surface unless greater care is observed than servants usually exercise. Copper has a more cleanly appearance than lead, and it is more durable. It is a mistake to economise in the thickness of the metal used, as so little is required that the difference in cost between 8 lb. and 6 lb. lead, for example, is not worth any consideration, and is more than balanced by the saving in repairs.

It is a common mistake to suppose that the waste-pipes from sinks need not be trapped inside the house provided they are cut off over a trap outside (see p. 72). All such pipes should have a syphon-trap fixed immediately under the grid, with a screw cap at the lower end for cleaning purposes (see p. 110). They should be fixed at one corner of the sink, at the back, and the bottom of the sink should have a slight slope in that direction, so as to insure that all water may drain away. The waste-pipe at the junction of the sink ought to expand, that is, it ought to be funnel-shaped, with a diameter at least an inch larger than the rest of the pipe, so as to allow of a grating being fixed without diminishing the possible discharge. This grating should be sunk in a cup below the bottom of the sink, which is fitted with a plug attached to a chain. This plug is useful for flushing purposes, as the sink may thus be periodically filled with water, which is allowed to discharge with full force through the waste-pipe. An overflow-pipe large enough to carry off the amount of water that may be delivered from the service-pipe, should it accidentally be left running while the waste may be closed, ought also to be fixed near the top, and either carried through the wall or connected with the syphon-trap below.

For sinks on the ground floor, the waste-pipe and syphon-trap may be $1\frac{1}{2}$ inch throughout, but in the case of draw-off sinks on upper floors, it is advisable to use a $1\frac{1}{4}$-inch "anti-D-trap" for a $1\frac{1}{2}$-inch waste, as a precaution against syphonage, and in such a case, as an additional security, the waste-pipe may be continued upwards as a ventilator, with which an air-pipe from the top of the syphon must be connected, as described under soil-pipe ventilation (see p. 126).

Slop-sinks.

In most houses the water-closet is used as a slop-sink, and with ordinary care on the part of servants, there is no reason why it should not be so used, although it is hardly possible to insure this. If the seat is hinged, and the servant will take the trouble to lift it and empty the slop-pail into the pan itself, no nuisance need arise, especially if the closet-pan is specially designed for the purpose, as some are, by having a broad margin, or "table top" as it is termed, the surface of which falls in all directions towards the basin for splashings to drain into it.

Special slop-sinks, however, are now frequently fixed. They consist of a basin, either of cast iron enamelled inside with white porcelain enamel, or of earthenware, and the connections in all respects resemble those of a wash-down closet, except that the waste-pipe need not be larger than from 2 to 2½ inches.

On account of the great danger of syphonage from the momentum of water that is usually discharged in this case, it is most essential to ventilate waste-pipes, and to connect the top of the syphon with the ventilator by means of an air-pipe the full diameter of the pipe itself. To avoid the risk of soap, scouring-cloths, &c., entering the waste-pipe, it ought to be protected by cross bars of brass.

All slop-sinks ought to be provided with a water-flush similar to that of a water-closet, and each time the sink is used it ought to be flushed, otherwise it is certain to become foul.

Urinals.

It is well, as far as possible, to avoid fixing urinals within houses, but, whether inside or outside, nuisance will arise from them unless an ample water-flush is provided. It is important also that all parts of the apparatus with which the urine comes in contact, should be exposed to the flush, otherwise corrosion will soon occur.

Perhaps the best system of flush is that which is connected with a treadle, upon which the person using the urinal stands, so that the urine enters the waste-pipe well diluted with water. In addition to this, a flush-tank with automatic discharge ought to be connected with the basin.

The disgusting nuisance that arises from a badly flushed urinal is too well known to require description; it is always present in the case of slate-back urinals without basins, so common in railway stations, although great improvements in these appliances are gradually being effected in the larger stations. Many excellent contrivances have been designed by various firms for limiting the nuisance arising from urinals, but space will not allow of a description of them; suffice it to say that, given a good supply of water, and a free hand as regards expenditure, no difficulty need be experienced in abolishing all the evils associated with them: at the same time no amount of freedom with regard to the latter requisite will compensate for an absence of the former. In other words, without a plentiful use of water, all appliances are unavailing.

It is unnecessary to say that all urine basins ought to have separate syphon-traps, properly ventilated, and that the waste-pipe should not be directly connected with a drain, but discharge into a gully or other suitable trap. Also, the walls, and more especially the floors, must be non-porous; wood floors are quite inadmissible.

BATHS.

As baths are frequently fixed in dressing-rooms, it is of the utmost importance that their wastes should be completely disconnected from the drains. This is done in the manner recommended in the case of sinks—that is, by a syphon-trap being fixed to the waste-pipe immediately beyond the discharge valve-box, the pipe then passing through the wall to join the waste-pipe, which may be common to other baths or lavatories, and which must discharge below on to a suitable trap, and be continued as a ventilator of full bore upwards to above the roof. The air-pipe, to prevent syphonage, must never be omitted; it should be of the same diameter as the junction waste-pipe, from which it should pass, from a point immediately beyond the trap to the air-pipe of the main waste, provided there are no other connections above. The best trap to use is the "anti-D,"* 1¼ inches, the branch pipe being 1½ inches, and the main waste pipe 2 inches.

The overflow-pipe must be carried through the wall, where it should be cut short, the usual hinged copper flap being fixed on the end to prevent the air from blowing up the pipe. As a protection against possible accident, a safe may be fixed under

* Hellyer.

the bath, which must be similarly treated, or rather one may be made to answer both purposes, by the overflow-pipe from the bath being carried to the mouth of the waste-pipe from the safe.

Lavatories.

Precisely the same precautions must be observed in fixing lavatories as have been described in the case of baths, and the same water-pipe may answer for both, provided it happens to be conveniently placed. If more than one lavatory basin should be connected with one waste-pipe, it is necessary that each should be separately trapped, and each trap ought to be provided with an air-pipe to prevent syphonage, as is shown in the sketch (Fig. 77).

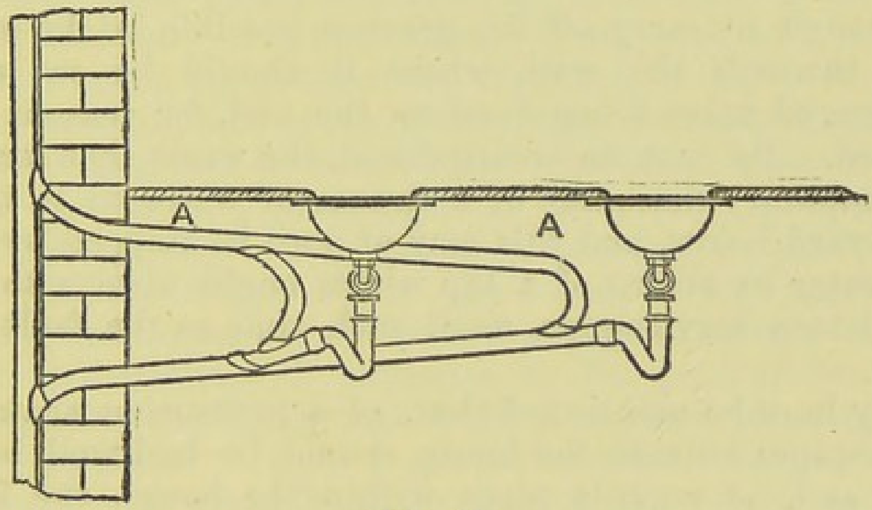


Fig. 77.

In the event of the waste-pipe being common to other lavatories or baths on upper floors, the air-pipe, A, A, ought not to be connected, as is shown in the sketch, but it should be carried to above the highest junction, for reasons already explained in the case of soil-pipes (p. 133).

Cisterns.

The materials of which storage cisterns should be made, as well as the position in which they should be placed, when their provision is necessary by reason of the water-supply being an intermittent one, has already been discussed, and the importance of not taking the service-pipe to a closet (slop-sink, urinal, &c.), direct from the storage cistern, has also been pointed out (p. 20).

It now remains to consider how **cistern overflows** must be dealt with. It is essential that all cisterns, large or small, should be provided with overflow-pipes, otherwise, in the event of the ball-valve which regulates the supply of water to them getting out of order, great damage may be done to ceilings, walls, and floors. Faults of the gravest description are often met with in connection with cistern overflows. They are often directly connected in the most reckless manner with soil-pipes, drains, and foul traps, so that every facility is offered for contamination of water-supply, and if the plumber in his wisdom interposes a trap in the course of the overflow, he fondly imagines that all is safe, forgetting that the only occasions on which such trap can be replenished with water is when the cistern actually does overflow, an occurrence which never takes place so long as the fittings are in order. The only safe way of dealing with these as with all overflows, is to carry the pipe (which ought to be large enough to carry off the greatest possible intake of water) straight through the wall, where it should be cut short, a copper-hinged valve being fixed on the end, for reasons already mentioned. By such an arrangement, the worst that can happen is the temporary discharge of a stream of water on to the pavement or yard below, and this may at once be stopped by turning off the water by means of a tap which ought always to be fixed on the cistern service-pipe, until such time as the fault may be repaired.

It may here be mentioned that, as a precaution against frost, all water-pipes outside the house should be laid well below the surface, and, as regards pipes within the house, the following instructions laid down by Mr. Hellyer ought to be observed :—
"No service-pipe should be fixed on the external nor on the internal face of an external wall, especially a wall facing the north or east, without being cased-in and thoroughly protected. When possible, service-pipes should be fixed on the cross-walls inside the house, and never on the main walls, for the cold penetrates through the external walls, and reaching any pipe fixed on its face, though inside the house, freezes the water in it. If a pipe **must** come down on the internal face of a main wall, then an inch board should be put between the pipe and the wall, and the pipe cased-up, and the casing filled with cocoa-nut fibre. All service-pipes in roofs should be boxed-in, and the boxes filled with this fibre. . . . Where the service-pipe could not be boxed or cased-in, and where the cold air could reach it—as *e.g.*, under water-closet seats, where the pipe has to leave the casing to reach the supply-valve of the water-closet—

the pipe should be bound round with two or three thicknesses of gaskin, and then be covered over with canvas, to protect it from frost; the cold air coming in through the overflow-pipe of the safe, and blowing upon an unprotected pipe, would soon freeze it."

Examples of Insanitary Plumbing.

Volumes might be written concerning defective plumbing work, it is only possible here to call attention to those defects most commonly met with. From what has already been said, the reader will have gathered in what direction he has to look for them, but, as a preliminary to such an enquiry, it is well to point out that, in investigating into the condition of the drainage of any house or premises, nothing must be taken for granted, the engineer must satisfy himself regarding each detail by personal observation. However likely it may appear that things are as they seem, or as they are reported to be, it is possible that they are not, and much money may be wasted, and extra expenditure incurred, by a too hasty conclusion being formed on evidence that is only presumptive. Owners of property often complain, and justly so, that notwithstanding extensive alterations carried out, it may be, on the advice of an expert, former nuisances continue as bad, or even worse than before. Too often this is to be attributed to ignorance on the part of the adviser, but it also frequently results from a careless investigation in the first instance. It is a golden maxim, therefore, in all such enquiries, to avoid forming conclusions except upon fully-ascertained facts.

The following authentic history well illustrates the importance of what has just been stated. In a modern house, under which the main drain passed to join the sewer, constant foul smells were experienced, and a considerable area of the wall, at the point of exit of the drain, was found to be damp. On the drain being exposed, it was found that leakage had occurred at various points in its course under the basement-floor, and a deposit had taken place which almost completely obstructed the passage of sewage. The remedy which was adopted consisted in relaying the pipes in concrete, with cement joints, a ventilator being fixed at both ends. For a time all appeared right, but it was noticed that the damp condition of the wall, in place of improving, became worse, and, as no other cause could be discovered, the ground was re-opened at the point where the drain passed out, when, what ought to have been found out at first was discovered, namely, that the pipes were not continuous through the wall, but stopped short on either side, the intervening portion being formed by the hole which had been driven through the brickwork. At the first inspection this disgraceful piece of work was overlooked, as the pipes where they joined the wall on both sides had been carefully cemented all round. Of course in this case it would have been better, in place of relaying the earthenware pipes, to have substituted iron pipes with caulked lead joints, but what was done would have answered the purpose had the want of continuity of the pipes been discovered by a more thorough examination in the first instance.

The following are a few examples of bad workmanship met with in the author's experience:—

In a large country house, which had been what was termed "thoroughly overhauled" about nine years previously (although the only trace of new work that could be found was the disconnection of the various sinks and rain-pipes over gully-traps), the following, among many other defects, were found:—

In the first place, all the drainage of the establishment, including stables, pig-styes, &c., discharged into a large cesspool, capable of holding about 10,000 gallons, situated in the stable-yard, within 20 feet of the house; adjoining this was a large soft-water tank, the overflow from which discharged direct into the overflow-drain from the cesspool. At various points in the course of the drains, which were 9 inches in diameter, miniature cesspools, in the shape of dipstone traps, were constructed, and in the midst of these, within 30 feet of the large cesspool, the well which supplied the drinking water of the household was situated. The pipes leading to the cesspool were jointed with cement, but the drain which carried the effluent on to an adjoining field, was constructed of ordinary agricultural drain-pipes, without joints. As the well (which was very deep) and the cesspool were built of pervious brickwork, and as the subsoil was gravel, it is needless to say that, on analysis, the water proved to be little other than dilute sewage, although, under favourable circumstances, the quality would have been good. So much for the external arrangements. Within the house, every conceivable description of bad plumbing was to be found. In one wing, where the water-closets were fixed, one above the other, the service-pipes were carried direct from a large cistern under the roof, which was filled by a force-pump from the well, and from which the drinking water also was drawn. The overflow-pipe, B, from this cistern was connected with the soil-pipe, which was of seamed lead, 5 inches in diameter.

The soil-pipe was placed within the house; it was unventilated, untrapped, and it leaked at various points along the seam. The highly objectionable pan closet, with D-trap, was fixed in each case, and the junctions with the soil-pipe were at right angles, and nearly on a dead level, the result being that each contained a filthy deposit. The overflow-pipes from the safes, E, which in this case had plenty of work to do, owing to the faulty condition of the closets, joined the soil-pipe junctions beyond the closet-traps, and so acted as ventilators connecting the soil-pipe and drains direct with the house. The soil-pipe joined a 9-inch drain, C, connected with a dipstone-trap, D. It is needless to remark that, apart from construction, the plumbing work itself was of the worst description. The accompanying sketch (Fig. 78) represents the closet connections as described above, but it by no means conveys an idea of the filthy conditions which were displayed when each part was exposed to view.

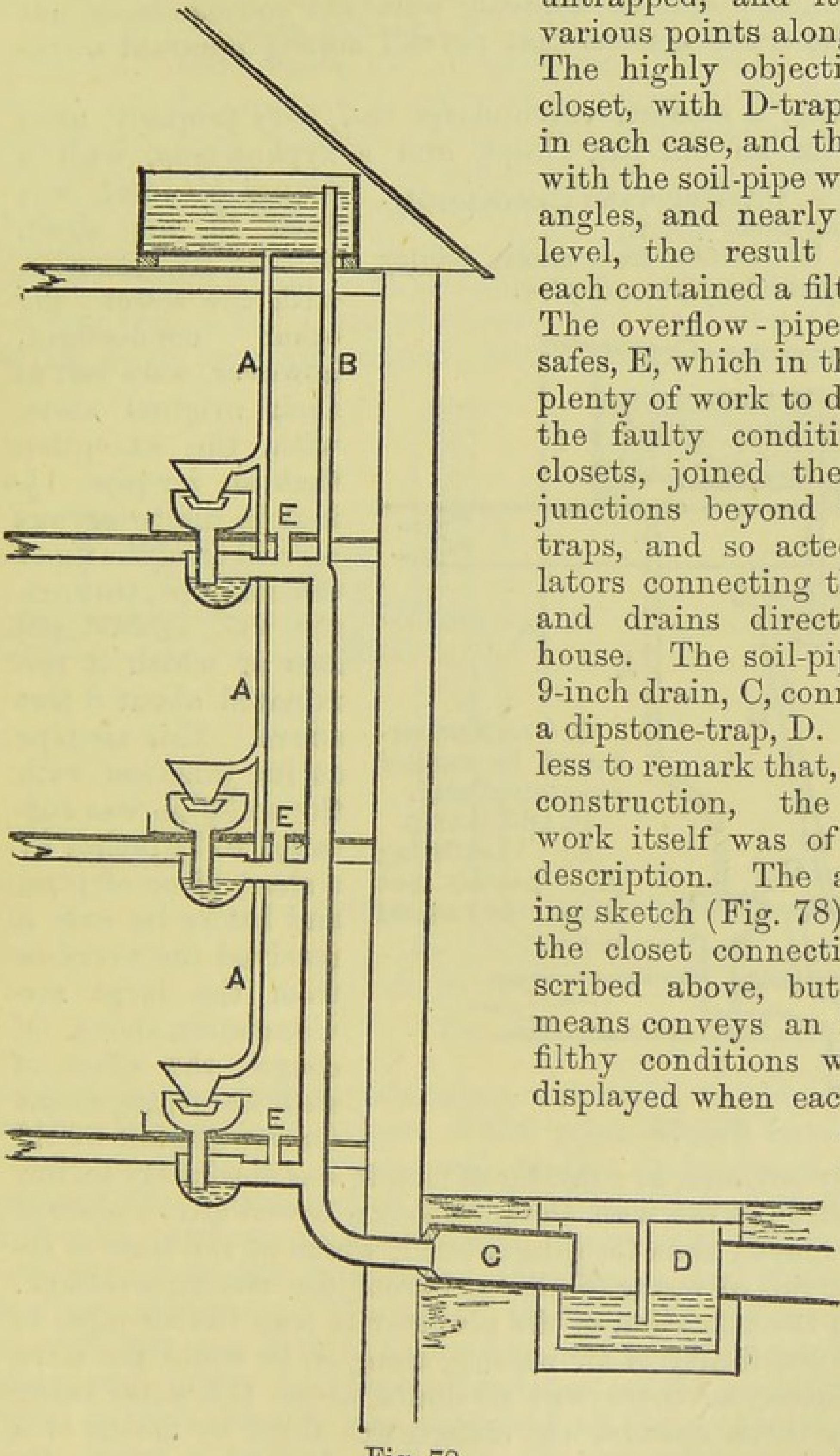
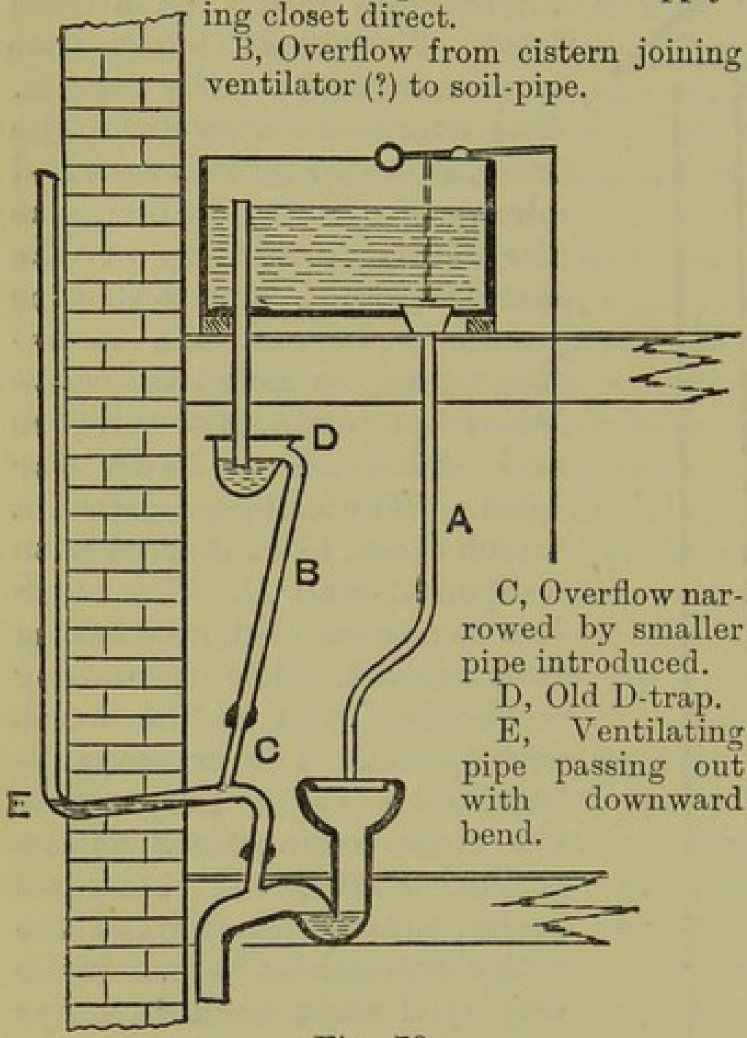


Fig. 78.

The following illustration (Fig. 79) is an example of work recently carried out in a large house by a plumber who was told by the confiding owner to put everything in thorough sanitary repair. It illustrates in a manner, which would be amusing were the consequences not so serious, the crude notions that prevail among ignorant workmen.

In this case, a modern valve closet had, very properly, been substituted for an old pan closet, and a syphon-trap, with a proper air-inlet, was fixed in the drain before its junction with the sewer; the other connections, however, were left in their original state, with the exception that an air-pipe $1\frac{1}{2}$-inch in diameter was carried from the top of the soil-pipe, through the wall, against the face of which it terminated about 8 feet above. This air-pipe at its junction with the soil-pipe was curtailed to $1\frac{1}{4}$ inches by a short piece of pipe, and before its exit it received the overflow from the large service-cistern above. Of course, the effect of such an arrangement for ventilation would be practically *nil*, and, as a matter of fact, it was absolutely so, for, in passing through the wall, the pipe took a downward in place of an upward course, thus forming a bend, which at the time of inspection was full of water discharged from the cistern overflow. Had it been the intention of the plumber to trap the air-pipe, to prevent the possibility of air passing along it, he could not have succeeded better, as there was no doubt about the water being permanently there, because the cistern was filled by means of a force-pump from the well, and must, therefore, have constantly reached the level of the overflow-pipe. The cistern overflow-pipe was $1\frac{1}{2}$ inches in diameter, but it also, before joining the soil-



A, Drinking-water cistern supplying closet direct.
B, Overflow from cistern joining ventilator (?) to soil-pipe.
C, Overflow narrowed by smaller pipe introduced.
D, Old D-trap.
E, Ventilating pipe passing out with downward bend.

Fig. 79.

pipe ventilator, was curtailed to $1\frac{1}{4}$ inches, and in its course within the wall an old D-trap was fixed.

This by no means exhausts all the faults found in connection with this water-closet, for, on exposing the drain between the house and the syphon-trap referred to above, it was found to consist of odd pipes, 4 inches and 6 inches in diameter, united indiscriminately along its course, some of them even without sockets, and those that had having clay-joints, the result being that, notwithstanding a good fall, the drain was more than half full of deposit. One would have thought that, before fixing the intercepting trap a few years previously, the condition of the drain would have been ascertained; but experience teaches us not to

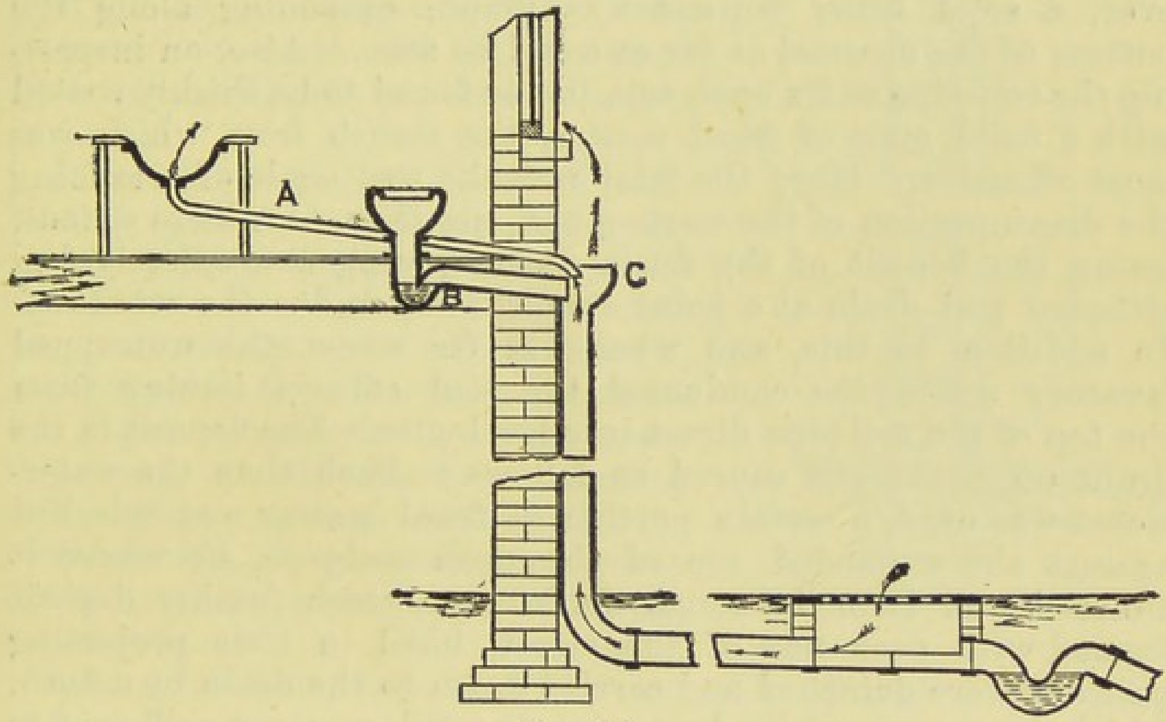


Fig. 80.

marvel that no such investigation was made, and the probability is that had it taken place, little good would have resulted. Gross mistakes are often made in the drainage of houses by persons who possess only a superficial knowledge of the subject, and who, without understanding the principles, endeavour to improve upon the established practice as laid down by able sanitary engineers. The above sketch (Fig. 80) is descriptive of what was met with in a house recently built, according to the plans, and under the superintendence, of an architect. As is usual in such cases, it was supposed by the owner of the house that, being a modern building, all the sanitary arrangements must necessarily be perfect, and on the occurrence of diphtheria in the house, the suggestion that the drainage might be at fault was ridiculed by him. The following among other faults were found :—Immediately under one of the windows the closet-pipe, B, together with an untrapped lavatory waste, A, discharged into the open end of a 4-inch iron pipe, C, connected with the drain below; about 10 or 15 feet off was a syphon-trap, and the drain, for a distance of 2 or 3 feet on the house side of the trap, was freely open to the surface, except for a perforated iron grating.

There was not much fault to be found with the construction of the drain, the trap was properly placed, and it was right that the air-inlet should be where it was, although its continuation along the drain was unnecessary. On lifting the grating, however, a solid filthy deposit was found, extending along the bottom of the channel as far as could be seen. Also, on inspecting the soil-pipe at its open top, it was found to be thickly coated with a solid mass of fæcal matter, the stench from which was most offensive. Here the fatal mistake was made of overdoing the disconnection of the waste-pipes, and thus, to a large extent, losing the benefit of the flush, and exposing a needlessly foul soil-pipe and drain at a point immediately under the windows. In addition to this, and what was far worse, the untrapped lavatory waste-pipe conducted the foul effluvia issuing from the top of the soil-pipe direct into the house. The deposit in the drain no doubt was caused as follows :—Each time the water-closet was used, a certain portion of fæcal matter was splashed against the expanded top of the open soil-pipe, C, where it adhered, and formed a rough surface, on which further deposit formed with each use of the closet, until in time projecting portions were detached and carried down to the drain by a flush, which, by reason of its being interrupted, was not sufficient to carry the solid matter onwards. In this way things went from bad to worse, until the drain practically became an elongated cesspool, ventilated into the house through the lavatory waste-pipe.

Drain-Ventilators.—As already pointed out, it is very desirable that all dumb ends of drains should be ventilated. The following sketch (Fig. 81) illustrates the importance of using lead in place of iron pipes for the purpose, owing to the tendency to corrosion in the case of the latter metal.

In the house in question, the architect had been most lavish in the provision of ventilating-pipes, but, although they presented an imposing appearance, and apparently provided for a very free circulation of air in the drains, when they came to be inspected, it was found that, with one exception, namely, that which was connected with the soil-pipe, they might all have been solid wooden dummies, so far as ventilation was concerned. The reason of this is apparent from the sketch; a solid deposit of iron rust, which had formed within the pipe, had gradually scaled off, and falling down, collected at the angle of the pipe, where it emerged from the ground, and formed a compact mass several inches in depth. The reason why the same had not happened in the case of the soil-pipe ventilator, was that the water-flush carried the rust off as it collected; from this, however, it must not be supposed that iron soil-pipes are desirable (see p. 126).

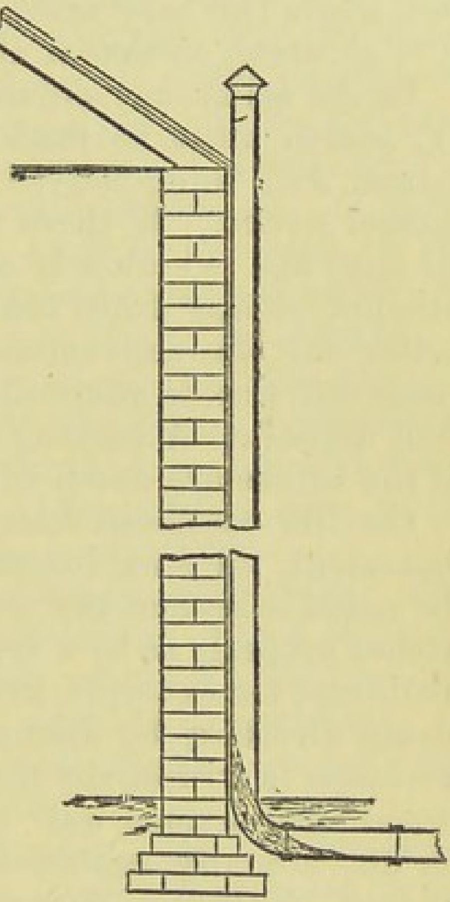


Fig. 81.

It is a common though a bad practice to make use of existing rain-water pipes as soil-pipe and drain ventilators, thereby liberating drain-air immediately under attic windows, and probably from pervious joints in the pipe as it passes the lower room windows. In addition to this, during rain, when upward ventilation is most needed, the down-flow of water converts these pipes into down-cast ventilators.

Space will not allow of other examples of bad work being given, although in recent as in old work they are innumerable; probably enough has been said in this and the preceding chapters to indicate the faults that are commonly met with.*

Inspection of House Drainage.

Inspections into the drainage arrangements of houses ought invariably to be conducted systematically, according to a fixed plan. It is convenient to start in the cellar and work upwards, completing each floor in its turn until the roof is reached, and while keeping in view the conditions that are likely to be met

* For many interesting examples of bad work see *Defects in Plumbing and Drainage Work*, by Francis Vacher. *Dangers to Health*, by T. Pridgin Teale.

with, they must not be allowed to bias one's mind, for thus fatal mistakes, which might easily be avoided, are often made; in fact, where proof is possible, take nothing for granted, and believe no one. It sometimes happens that a plan of the drainage exists, but, while this may assist one very much, it does not follow that it is accurate, so that it also has to be verified.

In the cellar any offensive smell must be noticed, and a careful search must be made for any drain connection, all barrels, boxes, &c., being moved, so that no portion of the floor may escape notice. If there is such a connection, the kind of trap (if any) and whether it contains water must be noted. In the absence of any drain connection, a pit is often provided in the cellar for the convenience of washing the floor, which, if of moderate size, is admissible, but usually it is large and contains foul deposit. A leaking drain under the floor may be suspected if the bricks are damp in circumscribed patches.

On the basement-floor, or on the ground-floor if there is no basement, the sink connections will next be inspected. It must be noted whether the waste-pipe is trapped within the house, either properly so by a syphon, or improperly by the objectionable bell-trap, for example, and also whether it communicates with the drain direct or by discharging on to an outside gully. If the soil-pipe is within the house, it will probably be found incased in wood within some wall, or in an angle formed by two walls, if it is not actually concealed by the plaster; possibly it may be placed within a pantry or larder. All coverings must be removed to enable an inspection to be made of the joints, seams, and substance of the pipe itself; damp brickwork or plaster will paint to the existence of flaws if they are not apparent in themselves. If there should be a water-closet or lavatory on this floor, both should be thoroughly inspected, but probably neither will be found, as servants' closets are usually placed in a detached building.

On the first floor all water-closets, baths, lavatories, and sinks must be overhauled in detail. Any casing of wood that may surround the closet must be removed, so as to expose the soil-pipe connection, and the safe, if there is one, and the waste-pipe from the latter must be traced; in fact, the investigation must be conducted in view of the requirements of the special class of closet, as already laid down. The water-flush should be tested, if it is a wash-out or wash-down closet, by placing several pieces of paper in the pan, and noticing whether they are carried clear of the trap, and while this is being done, the operator should ascertain whether any smell can be detected. The air-pipe from the top of the trap must be looked for, and if it be a valve closet, its overflow must be traced, as well as the air-pipe from the valve-box. The inspector must be careful to notice whether the supply-pipe is properly cut off from direct communication with the house cistern, should such exist, as will be the case if the water-supply is not a constant one, or if the house is dependent upon a private well for its supply. All pan closets ought to be condemned, however they are fixed. If the soil-pipe should be within the house, and there are other closets on the floor above, it must be inspected, as already described. If there is a bath-room on this floor, attention must be directed to the waste-pipe, to ascertain whether it is properly trapped under the bath, and disconnected outside from the drain, or whether it improperly discharges, either into the soil-pipe, or directly into the drain. Should there be a safe under the bath, its waste-pipe must be traced, remembering that it should be carried through the wall, where it ought to terminate; the overflow also, which should be similarly treated, must not be overlooked.

Lavatory wastes are often most carelessly dealt with. Not infrequently they are untrapped, and discharge into a soil-pipe or drain; but whether trapped or not, such connections are highly objectionable, and if met with, must be condemned. It must be remembered that traps in general are all very well, but no trap will excuse an otherwise bad connection.

The same remarks apply equally to sinks. In old houses it will very often be found that the sink is placed on solid brick-work, through which its waste passes to the drain, which is thus directly connected with the house, except for the feeble protection offered by a bell-trap. Under these circumstances, the brick-work is saturated with filth, and in a great many instances the bell part of the trap will be found to be absent, thus allowing of the freest entry of sewer gas into the house.

The enquiry as regards the upper floor of the house must be conducted on the same lines, all drain connections, whether from water-closets, baths, sinks, or lavatories, being carefully inspected.

The inspector's attention must be directed to the various cisterns within the house, either for drinking-water or for rain-water storage. Their condition with regard to cleanliness, their overflows, whether improperly connected with a soil-pipe or drain, or properly discharging into the open, or, in the case of a rain-water cistern, on to a gully-trap outside the house, must invariably be noticed, and, as regards the overflows of cisterns fed by ball-taps, it must be remembered that traps afford no protection against bad connections, as they will not contain water. The possibility that cisterns may be found under floors must not be overlooked.

Having completed the examination inside the house, the outside drains or cesspools, closets, or privies, and the provision for refuse storage, must be inspected.

The true state of the drains cannot be ascertained except by the tests which are described later, but all traps that are accessible, and none ought to exist that are not, should be examined to see that they are structurally in accordance with sanitary principles, and are kept properly cleansed. The provision for drain-ventilation in the shape of air-inlets and outlet-shafts, and the position of the latter with regard to windows, their size, the soundness of their joints, &c., must be noticed. It may be found that the rain-pipes are made use of as soil-pipe or drain-ventilators, or that they are not properly disconnected over gully-traps. If underground rain-water tanks exist, their condition as regards cleanliness should be noticed, and their overflows ought invariably to be traced.

As regards receptacles for filth, privy-middens, ashpits, and cesspools, it should be ascertained whether they are so constructed as to be impervious, and, in the absence of a public water-supply, their position with regard to the well must be considered.

Drain Testing.—It is not possible to assert positively that the drainage of a house is satisfactory from a mere surface inspection, particularly if the drains and their connections are within the house. The aim of all sanitary experts is to avoid laying drains under houses, and to carry each connection by as direct a route as possible through an external wall, all joints being placed where they can easily be inspected. Under such circumstances, it is easy to detect defective work in the case of new houses, but however thoroughly old houses may have been overhauled and their defects corrected, one never can tell that some disused drain may not have been allowed to remain concealed from view, although none the less dangerous on that account. The only means of ascertaining with certainty whether all is right, is by applying one or other of the approved tests, and as this involves but little time or trouble, it is advisable to make it an invariable practice, however perfectly the work may seem to have been carried out.

The smoke-test is handy and fairly reliable. It consists in filling the drains with smoke, so that it may find its way through any faulty joint or defective trap, and thus demonstrate by its presence, near to or within the house, the exact site of each of the various faults. It must be remembered that where smoke can penetrate, sewer gas may, and the ocular demonstration of the danger to which the inmates of the house are exposed, will often be the means of convincing them of the necessity for certain alterations, which might otherwise meet with opposition, on account of the expense or temporary discomfort they involve. There is nothing like smoke to convince a sceptic that the suggestions of an expert have a solid foundation in fact, and are not, what they are too often supposed to be, the outcome of a theorist's imagination.

In applying the smoke-test, one of the various apparatus that are made for the purpose must be used, and the best opening at which to blow in the smoke is the air-inlet to the drain on the house side of the trap which disconnects it from the sewer or cesspool, or, failing this, it may be introduced at any con-

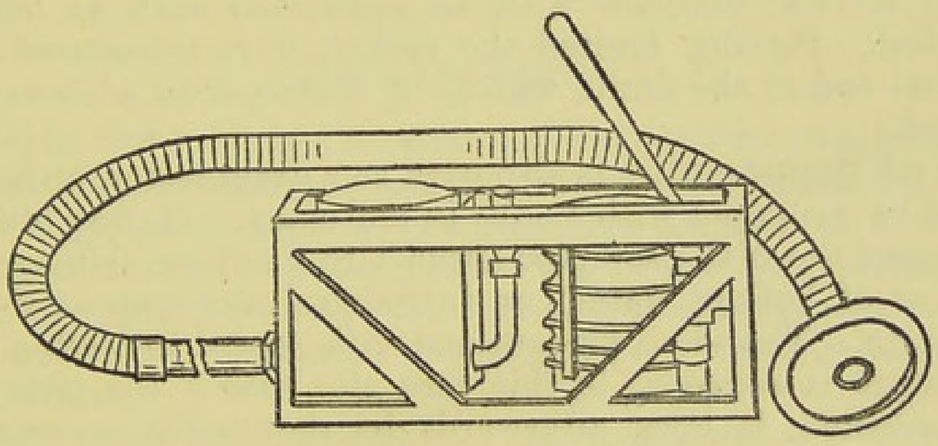


Fig. 82.

venient trap, by removing its water-seal. As soon as the smoke is seen to issue from the various soil-pipe or drain-ventilators, they must be plugged, as all are then charged with smoke, and afterwards a little pressure applied by the apparatus, not sufficient, however, to force the various traps, will send the smoke through all imperfections, if it has not already found its way through, which is more likely.

For small systems of drains, handy little machines are made which answer the purpose, but it is well to use one of the larger apparatus, such as Burn & Baillie's (Fig. 82), in the case of large premises. This apparatus consists of a double-action bellows, which communicates with a cylinder in which the smoke is generated by burning oily cotton-waste, and from which it is carried by a pipe into the drain. At the end of this pipe a flange surrounded by an india-rubber ring is fixed, which acts as a plug when introduced into the drain; these are made of various sizes, to suit different sized pipes. By means of an ingenious contrivance connected with the cylinder this apparatus can determine whether any leakages exist previous to their exact position being demonstrated by the smoke. This is managed as follows:—Round the cylinder is an outer casing containing water and supporting a float, which is raised with a few strokes of the bellows; provided there is no leakage at any point, the float will remain in its raised position; on the other hand, it will fall if the slight pressure of air that maintains it is lost through leakage. There is not much advantage gained by this, as, if leakage is demonstrated, it is afterwards necessary to make use of the smoke, in order to establish where the faults are.

Smoke rockets are sometimes used for testing drains, and they have often been instrumental in exposing faults, but they can in no way compare with an apparatus such as has been described. Having ignited the rocket, it is introduced at the terminal end of the drain, which, of course, must afterwards be plugged.

Oil of peppermint is also used as a drain-tester, although it cannot be compared with smoke in efficiency. It may either be discharged down the soil-pipe (from 1 to 2 ounces, followed by a few cans of boiling water), or introduced at a trap on the soil-pipe drain. The same precautions with regard to sealing up all ventilators is necessary in this case also, and if the trap is the place selected, it must afterwards be thoroughly covered with wet cloths to prevent the odour of the peppermint from escaping at that point. The person who introduces the oil ought not to be the one to search for the smell of it about the house, as the slightest particle of it on his hands or clothes will suffice to distribute its scent wherever he goes, and so blunt his power of detecting any escape. Also, if the peppermint should be introduced from a water-closet, the operator must remain in the closet until such time as others can satisfy themselves with regard to the soundness of the various connections.

Water Test.—The integrity of drains may be thoroughly tested by filling them full of water, until it reaches the level of one of the traps, having carefully plugged the outlet into the sewer or cesspool. If the water remains at the same level for about an hour, the drain may be pronounced sound; on the other hand, should it subside, leakage must be taking place, either from imperfect joints or fractured pipes. In order to discover which section of the drains is at fault, each must be tested separately. Soil-pipes may be tested in the same way by plugging the drain at the junction, as well as the various closet connections. Unless the joints are absolutely tight they will not resist this severe test.

CHAPTER VIII.

HOUSE CONSTRUCTION.

Many important details relating to house construction have already been dealt with in the previous chapters; the building itself and its site have now to be considered.

Building-Sites.

The site for a house is often selected without regard to its suitability from a health point of view. Speculative builders naturally take no interest in the question, landowners are only too anxious to avail themselves of the extra price offered for building-sites, and, as a rule, the public either under-estimate or are ignorant of the important influence that locality and soil have on health.

The important considerations in selecting a site are—*dryness*, *warmth*, *light*, and *air*, and, as a rule, dryness and warmth go together, as do light and air.

The dryness of a site is mainly dependent upon the facility with which rain can pass off or through the soil, and the distance from the surface of the subsoil water (see p. 13). It follows, therefore, that flat and non-porous land, or land which, though porous, has an impervious stratum immediately underneath, is not desirable as a building-site. *A gravelly soil*, of considerable depth, and on a slight slope, is probably the best site that can be selected from this point of view, for not only does it afford facilities for natural drainage, but, by reason of its depth, the subsoil water is a long way from the surface. On the other hand, although the surface be of sand or gravel, if within a few feet there is a bed of clay, the pervious upper layer simply acts as a sponge, and absorbs the water which lies on the impervious bed immediately underneath; such a site, therefore, is not a favourable one, although it may be much improved by subsoil drainage.

Impermeable rocks, as regards dryness, are healthy, as the water readily runs off them, but in country districts the difficulty of obtaining water in many cases militates against such sites.

Chalk soil is dry and healthy; so is **sandstone,** provided (for the reason given in the case of gravel) it is of considerable depth and uninterrupted by clay.

Clay and **marl,** but especially the former, are damp, and unless thoroughly drained are not desirable for building-sites.

The connection between damp surroundings and phthisis has already been referred to (p. 3), and it is probable that the prevalence of other lung diseases, as well as rheumatism and neuralgia, is influenced by damp.

Peat land, and all soils which contain much vegetable or animal matter, are unhealthy.

Made soils ought to be shunned, owing to the amount of organic matter they are likely to contain, which will exist in a state of putrefaction for years, and render the air surrounding the house impure.

The ground air—that is, the air which is intermixed with the soil from its surface down to the level of the subsoil or ground water—is continually being discharged into the atmosphere, owing, among other causes, to its displacement by the rainfall. This is the reason why it is important that the soil on which houses are built should, as far as possible, be free from vegetable and animal matter. It is to the presence of decaying vegetation that malaria is largely attributed. Typhoid fever and diphtheria are supposed by some authorities to be closely associated with ground air, while infantile diarrhœa, which is so fatal during the autumn months, would seem to be intimately connected with ground effluvia.*

The warmth of a site, other things being equal, is influenced by the nature of the soil and the degree of moisture it contains.

The power of absorbing heat differs in different soils, as has been proved by Schübler, who has estimated it as follows, assuming 100 as the standard:—

Sand with some lime,	100·0	Clayey earth,	68·4
Pure sand,	95·6	Pure clay,	66·7
Light clay,	76·9	Fine chalk,	61·8
Gypsum,	72·2	Humus,	49·0
Heavy clay,	71·1		

* See Report by Dr. Bullard published in 1889, as a supplement to the Report for 1887, of the Medical Officer of the Local Government Board.

These figures indicate how greatly superior the absorbing power of sand is as compared with clay, and, consequently, how much warmer it is as a site. Again, the evaporation from the surface (see p. 12) is greater the damper it is, and as loss of heat results from evaporation, consequently a damp site is colder than a dry one.

It follows from what has been said that, in selecting a site for a house, preference must be given to one which is dry, and if there is no alternative to building on a damp site, it is imperative that it should first be drained. Attention should be paid to encouraging the natural drainage, by removing obstructions that may exist to the free flow of the streams in the neighbourhood, and thus lowering the subsoil water. The measures to be adopted against damp as regards the building itself will be considered later.

The two important requirements, *light* and *air*, are to be secured, as regards the first, by selecting a southerly or south-westerly aspect, and as regards the second, a site well removed from other buildings, and not closely surrounded by trees. It is not always possible in towns to obtain the advantages in this respect afforded by the country, but the more breathing space that can be provided the better, and to insure attention to this, all urban authorities should adopt bye-laws defining the limits beyond which buildings shall not extend (see Appendix).

Building Materials.

Bricks of good quality should be heavy and hard, and when knocked one against the other, they ought to give a clear, ringing sound. Soft bricks are more absorbent than hard ones, consequently walls built of the former are more likely to be damp and cold. Frost also has a crumbling effect upon them. The usual size of bricks is 9 inches in length, by 4½ inches in width, and 3 inches in thickness.

The quality of bricks, as of other materials used in house building, varies, and upon it depends, in a great measure, the health and comfort of the inmates. In certain districts the clay is peculiarly well suited for brick-making, and there the chance of bad bricks being used is much less than in other districts, where, owing to the quality of the clay, the "tempering" process entails greater labour. An important part in the process of brick-making is the burning. The heat has to be raised gradually up to a certain point, at which it should be maintained, without variation, for several days and nights; should the heat be too great, the bricks will be vitrified, and if not sufficient, they will turn out soft and friable.

It may seem strange, but it is none the less true, that wind can pass through a brick wall. This may have its advantages if we consider how rarely any provision is made for ventilation in the houses of the poor; but, as porosity is the cause, and as water can penetrate where air can, the necessity for constructing as far as possible impervious walls becomes apparent.

The quality of **stone** for building purposes varies, and hardness and compactness, or non-porosity, are the important requisites. Granite, of course, is well adapted for the purpose, but it is not met with in all neighbourhoods, and the labour involved in dressing it adds greatly to the cost of the building. The atmosphere of large towns has a perishing effect on some stones (those, for example, containing lime and magnesia), owing to the solvent action of rain and moisture when charged with gases which act chemically on stone.

Builders often use stone of the most inferior nature for window-sills, and for decorative purposes; it imparts an air of grandeur to buildings, but, owing to its perishable nature, the effect is but temporary. It is important that the builder should lay the stone as it was in its natural bed, otherwise it is more likely to perish.

Mortar is composed of sand and slaked lime, in the proportion usually of three of the former to one of the latter. The sand should be clean, tolerably fine, and free from small stones. Builders are apt to be very careless with regard to the freedom from dirt in the sand they use. Should it contain clay, marl, or earthy matter the mortar will not "set," but crumble to pieces; for this reason, it is advisable to wash all sand used for the purpose that is likely to contain any foreign matter.

The quantity of mortar used should not exceed what is necessary for insuring adhesion and uniformity of pressure. Walls built with inferior mortar, especially if a large quantity is used, are extremely friable structures, and they are far more porous than those put together with proper material.

Mortar ought to be prepared in small quantities as it is wanted, the sand being added immediately after the lime has been slaked. If it is allowed to stand it absorbs carbonic acid from the atmosphere, and when again disturbed for the purpose of being used it will have lost much of its adhesive quality.

Portland cement is the material best suited for building work in which strength is necessary.

Plaster which is applied to the interior of walls, and is used in the construction of ceilings, is prepared in a variety of ways, lime or cement being the chief ingredient. Durability, smoothness of surface, and absence of porosity, are the features of a good plaster. Unless it is smooth it is difficult to clean, and if porous it absorbs organic impurities from the atmosphere of the room, and in time becomes saturated with such impurity. Very inferior plaster is often used by speculative builders, consisting of a mixture of lime and sifted vegetable mould; such a plaster is exceedingly liable to break, for example, when articles of furniture are pushed against the wall. If the walls are papered a certain amount of support is afforded to the plaster, but in re-papering, when an attempt is made to remove the old paper the surface is certain to be more or less injured. It may here be remarked that the common practice of re-papering walls on the top of old and filthy papers is most objectionable, and ought never to be followed.

Plaster ought to be applied in three layers. The first, con sisting of equal parts of lime and sand mixed with ox-hairs, is applied on the face of the wall or on laths. The second, or floating coat, is composed of slaked lime and a little hair, mixed to the consistency of thick cream. The final coat consists of a thinner mixture of lime and water, sometimes with the addition of a little plaster of Paris to facilitate setting.

Keen's cement, Martin's cement, and **Parian cement** are all mixtures of calcined gypsum and other substances; they all set hard, and are capable of receiving a high polish.

Concrete is a mixture of lime or cement and gravel from which the fine sand has been separated. Stone crushed into sharp fragments, broken pottery, and slag answer the purpose, however, better than gravel, which, owing to the smoothness of its particles, has less adhesive properties. Concrete is used for foundations, for floors, or even for the walls themselves. It ought to be made with cement when strength is of importance.

Slate is an altered form of fine clay which has been compressed and hardened by natural processes. Its laminated formation allows of its being easily split into thin sections; hence it is frequently used for roof covering.

Tiles are formed of baked clay, and are either flat (*plain tiles*), or bent (*pan tiles*). The latter are twice bent—that is, in cross sections they present both a convex and a concave surface, to allow of their overlapping laterally.

Lead is the most suitable material for covering flat roofs and gutters, because it is very durable and can easily be worked. It is also used to form a union between the brickwork and slates (flashings), and is much to be preferred to cement for this purpose, although the latter is often used for economical reasons, with the result that the wet penetrates.

Zinc may be used for the same purposes, and very often is so used on account of its comparative cheapness, but it is much inferior to lead.

Thatch, as a roof covering, is a good non-conductor of heat, and is, therefore, both cool in summer and warm in winter, but there are objections to it from a sanitary point of view. Being of a vegetable nature, it is liable to decay, and it harbours insects and dirt.

So much for the materials used in building. The details of construction, so far as they are important from a health point of view, have now to be considered.

The foundations are of great importance, although, as a rule, too little attention is paid to them. In this case, as in the case of all work that is covered over, the speculative builder who has no conscience, has a splendid field for scamping his work, and becoming rich at the expense of the unfortunate purchaser of the property.

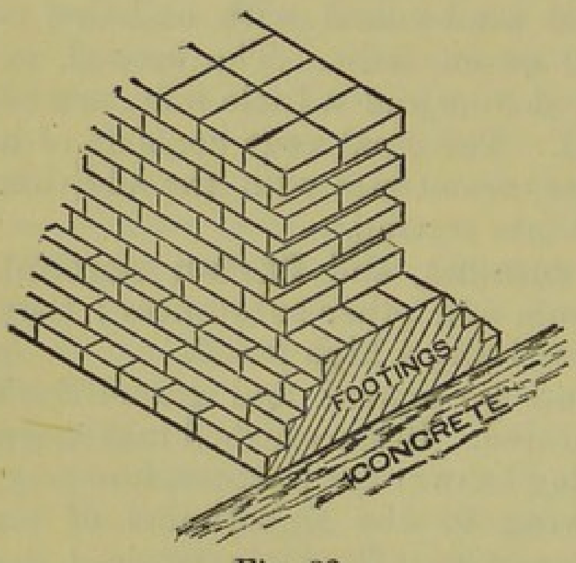


Fig. 83.

It is essential in all cases, except where the ground consists of rock or other solid material, to lay a foundation of good concrete, as a base for the wall footings. Unless this precaution is observed, buildings erected on loose soils are liable to subsidence which causes cracking of the walls. The depth of concrete for this purpose is regulated in accordance with the weight of the wall which has to be supported, but in no case ought it to be less than 18 inches. In width, it ought to extend at least 6 inches beyond the footings. The height of the footings themselves should correspond to at least two-thirds the thickness of the wall above them, and they ought to project on either side for a distance equal to at least one-half the thickness of the wall (Fig. 83).

Damp-proof Course.—Unless precautions are taken to impose a barrier to its upward progress, the moisture which is readily absorbed by the wall from the soil in contact with it, will rise, by capillary attraction, even as far as the upper rooms, and besides damaging the wall papers, will render the house damp and unhealthy. This is the most frequent cause of damp houses, and it is one that cannot well be remedied, except at considerable cost, when once the house is built, although it is easy to prevent it in the first instance. This is accomplished by placing a damp-proof course in the wall, a little above the level of the ground. Various materials are used for this purpose, such as sheet lead, two or three layers of slate imbedded in cement, or a layer of asphalt ¾ inch thick. Slabs of glazed stoneware are specially manufactured for the purpose, and perhaps answer better than anything else. They are perforated longitudinally, and thus serve another useful and necessary purpose, in allowing a current of air to pass freely under the flooring. These slabs are made in different widths, to suit walls of various thickness (Fig. 84).

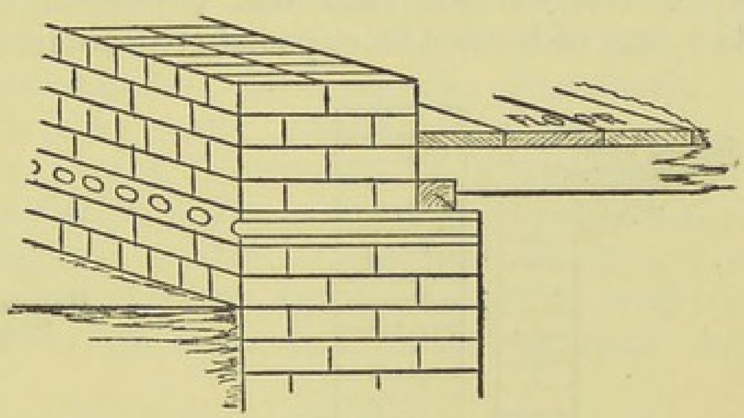


Fig. 84.

The above arrangement of damp-proof course is applicable in the case of a house without a basement storey, the flooring of which is above the ground level; it is obvious, however, that it would not answer the purpose in the case of a house with a basement, or one with the ground floor on a lower level than the surface. Under these circumstances, it is necessary to construct an area round the house, or a substitute for it, the bottom of which is below the level of the basement floor, so as to allow of a damp-proof course being inserted between the floor and the bottom of the area, in the manner just described. The construction of an area, however, is expensive, and not always practicable, but the same object may be attained, at less cost, by forming what is termed a **dry area** (Fig. 85). This practically corresponds with an ordinary area, except that it is covered, and is only sufficiently wide to keep the damp earth from touching the wall. Another plan (Fig. 86) that answers very well, is to build that portion of the wall which is below the ground level, **hollow**, and in this case it is necessary to insert two damp-proof courses, the one extending across the whole width of the wall below the basement floor, and the other across the outer section of the hollow wall a little above the ground level. The accompanying sketches will assist in making the above description clear.

No matter which plan is adopted, it is necessary to provide drainage from the bottom of the area or cavity, and, both in the case of the dry area and the hollow wall, ample openings must be provided for ventilation.

Impervious walls above the ground level are also of importance, otherwise driving rain will penetrate into them, especially in the case of houses in exposed situations, and during long periods

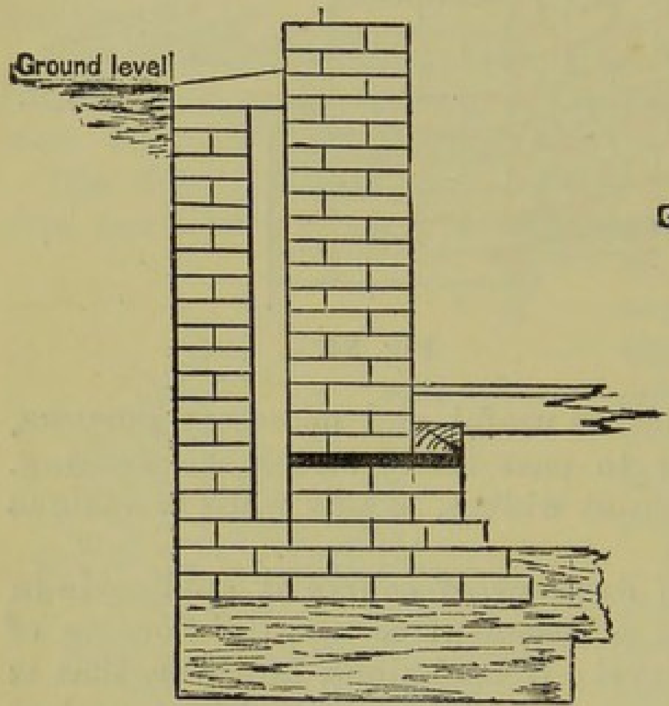


Fig. 85.

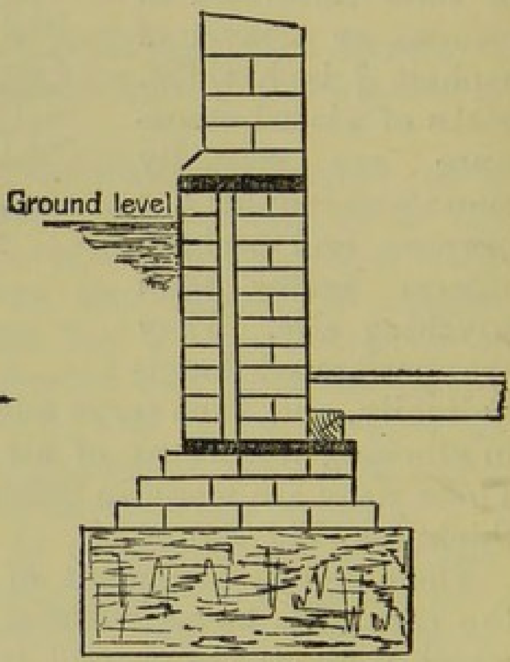


Fig. 86.

of rain. The fault is capable of correction in houses already built, but it is best to adopt precautions against it during the process of building.

Walls may be rendered practically waterproof by coating them with good Portland cement. Slates or tiles fastened to battens on the face of the wall, will also answer the purpose, although the former are unsightly, as indeed are the latter, unless in the original design it was intended to construct tiled walls. "Rough-casting," which consists of a coating of good mortar, on which shingle and small pieces of flint are sprinkled, answers the purpose when the work is well done, and it does not necessarily detract from the appearance of the house. Pitch or paint, if regularly renewed, will also protect the walls from damp, but both are unsightly, and the latter is costly.

Various plans are adopted for rendering the walls of houses impervious to wet in the first instance.

Cavity-walls are designed for this purpose; they are practically double walls, with a space of 2 or 3 inches between them, and these are tied together at intervals by bonding-ties of non-absorbent material, such as iron or glazed stoneware. In order to insure stability, the distance between each tie ought not to be greater than 3 feet horizontally, and 18 inches vertically, and if iron is the material used, it ought either to be galvanised, or coated with some other protective material, to prevent rusting. These walls, in addition to being impervious to wet, are bad conductors of heat; consequently, in houses so constructed, a uniform temperature is more easily maintained than in those built with solid walls of equal thickness. It is essential that ample means for the ventilation of the cavity should be provided.

Asphalt is sometimes used to fill up cavity-walls as a protection against damp, and it answers the purpose very well; in this case the space between the inner and outer wall need only be a narrow one.

There are other causes of damp walls besides those already mentioned. Damp may penetrate from the top, where **parapet walls** are unprotected. These may be protected in a variety of ways. The top line of bricks may be laid in cement upon a line of tiles, which project from the side to prevent rain from trickling down; or a sloping covering, consisting of slabs of stone, with the lower margins overhanging the sides, may be fixed along the top of the parapet. Another weak point is where the roof joins a parapet wall. The common method adopted in this case to prevent wet from entering the building is by cement flashings, but, sooner or later, the cement will separate from the brickwork, and cause leakage; lead flashings are much to be preferred (see p. 164). The lead is inserted in the joints of the brickwork, and passing across the angle formed by the wall and the roof is continued along the latter for a little distance.

Rain may collect on **window-sills** and run down the walls, unless the sills are constructed so as to project beyond the face of the wall. Again, a very common and serious cause of damp walls is **defective spouting**.

It is by no means uncommon, especially in the country and in small towns, to find houses entirely devoid of spouting. The evil arising from this is most serious, as any one who will take the trouble to look at the internal surface of the walls can discover for himself. It will also be found that along the base of the walls, unless the ground is paved, a gutter has been formed by the constant drip of the rain from the roof, and during the actual rainfall, this gutter will contain water, which is absorbed by the walls, within which it may rise to a considerable height. In the principal room down stairs, which in this class of property usually serves as the kitchen and living-room, the fire that is constantly kept burning modifies to a large extent the consequences of such defects, but in the bedrooms upstairs, in which there are no fires, the damp condition of the walls is at once apparent.

From what has been said concerning the danger to health arising from damp surroundings, it will be understood that it is the duty of authorities to insist upon all houses being spouted—a duty which is far too often disregarded. While recently inspecting a district in Staffordshire, the author met with a most striking example of the evil effects that had followed as the direct result of an important sanitary improvement. The greater portion of the district in question had been provided with a good and plentiful supply of water by a neighbouring company. The company's plant did not allow of the water being carried to one portion of the district, which was situated on a considerably higher level than the rest. The result was that, from the moment of the introduction of the water, the rain-spouts of the lower part of the district were allowed to decay, until little vestige of them was left, while the houses on the higher part were fairly well provided with spouts. The fact was, in the one case, the introduction of the water-supply rendered it unnecessary to conserve the rainfall, consequently it was allowed to take what course it liked; while in the other case, the absence of a water-supply rendered rain storage—and therefore spouting—necessary.

Thickness and Structure of Walls.—No house with one or two storeys ought to be built with walls of less thickness than 9 inches, and a 14-inch wall is much to be preferred; indeed, unless the building material is good, and the precautions against weather already described are taken, the latter thickness will not afford sufficient protection. If built of brick, the bricks ought to be properly bonded together, by being laid length-ways and cross-ways alternately, and only whole bricks should be used. This is important from the point of view of stability, as if broken bricks, or "bats" as they are called, are used, the wall is greatly weakened. When, from any cause, the foundations are at all doubtful, or if special strength is desired without increasing the thickness of the wall, **hoop-iron bonds** may be introduced.

The Roof.—The comfort of the householder is as much dependent upon the soundness of the roof as upon the goodness of the walls and foundations. Unless the material and workmanship are good, constant annoyance will be experienced from leakage, and, in addition to this, the temperature of the house is greatly influenced by the nature of its covering.

As already mentioned, roofs are generally covered with slates or tiles; in some localities, however, where suitable stone is available, thin slabs of it are used; stone, however, is objectionable, on account of its weight. For flat roofs, lead, zinc, and even copper are used. The inclination a roof ought to have is dependent upon the material with which it is proposed to cover it. If the material be metal, the slope need not be greater than will suffice for the rain to flow off into the gutters, and if slates or tiles are used, the necessary inclination depends, to some extent, upon their size and porosity. Large slates require less inclination than small ones. Stone slabs and tiles, being more porous than slates, ought to have a greater slope. The following figures indicate the inclination that is recommended in each case, including a thatched roof:— *

Large slab slates need	an inclination	of about	22°	with the	horizon.
Ordinary slates	,,	,,	26°	,,	,,
Stone slabs and tiles	,,	,,	30°	,,	,,
Thatch needs	,,	,,	45°	,,	,,

Slate varies very much in quality. For roofing purposes, it ought to be hard, non-absorbent, of fine quality, and free from veins or streaks. If veins are present, the slate in time will split, and unless it is hard it will break, or the nail-holes will gradually enlarge, and ultimately the slate will fall off.

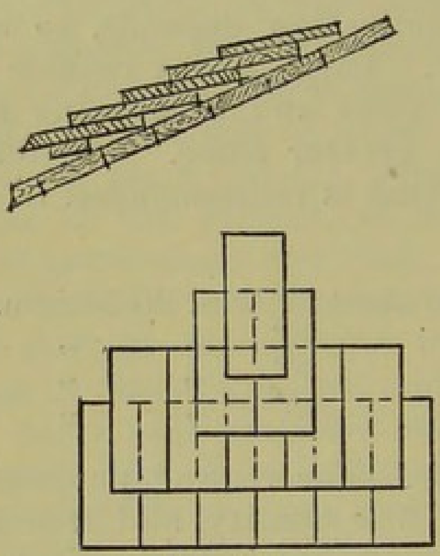
Slates are often laid on laths, but the practice is not a good one; boarding is far better suited for the purpose, as it forms a solid base, and offers a greater resistance to changes in temperature. If laths are used it is necessary to point the under side of the slates with hair mortar ("torching") in order to prevent the wind from blowing through, carrying with it rain or snow, as well as to steady the slates and keep them from rattling. It is an excellent practice to cover the boarding with felt before the slates are fixed; such an arrangement greatly conduces to the warmth of the house in winter, and its coolness in summer. Slating should be laid with a **3-inch lap,** otherwise the rain or snow will be driven through. This requires a little explanation which the accompanying sketch (Fig. 87) will make plain. By

* *Our Homes*, chapter on "Roofs and Roofing."

a 3-inch lap is meant, not simply that the lower edge of one slate should cover the top edge of the one immediately below it to that extent, but that it should overlap the next slate but one below it for 3 inches.

The nails used for fixing slates (two for each) ought to be made of copper or zinc, or a mixture of copper and tin; the first metal is best for the purpose, although composition nails and zinc nails answer very well. Iron nails ought never to be used as they rust, and ultimately break. Tiles are fastened by **oak pins.**

As already stated, **lead** is the material to be preferred as a covering for flat roofs, and **milled lead**—that is, lead that has been rolled out into sheets of uniform thickness—is the best.



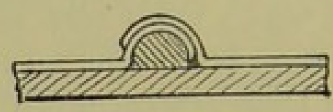


Fig 88.

Fig. 87.

Fig. 89.

The thickness of the lead used will depend upon whether there is a likelihood of the roof being walked upon to any extent, and if there is not 5 or even 4 pounds to the superficial foot will answer the purpose, although in some cases it may be necessary to use a thickness equal to 7 pounds.

In jointing the lead, it is important to remember that the metal expands by heat, so if seamed-joints are made, no play will be allowed for this expansion, and puckering, followed in time by splitting, will take place. To avoid this, it is best to unite the lead, by overlapping the edges over a wooden roll, in the manner shown in the sketch (Fig. 88).

As far as possible the use of nails must be avoided in all lead work, because of the galvanic action that takes place between the two metals leading to decay, and consequent leakage.

Zinc has certain advantages over lead, but these are far outweighed by its disadvantages, although, as now manufactured, it is admissible if proper care is observed in laying it. The advantages are its lightness and comparative cheapness; on the other hand, it is less durable, and more troublesome to fix. An angular roll (Fig. 89) is better suited for zinc than a circular one. With regard to the interior of the house, most points of importance have been dealt with in the chapters devoted to house drainage, but the construction of the floors has yet to be considered.

It is of the utmost importance that the **cellar** and **basement floors** should be laid so as to be absolutely impervious to ground air. The significance of this, from a health point of view, has already been noticed, and it is impossible to over-estimate it. The damp and disagreeable odour that rises from cellars is well known to every one, yet, even in modern buildings, precautions are seldom taken to correct the evil. Cellar floors are usually formed of bricks set on the ground itself, without even a bed of mortar being interposed, and thus but little opposition is offered to the entrance of unwholesome effluvia, which are attracted by the warmth of the house, from an area considerably larger than that upon which it stands.

That this happens there is ample proof in the penetration of gas from leaking street mains, especially during a continued frost, when the ground outside the house is more or less hermetically sealed, and the cellars are the only vents. If, then, ordinary gas can find its way into houses, why not sewer gas from pervious sewers and cesspools as well as the ground air, it may be, from a made site formed of decaying vegetable and animal matter?

The following striking example of the danger arising from pervious cellars recently occurred in the author's experience, and was attended with serious consequences.

In Darlaston, a mining town in South Staffordshire, a whole family, including the father, mother, and three children, were found one morning early in January, 1891, in bed, on the first floor of a small cottage, in a comatose condition. From this state it was impossible to rouse them, and unconsciousness lasted from twelve to twenty-four hours. The medical man in attendance at first could not account for the symptoms, and the condition of the patients was so serious, that he remained in the house for three hours. At the end of this time, he, as well as friends of the family who were assisting, began to suffer from severe headache and lassitude, and then it was decided to remove the patients to another house. as it was suspected that the symptoms were in some way associated with the surroundings of the cottage. The opinion that the illness was owing to some atmospherical cause, was ultimately strengthened by the discovery that two canaries and a cat had died during the night in the kitchen of the cottage, the former in a cage, and the latter in a cupboard, the door of which was open. The same morning, also, in a house on the opposite side of the road, the occupants of which had, for some time, suffered from headaches and depression, two birds were found dead in their cage in the kitchen. It is important to notice that all the animals died in the respective kitchens of the houses—and, therefore, on the ground floor—while the families slept on the first floor, a circumstance to which, in all probability, they owed their escape from death.

Enquiry afterwards elicited that the family in question, as well as at least two other families in adjoining houses, had suffered from headache, &c., more or less persistently for three weeks, a period which corresponded exactly with the existence of a fire in a disused mine, the workings of which were within 60 feet of the surface.

It was afterwards proved by analysis that poisonous air, containing carbonic oxide gas (see p. 63), the result of the combustion under ground, was being discharged into the houses through the pervious cellar floors, and this gas, combined no doubt with carbonic acid gas, was the undoubted cause of the illness.

It is interesting to notice, that for several weeks previous to the occurrence, the surface of the ground had been covered with snow, and frozen to a considerable depth; had this not been the case, possibly the illness would not have occurred, at any rate in such a severe form.

Such an occurrence as that just related is, happily, rare, but it possesses an interest to health officers, beyond the fact of its being unique, in the lesson that it teaches as to the importance of so constructing cellars of houses, that they shall be impervious to ground air.*

To render a cellar dry and impervious to ground air, it is necessary to cover the floor with a non-porous material, but unless a dry area or other contrivance has been provided, this alone will not suffice.

Concrete or asphalt, or both combined, is the most suitable material for cellar floors. It is a mistake to suppose that concrete, as it is commonly laid, is impervious; in order to

* For a full account of the above occurrence, see a paper by the author in *Public Health* for April, 1891.

be so, it must be well rammed down and laid 6 inches deep, the surface should then be well grouted with liquid cement, and afterwards floated with a smooth surface of cement. Nothing more need be done, as this will form an excellent floor, but, if it is preferred, a surface of asphalt may be laid on the top, or it may be bricked over, or stone flagging may be laid down. It is necessary to provide for ventilation, by fixing air-openings under the ceiling on opposite sides.

Such a floor as this will answer very well for the ground floor of houses without cellars, as it is smooth, cleanly, and free from any cracks that will harbour dust. If, however, wood flooring is desired, it should be laid on a similar bed of concrete, free ventilation being provided for underneath, either by means of ordinary air-bricks, or openings covered with iron-gratings, or by the perforated glazed slabs already described (p. 159).

Ordinary wood flooring in kitchens is conducive to black beetles, but what is known as a **wood-brick floor**, by reason of its solid construction, does not favour such vermin, and is warmer than bricks or tiles. These wood-bricks, which are generally 10 inches long by 3 inches wide, and from $\frac{3}{4}$ to $1\frac{1}{2}$ inch thick, are laid in a mixture of tar and asphalt, on a bed of concrete. Such a floor is noiseless, durable, and cleanly. Wood-brick floors are sometimes laid with the end grain of the wood upwards, but they are not so easily cleaned, and they stain more readily.

It is unnecessary to describe in detail the various kinds of wood flooring (fancy and otherwise) for upper rooms, but a few points, of importance in a sanitary sense, may be mentioned.

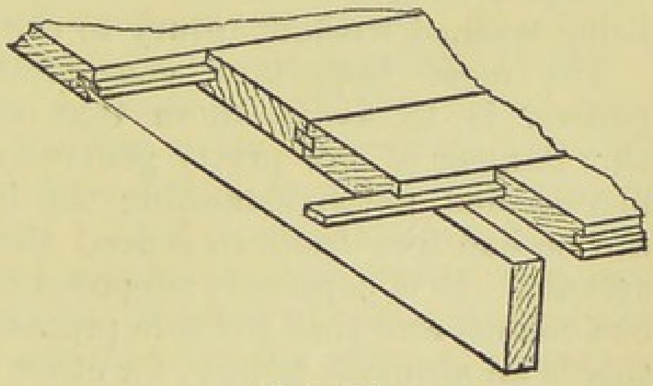


Fig. 90.

In the first place, it is essential that seasoned wood only should be used, otherwise spaces will very soon be formed between the boards, through which dust will fall into the space between the floor and the ceiling below. It would astonish most people to see the amount of filth that does so collect. To avoid this, one or other of the various plans for uniting the edges of the boards should be adopted, and the most usual is what is known as the **ploughed and tongued floor** (see Fig. 90). Both edges of the boards are grooved, so as to receive strips or tongues of wood or iron, the groove being deep enough to receive one-half the width of the strip, so that, when the abutting board is pushed home, an equal width of strip is embraced by both. If iron is used, it ought to be galvanised to protect it from decay. The joints between the ends of the timber are usually made by simply adjusting the two flat ends together, but it is better, in inexpensive work, to splay the ends, so that the one slightly overlaps the other. These joints ought invariably to correspond with the joists, and contiguous boards ought not to be jointed over the same joist.

Double joists, the upper lot for the floor, and the lower for the ceiling-laths of the room below, are much to be preferred to single joists only with ceiling-laths. They afford a firmer surface for the plaster, which, in consequence, does not crack so readily, and sound is less easily carried from one room to the other.

Wall-papers.—Mention has already been made of the most suitable material for lining walls, the great object to be attained being smoothness of surface, and non-porosity; the decorative part of the work has now to be considered, in so far as it relates to health.

A wall-paper ought to have a smooth surface, so that dust may not collect on it, although certain stamped papers that have an uneven surface are easily cleansed. The worst dirt collectors are flock papers. Most papers, unfortunately, absorb moisture, but the worst in this respect are the so-called satin papers. Washing papers are now manufactured, and some of these, for example, that known as "Muraline," certainly do permit of being washed without injury to the colour.

The most important consideration, however, in selecting papers, is to avoid those that contain **arsenic.** Although this danger is now pretty generally recognised, it is too often disregarded, notwithstanding the fact that papers in all colours can be had free from it, indeed the best makers no longer use arsenic. It is popularly supposed that green is the only dangerous colour, and that the sole precaution necessary is to avoid it; this is an absolute fallacy, for other coloured papers may contain arsenic.

The medicinal dose of arsenic varies from $\frac{1}{60}$ to $\frac{1}{12}$ grain, and when one considers that wall-papers have been found to contain as much as 17 grains per square foot, the gravity of the question becomes apparent. The danger attending the use of arsenical wall-papers arises from the substance being inhaled, either as dust particles, or in the form of a gas—namely, *arseniuretted hydrogen*, and the risk of both occurrences is increased by the methods adopted in the preparation of the paper. Size is used for the purpose of retaining the colour, and when it dries it has a tendency to crack and peel off, carrying with it particles of colouring matter, which are thus disseminated throughout the air of the room. It would appear also that size, in combination with arsenical compounds, has the power of liberating the highly poisonous gas already mentioned, which, owing to its ready absorption by the lungs, is the most fatal form in which the poison is met with.

There is no simple test by which the public can ascertain the presence of arsenic in wall-paper, so that the only safeguard is to deal only with reliable firms, and if there is any reason to doubt their honesty, it is well to ask for a guarantee with regard to the purity of the paper, which may afterwards be verified by the certificate of an analyst. It may be mentioned in passing, although it does not come within the scope of this work, that certain articles of clothing—muslin for example—as well as artificial flowers, and toys, may give rise to arsenical poisoning.

Re-Papering of Walls.—Before re-papering a room the old paper ought to be completely removed, and the walls should be thoroughly cleansed. This is a practice which is by no means invariably followed, although a moment's thought will convince one of its importance. Layer after layer of paper is applied, one above the other, by means of paste composed of organic matter, and the result of this is that decomposition, which is encouraged by the moisture and heat of occupied rooms (see p. 69), ultimately takes place, and unwholesome smells are given off.

In concluding this chapter on house construction, it may be laid down as a general axiom, as regards the interior, that angles and projections should be avoided as far as possible, especially in situations beyond convenient reach, as they encourage the accumulation of dust and dirt. This caution applies equally to articles of furniture, such as wardrobes, projecting cupboards, and bookcases, the tops of which, in place of being perfectly flat, have usually false cornices attached for the sake of appearance, forming deep receptacles in which the dust of ages collects. In the case of new houses, it is becoming customary to construct such articles of furniture as fixtures in the walls, a practice which economises space, and obviates the nuisance referred to.

To facilitate cleansing, it is also desirable that all floor coverings should be easily removed. **Carpets** ought not to extend over the whole floor, as they will then seldom be taken up, owing to the labour involved in moving heavy side pieces of furniture. Thus dirt will collect within the texture of the material, and be scattered throughout the air of the room by persons walking about. In bedrooms especially the less floor covering there is the better.

Unless under exceptional circumstances, wooden floors should not be washed, as damp is thus diffused throughout the room. This is especially important in the case of hospital floors. Polishing with beeswax is a far better proceeding, and it renders the floor almost non-absorbent.*

CHAPTER IX.

INFECTION AND DISINFECTION.

THE subject to which this chapter is devoted is one which ought to engage the serious attention of the Sanitary Inspector and the public generally. It is one concerning which the grossest ignorance prevails, at the cost of a large amount of needless suffering and death. The royal president of the recent International Congress of Hygiene and Demography, in alluding in his inaugural address to the class of diseases known as **preventable,** asked the question, "If preventable, why not prevented?" In reply, it may be said that apathy and ignorance on the part of the public are mainly responsible, and until the people wake up to the fact that without their assistance the efforts of sanitarians to stamp out contagion must be largely inoperative, little advance can be made.

In order to appreciate the importance of the precautionary measures which are recommended for the purpose of preventing or limiting the spread of infectious disease, it is necessary in the first place to consider what the nature of the infective agents is, and by what channels they enter the body. There are few subjects more interesting, none more important to the sanitarian, than investigations into the nature of that something, outside and apart from our bodies, to which we owe the existence of infectious disease. Modern research in this direction has

* For a more detailed, and at the same time simple, account of the principles of house construction, see the chapters devoted to the subject by Mr. P. Gordon Smith and Mr. Keith D. Young in *Our Homes*, edited by Shirley F. Murphy.

thrown considerable light on what formerly was wrapt in obscurity, and although much yet remains to be discovered, what has already been accomplished has exposed many fallacies and brought about many changes in the old methods of prevention.

The researches ot Pasteur, Koch, and Klein, along with those of many other investigators, have revolutionised preventive medicine, and, through their labours, the truth of what was known as the "germ theory of disease" may now be said to have been proved. As the discovery of the cause of disease is the first step towards the remedy, the more accurate our knowledge, the more active must our efforts be to make use of it. The investigations of these men have exposed dangers to health formerly unthought of, and already fresh legislation has been the result.

More particular attention has thus been directed to our food-supply as a source of danger to health, and this has led to the introduction of the "Dairies, Cowsheds, and Milkshops Order," and the recent "Infectious Diseases Prevention Act," both of which have added to the responsibilities of sanitary authorities. The study of diseases of animals in relation to those of man has brought to light new dangers; for example, the investigations, at the instance of the Local Government Board, into the cause of the now celebrated epidemic of scarlet fever at Hendon, and later at South Kensington, in which the contagion was apparently traced to an epidemic affection of the teats of cattle of a trivial nature.*

Dr. Creighton and others have established the identity between tuberculosis in man and animals, and the knowledge that, probably, the *bacillus* of tubercle, the micro-organism of that most fatal disease—consumption—may be introduced into the system by cow's milk and butcher's meat, has led to important results.†

Again, as regards the channels by which the contagion of diphtheria may gain admission, the opinion that domestic animals are in some cases responsible has, during the past few years, been gaining ground. In 1888, Dr. Bruce Low, in a report to the Local Government Board on an epidemic of this disease which occurred at Enfield, mentioned an instance in which a cat seems to have communicated the infection. It

* See also an account of an epidemic of scarlatina by Dr. Bostock Hill, *Public Health*, August, 1891.

† It is still an open question whether the flesh of animals suffering slightly from tubercle of the lung only ought to be condemned; see Chapter X.

appears that a child, who died from the disease, had vomited on to the floor on the first day of illness, and a cat was seen to lick the vomit. In the course of a day or two (and after the boy had died) the cat was found to be suffering severely from symptoms very similar to those noticed in the case of the boy, so much so that the owner destroyed it. Early in its illness this cat was let out into the back yard, and a few days later a cat belonging to a neighbour, which had also been in the yard, was found to be suffering in the same way. The second cat, during its illness, was constantly nursed by four little girls, all of whom developed diphtheria, and, apart from this, no other source of infection to which they had been exposed could be traced.

Dr. Klein, in a communication to the Royal Society in May, 1890, gave it as his opinion, and supported it by very striking evidence, that not only cats, but cows also, are liable to suffer from diphtheria.

Although, no doubt, in time further evidence will be forthcoming to establish a closer connection between the diseases of animals and those of man, by far the most frequent cause of infection is personal communication, either direct or indirect. This will be dealt with in discussing the preventive measures appropriate to each disease.

The belief, then, that all infectious diseases are associated with minute **living germs** (*micro-organisms*) is now generally accepted; in fact, in the case of several diseases the connection has been demonstrated.

These germs possess an independent existence, and, when introduced into the body, have the power of multiplying enormously. Whether they are the direct cause of the diseases with which they are associated, or whether the cause is to be attributed to morbific materials to which they give rise, is still an open question, but this does not affect the main fact that their presence is an essential element in the production of what are known as **specific infectious diseases.** Neither does it matter, for our present purpose, in what manner their existence within the body gives rise to the manifestations peculiar to each form of disease.

Some of these organisms are extremely tenacious of life, as is shown, for example, by the fact that the contagion of scarlatina has been proved to retain its virulence for years in clothing.

In order to combat the diseases of the infectious class, it is necessary to know the habits and understand the requirements of the organisms which give rise to them, and as filth, in its broad sense—foul air, foul water, and foul surroundings—is the chief essential to their existence, cleanliness is the weapon to be used against them. That filth and disease go hand in hand has long been recognised; it is the discovery of the reason that is of recent date. The old argument—still often used—that certain insanitary conditions, to which any outbreak of disease is attributed, had long existed without serious consequences, can now be answered as follows:—"True, but the one element necessary—the specific germ—was not present, although everything was ready for its reception; it might have come and gone had it not been so well received, and no one need have been conscious of its presence." Although, then, to the naked eye the actual organism of disease is not visible, the conditions upon which its growth and development depend are, and it is to these that our attention must be directed in order successfully to prevent the ravages of the invisible foe. Given a perfect state of cleanliness, in the broadest sense of the term, most diseases of the contagious class would become things of the past. Until this state of perfection is reached (should this ever happen), we must be prepared with the means of destroying contagion when it is met with.

Behaviour of Contagion within the Body.

After the introduction of the contagion into the body, by whatever channel, some time elapses before the disease manifests itself; this is termed the **period of incubation,** and it varies in different diseases from, it may be, a few hours to several weeks or even longer. This fact has an important bearing in connection with the preventive measures to be adopted, and it will be referred to again when we come to consider each disease separately.

During this period the germs rapidly multiply within the body, until what is termed the **period of invasion** is reached, when symptoms peculiar to the disease in question become manifest. The severity and duration of the second period varies, although in some diseases, such as enteric fever, the duration is fairly constant, but, sooner or later, if no secondary consequences follow, and the patient survives, the disease ends in **convalescence.**

The period of greatest danger, from an infectious point of view, varies in different diseases. In measles and whooping-cough, for example, it corresponds with the early stage of the malady, in enteric and typhus fevers with the acute stage, while in the case of scarlatina, small-pox, and possibly diphtheria, the danger is greatest in the later stages and during convalescence, although small-pox and diphtheria are both highly contagious from the first.

MEAN ANNUAL MORTALITY FROM SCARLATINA PER MILLION LIVING AT SUCCESSIVE AGE-PERIODS, 1859-85.

Age.	Annual Deaths per Million Living.	
	Males.	Females.
0 — 1	1,664	1,384
1 — 2	4,170	3,874
2 — 3	4,676	4,491
3 — 4	4,484	4,332
4 — 5	3,642	3,556
0 — 5	3,681	3,482
5 — 10	1,667	1,613
10 — 15	346	381
15 — 20	111	113
20 — 25	59	77
25 — 35	36	58
35 and upwards.	13	15
All ages.	778	717

It must not be inferred, however, from these remarks that a relaxation in the precautionary measures adopted is justifiable during any stage of infectious disease, and it must be remembered that as stringent precautions are necessary in mild as in severe cases, for it does not follow that the type will be maintained—a serious case may owe its origin to a mild one.

The common practice of exposing children to infection, on the pretext that the ailment, whatever it may be, is mild in its nature, and that, sooner or later, they will contract the disease in any case, is greatly to be condemned. One especially hears this argument used during outbreaks of measles, whooping-cough, and scarlatina. It is, however, highly fallacious, for the following reasons:—(1) A mild case may give rise to a serious one; (2) it by no means follows that all should suffer during some period of their existence; (3) one attack does not necessarily afford protection from a second; (4) the fatality in children is nearly always greater than in adults; (5) the liability to attack diminishes with age.

Case-Mortality. Deaths per 1,000 Cases of Scarlatina in Hospitals 1874-85.*

Age.	Males.	Females.
0 — 1	395	442
1 — 2	384	346
2 — 3	255	226
3 — 4	184	174
4 — 5	130	112
0 — 5	241	217
5 — 10	106	97
10 — 15	56	53
15 — 20	40	34
20 — 25	39	32
25 — 35	75	43
35 and upwards.	85	65

* English figures seem to show a greater case-mortality in the second than in the first year of life; *vide* paper by Dr. Whitelegge, *Epidemilogical Transactions*, 1887-8.

The foregoing tables, bearing on the last two statements as regards scarlatina, are taken from the Registrar-General's Report for 1886. The influence of sex, both as regards fatality and liability to attack, is also shown, but this does not concern us. As the figures on p. 174 are based upon nearly half a million deaths from scarlatina, which were registered during 27 years, conclusions may safely be drawn from them. The small number of deaths among adults as compared with children is very striking; that this is not entirely accounted for by the tendency to attack being greater in children, the figures on previous page show.

These figures are based upon 17,795 cases of scarlatina, which were treated in the Metropolitan fever hospitals during twelve years (1874–85), and 5,000 cases recorded in the different reports for Christiania as having occurred during four years (1870–73). The reason for including the latter cases was, that the records of the English hospitals did not permit of the deaths which occurred in children under five years being sub-divided into yearly age-periods, whereas the figures taken from the Christiania reports were so sub-divided, and as the death-rates under five years practically correspond in both cases, it was thought reasonable to conclude that the same would hold good as regards the yearly periods. Further comment upon these tables is unnecessary; they prove conclusively that the longer an attack of scarlatina is delayed after the fifth year of life, the less likelihood is there of its occurrence, and that, should it occur, it is less likely to prove fatal for every year that it is delayed after the second year of age.

As regards measles and whooping-cough—the other two diseases which are erroneously regarded as being incidental to the lives of all—practically the same remarks are applicable, although statistics on a large scale, showing this to be the case, are not available. Both of these diseases are less likely to occur in adult life than in childhood, and the risk of death is far greater in infants. Sixty per cent. of the deaths from measles occur during the first two years of life, 75 per cent. during the first three, and over 90 per cent. occur among children under five years; while of the fatal cases of whooping-cough, 40 per cent. occur under one year, 75 per cent. under two years, and 96 per cent. under five years.

Enough has been said to show the risks that children run through careless exposure to infection, and the facts cannot be too forcibly brought home to those whose duty it is to protect them

General Preventive Measures.

Before discussing in detail the special preventive measures recommended and practised in the case of each disease belonging to the infectious class, it may be well to consider the general principles that ought to guide one in forming an opinion regarding their efficacy under the following heads, namely—**Isolation, Quarantine,** and **Disinfection.**

Isolation of the patient, to be effective, cannot under ordinary circumstances be accomplished at home, but in large establishments it may, provided scrupulous attention is paid to certain details of management. Sometimes one does meet with thoughtful and intelligent parents, who in their anxiety to save the rest of the household from the disease, and at the same time keep the patient under their immediate care, will carry out, to the letter, all instructions regarding the requisite preventive measures; but more frequently, however anxious people may be not to err in any direction, inexperience is very apt, sooner or later, during a long and anxious illness, to lead to the neglect of some vital precaution. As a rule, the only person to be relied upon is a good nurse, who, from long training and experience, has acquired habits of caution which have become almost automatic.

Having selected rooms at the top of the house (or, better still, in a detached wing) that may be set apart for the patient and his attendants, all unnecessary articles of furniture, carpets, curtains, and bed-hangings should be removed, only such as are essential being retained in the room. The other occupants of the house must be forbidden, on any pretext whatever, to pass beyond a certain limit, and all necessaries, such as food, coal, &c., should be carried that distance and no farther.

Attention to ventilation in the sick room, by the frequent opening of windows at the top, is of the utmost importance, and a fire ought always to be kept burning, whatever the season may be, to insure that a constant current of air shall pass into the room and up the chimney, and thus limit the risk of infected air passing from the room into the house; besides, by having a fire in the room, all useless infected articles may be burned at once. No articles of clothing, or utensils, should be taken out of the room without first being disinfected, in a manner to be described presently. The persons in charge of the patient must not leave the room without first washing their hands and changing their outer clothing. It is well that the dress worn in nursing the case (which ought to be of a washing material), should be left in the sick room, and the substitute put on in an adjoining room, which also must be looked upon as closed to the rest of the household.

The common practice of hanging sheets, moistened in supposed disinfectants, outside the door of the sick room, serves no purpose whatever, as, even allowing that the material used may be a disinfectant, any air passing out of the room would not penetrate the sheet but pass under or round it. Vessels placed about the house, containing Condy's fluid or carbolic acid, are equally useless; both certainly act to some extent as deodorants, but by far the best deodorant is fresh air. The public have a strong faith in such measures as these, although, as will presently be explained, they have no real virtue, and on the ground that the false security they afford may encourage a less careful observance of needful precautions, their use ought to be discountenanced.

From the above account of what is essential to successful isolation, it will be apparent that the conditions cannot be fulfilled in the case of cottages and small houses.

With regard to the period during which the patient should remain isolated, that is a question which must be decided by the medical attendant, who ought to certify when the time of danger is past; it varies in different diseases, as will be pointed out later.

The structural arrangement and management of **isolation hospitals** hardly come within the scope of this little volume, but as it is only by their help that we can hope to cope with epidemics, and as at present their provision is entirely optional, it is important that the attention of sanitary authorities should be called to their true value as part of the necessary machinery of public health administration, in conjunction with the adoption of the recent Compulsory Notification of Infectious Diseases Act. It is only by the immediate isolation of early cases that one can hope to prevent an extension of infectious disease, and money is certainly well spent in providing the means of doing this, for not only is disease thus curtailed, and life saved, but economy is exercised, for illness means poverty, and poverty increases the rates.

In the case of small districts, there is, no doubt, some excuse for the absence of hospital accommodation, although the law provides for the union of districts, and consequent division of cost (a provision which some authorities have availed themselves of), but until the present permissive clause is made compulsory, or the provision of hospital accommodation is intrusted to

County Councils, little will be done in this direction. Were this branch of preventive medicine intrusted to a Central Authority, efficiency and economy would be secured. For example, a staff of trained nurses could then be established in a central position, and, as occasion required, they might be drafted off to any part of the county. The number of this staff could be regulated in accordance with the prevalence or otherwise of epidemics, but the probability is, that it would be fairly constant, and it is conceivable that, if necessary, one county might assist another, at times when the strain was greater in one than in another. By such a system as this, economy would undoubtedly be effected, and there need no longer be any delay in the isolation of first cases. At present, in the case of small hospitals with no permanent staff, this delay does occur, and often leads to unnecessary extension of disease.

To bring about this change legislation is necessary, and we all know that means time; those who are striving to bring about local reform under present conditions, must, therefore, be cautioned not to relax their efforts, as any expense that is wisely incurred will not be thrown away, whatever the future has in store for us.

In addition to isolation of the patient, it is necessary, in order to secure the full benefit from such a proceeding, to impose a period of **quarantine**—varying in different diseases, and regulated by the duration of the incubation stage—upon all those previously in contact with him. It is obvious that unless this precaution is observed, the object aimed at, namely, the stamping out of the disease, may be defeated, for others may already have contracted it, and thus the poison may be disseminated broadcast.

Difficult as it is to secure proper isolation, the difficulty is still greater as regards quarantine. When illness occurs in a family, it is more than ever necessary that the bread-winners should be at work. This argument, however, does not apply in the case of children, who ought always to be kept from school until all danger of communicating the disease is over. If the patient has been isolated, and the premises have been thoroughly disinfected, this period need not be prolonged beyond the full extent of the incubation period of the disease in question; but if, in the meantime, other members of the family should show symptoms of the disease, the quarantine period must start again *de novo* after the isolation or termination of the fresh cases, and the re-disinfection of the premises, &c. In certain diseases both isolation and quarantine must be enforced more rigidly than in others.

In the case of small-pox, for example, both are of the utmost importance, whereas a case of enteric (typhoid) fever does not call for such extreme caution, indeed, quarantine if not isolation may be dispensed with, provided every care is observed in dealing with the discharges from the patient, according to the instructions which are given later on. In the case of people engaged in certain occupations, quarantine must be strictly enforced. For example, tailoring, dress-making, glove-making, washing, milk-selling, and people engaged in handling food or clothing.

In some towns quarantine stations are provided by the authorities, and the occupants of infected houses are granted free board and lodging until the danger of communicating the disease is past.

In one town in Staffordshire the people themselves, assisted by the employers of labour, render immense assistance to the sanitary authority in preventing the spread of infectious disease, by subscribing to a fund for enabling the workmen either to stay away from work, or not to live at home when infectious disease breaks out in their families. The men employed in those works in which the "Infectious Disease Fund" is established, either have their wages paid regularly when not at work from this cause, or are provided with lodgings away from home free of cost, while the danger lasts. In this town, which has a population of 36,000, during the year 1890, £312 was paid to workmen from the fund in question. Commendable as this voluntary effort on the part of the people is, it cannot be productive of the good it might, because there is no isolation hospital in the district. Quarantine is an excellent thing in conjunction with isolation, but without the latter, the contagion is left to spread from a multiplicity of unguarded centres, in place of being confined to one selected spot.

The question of the **closure of schools** during epidemics is one concerning which a certain amount of difference of opinion prevails, and it may conveniently be discussed at this stage as the responsibility rests with the sanitary authority, under the advice of the Medical Officer of Health.

The view held by some is, that it is a valuable measure to adopt in all cases, while others doubt whether it has been demonstrated that much good results from it. The truth probably lies between these two opinions, and no hard and fast rule can be laid down; what is applicable to densely-populated towns, may not apply to widely-scattered rural districts, and in some cases a modified course might be the right one to adopt.

In rural districts the school is the centre of communication between families who possibly might otherwise see nothing of each other. In such cases, to allow children from distant villages—where, say, scarlet fever is prevalent—to continue to congregate daily, in a centre where they come in contact with children from other villages where the disease does not exist, would be a rash and dangerous proceeding; but it does not follow from this that complete closure of the school is essential in every case, as the exclusion of all children belonging to the infected area may, in many instances, meet the case. When several centres of infection exist in a scattered district, there is little doubt about the desirability of complete closure.

In densely populated urban districts, on the other hand, where, apart from school attendance, the children freely associate together in the streets and houses, the advantage of closing the schools is not so obvious, although, of course, all children from infected houses must be debarred from attending. At the same time, it is but reasonable to suppose that the risk run by meeting in the open air while at play is considerably added to by lengthened and close confinement in badly ventilated class rooms. On the whole, then, in arriving at a conclusion, while the consequences from an educational point of view ought not to be lost sight of, should any doubt exist with regard to the advisability of complete closure, it is unquestionably the wiser course to err on the safe side.

It is important that school teachers should be informed of the existence of infectious cases when other children of the families attend the school, so that they may be in a position to prevent their attending. Teachers may render valuable assistance to health officers during epidemics by notifying that certain children are absent from school owing to illness, as enquiry can then be made with regard to the cause. This assistance is usually willingly given, and is of value even if the Compulsory Notification Act is in force in the district, as all cases are not considered serious enough to require medical attendance, and so the parents may plead ignorance of the nature of the ailment, and not report the cases.

The all-important question of **disinfection** has now to be considered, in relation to patients, rooms, and articles of clothing and bedding.

The terms **disinfectant** and **disinfection** ought only to be applied to substances or proceedings which are absolutely destructive of the virus of disease. They are seldom, however, used by the public in this strict sense. Many substances possessing merely **antiseptic** properties (the power of arresting the development of germs), and even simple **deodorants,** are erroneously supposed to be disinfectants.

It has been proved that during certain stages in the development of disease organisms they are more tenacious of life than at others, and that what will suffice to kill the mature germ may be inoperative against the vitality of the *spores* or seed, which, surviving, continue to develop when favourable circumstances arise. A disinfectant, therefore, to be of any use, must not only **arrest the growth of,** but absolutely **destroy** the morbific agent; any action short of this, as already hinted, is worse than useless as regards checking the disease, for it gives a false security, and so encourages laxity in the exercise of other precautionary measures.

The following are the essential conditions in a true disinfectant:—

(1) *That it shall be capable of killing germs and their spores;* (2) *that it shall be applied to every part;* (3) *in sufficient strength;* (4) *for a sufficient time.*

These conditions have been established by experiment—the only safe method of arriving at a conclusion—and unless all are complied with, danger is not averted.

The experiments were conducted as follows:—A substance known to contain the virus of a certain disease, was subjected to the various methods of disinfection in use, and its virulence was afterwards tested by one of two methods—either by inoculating an animal susceptible to the disease in question, or by placing the material under conditions favourable to the development of the germs (cultivation), and observing the result. In the first case the animal will contract the particular disease unless the vitality of the germs has been absolutely destroyed, and in the second case failure is demonstrated by the fact that fresh germs will develop in the cultivating medium.

Of course these experiments were conducted with the utmost care, and the accuracy of the results was in all cases verified by "control experiments," that is, by inoculating with or cultivating the same virus which had not been disinfected.

The particular germs selected for these experiments were those which are associated with anthrax disease (anthrax bacilli). These were chosen for two reasons—first, because they can easily be cultivated, and when inoculated into animals susceptible to the disease, they give rise to unmistakable symptoms; and secondly, because the spores of these germs are not readily killed; therefore, what will destroy them will in all probability with greater certainty destroy those of other diseases. *

Process of Disinfection.

The process of disinfection is conducted in a variety of ways, according to the necessities of the particular case—that is, whether it be rooms, articles of clothing or bedding, discharges from patients, food and drink, &c., that are infected. The means at our disposal are—(1) **heat** (dry or moist); (2) **chemical substances** (in liquid or powder); (3) **fumigation** (by gases or vapours); and last, but by no means least, (4) **fresh air and general cleanliness.** Each will now be considered in the above order.

Heat is the best disinfectant we possess. By boiling an infected liquid or any article of clothing for ten minutes all disease-germs and their spores are destroyed. So, by exposing any infected article to steam at a temperature of 212° F., provided the second and fourth conditions (p. 182) are complied with, all danger is removed.

Dry heat is by no means so efficacious as moist. Experiments made by Drs. Parsons and Klein † show that it requires an exposure for a period of four hours to a dry heat, at a temperature a little over that of boiling water (212° to 216° F.), to destroy the spores of the anthrax germ; when the heat is raised to 245° F., however, one hour's exposure suffices. It must be remembered, however, that the latter temperature, as far as dry heat is concerned, very closely approaches the scorching point, most articles being injured by long exposure to a temperature above 255° F.

When the question of dry or moist heat is considered from the point of view laid down in the second *condition*, namely, *that it shall be applied to every part*, the advantage is again found to be in favour of the latter, because *the penetrating power of moist is much greater than that of dry heat.* Most articles that have to be disinfected in this manner—blankets, pillows, &c.—are bad conductors of heat, and as the infection is not confined to the exterior, but may penetrate into pillows and beds, and be enclosed in folds of blankets, it is essential that the temperature of the interior should be raised to the required point. The following figures show how difficult, indeed, how impossible it is, with

* For a simple account of the methods of cultivation, &c., of germs, see *The Story of the Bacteria and their Relations to Health and Disease*, by T. M. Prudden, M.D., published by G. P. Putnam & Sons.

† Supplement, 14th Annual Report Local Government Board.

dry heat, to arrive at this result. They are the outcome of 120 experiments by Dr. Whitelegge, with one of the best hot-air disinfecting apparatus in the market (Ransom's), and the figures given represent the mean of those obtained in the series.

During the whole period of exposure, the air introduced into the apparatus was heated to a temperature of 255° F., while the registered temperature of the escaping air at the end of the experiments ranged from 245° to 250° F.

REGISTERING MAXIMUM THERMOMETERS PLACED BENEATH LAYERS OF BLANKETS.

Duration of exposure.	2 Layers.	4 Layers.	6 Layers.	12 Layers.	18 Layers.
4 hours, . .	220° F.	206° F.	190° F.	162° F.	139° F.
6 „ . .	226° F.	214° F.	208° F.	174° F.	153° F.
8 „ . .	230° F.	221° F.	215° F.	196° F.	182° F.

The contrast between these results and those obtained by another series of experiments with steam disinfecting apparatus, is very remarkable, and demonstrates conclusively the advantage of moist as compared with dry air. "An electric thermometer set so as to ring at 212° F., was placed between sixteen or more layers of blankets, and served to indicate the exact interval between the first exposure to steam and the attainment of the required temperature—namely, 212° F. . . . the maximum interval noticed was 17 minutes." *

Not only, therefore, is steam greatly superior to hot air, but the economy in time required for the completion of the process is immense. Remembering also what has been said with regard to the inferiority of dry as compared with moist heat at the same temperature, even when in perfect contact with the infected article, and, considering that the one fails to do in eight hours what the other can accomplish in seventeen minutes, there is little question as to which should have the preference.

In the face of what has been said it may be asked, "Is it worth while continuing to make use of a hot-air apparatus?" The answer is—"Most certainly, if a steam apparatus cannot be obtained, only, take warning from what has been said, and continue the process for at least four hours after the thermometer

* *Hygiene and Public Health*, by B. A. Whitelegge, M.D.

has registered a temperature of 255° F. in the interior of the chamber." It must be remembered that the experiments upon which the requisite temperature has been fixed were conducted with the virus of a disease which, of all others, is probably the most difficult to destroy, and it is possible that a lower standard may meet the case as regards some infectious diseases, although the higher standard should be aimed at. The use of steam is inadmissible in the case of leather articles and bound books, as it destroys them, but, with those exceptions, it is less injurious to clothing, &c., than hot air.

Ransom's hot-air apparatus consists of an iron chamber with an external covering of felt and wood which economises the heat by acting as a non-conductor. The heat is supplied by means of a circular gas-burner connected with the under surface of the chamber by a flue which conducts the hot air, together with the products of combustion, into the interior, equable distribution being secured by a perforated plate at the bottom. An outlet-flue is fixed at the top of the chamber. In both flues a thermometer is fixed to indicate the temperature of the incoming and outgoing air. In addition to this, a mercurial regulator is fixed in the inlet-flue, by means of which the amount of gas consumed, and consequently the amount of heat produced, can be controlled, and this may be adjusted to any temperature desired. As a precaution against fire, an arrangement is connected with the outlet-flue by which, when the temperature reaches 300° F., a link of fusible metal is melted, and by this means a damper is closed and the supply of gas is shut off.

Washington Lyon's steam apparatus is perhaps the one most generally used for disinfection by moist heat. It consists of an oval chamber with double walls, and a door at each end fastened by screw-clamps, one for the introduction of infected articles, and the other for their removal when the process of disinfection is complete. Steam is discharged into the apparatus by two pipes, the one communicating with the cavity formed by the double walls, and the other with the interior of the chamber, the amount of pressure in each case being indicated by pressure gauges. The object of surrounding the chamber with this "jacket" of steam is, in the first place, to prevent loss of heat, and secondly, to check condensation. The steam-pressure usually employed is 10 lbs. per square inch in the cavity of the walls, and 5 lbs. in the interior. The articles to be disinfected are conveyed to a room at the inlet end of the apparatus, the walls and floor of which ought to be non-porous, to facilitate cleansing, and which must be completely separate from the receiving room at the outlet end. Having placed the articles in the wire-cage, or suspended them on the rack provided for the purpose, they are then pushed into the chamber along rails, and while the doors are being screwed up the steam may be admitted into the jacket of the apparatus, so as to warm the chamber, previous to its introduction into the interior. When the process is complete—in about half an hour—the steam is turned off from the interior, and the door at the reverse end of the apparatus is opened. It will assist the drying process, however, if the articles are left in the chamber for a short time longer exposed to the heat derived from the steam in the jacket, which has not yet been turned off. It is astonishing, however, how slightly moist the articles are, and how rapidly they become dry without any assistance.

The superior penetrating power of steam is attributed by Dr. Parsons to a variety of causes, and the following lucid description of the two principal ones is taken from Prof. A. Wynter Blyth's *Manual of Public Health* :—

1. "Probably the most important is the large amount of latent heat in steam. To convert 1 lb. of water at 212° F. into steam at 212° F. requires nearly 1,000 times as much heat as it does to raise 1 lb. of water from 211° to 212° F. Conversely a corresponding amount of heat is liberated when 1 lb. of steam at 212° F. is condensed into water at 212° F. When an object is heated by being placed in hot dry air, not only is no latent heat yielded up to it by the air, but on the other hand, before the object can attain the temperature of 212° any water which it may contain (and all textile fabrics, even though dried at ordinary temperatures, retain a quantity of hygroscopic moisture) must be evaporated; in this evaporation heat passes into the latent form, and the attainment of the required temperature is thus delayed.

2. "When steam penetrates into the interstices of a cold body it undergoes condensation in imparting its latent heat as aforesaid to the body. When condensed into water it occupies only a very small fraction of its former volume. To fill the vacuum thus formed more steam presses forward, in its turn yielding up its heat and becoming condensed, and so on until the whole mass has been penetrated. On the other hand, hot air in yielding up its heat undergoes contraction in volume it is true, but only to a very small extent as compared with that undergone by steam in condensing into water. Thus air at 250° in cooling to 50° F. would contract to $\frac{5}{7}$ of its previous volume." (See *Appendix B.*)

Another form of high-pressure steam disinfecting apparatus is manufactured by Goddard, Massey, & Warner, which differs in certain details from Lyon's; and still another, van Overbeck de Meyer's, which is designed for steam at atmospheric pressure. Both of these, like Lyon's, have been proved to fulfil all the conditions of rapid and thorough disinfection, but with low pressure the penetration of bulky articles is, probably, less rapid, although Koch contends, however, that there is little or no difference, and if this be so, the simplicity and economy of the low-pressure apparatus should entitle it to the preference.

The only efficient **chemical disinfectants** which can now be said to be practically available in a fluid form are—solutions of **corrosive sublimate** (bichloride of mercury) and **carbolic acid** (phenol), the requisite strength of the former being 1 part in 1,000, and of the latter, 5 parts in 100.

Carbolic acid has long been in popular favour as a disinfectant, but, as a rule, it has been used in such a diluted form as to reduce it to an ordinary deodorant, or at best an antiseptic. Wynter Blyth * summarises the estimate he formed of it, as the result of his own experiments and those of others, as follows:—"... A 1 per cent. solution is strong enough to destroy the more feeble infections, but to be certain that the more resistant forms of germ life are annihilated it will be necessary to use at least 5 per cent. solutions in water, and the action must be prolonged; if specific excreta are treated it is doubtful whether 5 per cent. solutions are of sufficient strength, because associated with the hurtful material there is a quantity of organic matter which must on the one hand remove some of the phenol from the sphere of action, and on the other impede the contact of the phenol with the substance which we wish to disinfect."

In talking of the efficiency of a disinfectant of a certain strength, it is necessary to bear in mind that it must come in contact with the germs to be destroyed without undergoing further dilution, and remain in contact with them a considerable time—not less than twenty-four hours—so that, if the material to be disinfected is bulky, the strength of the disinfecting solution must be increased accordingly. It is obvious from this that the thorough disinfection of sewage is hardly practicable.

Corrosive sublimate is a far more potent disinfectant than carbolic acid, as solutions only $\frac{1}{50}$ the strength (1 : 1,000) are requisite. Unfortunately, its extremely poisonous character interferes with its usefulness, but if it be artificially coloured (it is naturally colourless), and kept only in specially-shaped bottles

* *Manual of Public Health.*

with a prominent poison-label attached, the risk ought to be reduced to a minimum.

Potassic permanganate in 5 per cent. solution acts as a disinfectant when tested experimentally, but in practice it is necessary to use it in such large quantity as to forbid its use for any other than deodorising or antiseptic purposes. This arises from the fact that the permanganate is used up in oxidising the organic matter present in the infected fluid.

According to Koch, these reagents act as antiseptics (not as disinfectants) when diluted to the following extent in water :—

Corrosive sublimate . .	3	parts per 1,000,000
Potassic permanganate .	700	„ „ „
Carbolic acid . . .	1,200	„ „ „

Concerning the other so-called disinfectants, namely :—*Chloride of lime, chloride of zinc, sulphate of zinc, sulphate of copper, sulphate of iron, boracic acid, &c.*, experiment has proved that they come short of what is required in a true disinfectant.

Fumigation, by any of the reagents commonly used, has been shown by experiment to be far less effective than has hitherto been supposed. In practice, all we can hope to accomplish is destruction of the less resisting organisms, so that the process cannot be credited with true disinfecting powers.

Koch and others have demonstrated that *sulphurous acid*, when present in the proportion of 1 per cent. of the space to be fumigated, will destroy the germ of anthrax in half an hour, but that six times that amount is inoperative against the spores of the same organism even after several days exposure.

It has also been shown that the slightest covering will protect the germs from the effect of the reagent; for example, those that were enclosed in the pocket of a coat escaped destruction—from this it is clear that any infection other than that which is adherent to surfaces, is likely to retain its virulence after the process has been completed.

Sulphurous acid is generated by burning sulphur, broken into small pieces, in an iron vessel, and the quantity required to yield 1 per cent. of sulphurous acid is 1 lb. per 1,000 cubic feet of room space, that is supposing there is no loss from escape. As, however, it is impossible to insure that all openings are hermetically sealed, it is well to use a little more than this—say 1½ lbs. The process is conducted in the following manner:—Having carefully sealed all openings in the room, such as the fire-place, the spaces round the window-sashes, and any ventilating openings that may exist, by pasting brown paper over them, the articles of furniture, and all articles that cannot be boiled or otherwise disinfected, should be arranged so as to be as freely exposed as possible to the fumes. The necessary quantity of sulphur is then placed in one or more vessels (a sauce-pan answers very well) according to the size of the room, in a large room it is best to use two or more, placed well apart—and, as a precaution against fire, it is advisable to place each on two bricks, standing in a tray containing water, or supported on a pair of tongs over a bucket of water. Having added a little methylated spirit to facilitate lighting, the sulphur is then set fire to, and the operator must at once leave the room, close the door, and paste paper all round it. Of course if there is more than one door in the room, the others should previously be similarly sealed. The room must be left undisturbed for six hours, when the windows must be thrown freely open, and allowed to remain so for at least twenty-four hours. The furniture and other articles ought then to be carried into the open air, where they should undergo a thorough brushing and beating, and be left exposed to the air as long as possible.

Chlorine gas is another reagent which is preferred by some. The proceeding in this case, as regards the room, is the same as when sulphur fumigation is practised. The most convenient method of generating the gas is by adding strong hydrochloric acid to chloride of lime, in the proportion of 1½ to 2 pints of the former to each pound of the latter, and this is the quantity recommended per 1,000 cubic feet of space. In this case ordinary basins must be used, not metallic vessels, and several of them should be placed at various elevations about the room. As the gas, which is very poisonous, is given off immediately, it is necessary that the acid should be conveniently placed near each basin, so as not to cause any delay in the operation, and the operator must notice that the door is open so as to allow of his immediate exit. The room ought to remain closed for twelve hours.

The after treatment of the room, no matter what fumigant is used, is very important, and here it is that the mechanical effect of soap and water is of service as a disinfectant. If the room has previously been papered, the old paper ought to be stripped off, and the walls re-papered. If, on the other hand, the walls have been coloured, they should be scraped and lime-washed, or at least the latter. Painted walls must be thoroughly washed with soap and water, as must also the floor and all articles of furniture that allow of it.

Special Preventive Measures for Various Diseases.

So far, we have been considering the question of prevention from a general standpoint; we must now apply the principles laid down to each of the more common infectious diseases, and in order to do so it is necessary to go somewhat into detail concerning the characteristics of each, not from the point of view of diagnosis or treatment—questions with which medical men alone have to deal—but simply in order to make intelligible the reasons for the precautions recommended in each case.

First, then, with regard to **quarantine** and **isolation.** As already stated (p. 178), the duration of each is regulated by the **period of incubation** and the **period of infection.**

The following are the periods of quarantine and isolation recommended:—

	Quarantine to be required after last exposure to infection.	Shortest period of isolation after an attack.
Small-pox, ...	18 days.	6 weeks.
Chicken-pox, . . .	18 ,,	3 ,,
Scarlet fever,. . . .	14 ,,	6 ,,
Diphtheria, . . .	12 ,,	4 ,,
Measles, ...	16 ,,	3 ,,
German measles, . . .	16 ,,	3 ,,
Whooping-cough, . . .	21 ,,	6 ,,
Mumps, ...	24 ,,	4 ,,
Enteric fever, . . .	21 ,,	4 ,,
Typhus fever, . . .	21 ,,	4 ,,

The quarantine figures (excepting enteric and typhus) are those suggested by the Association of Medical Officers of Schools; those in the second column cannot be regarded as fixed and absolute under all circumstances. In the case of scarlet fever, for example, until all "peeling" has ceased the danger of infection is not over, and this may continue for a longer period than six weeks. Neither in the case of small-pox is the limit a safe one unless all scabs have fallen off. In fact, it is not wise to be guided by a hard and fast rule; in some cases the period specified may be needlessly long, while in others it may not be long enough; the question can only be definitely settled by the medical man in attendance.

With the medical treatment of infectious cases, as already stated, we have nothing whatever to do, but a knowledge of the special features of each, so far as they affect the management from a preventive point of view, must now be considered.

Small-pox, although still a much dreaded disease, has lost many of its terrors since the introduction of vaccination. The period of incubation, when the disease is contracted in the ordinary way by infection, is probably about twelve days, and within two days of attack the characteristic rash makes its appearance. The disease is infectious from the earliest period of its manifestation, probably by the breath, and danger exists during the whole course of the disease, but particularly after the pustular stage, when the scabs begin to separate. Danger is not over until all scabs have separated; in mild cases this may happen in about three weeks, but in others isolation may be necessary for six weeks, or even longer. In most cases probably the virus is inhaled, but in this, as in other infectious diseases, it is possible food may be the vehicle. It would appear from the evidence of recent epidemics that the infection may be conveyed by the air considerable distances, farther than is the case with other infectious diseases, a circumstance which has an important bearing on the position of small-pox hospitals.

In the management of small-pox cases, the free ventilation by open windows should never be omitted, and all the excretions and discharges from the patient ought to be disinfected, either by burning, or by the addition of a 1 per cent. solution of corrosive sublimate—this strength is necessary because of the diluting effect of the material to which it is added (see p. 187). Only old pieces of linen, or other suitable material that may be burned, should be used for the discharges, and all dirty linen, sheets, &c., should be saturated with corrosive sublimate solution, 1 part per 1,000. During the separation of the scabs, the application of vaseline or olive oil will diminish the chance of the infectious particles being scattered in the atmosphere, but no disinfectant can be used in such quantity as will serve any useful purpose, the oil simply acts mechanically in preventing the drying of the scabs.

On the termination of the illness, the room must be disinfected by the methods already described (p. 188). The great preventives, however, against small-pox are **vaccination** and **re-vaccination.** No one ought to be allowed to nurse a patient who has not either had the disease or been successfully re-vaccinated, and when an outbreak occurs, all persons over ten years ought to be re-vaccinated, and no delay should take place in the vaccination of children however young. All persons, whether exposed to infection or not, ought to be re-vaccinated after the age of twelve, and this they can have done, free of charge, at the vaccination stations.

People, also, who have not been successfully vaccinated or re-vaccinated, and who may have contracted the disease, may suffer from a greatly modified attack, if indeed it is not entirely arrested, provided they are vaccinated within three days, or even as late as the fifth or sixth day, after exposure to infection ; the earlier the operation is performed the better. The reason of this is that the short period of incubation in the case of vaccination enables the effect on the system to be produced before the onset of the malady itself. Strange to say, notwithstanding the overwhelming evidence in favour of the efficacy of vaccination, people are still met with who profess not to believe in it. The question is at present being investigated by a special commission, and it is to be hoped, that the report, when published, will, at any rate, have some effect in silencing the opponents of the practice.

Post-vaccinal Small-pox Mortality.

Cases of Small-pox Classified according to the Vaccination Marks.	Number of Deaths per cent. in each Class respectively.
Unvaccinated, ...	35½
(1) Stated to have been vaccinated but having *no* cicatrix,	21¾
(2) Having *one* vaccine cicatrix, ...	7½
(3) Having *two* vaccine cicatrices, ...	4⅛
(4) Having *three* vaccine cicatrices, ...	1¾
(5) Having *four* or more vaccine cicatrices, . . .	¾

Innumerable statistics might be brought forward in support of vaccination, but the foregoing figures, the outcome of twenty-five years observation by Mr. Marson, in 6,000 cases of post-vaccinal small-pox in the London Small-pox Hospital, ought to satisfy all whose minds are not prejudiced.

It is evident from these figures that, up to a certain point, the protection afforded by vaccination is in accordance with the number of cicatrices, a fact which ought to be impressed upon parents (especially mothers), who do their utmost to limit the operation to one, or at most two marks.

Chicken-pox is a disease which attacks persons of all ages, but more especially children. It is not a serious ailment, and in itself it is rarely, perhaps never, fatal. The period of incubation is about a fortnight, and the infection probably is communicated by the breath of patients. The disease is highly infectious, but, owing to its trivial character, disinfection is not usually practised.

Scarlatina or **scarlet fever,** which are one and the same disease, has already been commented upon, so far as its causation is concerned, in discussing the connection between certain diseases of the infectious class in man and animals (p. 171), but as yet no mention has been made of the risk to which the public are exposed, of infection being conveyed by milk directly contaminated by a scarlatinal patient. That such may happen in this, as in other infectious diseases, notably enteric fever, is unquestionable, and it behoves all those who are responsible for the public safety, to bear the fact in mind in their endeavours to arrive at the origin of such outbreaks.

A little advice to Sanitary Authorities on this subject may not be out of place. Milk sellers are specially apt to conceal the fact of the existence of infectious cases on their premises, or among persons they employ, as they are well aware that the law imposes certain conditions (see Appendix) with regard to the conduct of their business under such circumstances, and these must necessarily interfere with trade. When a culpable disregard of those conditions is clearly brought home to any individual, it is the imperative duty of the Authority to prosecute the offender, not so much with the view of inflicting a penalty, but rather as a wholesome example to other possible offenders.

By far the most frequent cause of scarlatinal infection, however, is from person to person, through neglect of precautionary measures, particularly in mild epidemics of the disease. Children run about the streets when actually in the "peeling" stage of the disease, convalescents are taken about the country in public conveyances, and by rail, before the risk of infection is over, infected clothing and other articles are recklessly sent to the laundry; in fact, the channels by which infection may be distributed broadcast among the people are endless, and yet the responsible authorities in many cases do not even provide the necessary appliances for disinfection. It is hardly reasonable to look for assistance from the public when their appointed guardians are so neglectful of the most ordinary precautions. The incubation period of scarlet fever is by no means defined; it is usually three or four days, but it may be as short as one day, or as long as seven. The rash appears about twenty-four hours after the attack. The disease is infectious throughout, and until desquamation (peeling) is complete, and the throat symptoms have entirely disappeared, the risk continues, and this may be for two or three months. The contagion does not seem to be conveyed long distances by the atmosphere, as is the case with small-pox, although of this we have no absolute proof, but, as already pointed out, infected articles or rooms, may remain so for long periods, if not freely exposed to the air, or disinfected by other means. The infection is given off by the breath, by discharges from the throat, and by the scales during the later period of the disease. The precautions to be observed as regards the patient, clothing, &c., and the room, are similar to those recommended in the case of small-pox.

Diphtheria, as regards its causation and prevention, has long been the subject of much discussion and enquiry. Dr. Thorne Thorne, of the Local Government Board, selected it as the subject of the Milroy lectures last year, and these, which have since been published, must be looked upon as the standard authority upon the subject. The following are the general conclusions the lecturer arrived at:—

"1. That a disease which, judged by the description given of it by different authors, is not to be distinguished from diphtheria as met with in the present day, was known before the Christian era, and prevailed in this country at intervals between the 14th and 18th centuries.

"2. That during the past twenty years there has been a progressive increase in the rate of mortality from diphtheria in England and Wales.

"3. That whilst the diphtheria mortality remains as heretofore, greater in sparsely peopled than in densely inhabited districts, a specially marked increase of its incidence is in progress in the group of large cities and towns. The disease is becoming, in fact, more and more one affecting urban populations.

"4. That the steady increase in the diphtheria mortality has coincided, in point of time, with steady improvement in regard of such sanitary circumstances as water-supply, sewerage, and drainage.

"5. That, alike in the country generally, and in the group of large towns, synchronously with the steady increase in the rate of mortality from diphtheria, the death-rates from all causes, from the group of 'zymotic diseases' (including diphtheria), and from enteric fever, have undergone continuous and marked diminution.

"6. That the broad geological features of a district have not, as such, any observed influence on the development and diffusion of diphtheria.

"7. That dampness of site, an aspect involving exposure to cold wet winds, and a surface soil favourable to the retention of wetness and of organic refuse, tend apparently to the fostering and the fatality of diphtheria.

"8. That season has a marked influence on the manifestation, and, above all, on the mortality from diphtheria. Epidemic prevalences of the disease commonly commence in September, reach their highest point during October and November, and then subside slowly during the following months of December and January—the smallest amount of mortality being witnessed in the months May to July.

"9. That there is some excess of diphtheria mortality in females as compared with males, and that it is probably due, at all periods of life, to greater opportunity of exposure of females to infection.

"10. That age has an important influence on the incidence of diphtheria; the greatest number of cases, actually and relatively, both fatal and non-fatal, occurring at the ages 3 years to 12 years.

"11. That prevalences of recognised diphtheria are commonly associated in their beginnings, during their continuance, and, after their apparent cessation, with a large amount of ill-defined throat-illnesses, and that fatal attacks of diphtheria in many localities get registered as croup, laryngitis, &c.

"12. That there is reason to believe that attacks of so-called 'sore throat' exhibit, under certain favouring conditions, a 'progressive development of the property of infectiveness,' culminating in a definite specific type which is indistinguishable from true diphtheria.

"13. That diphtheria in the human subject commonly begins as a local disease, manifesting itself at the point to which the contagion has been conveyed aerially or otherwise, and that a morbid condition of the tonsils, such as sore throat, whether due to faulty sanitary circumstances, or dependent upon such diseases as scarlatina, measles, &c., operates, in the presence of diphtheria, strongly as a predisposing cause to attack by that disease.

"14. That, apart from age susceptibility, 'school influence,' so called tends to foster, diffuse, and enhance the potency of diphtheria, and this, in part at least, by the aggregation of children suffering from that 'sore throat' which commonly is prevalent antecedent to, and concurrently with, definite diphtheria.

"15. That there is abundant evidence to show that diphtheria has often been conveyed through the medium of milk, and on several occasions strong presumption has arisen that infectivity of the milk has been due to some condition affecting the cow herself.

"16. That the intimate cause of diphtheria is a micro-organism, the *bacillus diphtheriæ*, cultivations of which, derived from human diphtheria membrane, when inoculated into the cow, produce a communicable disease, which is associated with certain definite symptoms, and with the secretion of milk charged with the same specific bacilli.

"17. That a specific communicable disease can be produced in cats as the result of similar inoculations, and that, on one occasion at least, the consumption by cats of the milk of cows suffering from the disease referred to has led to the production of 'cat diphtheria.'

"18. That, with a view to the prevention of diphtheria, the following points should receive attention :—(*a*) the separation of the sick from the healthy, including the control of school attendances; (*b*) the application to infected places and things of measures of disinfection and cleansing; (*c*) the use of such milk only as has been boiled or otherwise cooked; (*d*) the avoidance of infection from domestic animals; (*e*) such choice of residence as will secure dryness and general wholesomeness of site and surroundings, together with ample exposure to sunlight and free movement of air."

In the above summary particulars are introduced relating to diphtheria, which have not been referred to in speaking of other infectious diseases, for example, the seasonal prevalence of the disease, but the conclusions are reproduced in full, because most have a direct bearing on the question of prevention.

The period of incubation of diphtheria is probably from three to five days, but cases occur which point to its development almost immediately after exposure to the infection, and, on the other hand, it may be prolonged for even a fortnight. The details of preventive measures to be observed are similar to those recommended in the case of small-pox, particular attention being paid to the discharges from the throat and nose, and also to the clothing and bedding.

Children from infected houses must be kept from school, and in rural districts those living in villages where the disease is prevalent, whether living in infected houses or not, ought to remain at home. On the other hand, if the disease prevails generally throughout a district, the schools ought to be closed for a period, and during this time, they should be cleansed and disinfected, a precaution which in all cases ought to follow the closure of schools on account of infectious disease.

Measles, as already pointed out (p. 176), is a disease which is most fatal in childhood, and more especially so among children of the poorer classes, although in this respect it is not peculiar. The incubation period is about twelve days, and it is highly infectious from the first onset, before the characteristic rash makes its appearance, and before the nature of the malady is apparent. For this reason, and also because parents usually neglect all precautions to shield others from attack, when once the disease makes its appearance in a district probably few susceptible persons escape. Isolation of cases on a large scale has, so far, never been practised, but the closure of schools in rural districts at any rate is a wise precaution to take. Evidence points to the conclusion that insanitary surroundings increase the fatality, but it has not been proved that they increase the liability to attack. Apart from the usual precautions of isolation and disinfection, no special preventive measures are indicated.

German measles (*Rötheln*) is an affection accompanied by a rash which resembles that of measles, although it is quite a distinct disease. It is rarely fatal, and it is not highly infectious.

Whooping-cough is a disease from which people of all ages may suffer, but it is far more fatal among infants than among older children and adults. Its general prevalence, when once it appears in a district, is to be attributed to its highly infectious character, and to the reckless manner in which children are taken about, even to public places, while suffering from it. Neither water, milk, nor other food seem to be responsible for its transmission, but it is readily communicated from person to person by the air, and probably the contagion may be conveyed considerable distances in this manner, as well as by articles of clothing, &c.

Isolation ought to be practised, and also disinfection of the expectoration and vomit of patients, and of the sick-room on the termination of the illness. The period of incubation is about a fortnight, and the infectious period continues throughout the attack, and until the characteristic cough ceases, which may not be for two months, or even longer.

Mumps is a non-fatal but highly infectious disease, the contagion of which is conveyed by the breath of patients. It has an incubation period of about a fortnight, and from three to four weeks isolation is all that is necessary.

Enteric fever (typhoid) is the disease *par excellence* of insanitary conditions, but that such in themselves, without the introduction of a specific virus, can give rise to it, is, to say the least, improbable. Highly polluted water may be consumed for long periods; houses with every possible defect as regards drainage, standing on land saturated with filth, and situated in crowded and dirty neighbourhoods, may be occupied for long periods with impunity so far as this disease is concerned, however much health may suffer in other respects; but given the introduction of a case of typhoid into a locality where all or any of these conditions are present, and its spread is certain. The fact that it is not always possible to trace an outbreak to an antecedent case, in an isolated locality, where the movements of the people are known, in the opinion of some authorities, points to the probable origin *de novo* of the disease. On the other hand, as an argument against this, possibly a case so mild in character as not to have been recognised may have been imported. Again, until we are familiar with the conditions upon which the development of the virus depends, judging from what we do know concerning the life-history of some micro-organisms, and how their growth may be interfered with, while their vitality is not destroyed, by a few degrees difference in temperature, for example, it is impossible to deny that the typhoid germ may lie dormant for long periods until circumstances favour its renewed vitality. Granting such a possibility, there need be no limit to the interval between two or more outbreaks of the disease, consequent upon one original importation.*

It matters little, however, from the point of view of prevention, which theory is the correct one, so long as the important fact is remembered that serious consequences may result from the existence of sanitary defects.

Enteric fever differs from the other diseases we have been considering in the fact that the poison does not seem to be carried from one patient to another by means of the air. The

* See a paper by the author entitled "An Outbreak of Enteric Fever apparently traced to an antecedent case after an interval of twelve months." —*British Medical Journal*, April 2nd, 1892.

great source of danger lies in the **bowel discharges,** hence the risk that attends leaking drains and cesspools, and pervious wells, and hence the reason why water, directly, or indirectly through the medium of a milk-supply, is so frequently the cause of typhoid being distributed broadcast among a community.

The points to attend to, then, in the management of cases, are scrupulous cleanliness and thorough disinfection of the discharges. Nurses, for example, must be careful, in handling food of any description, to see that their hands are clean, otherwise the poison may be conveyed in that way. No typhoid stools should be thrown into a privy, or discharged into a cesspool, and, until they have been disinfected in the manner recommended in the case of small-pox discharges (see p. 191), they ought not to be discharged into any drain. The best method of getting rid of such discharges in country districts is to bury them (after disinfection) a good depth in the ground, at a site far removed from any water-supply.

These precautions must be continued until convalescence is established, and the stools have acquired their natural appearance.

From what has been said, it will be understood that in all outbreaks of typhoid the existence of antecedent cases ought to be enquired into. The sanitary conditions should be carefully investigated, in relation to the house, its surroundings, and its water-supply. It is important to ascertain, in the absence of any local cause to which the origin may without doubt be attributed, whether the patients have previously been in any locality where cases have occurred, and in forming an opinion regarding this, one must be guided by the period of incubation, which varies from two or three days up to three or perhaps four weeks, although the usual period is from twelve to fourteen days. Lastly, the milk-supply must be enquired into. This may involve a considerable amount of trouble, for if it does not come direct from a dairy-farm, it has to be traced from thence through the milk-seller, and all the possible risks to which it may have been exposed during storage and distribution, and the existence of other cases that may be connected with it, must carefully be noted.*

Typhus Fever.—The prominent features of this disease are (1) its association with dirt, poverty, and distress, and (2) the ease with which it may be prevented by cleanliness and ventilation.

* See p. 4 for effect of improved sanitary conditions on the death-rate from enteric fever; also "Ninth Report of the Medical Officer of the Privy Council," 1866.

The contagion, although very virulent in close proximity to the patient, soon loses its virulence when dispersed in the atmosphere. For this reason, in addition to isolation, quarantine, and disinfection, the necessity for free ventilation of the sick-room which applies to all infectious cases is more than ever indicated, and hence it is that the improved condition of dwellings has practically abolished the disease from the category of English epidemics. It is true that cases do occur in cleanly well-to-do households, but never, probably, except from direct contact with a previous case. From analogy, we may conclude that typhus fever is the outcome of the introduction into the system of a specific germ, but experience shows that insanitary conditions must co-exist, although, probably, in themselves they cannot give rise to the disease.

The period of incubation is by no means defined, and is probably dependent upon the amount of concentration of the poison. Twelve days is perhaps the usual duration, although, possibly, it may be as short as a few hours, or as long as three weeks. The fever runs its course usually in about a fortnight. Infection is given off by the breath, by exhalation from the body, and possibly by the excreta.

Remembering what preventive measures have been recommended in other infectious diseases, those applicable in this disease will be apparent from the above description, but the all-important considerations are cleanliness and fresh air.

Relapsing fever closely resembles typhus as regards its causation and prevention, and not infrequently both diseases occur simultaneously. It is not often met with in England, but in Scotland, and still more in Ireland, epidemics are less infrequent.

Diarrhœa is a symptom which accompanies a variety of ailments, but the name is also used to designate an affection, which, from its frequent occurrence in epidemic form, is classed among the zymotic diseases. This disease, which is so fatal among young children, occurs during the summer and autumn, and, to whatever cause its origin may be attributed, its prevalence is undoubtedly governed by temperature; it also would appear that those districts, in which sanitary observances receive least attention, suffer most. In recent years, since sanitation has come more to the front, the diarrhœa death-rate has greatly fallen, and no doubt a still further reduction may be effected by continued efforts to improve the dwellings and surroundings of the poor. It has been truly said, that one of the best tests of the sanitary state of a district is its infant death-rate, first, because the statistics, being calculated upon the births, are not dependent upon what may be a mistaken estimate of the population, and secondly, because infants are, as a rule, more susceptible to diseases that specially arise from insanitary surroundings.

It rests with Sanitary Authorities to see that children are wholesomely housed, but as predisposing causes, ignorance and neglect on the part of parents have also to be dealt with. If by some process it could suddenly be made apparent to mothers that milk is a food upon which children can live and thrive, and that fresh air, warmth, and cleanliness are essential to child life, at one stroke thousands of lives might be saved. This cannot suddenly be brought about, but may it not be achieved gradually through education—not by adding to the already congested condition of the educational standard, but by substituting for some of the more fancy subjects of the present school curriculum, a branch of instruction in popular hygiene? Would not the time, when the minds of the rising generation are most susceptible to demonstrative instruction, be more profitably and agreeably spent in acquiring a knowledge of the elementary laws of health, concerning which, at present, people are allowed to grow up in complete ignorance? The practice of mothers going to work and leaving their children to the care of others, cannot conduce to their welfare, and it has been suggested that the legislature might step in and make it compulsory for the mother to remain at home with her child for a specified time after its birth; whether such a course is feasible—there is no doubt about its being desirable—others must determine.

Cholera, which is rarely absent in some parts of India, and which has occurred in epidemic form in this country on four occasions since 1831 (the last being in 1865-6 when 5,548 deaths were attributed to it in London, and 14,378 in England), is a disease which is undoubtedly associated with insanitary surroundings. It resembles enteric fever in the manner in which it is propagated, the discharges from patients being, in all probability, alone responsible, and the chief mode of origin is through specifically contaminated water or food.

Granting, then, that a district is supplied with water from a pure source, that it is not liable to pollution, either during storage or distribution, and provided the dwellings are in every respect wholesome from a sanitary point of view, an imported case of cholera need not give rise to any undue alarm, provided every precaution as regards disinfection, &c., as laid down in the case of enteric fever, is observed.

The following official memorandum, dated August 26th, 1892, which has been drawn out by Dr. Thorne Thorne, medical officer to the Local Government Board, is given *in extenso*, as it indicates so clearly the risks attending the disease, and the precautionary measures that are necessary :—

"1. The Order of the Local Government Board of July 12th, 1890, now in force, gives certain special powers to port and riparian Sanitary Authorities, enabling them to deal with any cases of cholera brought into their districts, so as to prevent, as far as possible, the spread of disease into the country. But it is to be remembered that cases of choleraic infection differ widely in severity, and that persons suffering only slightly from the disease, or incubating it, are likely to be landed at English seaboard and riparian towns, and to make their way to inland places. This has, in fact, occurred in former epidemics.

"2. Former experience of cholera in England justifies a belief that the presence of imported cases of the disease at various spots in the country will not be capable of causing much injury to the population, if the places receiving the infection have had the advantage of proper sanitary administration; and, in order that all local populations may make their self-defence as effective as they can, it will be well for them to have regard to the present state of knowledge concerning the mode in which epidemics of cholera (at least in this country) are produced.

"3. Cholera in England shows itself so little contagious, in the sense in which small-pox and scarlatina are commonly called contagious, that, if reasonable care be taken where it is present, there is almost no risk that the disease will spread to persons who nurse and otherwise attend closely on the sick. But cholera has a certain peculiar infectiveness of its own, which, *where local conditions assist*, can operate with terrible force, and at considerable distances from the sick. It is characteristic of cholera (and as much so of slight cases where diarrhœa is the only symptom, as of the disease in its more developed and alarming forms), that *the matters which the patient discharges from his stomach and bowels are infective.* Probably, under ordinary circumstances, the patient has no power of infecting other persons except by means of these discharges; nor any power of infecting even by them, except in so far as these matters are enabled to taint the food, water, or air which people consume. Thus, when a case of cholera is imported into any place, the disease is not likely to spread unless in proportion as it finds locally open to it, certain facilities for spreading by *indirect infection.*

"4. In order rightly to appreciate what these facilities must be, the following conditions have to be borne in mind—first, that any choleraic discharge, cast without previous thorough disinfection into any cesspool or drain, or other depository or conduit for filth, is able to infect the excremental matters with which it there mingles, and probably, more or less, the effluvia which those matters evolve; secondly, that the infective power of choleraic discharges attaches to whatever bedding, clothing, towels, and like things have been imbued with them, and renders these things, if not thoroughly disinfected, capable of spreading the disease in places to which they are sent for washing or other purposes; thirdly, that if, by leakage or soakage from cesspools or drains, or through reckless casting out of slops and wash-water, any taint (however small) of the infective material gets access to wells or other sources of drinking water, it imparts to enormous volumes of water the power of propagating the disease. When due regard is had to these possibilities of direct infection, there will be no difficulty in understanding that even a single case of cholera, perhaps of the slightest degree, and perhaps quite unsuspected in his neighbourhood, may, *if local circumstances co-operate*, exert a terribly infective power on considerable masses of population.

"5. The dangers which have to be guarded against as favouring the spread of cholera infection are particularly two. First, and above all, there is the danger of water supplies which are in any (even the slightest) degree tainted by house refuse or other like kinds of filth: as where there is outflow, leakage or filtration from sewers, house-drains, privies, cesspools, foul ditches, or the like, into springs, streams, wells, or reservoirs, from which the supply of water is drawn, or into the soil in which the wells are situate; a danger which may exist on a small scale (but perhaps often repeated in the same district) at the pump or dip-well of a private house, or, on a large or even vast scale, in the case of public water works. And secondly, there is the danger of breathing air which is foul with effluvia from the same source of impurity.

"6. Information as to the high degree in which those two dangers affect the public health in ordinary times, and as to the special importance which attaches to them at times when any diarrhœal infection is likely to be introduced, has now for so many years been before the public, that the improved systems of refuse removal and water-supply, by which those dangers are permanently obviated for large populations, and also the minor structural improvements by which separate households are secured against them, ought long ago to have come into universal use.

"So far, however, as this wiser course has not been adopted in any sanitary district, security must, as far as practicable, be sought in measures of a temporary and palliative kind. (*a*) Immediate and searching examination of sources and conduits of water supply should be made in all cases where drinking water is in any degree open to the suspicion of impurity, and the water, both from private and public sources, should be examined. Where pollution is discovered, everything practicable should be done to prevent the pollution from continuing, or, if this object cannot be obtained, to prevent the water from being drunk. Cisterns should be cleaned, and any connections of waste-pipes with drains should be severed. (*b*) Simultaneously, there should be immediate thorough removal of every sort of house refuse and other filth which has accumulated in neglected places; future accumulations of the same sort should be prevented; attention should be given to all defects of house-drains and sinks through which offensive smells can reach houses; thorough washing and lime-washing of uncleanly premises, especially of such as are densely occupied, should be practised again and again.

"7. It may fairly be believed that, in considerable parts of the country, conditions favourable to the spread of cholera are now less abundant than at any former time; and in this connection, the gratifying fact deserves to be recorded that during recent years, enteric fever, the disease which in its methods of extension bears the nearest resemblance to cholera, has continuously and notably declined in England. But it is certain that in many places such conditions are present as would, if cholera were introduced, assist in the spread of that disease. It is to be hoped that in all these cases the local sanitary authorities will at once do everything that can be done to put their districts into a wholesome state. Measures of cleanliness taken beforehand are of far more importance for the protection of a district against cholera than removal or disinfection of filth after the disease has actually made its appearance.

"8. It is important for the public very distinctly to remember, that pains taken and costs incurred for the purposes to which this memorandum refers cannot in any event be regarded as wasted. The local conditions which would enable cholera, if imported, to spread its infection in this country, are conditions which, day by day, in the absence of cholera, foster and spread other diseases, diseases which are never absent from the country, and are in the long run far more destructive than cholera.

Hence the sanitary improvements which would justify a sense of security against any apprehended importation of cholera would to their extent, though cholera should never re-appear in England, give ample remunerative results in the prevention of other diseases."

As **yellow fever** and **malarial fevers** do not occur in this country, their nature and prevention need not be considered.

Erysipelas, puerperal fever, and what is popularly known as **blood-poisoning** are all diseases belonging to the infectious class, and each, no doubt, owes its origin to specific micro-organisms, which gain admission into the body either by means of surface abrasions or wounds, or by contact with some absorbent surface.

It has long been supposed that puerperal fever, which, as its name implies, is a disease peculiar to lying-in women, is likely to result from exposure to the infection of scarlet fever, but recent experience tends to the conclusion that the two diseases are distinct, and that lying-in women may suffer from the latter without showing any signs of the former.

As these diseases are associated with dirt and insanitary conditions generally, their prevention can only be accomplished by careful attention to disinfection and cleanliness in all their details.

Hydrophobia is the term applied to that fatal affection in man which results from the inoculation of the poison of the disease known as **rabies** in dogs and other animals. Till recently, when once the virus had undoubtedly gained admission into the system, death was looked upon as the only termination. Of recent years, however, owing to the labours of Pasteur, a remedy has been found in the shape of attenuated cultivations of the virus, which, when inoculated into a person who has been bitten by a rabid dog, have the effect of greatly diminishing the risk of death, especially if the "vaccination" is performed soon after the accident. A series of vaccinations are necessary, highly attenuated virus being used at first, the virulence of the material being gradually increased with each successive operation, until at last the actual poison itself (obtained from the spinal cord of a rabid animal) is introduced. The efficacy of this treatment has been questioned, but careful enquiry has shown that the mortality from hydrophobia, which, in the absence of treatment, amounts to 15 per cent. of all persons bitten by rabid animals, is reduced by treatment to 1·36 per cent.*

* See Report by Special Committee appointed by the Local Government Board to inquire into M. Pasteur's treatment of Hydrophobia, presented in 1887. Also paper by Dr. Victor Horsley (Secretary to the Committee) in the Epidemiological Society's Transactions, 1888-9.

By muzzling all dogs for a sufficient length of time the disease could no doubt be stamped out, as has been demonstrated in other countries. The partial muzzling even, as adopted from time to time in England, has invariably had the effect of diminishing the prevalence of the disease, but sentiment has been allowed to interfere with its being enforced generally.

The period of incubation of hydrophobia is very variable; in some cases the disease manifests itself as early as one week after the introduction of the poison, but this is rare, six weeks being the usual interval, although it may be prolonged even to two years.

Tuberculosis must now be looked upon as an infectious disease from the fact of its proved connection with a specific organism. Heredity undoubtedly plays an important part in the production of this as well as of other diseases, by the transmission of a constitutional peculiarity favourable to the development of the germs when they are introduced into the system.

The lungs are the organs most frequently affected, and **phthisis** or **consumption** is responsible for more than 80,000 deaths annually in the United Kingdom, or 11 out of every 100. But this by no means represents the sum total, for there are other tubercular affections that also contribute largely to the death-roll. Although for some time previously it had been suspected that consumption was caused by a micro-organism, it was not until 1882 that Koch published the results of his researches which established the parasitic nature of the disease.

Since then independent testimony has proved the accuracy of his conclusions, and now no one doubts that tubercular disease is associated with the introduction into the body of an extremely minute rod-shaped germ called the **tubercle bacillus.** As may be imagined, great results were anticipated from the discovery; it was hoped that it would prove to be the first step towards finding the specific for a disease which hitherto had been looked upon as incurable, but, alas, these expectations have not as yet been fulfilled. Many so-called remedies have been advocated from time to time, but upon trial all have been discarded as worthless. The most remarkable of these, for which Koch himself was responsible, was made public in 1890, and created even a greater sensation than the discovery of the *bacillus* itself. Unfortunately owing to the publicity given to this supposed specific, and the exaggerated accounts of its value published in the lay press, combined with the secrecy which was at first observed concerning the nature of the remedy, thousands who had reconciled themselves to the fact that they were suffering from a fatal disease, were induced to hope that a cure had at last been discovered, a hope that was soon to be cruelly shattered.

It is well known that the treatment consists of repeated inoculations with a fluid specially prepared from cultivations of the tubercle bacillus; the details, however, need not here be discussed. Suffice it to say, that an extended trial of the remedy has led to its being discarded as a means of treatment.

It may be that some efficient preventive against tubercular disease will ultimately be discovered, but, in the meantime, previous failures in this direction must not be allowed to detract from the value of Koch's original discovery. Through it we have not only been enabled to arrive at the important fact already referred to (p. 171), of the similarity between tubercular diseases in animals and in man, but it has also paved the way for more efficient steps being taken to limit the risk of the disease being conveyed from one person to another by means of infection. The fact that the germs of consumption are found in the air of rooms occupied by consumptive patients, indicates the risk that others run—at any rate those who are susceptible to the disease—in occupying the same room, and points to the necessity for precautions being taken in the shape of free ventilation and the disinfection of the sputum which is charged with the virus of the disease.

As in the case of other specific diseases there are many predisposing causes of consumption, the most important of which are dampness of locality, damp and ill-ventilated houses, overcrowding in houses and factories, and certain occupations, more especially those that are attended with the inhalation of irritating dust.

The discovery that **dampness of soil** predisposes to consumption and other tubercular affections was at first accidental, and arose out of the enquiry already referred to, which was conducted by Dr. Buchanan, as to the effect that general sanitary improvements in certain towns had had on the death-rates from diseases which are known to be influenced by insanitary conditions. The enquiry extended over a period of twenty years, in some cases longer. The table given on p. 4 is compiled from Dr. Buchanan's report, and columns 4 and 5 have reference to the question as regards phthisis. It will be seen that in nineteen instances out of the twenty-four more or less drying of the surface had followed the construction of sewers, and of these in no fewer than sixteen instances, the mortality from consumption showed a reduction varying from 49 to 1 per cent., the average being about 28. This led to a further enquiry on a comprehensive scale being made the following year (1867) into the influence of dampness of soil on consumption, and the following are the general conclusions resulting from it, based upon the ten years' returns (1851–60):—

"1. Within the counties of Surrey, Kent and Sussex there is, broadly speaking, less phthisis among populations living on pervious soils than among populations living on impervious soils.

"2. Within the same counties there is less phthisis among populations living on high-lying pervious soils, than among populations living on low-lying pervious soils.

"3. Within the same counties there is less phthisis among populations living on sloping impervious soils, than among populations living on flat impervious soils.

"4. The connection between soil and phthisis has been established in this enquiry—

"(*a*) By the existence of general agreement in phthisis mortality between districts that have common geological and topographical features, of a nature to affect the water-holding quality of the soil.

"(*b*) By the existence of general disagreement between districts that are differently circumstanced in regard of such features; and

"(*c*) By the discovery of pretty regular concomitancy in the fluctuations of the two conditions, from much phthisis with much wetness of soil to little phthisis with little wetness of soil.

"But the connection between wet soil and phthisis came out last year in another way, which must here be recalled—

"(*d*) By the observation that phthisis had been greatly reduced in towns where the water of the soil had been artificially removed, and that it had not been reduced in other towns where the soil had not been dried.

"5. The whole of the foregoing conclusions combine into one—which may now be affirmed generally, and not only of particular districts—*that wetness of soil is a cause of phthisis to the population living upon it.*

"6. No other circumstance can be detected, after careful consideration of the materials accumulated during *this* year, that coincides on any large scale with the greater or less prevalence of phthisis, except the one condition of soil.

"7. In this year's enquiry, and in last year's also, single apparent exceptions to the general law have been detected. They are probably not altogether errors of fact or observation, but are indications of some other law in the background that we are not yet able to announce."

The conclusions exactly correspond with those arrived at by Dr. Bowditch of Boston, U.S.A., upon very thorough investigation into one of the causes of consumption in Massachusetts, which is noticed in a report by the Registrar-General for Scotland written at the end of 1867, in which he refers to the mortality from consumption in the eight principal towns of Scotland as follows:—"Taking a five years' average (1857 to 1861 inclusive), it is found that supposing all these towns are brought to an uniform population of 100,000 persons, there died annually from consumption 206 persons in Leith, 298 in Edinburgh, 310 in Perth, 332 in Aberdeen, 340 in Dundee, 383 in Paisley, 399 in Glasgow, and 400 in Greenock. The fact is, that if each town had been arranged in the order of comparative dryness of its site, they would almost have arranged themselves in the above position—Leith and Edinburgh the most free from consumption, and also having the driest sites; Glasgow and Greenock the most ravaged by that disease, and beyond all comparison situated on the dampest sites."

It is needless to point out that the above conclusions are of vital importance when considered in relation to the existence of weirs on rivers, especially in flat districts, as through them the subsoil water (see p. 13) is maintained at a height near the surface, to the detriment of the inhabitants of towns situated in the valley of the water-course.

The effect of **overcrowding**, as an exciting cause of consumption, is well shown by the various tables in the introductory chapter, but particularly by the figures in column 4 in the table on page 9.

Army and prison statistics also afford valuable evidence on this point, as by means of them a comparison can be drawn between the mortality among large bodies of men, similarly fed and clothed, but housed under different conditions. For example, in one prison in Vienna, "which was very badly ventilated," the deaths from consumption amounted to 51·4 per 1,000, during the years 1834-47. On the other hand, in a well-ventilated prison in the same town, during the years 1850-54, the deaths from this disease amounted to 7·9 per 1,000.*

* *Hygiene*, by Parkes, edited by J. L. Notter, M.D.

In a report to the Local Government Board by Dr. Barry and Mr. Gordon Smith, published in 1888, evidence is given as to the effect of back-to-back houses on the death-rates from lung diseases, including consumption, and also from diarrhœa.*

The effect of **occupation** on the death-rate from consumption is shown in the table on page 6. Those occupations in which fine particles of sharp angular dust are inhaled are highly injurious, whereas equally dusty occupations, attended with the inhalation of smooth particles, such as coal dust, are far less so. This, probably, arises from injury to the lung tissue by the sharp particles leading to a chronic inflammatory condition which predisposes to the reception of the virus, whereas no such injury arises from the inhalation of smooth dust.

The dangers arising from the consumption of tuberculous meat and milk will be dealt with in the chapter devoted to unwholesome food.

From what has been said concerning the nature of consumption, the preventive precautions to be observed will be apparent; they need not therefore be gone into. The safety of others will best be secured by the free ventilation of rooms, and by forbidding healthy persons to occupy the same bedroom as the patient. The greatest care should be observed in dealing with the sputum; it ought either to be disinfected with solution of perchloride of mercury, or a 10 per cent. solution of carbolic acid, or, better still, rags may be freely used, and immediately burned. On no account must the expectoration be allowed to dry on the clothes, or on the floors, as the infective material will thus be scattered through the room.

Compulsory Notification of Infectious Diseases Act.

One word on the advantages to be derived from the adoption of this Act (see Appendix), which, except as regards the Metropolis, is unfortunately permissive, although a large majority of the sanitary authorities have very wisely adopted it. One important consideration, which ought to weigh with those authorities who have not adopted the Act, is that by being unprotected themselves they seriously diminish the benefit that protected districts may reasonably look for, who, therefore, with perfect justice may say—"while we are exercising every precaution within our power to protect our districts from infection, you are in a great measure defeating our efforts by refusing to

* This report is published by itself and does not appear in the Annual Report of the Medical Officer to the Local Government Board.

avail yourselves of the means of protection which the law provides."

It is said that cost has, in many instances, influenced authorities in their determination not to adopt the Act. This of course varies greatly, and is dependent upon the prevalence of diseases that should be notified. Taking as an example the administrative County of Stafford, in which the Act has been adopted in thirty-seven districts, the average cost per 1,000 of the population in 1890 amounted to 18s. 6d. One hardly likes to discuss a question which is one of life and death from the point of view of economy, but even the most careful guardian of the ratepayers' pockets could hardly object to a charge, for so excellent an object, of what, in the case of an average district, would only amount to the seven-hundredth part of a penny in the pound, more especially as the return, in the shape of a reduction in the costly sickness expenditure, would far more than compensate for so trivial an outlay.

The objection at first raised, that the Act, for a variety of reasons, would not work smoothly, has been amply refuted by experience. Although it by no means follows that the Act is of little service in the absence of an isolation hospital, still great benefit can hardly be looked for unless means for the early isolation of notified cases, and the disinfection of clothing, &c., are available.

Duties of an Inspector during an Epidemic.—During an epidemic the sanitary inspector ought to be diligently occupied in attending to the work of disinfection, in visiting infected houses in order to caution the occupants against unnecessary intercourse with others, and in instructing the people how to use such disinfectants as are provided by order of the medical officer, and it is important that special attention should be paid at such times to all insanitary conditions. The practice of distributing bills with printed instructions, drawn out on not too elaborate a scale, is likely to be of service.

CHAPTER X.

FOOD.

It is not intended in this chapter to consider the question of our food supply, except in so far as it is important from a Sanitary

Inspector's point of view, in relation to the duty that may be imposed upon him under the Public Health Act (see Appendix). The purely medical aspect of the question, the elements essential to health, and the proportion, under varying circumstances, in which each should be present in our diet, does not specially concern him, and will not therefore be touched upon. Notwithstanding this limitation, however, the subject is one which ultimately concerns us all, especially in the light of modern experience, which tends more and more to establish a close relationship between diseases of animals and many of the ills that human flesh is heir to.

The Act empowers an inspector to examine "any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk exposed for sale, or deposited for the purpose of sale, or of preparation for sale, and intended for the food of man;" and it gives him power to seize the same if he finds that it is "diseased, unsound, or unwholesome." An inspector then must be familiar with the characteristics of sound and unsound food, so as to be able to detect that which is unwholesome, whether from disease or other causes.

It is obvious that this knowledge can only be acquired by experience, but unless he has some guide as to what he ought to look for, and some means of gauging the significance of what he sees, little progress will be made.

Meat may be unwholesome from a variety of causes. In all cases, a carcase, though free from disease, which shows evidence of decomposition, and in most cases the meat of animals that have suffered from disease, ought to be condemned as unfit for the food of man. Again, immature veal and lamb is considered unwholesome, and, undoubtedly, what is known as "slink" meat, that is the meat of calves or lambs that have been cast prematurely, or have died during birth, should be condemned. The meat of animals that have been "physicked" must be looked upon with suspicion, but the smell of physic, which may often be perceived in dead meat, and especially in the stomach, does not in itself afford sufficient grounds for seizure, although it indicates that all is not right, and warrants a more searching enquiry, with a view to the discovery of any diseased condition of the carcase that may account for the physicking, and possibly lead to its being condemned as unfit for food. The meat of animals that have not been killed, but have died, either from accident or illness, should be condemned, even although, as regards the latter, there is no distinct evidence of the nature of the malady. The meat of animals that have been slaughtered after injury need not be condemned, provided the health of the animal has not suffered in the interval, and the carcase has been perfectly bled. The fraudulent sale of the flesh of one animal, representing it to be that of another, is perhaps a more common practice than is generally supposed. The most common deception is the substitution of the flesh of the horse for that of the ox, and on the ground of health no objection can be raised to it. Recently an Act has been passed (The Sale of Horse Flesh Act, see Appendix), which legalises the sale under certain restrictions, and in order to detect any infringement of this Act, the meat inspector should be able to distinguish the flesh of one animal from that of another. The flesh of dogs and cats is sometimes substituted for or mixed with pork and mutton in the manufacture of sausages and pies; as, under these circumstances, the meat is cut up into fine pieces, the detection of the fraud is hardly possible, and it concerns the police officer rather than the sanitary inspector.

Inspection of Live Animals.

Although an unhealthy animal intended to be used as food may be seized alive, it is not often that an inspector is called upon to pronounce upon such, and if he should be, it is not desirable for him to act on his own responsibility; the Medical Officer of Health ought invariably to be consulted in this, as in all doubtful cases, and it will probably be expedient to call in a veterinary surgeon. In order, however, that the initiative may be taken, it is well to be familiar with the ordinary signs of disease.

A healthy animal should be well nourished; its coat should be in good condition, not rough and standing; its skin supple, and its flesh tolerably firm and elastic. It should not shiver, nor show any sign of being in pain; it should be able to get about without showing any indication of lameness, and to get up with ease. The eyes should be bright, the nostrils red and healthy looking, and, although moist, there should be no discharge from them; the tongue should not be hanging; and in the cow the teats should not be hot. An important indication of health is regular and easy breathing, and an absence of offensive odour in the breath.

Inspection of Meat.

The Carcase.—The inspector has a much better chance of forming an opinion regarding the quality of meat before it has been cut up, and the inspection, to be thorough, should include the various organs. Unless these are healthy, the butcher will carefully conceal them, so if the slaughtering has recently taken place, and they are not forthcoming, the probability is he has an excellent reason for their concealment.

A carcase should be thoroughly "set" in about twenty-four hours after slaughtering, or when it is quite cool, but this period varies in accordance with the temperature and moisture of the atmosphere, &c.; it should be well bled, free from bruises and bile stains, and one side or quarter should not differ from another, as regards colour. On applying pressure with the finger to the fleshy parts there should be no pitting nor crackling; the former indicates a dropsical condition, and the latter the presence of air within the tissues.

The appearance of the **interior of the chest** is of the utmost importance, especially if the lungs cannot be examined, as most diseases affecting these organs leave indelible traces on the interior of the chest walls. In a healthy animal these should be perfectly smooth, and the ribs, with the intervening fleshy parts, should be clearly seen through a transparent membrane. On the other hand, if the interior of the chest wall is very rough, and the lining membrane cloudy, the animal has probably suffered from an inflammatory affection, and the chances are that other signs of acute illness, sufficient to condemn it, will be found in the carcase. Butchers, as a rule, take care to remove, as far as possible, the evidence of such inflammatory mischief from the chest walls, but no amount of manipulation will restore the normal appearances sufficiently to deceive an ordinary skilled observer. By carefully removing all trace of the inner covering of the chest (the pleura), the surface, after being exposed to the air, may not show much sign of having been interfered with, but if it be moistened with a damp cloth or sponge, the torn fibres will become opaque, and thus any doubt will at once be removed.

The lungs should be spongy, of a bright pink colour, and when cut into pieces each portion should float in water. The latter test, however, by no means proves that the lung is healthy, as it is only in advanced disease that the texture is so devoid of air as to cause it to sink in water. The lungs also should be free from cavities, matter (pus), and nodules.

The liver should be sufficiently firm not to break down easily on pressure; it should be of a dark brown colour and free from abscesses.

The stomachs and bowels should be free from ulcers and all appearance of inflammation in the shape of blotchy redness, and they should not smell of drugs.

A more detailed description of the appearances to be looked for in the various organs will be found under the heading of the diseases that specially affect them.

Characteristics of Horse Flesh.—The sale of horse flesh, including the flesh of asses and mules, is permitted by law, provided the public are not deceived with regard to what they are purchasing (see Appendix). To guard against any such fraud, it is necessary that the meat inspector should be able to distinguish between the flesh of the horse and that of the ox. If the whole carcase can be inspected, the detection is a comparatively simple matter, but when the meat is cut up, especially if it has been boned, which is sometimes the case, it is not so easy.

The horse has eighteen **ribs** on each side, while the ox has only thirteen, and in the latter they are broader, flatter, and less arched, and are united to the cartilages by joints, while those of the horse have a fixed union.

The breastbone of the ox is flat above and below, while that of the horse is keel-shaped—that is, flat sideways. The bones of the horse are mostly larger than those of the ox, and they contain more fatty matter, which is of an oily consistence. Throughout the whole skeleton there are distinguishing features, although it is difficult to convey an idea of them in writing; an hour's study in a natural history museum, with the two skeletons side by side, will do more good than any description, however lengthy.

The tongue of the horse is broad at the point, while that of the ox is pointed, and the upper surface of the latter is rough, and has a distinct prominence about mid-way between the root and the tip. If the bone of the tongue is examined in the ox, it will be found to consist of nine segments, whereas in the horse it is formed of five.

The liver of the ox forms one continuous mass, with one small segment or lobe at the upper and back part, and it has a gall-bladder attached. The liver of the horse, on the other hand, is formed of three large lobes and a small one, and it has no gall-bladder.

The heart of the ox is more conical or pear-shaped than that of the horse, and as a rule it has a larger deposit of fat on the surface, and this is paler and of a firmer consistency than that found on the horse's heart. In the base of the former there is a bone which is not found in the heart of the horse.

Horse flesh has a characteristic odour; it is darker, and has a coarser texture than beef, and there is little or no fat intermixed with its fibres.

The fat of a horse is very characteristic, so much so, that the butcher, if he wishes to deceive the public, removes the natural fat and substitutes that of the ox for it. It is darker and softer than ox fat, and has a peculiar flavour.

Characteristics of Good Meat.—Good meat should be firm and elastic to the touch, not doughy, and when pressure is applied by the finger it should not pit; after standing for a day or two, it should present a dry surface. The colour will vary according to the age of the animal; veal is quite pale in colour, and the flesh of an ox two or three years old is lighter in colour than that of an animal twice that age. Meat may either be too light or too dark in colour, as the result of disease; an exhausting illness, for example, may cause pallor, and the flesh of animals that have died with the blood in them will be dark, even purple; it will set badly and decompose readily. In both cases, however, other signs of disease will probably be found. Veins of fat should be intermixed with the flesh, so as to present a marbled appearance; there should be an absence of moisture, and on pressure no mucilaginous or mattery-looking fluid should exude from the tissue between the fleshy bundles (muscles), although on standing a thin, clear, red fluid may exude in small quantity.

The odour should be fresh, and by no means disagreeable, and if putrefaction has started, the nose will detect it long before any discoloration takes place. Early putrefaction is likely to be most apparent in the deeper parts, close to the bone, and it may be detected by introducing a knife and smelling it as soon as it is withdrawn. Another means of bringing out any odour, is to bruise a piece of meat and pour hot water over it in a glass, which is then held close to the nose while the steam rises from it. As putrefaction advances, the meat softens and turns pale or livid, and at a later stage green. The earliest actual change in appearance, the result of putrefaction, is most likely to be found in the flanks, and in the marrow of the long bones; the latter loses its pink salmony colour and solid consistency, and becomes soft and dirty looking. Fresh meat has a slightly acid reaction when tested with litmus paper, but when putrefaction is established the reaction is distinctly alkaline.

The fat should be white or straw coloured, and show few blood spots. The fat of animals that are fed on oil cake is sometimes of rather a dark yellow colour, and the fat of Jersey and Guernsey cattle is darker naturally than that of other breeds.

Veal is paler in colour than beef, particularly if the animal has been bled before slaughtering—a common practice in the past, which happily is now seldom adopted—and both the flesh and fat are less firm than in the ox. In the immature calf the flesh is watery and has a distinctive odour.

Mutton is less florid in colour than beef, and the younger the animal, up to a certain point, the lighter the colour. The fat is white and very firm.

Pork is paler than mutton, although in this case also it is influenced by the age of the pig; it is less firm, and the fat has a more oily or greasy consistency.

Meat Unfit for Human Food.

The meat of healthy animals may become unwholesome from putrefactive change, the result of being kept too long, or disease may render it unfit for food.

Putrid meat may give rise to very alarming and even fatal illness, particularly if, in the first instance, the animal has suffered from disease. It would appear, from the recorded investigations of such illnesses, that the cause may be attributed, either to the presence in the meat of minute organisms, or to an organic chemical poison resulting from putrefaction.

One of the most remarkable outbreaks of illness from this cause occurred at Welbeck in 1880, among persons attending the sale of the late Duke of Portland's effects. Dr. Ballard, who conducted the enquiry, found that seventy-two persons were attacked by the disease, which proved fatal in four cases. The people were attacked with pain, intense diarrhœa, and symptoms of fever from twelve to thirty-six hours after luncheon. By a process of exclusion, it was found that the only articles partaken of which were open to suspicion as having produced the disease were sandwiches composed of beef and ham. Experiments conducted by Dr. Klein afterwards showed that the ham was infested with a special organism, numerous specimens of which were also found in the kidney of one of the patients who had died from the disease.* In addition to this, certain animals that were fed on, or inoculated with, portions of the suspected ham, were seized with a similar illness, which proved fatal to many of them; a like result also followed the

* For an account of the organisms found, see *Micro-Organisms and Disease*, Klein.

inoculation of the organisms from the hams, after cultivation in the white of egg.*

Another outbreak very similar in character occurred at Nottingham in February, 1881. Dr. Ballard, who investigated this outbreak also, found that after eating baked pork, obtained from a certain shop, fifteen persons were attacked, and one died. Unfortunately, in this instance, none of the suspected pork could be obtained, but numerous organisms, similar to those associated with the Welbeck outbreak, were found in the body of the patient who died, and cultivations of them, inoculated into mice and guinea-pigs, gave rise to the disease in every instance.†

In the same report in which the above history appears, the details of a fatal case of sausage poisoning at Arlford, which was investigated by Dr. Ballard, are given. Also in the "Report of the Medical Officer of the Local Government Board for 1887," an account is given by Mr. Spear of seventy cases of poisoning from pork-pie and brawn, which occurred at Retford, and proved fatal in one case.

Although it would seem that pork is the meat to which poisonous symptoms are most usually attributed, both beef and veal may undoubtedly give rise to similar illnesses. With regard to venison and game, on the other hand, it is a remarkable fact, not easily accounted for, that both are habitually consumed in a state of decomposition, apparently with impunity.

Diseases of Animals in Relation to Food Supply.

Beyond the short summary already given of the more common signs of disease in animals during life, no attempt will be made, in the following account, to describe the symptoms by which the various diseases mentioned may be recognised; the signs of each disease in the carcase, and the significance, from a health point of view, of the altered condition of the meat will alone be dealt with.

The following are the diseases commonly met with that may affect, more or less, the quality of the meat:—Measles in pig and ox, trichinosis in pig, foot-and-mouth disease, pleuro-pneumonia, cattle-plague, pneumo-enteritis in pig, swine fever, puerperal

* "Tenth Report of the Medical Officer of the Local Government Board," 1880.

† "Eleventh Report of the Medical Officer of the Local Government Board," 1881.

fever, small-pox in sheep, rot in sheep, actinomycosis, anthrax, charbon symptomatique, tuberculosis, glanders and farcy in horses, and acute febrile disorders from various causes.

Measles (*bladder worm, Cysticercus cellulosæ*) is the term applied to a disease which occurs in pigs and oxen. It has absolutely nothing to do with the infectious disease of the same name in man, and is characterised by the existence of parasites in the muscles throughout the body. These parasites are enclosed in cysts or bladders, situated between the fibres of the muscles, and these are the larvæ of the human tape-worm. The species which affects the pig differs from that found in the ox, although the difference is not sufficiently marked to be apparent to the naked eye. The tape-worm which develops from each species also differs; that which occurs in the pig producing what is known as **Tænia solium,** while that found in the ox produces the **Tænia medio-canellata.**

The cysts may be seen by the naked eye; they are oval in shape, and vary in length from one-eighth to three-eighths of an inch; they are found in immense numbers everywhere throughout the muscular system, but more especially in the muscles of the tongue, the neck, the diaphragm and the shoulders; they may be found in the liver, kidney, heart, brain, and other organs and tissues.

If one of the bladders is removed and placed on a glass slide, it may be opened, when, with the aid of a good pocket lens, the worm will be seen within it. If examined under the low power of a microscope, a small depression will be seen at the apex of the head which is surrounded with hooklets.

The appearance of the flesh infected with these parasites has given rise to the name measly; when cut in sections it is pale and flabby, and looks dropsical. Putrefaction commences early, and the flesh does not take on salt, but remains flabby after long curing. If the bladders have been in existence for a long period, they will have become chalky, in which case, on cutting through the flesh, a grating sensation will be imparted to the hand.

The life-history of these animals is as follows :—Each segment of the mature tape-worm which inhabits the human bowel contains thousands of eggs (it may be as many as 35,000); these segments are discharged from the bowel, and, in one way or another, the eggs are swallowed by the pig or ox, and are hatched within the animal. The embryo, when hatched, finds its way into the tissues of the animal by the aid of hooklets, six in number, placed round its mouth, and as soon as it has arrived at a favourable spot, it develops into the bladder form or cyst, which has just been described. In this position it remains during the life-time of the animal, and when slaughtering takes place, and the flesh is consumed by the human subject, the parasite attaches itself to the bowel, and develops into the tape-worm, from the eggs of which it has sprung in the first instance.

During life, these cysts may be found by examining the under surface of the tongue, which is pulled out, and fixed with the aid of a piece of wood introduced crossways between the jaws.

Heat amounting to 170° F. destroys the parasite, so that infested pork, if thoroughly well cooked, may be consumed with impunity, but, as the cooking process may only be partial, and as the interior of a piece of meat is as likely to be affected as the surface, in order to avoid risk all such meat should be condemned.

Trichinosis is the term applied to an affection which occurs in the pig and in man, owing to the existence within the muscles of small thread-like worms. Unlike the cysticercus, which is found *between* the muscular fibres, the *Trichina spiralis*, as it is called, is enclosed in a much smaller oblong cyst *within* the muscular fibres themselves, although it would seem, they may be found in other tissues.*

Owing to the small size of the cysts within which the little worms live coiled up, they cannot so easily be seen as the cysticercus parasite, but, if present in large numbers, the naked eye can detect the speckled appearance presented by the flesh. To examine meat for trichinæ by the microscope, it is only necessary to use a low power. A thin section of the flesh is cut and placed upon a watch-glass containing a little solution of potash to disintegrate the muscular tissues, and it is then teased out by the aid of needles. If the cyst should be calcified, which is often the case, after washing with water, the addition of a little hydrochloric acid will soon clear it up, and the specimen can then be placed on a slide, under a cover glass, when the worm will readily be seen through the transparent cyst.

Although the parasites may be found in all parts of the muscular system, the favourite sites for them are in the muscles in the neighbourhood of the bowels—the diaphragm and abdominal muscles. It has been calculated that a cubic inch of flesh may contain as many as 100,000 parasites.

The male worm, when fully developed, measures $\frac{1}{18}$ inch, the female is much larger, measuring $\frac{1}{8}$ inch. The female contains from 500 to 600 eggs, and they are hatched within the body, so

* *Lancet*, 23rd Sept., 1882.

that the process of reproduction is *viviparous*. The recently-hatched worms pierce the bowels, and, travelling along, ultimately take up their abode in the muscles, where a cyst forms round each, the muscular fibres, in the meantime, having degenerated at the spot where the cyst forms. During the migration of these worms, the individual affected suffers from pains throughout the body, and is feverish, and if the infested meat has been consumed in a large quantity, the disease may prove fatal. After the worm becomes encysted, it remains quiescent in the muscle, and the symptoms subside.

It is supposed that the pig becomes trichinous from eating offal, and man contracts the disease from eating pork from trichinous pigs. The trichinæ, as they exist in flesh, are not readily destroyed, and if they have been encysted, say for twelve months, salting is quite inoperative against them. With regard to the effect of cooking, unless it is thorough, the vitality of the worms is not impaired by it, and it has been proved that they resist a temperature of 122° F. Imperfectly cooked food, therefore, is not safe, and all infested pork should be condemned.

Foot-and-mouth disease (*Eczema epizootica*) is a highly infectious malady, which attacks principally cattle, but sheep and pigs also suffer. As a rule it does not produce much constitutional disturbance, and as the internal organs and structures are not affected, the only signs of the disease in the carcase are to be found on the tongue and lining membrane of the mouth, between the claws of the hoof, and on the udder of cows. Blisters are found at these sites in the first instance, and these afterwards break and form ulcers. As the milk of cows suffering from the disease may produce a similar affection in man, it ought to be condemned. It has not been proved that the flesh is injurious, and unless it has undergone a change from constitutional disturbance, it is doubtful whether it should be destroyed, although some authorities consider that it is wise to err on the safe side, and condemn it, on the ground that the animal has suffered from a general disease. There is no question with regard to the propriety of condemning those parts of the animal which are affected by the disease.

Pleuro-pneumonia is a contagious affection which specially attacks cattle, and, as its name implies, the parts affected are the lungs and the lining membrane of the chest (*Pleura*). Serious though the disease is, and great as are the changes produced within the chest, it is a remarkable fact that, as a rule, the carcase itself, as far as appearance goes, is unaltered, so that, unless the lungs or the walls of the chest are examined, no evidence of the disease will be found, provided the animal has been slaughtered. If, however, the animal is allowed to live until the disease is far advanced, the flesh may present a dark appearance, and the fat is tinted yellow from bile-staining. Of course, the butcher will take care to remove as far as possible all trace of the disease from the chest, but, if the lungs can be examined, they will be found to have lost their spongy character, and their surfaces, as well as the lining of the chest wall itself, will be thickened and rough. The lung substance in the early stage of the disease will present a grey appearance intermixed with red or purple patches, and in the later stages, a dark and marbled appearance. To the touch, it will be solid and resisting, and sections of the organ will be found to sink in water. The cavity of the chest will probably contain fluid.

If efforts have been made to conceal the disease by removing the pleura, the inspector will have little difficulty in detecting the fraud by remembering the instructions already given (see p. 214). It cannot be said that any injurious effects have been proved to result from this disease, still, as in the sale of such meat, an attempt is made to palm off upon the public as a sound article, that which is clearly not sound, reasonable grounds exist for condemning it.

Cattle-plague (*Rinderpest*).—This is a highly contagious and fatal disease, which is occasionally widely prevalent. The *post-mortem* signs in this case are to be found in the digestive tract, and in the skin. The flesh does not undergo a marked change, unless the malady has reached an advanced stage; the mucous covering of the bowel will be found to be congested, with extravasations of blood in patches, and, later on, more general inflammation, with ulcerations and hæmorrhages. Pustular sores may be found on the skin. If the disease has been well developed, the flesh will be dark and flabby, it will not set well, and it may crackle on pressure, owing to the tissues being infiltrated with air.

All authorities are agreed that the flesh of animals which have suffered from this disease ought to be condemned.

Pneumo-enteritis in the Pig (*Pig typhoid, hog cholera, red soldier, &c.*).—This is an infectious malady, which is rather common in England, and very fatal. The characteristic signs of the disease are usually to be found in the skin, the bowels, and the lungs. A patchy redness is usually found on the skin, hence the term "red soldier," or there may be livid blotches, when the disease is termed "blue soldier." Sometimes an eruption occurs resembling that of small-pox, with the secretion of matter, which afterwards forms scabs. The red patches referred to are not confined to the skin, but may extend to the fat beneath, in which case the butcher may attempt to disguise it by rubbing in salt along the cut edges, but by removing the edge with a knife, the fraud is at once exposed. It is not likely, however, if the skin is much affected, that the carcase will be exposed for sale.

Marked changes will be found in the bowel, particularly if the disease is advanced; signs of intense inflammation are present, and usually patches of ulceration (sores). The glands also within the abdomen will be enlarged, and fluid may be found in the cavity.

The lungs are usually congested or inflamed. As a rule the muscular system is not perceptibly altered, so that an examination of one portion of the carcase only may lead to the meat being passed as sound. In protracted and severe illness, on the other hand, the flesh may appear pale, flabby, and moist. Although it does not appear that the disease can be communicated to man, the meat of animals that have died from the disease, or been slaughtered while suffering from it, ought to be condemned.

Puerperal Fever (*Milk fever*).—This term is very loosely applied to all affections that cows suffer from after calving. With regard to the quality of the meat, it certainly ought to be condemned if the animal has been slaughtered while suffering from the disease. The signs of recent parturition will be apparent, or the tissues round the outlet of the pelvis may have been removed, in which case the existence of the disease may be suspected, in the absence of any tissue change, such as congestion, moisture, and flabbiness.

If, from any physical cause, delivery cannot be accomplished, and the animal is slaughtered at an early stage, before any effect has been produced in the tissues, it is a question about which there is difference of opinion whether the meat should be condemned, although the general view is that it need not be.

Small-Pox in Sheep (*Variola*).—The cow, the horse, the sheep, and the pig are all liable to suffer from an affection which is termed variola or small-pox, but whether in all cases the disease is identical, is a question. In all, with the exception of the sheep, the disease is unimportant, but in that animal it is very malignant and fatal, and renders the meat quite unfit for food.

The chief feature of the disease is an eruption, which at first appears as red nodules, becoming afterwards watery vesicles, which in time contain matter (pus). Presently these break and discharge, forming scabs, which afterwards fall off. Apart from these signs, the carcase does not present very marked changes, except that the glands may be inflamed, and the flesh, if the animal has suffered severely, will have a disagreeable odour.

Rot in Sheep (*Liver rot, Flukes*).—This disease, which destroys an immense number of sheep annually, is caused by the presence of a worm (*Distoma hepaticum*) in the liver. This worm, which is shaped like a sole, and measures from an inch to an inch and a half in length, attaches itself to the bile-ducts within the liver, and in the later stages of the disease it is present in large numbers, choking up the ducts, and leading to destruction of the tissue.

The disease in itself is unimportant as regards man, and if only a few flukes are found in the liver of an animal, the flesh is perfectly wholesome, although the liver itself should be destroyed. On the other hand, if the disease has led to the animal becoming emaciated, and the flesh dropsical and bile-stained, the meat should be condemned.

Actinomycosis is a disease which specially affects the ox, although it is probable the horse and the pig also suffer from it. The disease, which is produced by the "ray fungus" (*Actinomyces*), mostly attacks the tongue of the ox and immediately adjacent tissues, including the jaw, but it may invade other bones, and also the lungs. The fungus, in all probability, is introduced with the food, and on entering the tissues it sets up inflammation, and causes a deposit of fibrous tissue. The tongue is hard and dense (*wooden tongue*), and very much enlarged, so much so that it may protrude some inches from the mouth; on cutting into it, it presents a nodular appearance. When the disease occurs in the lung, it is apt to be mistaken for tuberculosis, which, to the naked eye, it closely resembles.

The disease does not, as a rule, produce fever or much constitutional disturbance, consequently the meat may not show any signs of having deteriorated in quality. Opinions differ with regard to the necessity for condemning such meat, although there is no question but that the affected organs should be condemned. According to Prof. Wynter Blyth the flesh of animals suffering from the disease, however healthy it may appear, is unfit for human food.

Anthrax (*Splenic fever*, and in man, *wool-sorter's disease*) is a most fatal disease which arises from the introduction into the body of a micro-organism (*Bacillus anthracis*). It commonly attacks oxen and sheep, but pigs also may be affected. The tissues of animals that have suffered, present swellings and tumours at various parts containing gelatinous matter, and decomposition sets in immediately after death, particularly in the regions where the swellings occur; soon, also, the body of the animal becomes immensely swollen, from the formation of gas. The tissues are watery, the muscles are very friable, and of a dark red, or even black colour, from being stained by the blood, which is black and fluid. The spleen may be ruptured; as a rule it is enormously enlarged; it is black, and when divided an ink-black fluid runs from the cut surface. The heart-tissue is soft, and it, like the other organs, the liver, the kidneys, and the lungs, is congested.

The above are the usual *post-mortem* signs of anthrax, but there is another affection, popularly known as **black-leg,** or **quarter-ill** (from the fact that the disease is confined specially to one or other of the quarters), which is often described as being a form of anthrax, although it is unattended by enlargement of the spleen, or the fluid and black condition of the blood, and results from a micro-organism which differs in appearance from that of anthrax proper. The other signs of this disease in the carcase resemble those of anthrax. There is the same tendency to rapid putrefactive change, and the tissues are friable, moist, and doughy. The name given to this disease is **Charbon Symptomatique.***

The appearances presented by the carcase, both in the case of anthrax and charbon symptomatique, will at once indicate, even if the organs cannot be inspected, that the animal has suffered from a serious constitutional malady, and there is no question whatever but that the flesh should be unhesitatingly condemned.

Tuberculosis (*Consumption*).—The relationship that exists between this disease in man and animals has already been referred to in the chapter devoted to infectious disease. We have now only to consider the signs of the disease in the carcase, and the consideration which ought to weigh with one in determining whether the meat may safely be used for the food of man. The disease is common among oxen, but sheep and swine are not exempt from it, and it does occur, although rarely, in horses. The chief signs are usually found in the lungs, but other organs, particularly the glandular structures of the bowels, may be affected.

* See "Thirteenth Annual Report of Medical Officer of the Local Government Board," 1883, "On the Etiology of Charbon Symptomatique," by G. F. Dowdeswell, M.A., F.L.S., F.C.S., &c.

The appearances presented differ at different stages of the malady. Rounded growths, at first hardly visible to the naked eye, form in the tissues, and increase in size, until they approach that of a pigeon's egg, or even larger. This has given rise to the disease being known as "pearl disease," or the "grapes," among butchers. The favourite site for the development of these, is on the surface of the lung and the walls of the chest, and they afterwards invade the interior of the lung, giving rise to an inflammatory condition of the organ. The little growths, on being cut into, have a yellow appearance, and cheesy consistency, although sometimes they are hard and gritty. As the disease advances, the lung is apt to break up, and abscesses may form in its substance. It does not follow, particularly in the early stages, that the carcase should be emaciated, although, as a rule, if marked evidence of the disease is present, the flesh is poor and lean.

Unless the inspector should come upon the scene early, he will probably find that efforts have been made to remove all trace of the disease, but a careful inspection of the chest walls, in the manner already described (p. 214), will reveal that they have been stripped of their internal covering, and the characteristic deposits or abscesses may be found in other organs or tissues of the body if careful search is made for them. In addition to the lungs, the most likely sites for the development of the tubercles, or pearls, are the glands in connection with the bowels, and the glands about the neck, but the liver, and other organs and tissues, may also be affected.

Should Tubercular Meat be Condemned?—At present opinions differ regarding this important question. Some authorities say that the flesh of all animals suffering from tuberculosis, even if the disease is only slightly developed, and confined to the lungs, is unfit for food. Others maintain that one is not justified in condemning such meat, unless the local evidence of the disease, whether in the lungs or in other organs, is considerable, or when more general signs of the disease, however slight, are present. There are others who go the length of saying that such meat may be consumed with safety, however advanced and general the disease may be, provided the organs affected are discarded. The last opinion may be dismissed at once, as being reckless in the extreme, but the former two are open to discussion.

Of course, so far as man is concerned, it cannot be determined experimentally whether the consumption by him of the meat of tubercular animals can induce the disease, and, as so many other known causes are in operation, it is impossible to differentiate between them. Careful experiments, however, have been made with animals that are susceptible to the disease, and the conclusion arrived at, by independent investigators, is that it can be communicated by feeding them with tubercular meat. This being the case, it may well be questioned whether it is expedient to run the risk of contracting so fatal a malady by using, as food, the meat of a tubercular animal, however slight the evidence of the disease in the carcase may be. The question is one which cannot be answered by the sanitary inspector, the Medical Officer of Health must decide it, and in this, as in all cases in which there is any room for doubt, his opinion must be sought.

Although the disease produces distinct local changes, it is also undoubtedly a constitutional malady, and the specific germs have been found in the fluids and general tissues of the body. That being the case one cannot be too careful in the advice one gives, and until the question is more definitely settled, it is well to err on the safe side. Although individual opinions may differ, one is hardly justified in recommending what is opposed to the general consensus of opinion as expressed by the profession.

In Glasgow, a few years ago, an important decision was given in the Sheriff's Court, after an exhaustive enquiry, in which the evidence of many experts was taken. This decision, which condemned the flesh of animals that had suffered only slightly from tuberculosis, has since been repeated in other and similar cases.*

In 1888 a Departmental Committee of the Privy Council came to the conclusion "that although bacilli may be found but rarely in the flesh, still the chance of their being present either there or in the blood is too probable to ever allow the flesh of a tubercular animal being used for food under any circumstances, either for man or the lower animals." Again, in the same year, the Congress on Tuberculosis, which met in Paris, passed a resolution condemning the flesh of all tuberculous animals. This was upheld by a second congress, held in 1889, when the following resolution was passed:—"There is reason to prevent the consumption, by men or animals, of the flesh of tubercular animals —mammals or birds—whatever the degree of tuberculosis, or whatever the apparent quality of the meat."

Glanders and farcy are one and the same disease which, apparently, is confined to horses and man. It is highly contagious, and may be communicated from the horse to man.

The signs of **glanders** are to be found in the membrane

* For a full report of this case, see *Public Health*, vol. ii., p. 75.

lining the cavity of the nose, which is ulcerated; in the glands under the jaw, which are enlarged; and in the lungs, which are inflamed.

In farcy, one or more of the limbs are swollen, and nodular swellings ("buds"), the size of a marble, form under the skin in the course of the lymphatic glands. These, which contain a yellow-coloured fluid, ultimately burst, leaving inflamed open sores.

The flesh of horses that have suffered from the disease should undoubtedly be condemned.

Acute Febrile Disorders.—Only the more common ailments from which animals suffer have been noticed, but all affections of a febrile nature are likely to produce changes in the carcase that render it more or less unfit for human food. Any departure then from the normal appearances, even if there are no signs of specific disease to be found in the organs, must be viewed with suspicion.

Tinned meat is responsible in many instances for serious, and sometimes fatal illness. This may arise from the meat in the first instance having been diseased, but more frequently it is owing to putrefactive changes having taken place from imperfect preservation. Sometimes, also, poisonous metals are absorbed from the can or solder. In such cases the inspector is powerless until illness calls attention to them.

Practical experience necessary.—Book-knowledge is all very well in its way, but unless the meat-inspector takes the trouble to make himself practically acquainted with what he reads, he is certain to make mistakes. It is an easy matter to familiarise oneself with the appearances of sound meat, but this is not all that is necessary. No opportunity of acquiring a practical knowledge of the changes in the carcase, the result of disease, should be allowed to pass.

So long as the system of slaughtering animals in private slaughter-houses adjoining butcher's shops, is general throughout the country, we must not expect that our food supply will receive that careful scrutiny which, it is daily becoming more apparent, it ought to. Neither is it possible under existing circumstances, except in the case of large towns, for the duty of meat-inspection to be intrusted to men specially trained in the work. In time, it is to be hoped, that private slaughter-houses will give place to public abattoirs, under the management of central controlling authorities, and then, properly trained inspectors may be appointed throughout the country, but, until then, the sanitary inspector will probably be held responsible.

Fish unfit for Food.

Fish that has undergone putrefactive change may give rise to serious symptoms, and the least taint is sufficient to condemn it. The inspector will experience no difficulty in judging of its quality, the odour alone being sufficient to determine the point. The flesh ought to be firm, the eye bright and prominent, and the gills healthy-looking. Commencing putrefaction may readily be detected by applying the nose close to the open gills and mouth.

Certain kinds of fish, and more especially shell-fish, are more likely to give rise to serious symptoms than others. Many examples may be given, and a very striking one was recently reported by Sir C. Cameron. Seven persons were attacked about twenty minutes after having eaten stewed mussels, and the symptoms were vomiting, swelling of the face, spasms, &c.; five of the cases were fatal, and the two persons who recovered had only partaken of a few of the mussels.*

Milk Unfit for Food.

Milk.—As already noticed, it is possible that milk may be the vehicle of contagion of certain infectious diseases, not only by the virus in question being introduced from an outside source, but also, because the cow may be suffering from a corresponding ailment. It is probable that scarlet fever, foot-and-mouth disease, and, possibly, diphtheria, may thus be directly transmitted, although, in the case of scarlet fever as well as enteric fever the danger, as regards milk, is usually an indirect one, arising from its accidental contamination from an outside source.

It has also been proved that the milk of tubercular cows may convey that disease to animals, and although it cannot be asserted positively that man runs a similar risk, it is highly probable that he does.

The bacillus of tubercle has been found, not only in the milk of cows suffering from tubercular affections of the udder, but also in the milk of tubercular cows in whose udders no trace of the disease could be found. This being the case, it can hardly be said that such milk may be consumed with impunity, especially as the disease is so fatal among children, at an age

* *British Medical Journal*, July 19th, 1890.

when milk forms an important part of their diet. All risk may be avoided by boiling the milk, but cooking is not equally serviceable in the case of meat, as the temperature in the interior is not likely to be raised sufficiently to destroy the bacilli.

In the face of the above facts, and bearing in mind the influence that unwholesome surroundings have in the production of tubercular affections, the importance of inquiring into the cubic space, ventilation, and drainage of cowsheds will be understood.

Vegetables and Fruit.

The signs of decay in fruit and vegetables are sufficiently apparent not to require description, and in condemning any which are decayed, the inspector must use his own judgment, or, if in doubt, appeal to the Medical Officer of Health for guidance. As a rule the public are capable of protecting themselves.

The danger arising from the consumption of decayed fruit, in the case of young children, is a serious one, owing to the tendency it has to cause diarrhœa.

Corn, Bread, and Flour.

The question of the wholesomeness of corn, bread, or flour, is one which must be decided by the Medical Officer of Health or analyst, but it is an inspector's duty to submit samples of any of these articles should he have reason to suspect that they are unsound or unwholesome.

APPENDIX A.

THE ACTS OF PARLIAMENT

RELATING TO

PUBLIC HEALTH IN ENGLAND AND WALES.

ARRANGED AND ANNOTATED

BY

HERBERT MANLEY.

INDEX OF ACTS OF PARLIAMENT REFERRED TO IN THIS APPENDIX.

Session and Chapter.	Short Title and Year.	Abbreviation.
38 & 39 Vict. c. 55,	Public Health Act, 1875,	P.H.A.
10 & 11 Vict. c. 34,	Towns Improvement Clauses Act, 1847,	T.I.C.
10 & 11 Vict. c. 89,	Towns Police Clauses Act, 1847,	T.P.C.
38 & 39 Vict. c. 63,	Food and Drugs Act, 1875,	F.D.
39 & 40 Vict. c. 75,	Rivers' Pollution Prevention Act, 1876,	R.P.
40 & 41 Vict. c. 60,	Canal Boats Act, 1877,	C.B.
41 Vict. c. 16,	Factory and Workshops Act, 1878,	F.
41 & 42 Vict. c. 25,	Public Health (Water) Act, 1878,	P.H.W.
41 & 42 Vict. c. 74,	Contagious Diseases (Animals) Act, 1878,	C.D.
42 & 43 Vict. c. 30,	Food and Drugs Act, 1879,	F.D.
46 & 47 Vict. c. 53,	Factory and Workshops Act, 1883,	F.
47 & 48 Vict. c. 75,	Canal Boats Act, 1884,	C.B.
48 & 49 Vict. c. 72,	Housing of the Working Classes Act, 1885,	H.W.C.
49 & 50 Vict. c. 32,	Contagious Diseases (Animals) Act, 1885,	C.D.
50 & 51 Vict. c. 19,	Quarry Fencing Act, 1887,	Q.
50 & 51 Vict. c. 29,	Margarine Act, 1887,	M.
51 & 52 Vict. c. 41,	Local Government Act, 1888,	L.G.A.
52 & 53 Vict. c. 11,	Sale of Horseflesh Act, 1889,	H.
52 & 53 Vict. c. 72,	Infectious Diseases (Notification) Act, 1889,	I.D.N.
53 & 54 Vict. c. 34,	Infectious Diseases (Prevention) Act, 1890,	I.D.P.
53 & 54 Vict. c. 59,	Public Health Acts Amendment Act, 1890,	P.H.A.A.
53 & 54 Vict. c. 70,	Housing of the Working Classes Act, 1890,	H.W.C.
54 & 55 Vict. c. 75,	Factory and Workshops Act, 1891,	F.
54 & 55 Vict. c. 76,	Public Health (London) Act, 1891,	London.

APPENDIX A.

THIS appendix makes no pretence to originality, and is merely intended as a short and summarised form of the principal Acts of Parliament and Local Government Board Orders and Memoranda which concern inspectors of nuisances directly or indirectly.

The basis of the scheme is the Public Health Act of 1875, and, in the main, the sequence of clauses in that Act has been followed; here and there clauses have been rearranged, and all amending clauses from subsequent Public Health Laws have been inserted in their appropriate places; the more important clauses and memoranda have been quoted in full, and others epitomised; such notes only as were absolutely necessary to illustrate the operation of the clauses and the practice followed by Sanitary Authorities have been added.

Readers who seek a more full and complete exposition of the Public Health Acts are referred to the well-known works of Glen, Lumley, and MacMorran, from which the greater part of the notes in this appendix has been collected.

The following abbreviations are used :—

M.O.H., Medical Officer of Health; L.A., Local Authority; S.A., Sanitary Authority; L.G.B., Local Government Board.

Appointment of Inspector of Nuisances.

Every Sanitary Authority is required (P.H.A., 189, 190, and 191) to appoint an inspector of nuisances, who may also be the surveyor; and power is given at the same time for the same inspector to act for two or more districts with the sanction of the L.G.B., and subject to such arrangements as to salary, proportionate expenses, &c., as they shall by order prescribe. P.H.A., 189, 190, 191.

No special power has yet been given to county councils to appoint a county sanitary inspector or inspector of nuisances, although such a course has, in at least one instance, been adopted.

London, 108. Under the Acts in force outside the Metropolis no qualification is demanded for this office; but in the London Act of 1891 (108 i.d.), it is laid down that every

"Sanitary Inspector appointed after the first day of January one thousand eight hundred and ninety-five shall be holder of a certificate of such body as the Local Government Board may from time to time approve, that he has by examination shown himself competent for such office, or shall have been, during the three consecutive years preceding the year one thousand eight hundred and ninety-five, a sanitary inspector or inspector of nuisances of a district in London, or of an urban sanitary district out of London containing according to the last published census a population of not less than twenty thousand inhabitants."

It is probable that a similar provision will be inserted in any future consolidation of the Public Health Acts for the country generally.

Duties.—The L.G.B. in an order dated March 23rd, 1891, have definitely prescribed the duties of inspectors of nuisances under the various Public Health Acts which is here appended:—

"1. He shall perform, either under the special directions of the Sanitary Authority, or (so far as authorised by the Sanitary Authority) under the directions of the Medical Officer of Health, or, in cases where no such directions are required, without such directions, all the duties specially imposed upon an Inspector of Nuisances by The Public Health Act, 1875, or by any other Statute or Statutes, or by the Orders of the Local Government Board, so far as the same apply to his office.

"2. He shall attend all meetings of the Sanitary Authority when so required.

"3. He shall by inspection of the District, both systematically at certain periods, and at intervals as occasion may require, keep himself informed in respect of the nuisances existing therein that require abatement.

"4. On receiving notice of the existence of any nuisance within the District, or of the breach of any bye-laws or regulations made by the Sanitary Authority for the suppression of nuisances, he shall, as early as practicable, visit the spot, and inquire into such alleged nuisance or breach of bye-laws or regulations.

"5. He shall report to the Sanitary Authority any noxious or offensive businesses, trades, or manufactories established within the District, and the breach or non-observance of any bye-laws or regulations made in respect of the same.

"6. He shall report to the Sanitary Authority any damage done to any works of water supply, or other works belonging to them, and also any case of wilful or negligent waste of water supplied by them, or any fouling by gas, filth, or otherwise, of water used for domestic purposes.

"7. He shall from time to time, and forthwith upon complaint, visit and inspect the shops and places kept or used for the preparation or sale of butchers' meat, poultry, fish, fruit, vegetables, corn, bread, flour, milk, or any other article to which the provisions of The Public Health Act, 1875, in this behalf shall apply, and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, milk, or other article as aforesaid, which may be therein; and in case any such article appear to him to be intended for the food of man, and to be unfit for such food, he shall cause the same to be seized, and take such other proceedings as may be necessary in order to have the same dealt with by a Justice: Provided that in any case of doubt arising under this clause, he shall report the matter to the Medical Officer of Health, with the view of obtaining his advice thereon.

"8. He shall, when and as directed by the Sanitary Authority, procure and submit samples of food, drink, or drugs suspected to be adulterated, to be analysed by the analyst appointed under 'The Sale of Food and Drugs Act, 1875,' and upon receiving a certificate stating that the articles of food, drink, or drugs are adulterated, cause a complaint to be made, and take the other proceedings prescribed by that Act.

"9. He shall give immediate notice to the Medical Officer of Health of the occurrence within the District of any contagious, infectious, or epidemic disease; and whenever it appears to him that the intervention of such Officer is necessary in consequence of the existence of any nuisance injurious to health, or of any overcrowding in a house, he shall forthwith inform the Medical Officer of Health thereof.

"10. He shall, subject to the directions of the Sanitary Authority, attend to the instructions of the Medical Officer of Health with respect to any measures which can be lawfully taken by an Inspector of Nuisances under The Public Health Act, 1875, or under any other Statute or Statutes, for preventing the spread of any contagious, infectious, or epidemic disease of a dangerous character.

"11. He shall enter from day to day, in a book to be provided by the Sanitary Authority, particulars of his inspections and of the action taken by him in the execution of his duties. He shall also keep a book or books, to be provided by the Sanitary Authority, so arranged as to form, as far as possible, a continuous record of the sanitary condition of each of the premises in respect of which any action has been taken under The Public Health Act, 1875, or under any other Statute or Statutes, and shall keep any other systematic records that the Sanitary Authority may require.

"12. He shall at all reasonable times, when applied to by the Medical Officer of Health, produce to him his books, or any of them, and render to him such information as he may be able to furnish with respect to any matter to which the duties of Inspector of Nuisances relate.

"13. He shall, if directed by the Sanitary Authority to do so, superintend and see to the due execution of all works which may be undertaken under their direction for the suppression or removal of nuisances within the District.

"14. He shall, if directed by the Sanitary Authority to do so, act as Officer of the said Authority as Local Authority under the Contagious Diseases (Animals) Act, 1886, and any Orders or Regulations made thereunder.

"15. In matters not specifically provided for in this Order, he shall observe and execute all the lawful orders and directions of the Sanitary Authority, and the Orders of the Local Government Board which may be hereafter issued applicable to his office."

It is to be regretted that no fixity of tenure is attached to the office of inspector of nuisances, and that, except for the contribution of a moiety of the salary in certain cases, no supervision of salary is exercised by the L.G.B. or the County Council.

In the Public Health Act, 1875, this officer is always spoken of as the inspector of nuisances, and he must be formally appointed under that title; the Act does not recognise the title Sanitary Inspector.

These duties are regulated further by the provisions of various Acts of Parliament, the material clauses of which are here set out in full with such comments as appear necessary, commencing with the Public Health Act, 1875.

P.H.A., 4. DEFINITIONS.—"'Street' includes any highway (not being a turnpike road), and any public bridge (not being a county bridge), and any road, lane, footway, square, court, alley or passage, whether a thoroughfare or not.

"'House' includes schools, also factories and other buildings in which more than twenty persons are employed * at one time.

"'Drain' means any drain of and used for the drainage of one building only, or premises within the same curtilage, and made merely for the purpose of communicating therefrom with a cesspool or other like receptacle for drainage, or with a sewer into which the drainage of two or more buildings or premises occupied by different persons is conveyed.

"'Sewer' includes sewers and drains of every description, except drains to which the word 'drain' interpreted as aforesaid applies, and except drains vested in or under the control of any authority having the management of roads and not being a local authority under this Act.

"'Slaughter-house' includes the buildings and places commonly called slaughter-houses and knackers' yards, and any building or place used for slaughtering cattle, horses, or animals of any description for sale."

London, 141. *Note.*—The P.H.L. Act, 1891, adds to the definition of a street the words "whether or not there are houses in such street;" it does not limit the number of persons to be employed in a house; and it further states that "the expressions 'building' and 'house'" respectively include the curtilage of a building or house wholly or partly erected under statutory authority.

Curtilage is defined as a "court yard, backside or piece of ground lying near to a dwelling-house" (*Wharton*). Questions have been raised as to whether a number of separate yards connected by doors though separated by walls, and belonging to one owner, are within the same curtilage; this question is of great importance in connection with the distinction between a drain and a sewer; and is further affected by section 19 of

P.H.A.A., 19. the Public Health Acts Amendment Act which is as follows:—

* The number of persons employed is now immaterial. (Factory Act, 1878, 101.)

"1. Where two or more houses belonging to different owners are connected with a public sewer by a single private drain, an application may be made under section forty-one of the Public Health Act, 1875, (relating to complaints as to nuisances from drains), and the local authority may recover any expenses incurred by them in executing any works under the powers conferred on them by that section from the owners of the houses in such shares and proportions as shall be settled by their surveyor or (in case of dispute) by a court of summary jurisdiction.

"2. Such expenses may be recovered summarily or may be declared by the urban authority to be private improvement expenses under the Public Health Acts, and may be recovered accordingly.

"3. For the purposes of this section the expression 'drain' includes a drain used for the drainage of more than one building."

Further definitions which affect sanitary inspectors are to be found in the Factory and Workshop Acts:—

"The expression 'retail bakehouse' means any bakehouse or place, the bread, biscuits, or confectionery baked in which are not sold wholesale but by retail in some shop or place occupied together with such bakehouse, which is not a factory within the meaning of the Act of 1878. Not to include any bakehouse which is a factory, *i.e.*, in which motive power is employed." F., 1883, 18. F., 1891, 36.

"The expression 'ashpit' in the Public Health Acts and in this Act shall for the purposes of the execution of those Acts and of this Act include any ashtub or other receptacle for the deposit of ashes, fæcal matter, or refuse." P.H.A.A., 11.

This is an additional definition in the Public Health Amendment Act, 1891, and has reference to sections 35, 39, 40, 41, 91 *et seq.* of the Public Health Act, 1875. See next section of this appendix.

"The expression 'sanitary convenience' includes urinals, water-closets, earth-closets, privies, ashpits, and any similar convenience." P.H.A.A., 11.

This is a new definition and extremely convenient.

"'Lands' and 'premises' include messuages, buildings, lands, easements and hereditaments of any tenure."

The term "premises" is used several times in this Act, notably in section 91, and it is inserted in the definitions to avoid difficulties which have formerly arisen.

Other definitions will be found in their respective places where minor acts are dealt with in detail: for example, in the Housing of the Working Classes Act, 1890, quite a different definition of the term "street" is employed.

Sanitary Authorities.

The second part of the Public Health Act, 1875, sections 5-12 inclusive, is devoted to the definition of the various authorities P.H.A., 5-12.

who are entrusted with the carrying out of its provisions. By these sections the whole of England and Wales (excepting the metropolis) is divided into **urban** and **rural** sanitary districts.

Urban districts include—1. Municipal boroughs whenever constituted, described formally as "The mayor, aldermen, and burgesses, acting by the council."

2. Local Government Districts whenever formed and acting by the Local Board.

3. Improvement Act Districts formed prior to the passing of the Act, governed by the Improvement Commissioners.

Rural districts are those parts of any Union which are not included in any urban district, and are governed by such members of the Board of Guardians as represent those parts. Although the Rural Sanitary Authority only consists of a portion of the Board of Guardians, all acts must be done in the name of the whole Board, and all sealed documents be sealed with the seal of the Board.

Local Gov. Act, 17, 18, 19. A further distinction has now been made by the Local Government Act of 1888 by which certain sanitary powers are given to the **County Councils** with regard to the appointment of medical officers of health for the county, and to the payment of district medical officers of health, and further they may cause a representation to be made concerning any district in the county to the L.G.B., if the provisions of the Public Health Act are not properly enforced therein.

The Metropolis is a county by itself, and is governed in this matter by the special Acts relating to its vestries and district boards, which are fully set out in Schedules A and B to the Metropolis Management Act, 1855, with the addition of the City of London and the Local Board of Woolwich, whose position is now clearly defined. The law of public health in the metropolis is frequently alluded to in this appendix, and any special differences in it are noted.

Sanitary Provisions.

The sanitary provisions of the Act of 1875 are contained in Part iii., and comprise 131 sections, grouped under various headings. The first of these is **Sewerage and Drainage**, and includes sections 13-34 inclusive. The details therein contained are more especially within the province of the surveyor, and their more important features are briefly summarised.

P.H.A., 13-34.

In considering these clauses, attention must be given to the definitions of a drain and a sewer (p. 236), and it should be clearly understood that all drains which are used for more than one curtilage are sewers; that the provisions of section 19 of the Amending Act of 1890 are so ill-defined and open to misinterpretation, that it is dangerous at present to rely upon its operation; and that all sewers are vested in the local authority. It is not, therefore, to be expected that local authorities will sanction the laying of a sewer (*i.e.*, a common drain for several houses having separate backyards) upon private land, since, in the event of it being necessary to examine their sewer, they would be compelled to enter upon private property, and would probably be exposed to a demand for compensation for so doing.

In the metropolis, and in at least one provincial town (Reading) the difficulty is met by permitting the drainage of such a row of houses to be effected by a *combined operation;* this or some similar provision is urgently needed in the general law.

The sewers, with certain special exceptions, being the property of the L.A., whether made or purchased by them, they are bound to provide efficient sewers and to keep them in repair; and they must purify their sewage before discharging it into any natural stream, a provision which will receive further notice when the Rivers' Pollution Act is treated of (p. 278). Powers are also given R.P. for the construction of works, &c., for the treatment and disposal of sewage, with certain restrictions, and subject to an enquiry by the L.G.B.; the system of sewers must be properly constructed, ventilated, cleansed and covered, and must not be allowed to become a nuisance or injurious to health.

Owners or occupiers of premises are entitled to carry drains P.H.A., into the public sewer after notice and on compliance with the regu- 21-26. lations of the L.A.; and, on the other hand, if there be a sewer within 100 feet from the site of any house, *i.e.*, the boundary of the private land, the L.A., unless there is already a drain sufficient for effectual drainage, may require the owner or occupier to make a *covered drain* to the sewer according to their directions as regards material and levels. Further than that, if the L.A. make a change in their system of sewerage, they may adapt the existing private drains to the new system, and close the old sewers. Houses newly erected or rebuilt in *urban* districts must be drained to the satisfaction of the L.A. No person may erect any building over the sewers of an urban authority without their written permission.

Privies, Closets, &c.—The next sub-heading deals with privies, water-closets, &c., and includes sections 35-41.

The duties of a sanitary inspector with respect to these are laid down in the following sections:—

P.H.A., 36. "If a house within the district of a local authority appears to such authority by the report of their surveyor or inspector of nuisances to be without a sufficient water-closet, earth-closet or privy, and an ashpit furnished with proper doors and coverings, the local authority shall, by written notice, require the owner or occupier of the house, within a reasonable time therein specified, to provide a sufficient water-closet, earth-closet or privy, and an ashpit furnished as aforesaid, or either of them, as the case may require."

"If such notice is not complied with, the local authority may, at the expiration of the time specified in the notice, do the work thereby required to be done, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses: Provided that where a water-closet, earth-closet or privy has been and is used in common by the inmates of two or more houses, or if in the opinion of the local authority a water-closet, earth-closet or privy may be so used, they need not require the same to be provided for each house."

See extended definition of an ashpit, p. 237.

By this section, a Local Authority may require a water-closet to be substituted for a privy if the latter is in their opinion insufficient, but they cannot pass a general order; each case must be reported and considered on its merits. In this connection it has also been held that one privy is sufficient for two houses.

P.H.A., 37. The following section provides that, with the sanction of the L.A., an earth-closet may be substituted for a water-closet; and an earth-closet is further defined as "any place for the reception and deodorisation of fæcal matter constructed to the satisfaction of the L.A."

P.H.A., 38. The next section refers to the provision of proper privy accommodation for factories, but the duty of certifying is, in this case, assigned to the surveyor. In connection with this provision,
P.H.A.A., 22. the twenty-second section of the Public Health Acts Amendment Act, should be read, as, wherever this Act has been adopted, the earlier section has been superseded thereby. It is as follows:—

"1. Every building, used as a workshop or manufactory, or where persons are employed or intended to be employed in any trade or business, whether erected before or after the adoption of this part of this Act in any district, shall be provided with sufficient and suitable accommodation in the way of sanitary conveniences, having regard to the number of persons employed in or in attendance at such building, and also where persons of both sexes are employed, or intended to be employed, or in attendance, with proper separate accommodation for persons of each sex.

"2. Where it appears to an urban authority on the report of their surveyor that the provisions of this section are not complied with in the case of any building, the urban authority may, if they think fit, by written notice, require the owner or occupier of any such building to make such alterations and additions therein as may be required to give such sufficient, suitable, and proper accommodation as aforesaid.

"3. Any person who neglects or refuses to comply with any such notice shall be liable for each default to a penalty not exceeding twenty pounds, and to a daily penalty not exceeding forty shillings.

"4. Where this section is in force, section thirty-eight of the Public Health Act, 1875, shall be repealed."

This section cannot be adopted by rural authorities.

The duty of carrying out this section is imposed upon the surveyor, and not upon the inspector of nuisances.

With this section should also be read the third and fourth sections of the Factory Act, 1878 :—

"A factory shall be kept in a cleanly state and free from effluvia arising from any drain, water-closet, earth-closet, privy, urinal, or other nuisance. F., 1878, 3.

"A factory shall not be so overcrowded while work is carried on therein as to be dangerous or injurious to the health of the persons employed therein, and shall be ventilated in such a manner as to render harmless, so far as practicable, all the gases, vapours, dust, or other impurities generated in the course of the manufacturing process or handicraft carried on therein that may be injurious to health.

"A factory in which there is a contravention of this section shall be deemed not to be kept in conformity with this Act.

"Where it appears to an inspector under this Act that any act, neglect, or default in relation to any drain, water-closet, earth-closet, privy, ashpit, water-supply, nuisance or other matter in a factory or workshop is punishable or remediable under the law relating to public health, but not under this Act, that inspector shall give notice in writing of such act, neglect, or default, to the sanitary authority in whose district the factory or workshop is situate, and it shall be the duty of the sanitary authority to make such inquiry into the subject of the notice, and take such action thereon, as to that authority may seem proper for the purpose of enforcing the law. F., 1878, 4.

"An inspector, under this Act, may, for the purpose of this section, take with him into a factory or workshop a medical officer of health, inspector of nuisances, or other officer of the sanitary authority."

The next section provides that any *Urban* L.A. may provide public conveniences, urinals, &c.; and by the provisions of the Public Health Acts Amendment Act, 20, 21, the L.A. may make a number of regulations respecting such places, both as regards sub-letting and management. P.H.A., 39, and P.H.A.A., 20-21.

Section 40 provides that the L.A. shall provide for the proper keeping of all drains, water-closets, earth-closets, privies, ashpits, and cesspools. P.H.A., 40.

Section 41 deals with the action to be taken in the event of a nuisance from any of the above being reported to the S.A. :—

"On the written application of any person to a local authority, stating that any drain, water-closet, earth-closet, privy, ashpit or cesspool on or P.H.A., 41.

belonging to any premises within their district is a nuisance or *injurious to health* (but not otherwise), the local authority, may, by writing, empower their surveyor or inspector of nuisances, after twenty-four hours' written notice to the occupier of such premises, or in case of emergency without notice, to enter such premises, with or without assistants, and cause the ground to be opened, and examine such drain, water-closet, earth-closet, privy, ashpit or cesspool. If the drain, water-closet, earth-closet, privy, ashpit or cesspool on examination is found to be in proper condition, he shall cause the ground to be closed, and any damage done to be made good as soon as can be, and the expenses of the works shall be defrayed by the local authority. If the drain, water-closet, earth-closet, privy, ashpit or cesspool on examination appear to be in bad condition, or to require alteration or amendment, the local authority shall forthwith cause notice in writing to be given to the owner or occupier of the premises requiring him forthwith or within a reasonable time therein specified to do the necessary works; and if such notice is not complied with, the person to whom it is given shall be liable to a penalty not exceeding ten shillings for every day during which he continues to make default, and the local authority may, if they think fit, execute such works, and may recover in a summary manner from the owner the expenses incurred by them in so doing, or may by order declare the same to be private improvement expenses."

This section is of importance to the sanitary inspector, and in carrying out its provisions it is most essential that he should obtain the proper consent of his committee or board, and, if emergency is declared, it should be expressly so stated in writing. An inspector should be careful where the words, "injurious to health," are used that injury can be proved, it having been held by magistrates that "injurious" means that an injury has been done, not that it may occur. *N.B.*—There is no decision of a higher court to this effect.

P.H.A.A., 24. In connection with privy and ashpit nuisances, the new provision in the P.H.A.A., 24, is of great value and importance in those urban districts where it has been adopted (it cannot be adopted by rural authorities). It reads as follows :—

P.H.A.A., 24. "1. Where any portion of a room extends immediately over any privy (not being a water-closet or earth-closet), or immediately over any cesspool, midden, or ashpit, that room, whether built before or after the adoption of this part of this Act, shall not be occupied as a dwelling place, sleeping place, or workroom, or place of habitual employment of any person in any manufacture, trade, or business during any portion of the day or night.

"2. Any person who after the expiration of one month after the adoption of this part of this Act, and after notice from the local authority of not less than seven days, so occupies, and any person who suffers to be so occupied, any such room, shall be liable to a penalty not exceeding forty shillings, and to a daily penalty not exceeding ten shillings."

The term ashpit is defined *ante,* and includes a movable receptacle

The duties of an inspector of nuisances, in towns containing much old property and many midden-privies, under these provisions must necessarily be heavy; his time will be occupied with a number of privy nuisances which ought not to exist, and he will do well to insist upon the provision of proper receptacles, and, as far as practicable, to induce his authority to compel the substitution of water-closets.

Sections 42-50 inclusive, of the P.H.A., deal with **scavenging and cleansing**, but only 43, 47, 48, 49, and 50 require special notice here.

"If a local authority who have themselves undertaken or contracted for the removal of house refuse from premises, or the cleansing of earth-closets, privies, ashpits and cesspools fail, without reasonable excuse, after notice in writing from the occupier of any house within their district requiring them to remove any house refuse or to cleanse any earth-closet, privy, ashpit or cesspool belonging to such house or used by the occupiers thereof, to cause the same to be removed or cleansed, as the case may be, within seven days, the local authority shall be liable to pay to the occupier of such house a penalty not exceeding five shillings for every day during which such default continues after the expiration of the said period." P.H.A., 43.

Note.—This "notice in writing" does not mean notice given to the inspector, but addressed to the L.A. through their clerk or at their offices.

By Section 47 it is unlawful in an *urban* district P.H.A., 47.

"1. To keep swine in any dwelling-house, or so as to be a nuisance.

"2. To suffer any waste water to remain within any dwelling-house for twenty-four hours after written notice from the urban authority.

"3. To allow the contents of any water-closet, privy or cesspool to overflow or soak therefrom."

In this section no proof of injury to health is required, and action must be taken against the *occupier;* the owner is not mentioned.

The 44th section, though not referring to an inspector of nuisances, is important with regard to bye-laws; and is further supplemented by section 26 of the Public Health Acts Amendment Act, which is partly *urban* and partly *rural* in its operation. P.H.A., 44. P.H.A.A., 26.

Under these sections power is granted to make bye-laws, imposing upon occupiers the duties of cleansing footpaths, removing house refuse, and cleansing privies, &c., when such duties are not undertaken by the L.A., and even where the L.A. undertake to remove house refuse, they may impose duties in connection therewith on the occupier. Urban authorities may further make bye-laws respecting the hours for removal of manure, &c., the method of cartage, and the cleansing in case any be spilled. P.H.A.A., 26.

The remaining sections of this portion of the Act are appended in full :—

P.H.A., 48. "48. Where any watercourse or open ditch lying near to or forming the boundary between the district of any local authority and any adjoining district is foul and offensive, so as injuriously to affect the district of such local authority, any justice having jurisdiction in such adjoining district may, on the application of such local authority, summon the local authority of such adjoining district to appear before a court of summary jurisdiction to show cause why an order should not be made by such court for cleansing such watercourse or open ditch, and for executing such permanent or other structural works as may appear to such court to be necessary; and such court, after hearing the parties, or *ex parte* in case of the default of any one of them to appear, may make such order with reference to the execution of the works, and the persons by whom the same shall be executed, and by whom and in what proportions the cost of such works shall be paid, and also as to the amount thereof, and the time and mode of payment, as to such court may seem reasonable.

P.H.A., 49. "49. Where in any *urban* district it appears to the inspector of nuisances that any accumulation of manure, dung, soil or filth or other offensive or noxious matter ought to be removed, he shall give notice to the person to whom the same belongs, or to the occupier of the premises whereon it exists, to remove the same; and if such notice is not complied with within twenty-four hours from the service thereof, the manure, dung, soil or filth or matter referred to shall be vested in and be sold or disposed of by the urban authority, and the proceeds thereof shall be applied in payment of the expenses incurred by them in the execution of this section; and the surplus (if any) shall be paid on demand to the owner of the matter removed.

"The expenses of removal by the urban authority of any such accumulation, if and so far as they are not covered by the sale thereof, may be recovered by the urban authority in a summary manner from the person to whom the accumulation belongs, or from the occupier of the premises, or (where there is no occupier) from the owner.

P.H.A., 50. "50. Notice may be given by any *urban* authority (by public announcement in the district or otherwise) for the periodical removal of manure or other refuse matter from mews, stables or other premises; and where any such notice has been given any person to whom the manure or other refuse matter belongs who fails so to remove the same, or permits a further accumulation, and does not continue such periodical removal at such intervals as the urban authority direct, shall be liable without further notice to a penalty not exceeding twenty shillings for each day during which such manure or other refuse matter is permitted to accumulate."

These clauses need no special comment; the last two are applicable only to urban authorities.

Water Supply.—Passing over sections 51 to 61 which deal with power to provide water supply and the restrictions thereon, the next important section is 62 :—

P.H.A., 62. "Where on the report of the surveyor of a local authority it appears to such authority that any house within their district is without a proper supply of water, and that such a supply of water can be furnished thereto at a cost not exceeding the water rate authorised by any local Act in force within the district, or where there is not any local Act so in force at a cost not exceeding twopence a week, or at such other cost as the Local Government Board may, on the application of the local authority, determine under all the circumstances of the case to be reasonable, the local authority shall give notice in writing to the owner, requiring him, within a time therein specified, to obtain such supply, and to do all such works as may be necessary for that purpose.

"If such notice is not complied with within the time specified the local authority may, if they think fit, do such works and obtain such supply, and for that purpose may enter into any contract with any water company supplying water within their district, and water rates may be made and levied on the premises by the authority or company which furnishes the supply and may be recovered as if the owner or occupier of the premises had demanded a supply of water and were willing to pay water rates for the same, and any expenses incurred by the local authority in doing any such works may be recovered in a summary manner from the owner of the premises, or may by order of the local authority be declared to be private improvement expenses."

This section affects rural as well as urban districts. It will be observed that action can only be taken on the report of the surveyor; it is, therefore, the duty of the inspector of nuisances, in all instances where he finds premises without a water supply, to report the same to the surveyor. In rural districts, the two offices are often combined (see above, section 4). Authorities differ as to whether a proper supply of water refers to quality or only to quantity.

Sections 63 to 67, and also the incorporated clauses of the Water-works Clauses Acts, are unimportant and require no notice here; but passing mention should be made of the Public Health (Water) Act, 1878, which provides in its third section that it shall be the duty of every *rural* S.A. to see that every occupied dwelling-house has, within reasonable distance, an available supply of wholesome water, sufficient for consumption and use for domestic purposes. Reports as to these points may be made by either the M.O.H. or the inspector of nuisances, and the S.A. have power to act on such reports. P.H.A., 63-67.

Further, in section 7 of the same Act the duty of periodical inspection of the water supply by the officers of the authority is provided, and powers of entry upon premises for such a purpose are conferred upon officers, as in the Public Health Act, 1875, 102, 103, *infra*.

The remainder of the Act is unimportant in this context.

Sections 68, 69, deal with the pollution of streams by gas, washing, or sewage; and section 70 with polluted wells, tanks, &c.:— P.H.A., 68, *et seq.*

"On the representation of any person to any local authority that within their district the water in any well, tank or cistern, public or private, or supplied from any public pump, and used or likely to be used by man for drinking or domestic purposes, or for manufacturing drinks for the use of man, is so polluted as to be injurious to health, such authority may apply to a court of summary jurisdiction for an order to remedy the same; and thereupon such court shall summon the owner or occupier of the premises to which the well, tank or cistern belongs, if it be private, and in the case of a public well, tank, cistern or pump any person alleged in the application to be interested in the same, and may either dismiss the application or may make an order directing the well, tank, cistern or pump to be permanently or temporarily closed, or the water to be used for certain purposes only, or such other order as may appear to them to be requisite to prevent injury to the health of persons drinking the water.

"The court may, if they see fit, cause the water complained of to be analysed at the cost of the local authority applying to them under this section.

"If the person on whom an order under this section is made fails to comply with the same, the court may, on the application of the local authority, authorise them to do whatever may be necessary in the execution of the order, and any expenses incurred by them may be recovered in a summary manner from the person on whom the order is made.

"Expenses incurred by any rural authority in the execution of this section, and not recovered by them as aforesaid, shall be special expenses."

P.H.A., 70. This provision is extremely important and requires comment. It is to be noticed that it is open to any person, not of necessity an officer of the Authority, to make representation; and, further, it has been held *by magistrates* (Corporation of Birmingham *v.* Shaw), that injurious is not synonymous with dangerous, but that it is necessary to prove injury; this difficulty has been dealt with in the corresponding clause of the Public Health (London) Act, 1891, by the insertion of the words "or dangerous" after "injurious," and "or danger" after "injury." It is further to be noted that this section does not provide for the supply of water in the place of the closed well, but the premises will then come under sec. 62, P.H.A., *supra*.

London, 54.

P.H.A., 71-75. Sections 71-75 deal with **cellar dwellings.** The occupation of any cellar built or rebuilt since 1848 as a dwelling, is absolutely prohibited, and no cellar can be occupied as a dwelling at all unless it fulfils the following requirements:—

1. Height not less than 7 feet, 3 feet being above the ground level.

2. In front of the cellar, there must be an area 2 feet 6 inches wide in every part, and 6 inches below the level of the floor.

3. The cellar must be drained by a drain at least 1 foot below the level of the floor.

4. There must be proper closet and ashpit accommodation. (N.B.—Such accommodation cannot now be *under* any urban dwelling-house, according to the P.H.A.A., 24).

5. There must be a fireplace and chimney; and a window at least 9 square feet in area, made to open.

A cellar is deemed to be occupied by any one passing the night in it.

The provisions relating to cellar dwellings in the London Act, 1891, are detailed at the end of this appendix.

The regulation of **Common Lodging-houses** is dealt with in sections 76-84, of which the leading provisions may be briefly summarised as follows:— P.H.A., 76-84.

Common Lodging-houses are to be registered by the S.A., and are not to be used unless so registered; they must be inspected before registration by an officer of the local authority (not necessarily the inspector of nuisances, in some cases a member of the police force is appointed), and notice of the registration must be affixed to the house.

The L.G.B. have issued an important memorandum in connection with their Model Bye-laws for Common Lodging-houses in which the necessary qualifications for structural fitness are most minutely laid down, and which is here appended:—

"The rules which should guide the inspecting officer in his examination of the premises may be thus briefly indicated:—The house should (1) possess the conditions of wholesomeness needed for dwelling-houses in general; and (2) it should further have arrangements fitting it for its special purpose of receiving a given number of lodgers.

"1. The house should be dry in its foundations, and have proper drainage guttering and spouting, with properly laid and substantial paving to any area or yard abutting on it. Its drains should have their connections properly made, and they should be trapped where necessary, and adequately ventilated. Except the soil-pipe from a properly trapped water-closet, there should be no direct communication of the drains with the interior of the house. All waste pipes from sinks, basins and cisterns should discharge into the open air over gullies outside the house. The soil-pipe should always be efficiently ventilated. The closets or privies and the refuse receptacles of the house should be in proper situations, of proper construction and adapted to any scavenging arrangements that may be in force in the district. The house should have a water supply of good quality, and if the water be stored in cisterns they should be conveniently placed and of proper construction to prevent any fouling of water. The walls, roof, and floors of the house should be in good repair. Inside walls should not be papered. The rooms and staircases should possess the means of complete ventilation; windows being of adequate size, able to be opened to their full extent, or, if sash windows, both at top and bottom. Any room proposed for registration that has not a chimney should be furnished with a special ventilating opening or shaft, but a room not having a window to the outer air, even if it have special means of ventilation, can seldom be proper for registration.

"2. The numbers for which the house and each sleeping room may be registered will depend, partly upon the dimensions of the rooms and their facilities for ventilation and partly upon the amount of accommodation of other kinds. In rooms of ordinary construction to be used for sleeping, where there are the usual means of ventilation by windows and chimneys, about 300 cubic feet will be a proper standard of space to secure to each person; but in many rooms it will be right to appoint a larger space, and this can only be determined on inspection of the particular room. The house should possess kitchen and dayroom accommodation apart from its bedrooms, and the sufficiency of this will have to be attended to. Rooms that are partially underground may not be improper for dayrooms, but should not be registered for use as bedrooms. The amount of water supply, closet or privy accommodation, and the provision of refuse receptacles should be proportionate to the numbers for which the house is to be registered. If the water is not supplied from works with constant service, a quantity should be secured for daily use on a scale, per registered inmate, of not less than 10 gallons a day where there are water-closets, or 5 gallons a day where there are dry closets. For every twenty registered lodgers a separate closet or privy should be required. The washing accommodation should, wherever practicable, be in a special place and not be in the bedrooms; and the basins for personal washing should be fixed and have water-traps and discharge pipes connected with them."

These suggestions are of great value, more especially because the inspection of common lodging-houses in the metropolis is under the charge of the police, whose knowledge of sanitary requirements is not very great. It is to be regretted that a similar practice obtains in some provincial towns where the Sanitary Authority appoint a police inspector to report upon the common lodging-houses; the consequence being that their sanitary condition is far from creditable.

P.H.A.A., 32. Power is also given to the S.A. to make bye-laws, to enforce the provision of water, to compel lodging-house keepers to limewash twice a year, and to order reports from keepers of houses receiving vagrants, &c. All cases of infectious disease must be reported to the M.O.H. and the relieving officer under a penalty. The remaining clauses relating to common lodging-houses are of no special importance to the inspector of nuisances.

The definition of a common lodging-house has been a subject of some dispute, and it has been explained as "that class of lodging-house in which persons of the poorer class are received for short periods, and, though strangers to one another, are allowed to inhabit one common room." This definition has been held not to apply to shelters maintained as charitable institutions, and not for purposes of gain.

H. W. C., 1885, 8. With regard to **houses let in lodgings**, any local authority has power to make bye-laws for such houses, as regards inspection, cleansing, drainage, &c., and precautions against infectious diseases.

H. W. C., Part iii., 53-71. It may here be noticed in connection with the law relating to common lodging-houses, that the Housing of the Working

Classes Act, 1890, part iii., deals wholly with the provision of such houses by local authorities, whether urban or rural. This enactment is adoptive under certain restrictions, and gives power to acquire land, erect or purchase buildings, and provide bye-laws, &c., for the management of common lodging-houses, the control of which is vested in the L.A.

Nuisances.—The 91st section of the Public Health Act, 1875, is of very great importance to all inspectors of nuisances, since it defines a nuisance under the Act:— P.H.A., 91.

"For the purposes of this Act—

"1. Any premises in such a state as to be a nuisance or injurious to health;

"2. Any pool, ditch, gutter, watercourse, privy, urinal, cesspool, drain, or ashpit, so foul, or in such a state as to be either a nuisance or injurious to health;

"3. Any animal so kept as to be either a nuisance or injurious to health;

"4. Any accumulation or deposit which is a nuisance or injurious to health;

"5. Any house or part of a house so overcrowded as to be dangerous or injurious to the health of the inmates, whether or not members of the same family;

"6. Any factory, workshop, or workplace, not kept in a cleanly state, or not ventilated in such a manner as to render harmless as far as practicable any gases, vapours, dust, or other impurities generated in the course of the work carried on therein that are a nuisance or injurious to health, or so overcrowded while work is carried on as to be dangerous or injurious to the health of those employed therein;

"7. Any fireplace or furnace which does not as far as practicable consume the smoke arising from the combustible used therein, and which is used for working engines by steam, or in any mill, factory, dyehouse, brewery, bakehouse, or gaswork, or in any manufacturing or trade process whatsoever; and

"Any chimney (not being the chimney of a private dwelling-house) sending forth black smoke in such quantity as to be a nuisance, shall be deemed to be nuisances liable to be dealt with summarily, in manner provided by this Act."

"Where any quarry dangerous to the public is in open or unenclosed land, within fifty yards of a highway or place of public resort dedicated to the public, and is not separated therefrom by a secure and sufficient fence, it shall be kept reasonably fenced for the prevention of accidents, and unless so kept shall be deemed to be a nuisance liable to be dealt with summarily in manner provided by the Public Health Act, 1875." Quarry Fencing Act, 1887.

"The term 'quarry' includes every pit or opening made for the purpose of getting stone, slates, lime, chalk, clay, gravel, or sand, but not any natural opening."

"A tent, van, shed, or similar structure used for human habitation, which is in such a state as to be a nuisance or injurious to health, or which is so overcrowded as to be injurious to the health of the inmates, whether or not members of the same family, is also deemed to be a similar nuisance." Housing of the Working Classes Act, 1885, 9.

This section (9), together with the contiguous sections (7) and

(10) of the same Act (which imposes upon the S.A. the duty of "putting into force the powers with which they are invested, so as to secure the proper sanitary condition of all premises within the area under the control of such authority"), are now the only remains of the Act of 1885 which are material to our present purpose. The sanitary authority have power to make bye-laws for such habitations, and power of entry is given to any person, duly authorised (presumably in writing) by the S.A. or by a Justice, where there is reasonable cause to suspect a breach of the law or the existence of dangerous infectious disease.

With respect to these forms of nuisance a few notes may not be amiss. Inspectors will find that with respect to pig keeping, it is often preferable to take action under section 47, *supra.*

The inspection of factories does not concern the local authority, as all the sanitary regulations relating to factories were transferred to the Factory Inspector by the Act of 1878; but the L.A. are required to administer the provisions of this section in every factory not included in the provisions of the Factory Act of 1878 (see section 93 of that Act); and in all workshops by the Factory Act, 1891, sec. 4, which is appended:—

F.A., 1878, 101.

"1. Every workshop as defined by the principal Act (including any workshop conducted on the system of not employing any child, young person, or woman therein), and every workplace within the meaning of the Public Health Act, 1875, shall be kept free from effluvia arising from any drain, water-closet, earth-closet, privy, urinal, or other nuisance, and unless so kept shall be deemed to be a nuisance liable to be dealt with summarily under the law relating to public health.

"2. Where on the certificate of a medical officer of health or inspector of nuisances it appears to any sanitary authority that the limewashing, cleansing, or purifying of any such workshop, or of any part thereof, is necessary for the health of the persons employed therein, the sanitary authority shall give notice in writing to the owner or occupier of the workshop to limewash, cleanse, or purify the same or part thereof, as the case may require.

"3. If the person to whom notice is so given fails to comply therewith within the time therein specified, he shall be liable to a fine not exceeding ten shillings for every day during which he continues to make default, and the sanitary authority may, if they think fit, cause the workshop or part to be limewashed, cleansed, or purified, and may recover in a summary manner the expenses incurred by them in so doing from the person in default.

"4. This section shall not apply to any workshop or workplace to which the Public Health (London) Act, 1891, applies."

With respect to smoke nuisances the provision which follows at the end of the section renders successful action very difficult; the extreme unwillingness of local authorities to interfere with trade, the presence of large manufacturers upon committees, and the unwillingness of local magistrates to convict, all render this subsection extremely difficult to enforce. In taking action, the L.A. must be prepared to show that there is a better method of dealing with the smoke than that employed. Successful prosecutions for smoke nuisance are not uncommon in many towns, but they are not to be undertaken lightly.

Further information regarding special smoke nuisances, *e.g.*, coke burning, &c., can be obtained from Dr. Ballard's reports to the L.G.B. on effluvium nuisances.

The sections next following deal with **procedure** in respect of nuisances. It is the duty of the S.A. to have the district periodically inspected to ascertain what nuisances exist, and power is given to any person aggrieved, or the relieving officer, or any two householders, or the police, to give information of any nuisance (presumably to the clerk, unless otherwise appointed). P.H.A., 92. 93.

The next section has reference to the service of notice, and is appended :—

"On the receipt of any information respecting the existence of a nuisance, the local authority shall, if satisfied of the existence of a nuisance, serve a notice on the person by whose act, default, or sufferance, the nuisance arises or continues, or, if such person cannot be found, on the owner or occupier of the premises on which the nuisance arises, requiring him to abate the same within a time to be specified in the notice, and to execute such works and do such things as may be necessary for that purpose. Provided— 94.

"First. That where the nuisance arises from the want or defective construction of any structural convenience, or where there is no occupier of the premises, notice under this section shall be served on the owner.

"Secondly. That where the person causing the nuisance cannot be found, and it is clear that the nuisance does not arise or continue by the act, default, or sufferance of the owner or occupier of the premises, the local authority may themselves abate the same without further order."

This notice cannot be served until the existence of the nuisance has been reported to the S.A., and they have given directions for the service of the notice. It is not enough for the committee to whom the sanitary duties are delegated to pass any general resolution or to give general instructions, each case must be reported and considered on its merits; the Council or Local Board, as the case may be, can delegate their powers under this Act to a committee, and, subject to certain restrictions, such committee shall have full powers under this Act without the necessity for confirmation by the Local Board or Council. P.H.A., 200. London, 3.

In this matter the Public Health (London) Act, 1891, goes even further, as it directs that—

"It shall be the duty of the sanitary authority to give such directions to their officers as will secure the existence of the nuisance being *immediately* brought to the notice of any person who may be required to abate it, and the officer shall do so by serving a written intimation."

It must be particularly noted that the committee cannot delegate their powers either to a sub-committee or to any officer.

P.H.A., Schedule iv., A. A form of notice is appended to the Act in Schedule iv. Form A, and certain provisions as to authentication and service occur in sections 266, 267, *post*.

95. If this notice be not complied with, or if the nuisance, though abated, is likely to recur, the L.A. *shall* make complaint to a justice, who shall summon the person on whom the notice was served.

It is in many places the practice for the Local Authority to reconsider the matter and give directions before a prosecution is undertaken, but by the wording of the section they are bound to proceed with the prosecution.

96. The Court may make an order dealing with the nuisance, or a recurring order, or both, and may also impose a penalty and give costs.

97. In the case of a house rendered unfit for habitation owing to a nuisance, the Court may make a closing order, but such cases will be further considered under the Housing of the Working Class Act, 1890, *post*.

98-101. Provision is made for penalty in case the order of the Court is not complied with, and for appeal to Quarter Sessions without continuing penalty; also that where the person in default is not known or cannot be found, the order may be addressed to the L.A.; and for the public sale of any matter or thing removed by the L.A. while abating the nuisance.

104-108. The remaining clauses of this portion of the Act, except section 102, are unimportant to the sanitary inspector, and deal with costs and expenses in the execution of the Act, the power of individuals to complain to a justice, the power of the police to act on the order of the L.G.B. in default of the L.A., the right to take proceedings in a superior court, and the power to institute proceedings where a nuisance is caused by some act or default outside the district.

P.H.A., 102-103. The **power of entry** upon private premises is provided for in sections 102, 103.

"The local authority, or any of their officers, shall be admitted into any premises for the purpose of examining as to the existence of any nuisance thereon, or of enforcing the provisions of any Act in force within the district requiring fireplaces and furnaces to consume their own smoke, at any time between the hours of nine in the forenoon and six in the afternoon, or in the case of a nuisance arising in respect of any business, then at any hour when such business is in progress or is usually carried on.

"Where under this Act a nuisance has been ascertained to exist, or an order of abatement or prohibition has been made, the local authority or any of their officers shall be admitted from time to time into the premises between the hours aforesaid until the nuisance is abated, or the works ordered to be done are completed, as the case may be.

"Where an order of abatement or prohibition has not been complied with, or has been infringed, the local authority, or any of their officers, shall be admitted from time to time at all reasonable hours, or at all hours during which business is in progress or is usually carried on, into the premises where the nuisance exists, in order to abate the same.

"If admission to premises for any of the purposes of this section is refused, any justice on complaint thereof on oath by any officer of the local authority (made after reasonable notice in writing of the intention to make the same has been given to the person having custody of the premises), may, by order under his hand, require the person having custody of the premises to admit the local authority, or their officer, into the premises during the hours aforesaid; and if no person having custody of the premises can be found, the justice shall, on oath made before him of that fact, by order under his hand authorise the local authority or any of their officers to enter such premises during the hours aforesaid.

"Any order made by a justice for admission of the local authority or any of their officers on premises shall continue in force until the nuisance has been abated, or the work for which the entry was necessary has been done."

In the following section a penalty not exceeding £5 is assigned for disobedience.

The above clauses refer to the right of entry for the purpose of inspection of nuisances; other clauses referring to powers of entry are as follows:—

1. Section 116. To inspect food, &c. at all reasonable times.

2. Section 137. To carry out L.G.B. orders on all premises and vessels; no limit of time specified.

3. Towns Improvement Clauses Act, 1847, section 131. P.H.A., 169.
To inspect any place whatever used for the sale of butchers' meat, any slaughter-house, &c.

4. Infectious Diseases Prevention Act, 1890, sections 5, 17.
Between 10 a.m. and 6 p.m., on production of authority signed by clerk to L.A., for purpose of cleansing and disinfecting, in default of owner or occupier.

5. Factory Act, 1891, 3, and 1878, 68.
To enter, inspect, and examine at all reasonable times by day and night a workshop and every part thereof when the authorised inspector has reasonable cause to believe that any person is employed therein, and to enter by day any place which he has reasonable cause to believe to be a workshop.

6. Canal Boats Act, 1877, 5.

By day upon any canal boat on producing, if demanded, a copy of his authorisation.

7. Housing Working Classes Act, 1885, 9.

By day into any tent, shed, van, or similar structure used for human habitation on producing, if demanded, a copy of his authorisation.

Offensive Trades.

P.H.A., 112, *et seq.* "Any person who, after the passing of this Act, establishes within the district of an urban authority, without their consent in writing, any offensive trade; that is to say, the trade of—

Blood boiler, or
Bone boiler, or
Fellmonger, or
Soap boiler, or
Tallow melter, or
Tripe boiler, or
Any other noxious or offensive trade, business or manufacture,

shall be liable to a penalty not exceeding fifty pounds in respect of the establishment thereof; and any person carrying on a business so established shall be liable to a penalty not exceeding forty shillings for every day on which the offence is continued, whether there has or has not been any conviction in respect of the establishment thereof."

This section and the three sections next following are of great importance to all urban authorities, since they deal with a form of nuisance, which, by reason of its trade connections, is extremely difficult to deal with. The section already quoted expressly names six offensive trades; in addition to these the model bye-laws of the L.G.B. enumerate the following:—Blood-drier, leather-dresser, tanner, fat-melter or fat-extractor, glue-maker, size-maker, and gut-scraper. L.G.B. inspectors are apt to consider that offensive trades are essentially trades which deal with animal refuse, and this is borne out by certain rulings, in which it has been held that brick-making, manure-making, and fish-frying are not within the meaning of the clause, but that rag and bone shops are. It is therefore important to remember that while a trade may be the source of a nuisance it need not be an offensive trade.

The classical authority upon **effluvium nuisances** and **offensive trades** is the report issued by Dr. Ballard in the annual reports of the Local Government Board. In his very exhaustive report he divides his subject into the following heads:—

1. Effluvium nuisances in connection with the keeping of animals, *e.g.*, Horsekeeping, Cowkeeping, Pigkeeping, and animals improperly kept.

2. Effluvium nuisances arising in connection with the slaughtering of animals, *i.e.*, for human food or in knackers' yards.

3. Effluvium nuisances arising in connection with industries in which substances of animal origin are principally dealt with. These include the trades dealt with in the above section as well as some others.

4. Effluvium nuisances arising in connection with industries in which substances of vegetable origin are dealt with, *e.g.*, malt-roasting, indiarubber-making, distillation of palm oil, &c.

5. Effluvium nuisances where mineral substances are dealt with, *e.g.*, Brick-burning, Coke-burning, Alkali works, &c.

6. Effluvium nuisances where matters of mixed origin are dealt with, *e.g.*, Towns' Refuse works and Rag and Bone yards.

With regard to the trades specially mentioned in the above P.H.A., clause, the urban authority may make bye-laws, as they can with 113. regard to any offensive trades established with their consent; and, further, by the next section it is provided that

"Where any candle-house, melting-house, melting-place or soap-house, 114. or any slaughter-house, or any building or place for boiling offal or blood or for boiling, burning or crushing bones, or any manufactory, building or place used for any trade, business, process or manufacture causing effluvia is certified to any *urban* authority by their medical officer of health, or by any two legally qualified medical practitioners, or by any ten inhabitants of the district of such urban authority to be a nuisance or injurious to the health of any of the inhabitants of the district, such urban authority *shall* direct complaint to be made before a justice, who *may* summon the person by or on whose behalf the trade so complained of is carried on, to appear before a court of summary jurisdiction."

If it appears to the court that there is a nuisance or injury to health, and that the best practicable means have not been adopted to prevent such nuisance, the court may impose penalties, &c.

These provisions also apply where the nuisance arises from 115. trades carried on outside the complaining urban authority.

It will be observed that this section considerably extends the trades of which complaint may be made, and that, therefore, a distinction must be made between offensive trades and effluvium nuisances. Under this section it is possible to deal with fried fish shops, coke hearths, and manure works.

These cases are often very difficult to bring to a successful issue, and where an inspector is about to undertake such a prosecution as this it is wise to proceed, if possible, on the complaint of the aggrieved inhabitants to whom it is a nuisance; it is also very necessary to be armed with reliable information and evidence as to the best practicable means for remedying such nuisance.

London, 19-22. These provisions are repeated in the Public Health (London) Act, with the important addition that in future no one will be able to establish in the metropolis the business of a blood-boiler, bone-boiler, manure manufacturer, tallow-melter or knacker under any circumstances.

For full details of the processes of these trades see Dr. Ballard's reports published by the L.G.B. in 1877, 1878, and 1879.

P.H.A., 169. In connection with the provisions which deal with offensive trades it is convenient also to deal with **slaughter-houses.** Power is given by sec. 169 to the urban authorities to provide slaughter-houses, a power of which few authorities have availed themselves, for reasons which will be stated below.

Towns Improvement Clauses Act, 1847, 125-130. This section also incorporates certain provisions of the Towns Improvement Clauses Act, the substance of which is appended:—

An urban sanitary authority may license slaughter-houses and knackers' yards, and no such place shall be used or occupied without a license unless it was so used before the passing of the special Act (*i.e.*, 1875), and has so continued ever since; and if so used, the person using it shall be liable to a penalty not exceeding £5, and a like daily penalty after conviction. All places so licensed or in existence before 1875 must be registered, and the sanitary anthority shall keep a register, and *must* also make bye-laws for licensing, registration, prevention of cruelty, cleanliness, removal of filth, and proper water-supply. Any person convicted of a breach of these clauses or of bye-laws may have his license suspended for two months, and in the case of a second conviction it may be absolutely revoked, and the sanitary authority may refuse to grant him a license for that place or any other. There is also a penalty for any breach of a suspension order.

P.H.A., 170. In addition to this, the 170th section of the Public Health Act provides that the words "licensed slaughter-house" or "registered slaughter-house," as the case may be, shall be affixed to and kept legible on the premises.

P.H.A.A., 29, 30, 31. Further important clauses have been added in the Public Health Act of 1890, viz.:—

"29. Licences granted after the adoption of this part of this Act for the use and occupation of places as slaughter-houses shall be in force for such time or times only, not being less than twelve months, as the urban authority shall think fit to specify in such licences.

"30. (1) Upon any change of occupation of any building within an urban sanitary district registered or licensed for use and used as a slaughter-house, the person thereupon becoming the occupier or joint occupier shall give notice in writing of the change of occupation to the inspector of nuisances.

"(2) A person who fails or neglects to give such notice within one month after the change of occupation occurs shall be liable to a penalty not exceeding five pounds.

"(3) Notice of this enactment shall be endorsed on all licences granted after the adoption of this part of this Act.

"31. If the occupier of any building licensed as aforesaid to be used as a slaughter-house for the killing of animals intended as human food is convicted by a court of summary jurisdiction of selling or exposing for sale, or for having in his possession, or on his premises, the carcase of any animal, or any piece of meat or flesh diseased or unsound, or unwholesome or unfit for the use of man as food, the court may revoke the licence."

Licences are not necessarily granted in writing, it having been held that a resolution of a committee, confirmed by the board, is equivalent to a licence, even though no notice to that effect had been given to the applicant, and also that a licence for the erection of a slaughter-house implies its use; it is therefore most essential that all plans for such buildings should be submitted for approval to the Sanitary Inspector and Medical Officer, who may inspect and report to the sanitary committee, before permission is given to erect the slaughter-house.

The continuance of use is of great importance, as it will frequently be found that slaughter-houses are disused as such, and applied to other purposes.

In that case they cannot again be used as slaughter-houses without application for a licence; and, if Part iii. of the Public Health Act, 1890, has been adopted, such licence is for a limited period.

The difficulty of terminating the use of old and badly arranged slaughter-houses, and the absence of any power to compel butchers to use a public abattoir when provided, have, without doubt, militated against the erection of suitable public slaughter-houses.

With regard to slaughter-houses within the metropolis, the Public Health (London) Act, 1891, contains similar provisions to those already detailed, which apply to all slaughter-houses London, (with certain exceptions in favour of the Metropolitan Meat 20. Market); regulations for the method of licensing; and the right to refuse licences. Power of entry is given (i.) at any hour by day, *i.e.*, between 6 a.m. and 9 p.m., or (ii.) at any hour when business is in progress or is usually carried on.

A form of licence is given in the Model Bye-laws for slaughter-houses, but this is now obsolete; and should not be used, as it is most advisable that slaughter-house licences should in future be annual.

L.G.B., 1877. The Model Bye-laws on this subject issued by the L.G.B. are accompanied by a memorandum on the requirements for slaughter-houses, which is here appended:—

"1. The premises to be erected or to be used and occupied as a slaughter-house should not be within 100 feet of any dwelling-house; and the site should be such as to admit of free ventilation by direct communication with the external air on two sides at least of the slaughter-house.

"2. Lairs for cattle in connection with the slaughter-house should not be within 100 feet of a dwelling-house.

"3. The slaughter-house should not in any part be below the surface of the adjoining ground.

"4. The approach to the slaughter-house should not be on an incline of more than one in four, and should not be through any dwelling-house or shop.

"5. No room or loft should be constructed over the slaughter-house.

"6. The slaughter-house should be provided with an adequate tank or other proper receptacle for water, so placed that the bottom shall not be less than six feet above the level of the floor of the slaughter-house.

"7. The slaughter-house should be provided with means of thorough ventilation.

"8. The slaughter-house should be well paved with asphalt or concrete, and laid with proper slope and channel towards a gully, which should be properly trapped and covered with a grating, the bars of which should be not more than three-eighths of an inch apart.

"Provision for the effectual drainage of the slaughter-house should also be made.

"9. The surface of the walls in the interior of the slaughter-house should be covered with hard, smooth, impervious material, to a sufficient height.

"10. No water-closet, privy, or cesspool should be constructed within the slaughter-house.

"There should be no direct communication between the slaughter-house and any stable, water-closet, privy, or cesspool.

"11. Every lair for cattle in connection with the slaughter-house should be properly paved, drained, and ventilated, and no habitable room should be constructed over any lair."

Unsound Meat, &c.

P.H.A., 116-119. The powers given to the inspector of nuisances to enter and inspect articles of food are contained in sections 116-119, and also in section 131 of the Towns Improvement Clauses Act (see power of entry *supra*).

"Any medical officer of health or inspector of nuisances may at all reasonable times inspect and examine any animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour or milk exposed for sale, or deposited in any place for the purpose of sale, or of preparation for sale, and intended for the food of man, the proof that the same was not exposed or deposited for any such purpose, or was not intended for the food of man, resting with the party charged; and if any such animal, carcase, meat, poultry, game, flesh, fish, fruit, vegetables, corn, bread, flour, or milk appears to such medical officer or inspector to be diseased or unsound or unwholesome or unfit for the food of man, he may seize and carry away the same himself or by an assistant, in order to have the same dealt with by a justice." P.H.A., 116.

This clause is amended and extended by section 28 (1) of the Public Health Act, 1890, as follows:—

"1. Sections one hundred and sixteen to one hundred and nineteen of the Public Health Act, 1875 (relating to unsound meat), shall extend and apply to all articles intended for the food of man, sold or exposed for sale, or deposited in any place for the purpose of sale, or of preparation for sale within the district of any local authority." P.H.A.A., 28.

By section 117, any magistrate before whom the article seized is taken may order it to be destroyed, and the offender may be taken before the justices and fined a sum not exceeding £20 for each article, or sentenced to not more than three months' imprisonment. This section has been further amended by the second part of the same clause, thus:— P.H.A., 117.

"2. A justice may condemn any such article, and order it to be destroyed or disposed of, as mentioned in section one hundred and seventeen of the Public Health Act, 1875, if satisfied on complaint being made to him that such article is diseased, unsound, unwholesome, or unfit for the food of man, although the same has not been seized as mentioned in section one hundred and sixteen of the said Act." P.H.A.A., 28.

By this amendment any question as to the mode of seizure is disposed of.

In the following sections penalties are assigned for obstructing the entry of the medical officer or inspector, and for the issue of a warrant for entry when complaint is made on oath by either of those officers. P.H.A., 118-119.

Section 13, of the Towns Improvement Clauses Act differs only from the preceding sections in that the L.A. may appoint any officer besides those mentioned above, *e.g.*, a police constable, to carry out this clause.

With respect to these provisions it may be remarked that, whereas it is well not to take cases into court before members of the L.A., there is no objection to taking meat to a Justice who happens to be a member of the L.A. for condemnation; and that it need not be the same Justice who has condemned that afterwards adjudicates. It has been held under these sections that entry may take place even on Sunday, and that living animals as well as dead come under their operation.

Horseflesh Act, 1889. In connection with the seizure of meat, it is convenient briefly to mention the Horseflesh Act, 1889, which provides that horseflesh shall not be sold for human food elsewhere than in a shop, stall, &c., conspicuously labelled as a place where horseflesh is sold, and gives the medical officer of health and inspector of nuisances powers of inspection, &c., of the meat. The penalty for breach of the Act is £20. "Horseflesh" includes the flesh of "asses" and "mules," and means "horseflesh" sold cooked or uncooked, alone, or in combination with any other substance.

This Act, though here included under the heading of meat, &c., more properly belongs to the same place as the Margarine Act, which it resembles. The need for its operations is at present very limited, and its provisions call for no comment; it is of course important for sanitary officers and others to be capable of distinguishing horseflesh when they see it.

Infectious Diseases, Infectious Hospitals, Epidemic Diseases.

P.H.A., 120-140. These extremely important subjects are provided for in the Public Health Act, sections 120-140; in the Infectious Diseases (Notification) Act, 1889; in the Infectious Diseases (Prevention) Act, 1890; and in the Public Health Acts Amendment Act.

The more important provisions of these Acts will be given in detail, with notes showing how far they may be considered to affect inspectors of nuisances although they are not expressly charged with any duties therein.

P.H.A., 120. By section 120, the duty of causing premises to be cleansed and disinfected is laid upon the L.A., whenever they are satisfied, on the certificate of their own medical officer or any other qualified practitioner, that such action is necessary to prevent or check infectious disease.

P.H.A., 46. This section is not unlike section 46, which gives power to the L.A. to require the purification of houses where it appears that their filthy condition endangers the health of any person, or in the case of infectious disease as above; this section, however, requires a certificate from any *two* medical practitioners or the medical officer of health.

Notice may be given to either owner or occupier, and the inspector will best judge which it is advisable to serve with a notice.

It will be obvious that proceedings under these clauses are open to much vexatious delay.

In the Infectious Diseases (Prevention) Act, section 5, the I.D.P., 5.
120th section above summarised is repealed, and provision is made for a much more rapid execution of the cleansing, &c. required :—

By this clause, on the receipt of certificate as above the clerk to the L.A. *shall* give notice in writing to owner or occupier that the L.A. will cleanse and disinfect at the cost of the owner or occupier, unless he engages within twenty-four hours to do it I.D.P., 17.
himself to the satisfaction of the medical officer. If he fails to do so, the L.A. may enter, by their officer, on producing written authority (presumably signed by the clerk to the L.A.), do the work, and recover the cost.

Where it appears that the owner or occupier is unable to do the work in the opinion of the L.A. or of the M.O.H., it may be done with the consent of the owner or occupier at the cost of the L.A., by their officers.

Inasmuch as promptness in disinfection is all important, it is becoming more and more common for local authorities to do such disinfection themselves without question; at any rate, in the poorer class of houses.

They may afterwards require such whitewashing, &c., as is necessary, to be done by the owner or occupier, as the case may be.

So far, no definition of infectious disease has been given, and the Public Health Act, 1875, does not profess to supply one; since in one place (120) it speaks merely of infectious disease, in another (124) it speaks of a *dangerous* infectious disorder.

The Notification Act of 1889, however, defines the diseases to I.D.N., 6.
which the Act applies, in section 6—

"6. In this Act the expression 'infectious disease to which this Act applies, means any of the following diseases, namely, small-pox, cholera, diphtheria, membranous croup, erysipelas, the disease known as scarlatina or scarlet fever, and the fevers known by any of the following names, typhus, typhoid, enteric, relapsing, continued, or puerperal, and includes as respects any particular district any infectious disease to which this Act has been applied by the local authority of the district in manner provided by this Act."

and this definition is further continued by the second section of the Prevention Act, 1890—

"2. Expressions used in this Act shall, unless the context otherwise requires, have the same meaning as the like expressions used in the

Infectious Disease (Notification) Act, 1889; and the provisions of this Act shall apply to the infectious diseases specifically mentioned in that Act, and may be applied to any other infectious disease in the same manner as that Act may be applied to such disease."

Other diseases which may be considered as coming under this category are measles, whooping cough, chicken pox, influenza, and, perhaps, mumps and roserash.

The operation of the Notification Act more especially concerns the M.O.H., but certain duties must necessarily devolve upon the inspector of nuisances in connection with premises upon which infectious disease is notified to exist. Inspectors must remember that it is no part of their duty either to form a diagnosis of infectious diseases or to question the accuracy of the diagnosis of any medical practitioner who notifies a case, but they are usually expected to visit and report upon all premises, and for this purpose a form of register is appended. It is convenient that this form should exactly correspond to the register of all notifications received, kept by the medical officer.

Infectious Dis. Cert. No.	No. of Inmates, Adults
Disease	,, ,, Children
Medical Attendant	,, ,, Lodgers
Date Cert. Recd.	School Attending (if any)
Name of Patient	Water Supply
Situation of House	W.C. or Privy
Name of Tenant	Milk Supply
,, Owner or Agent	Drainage
Address of ,,	Action Taken
No. of Rooms, Living	General Remarks
,, ,, Sleeping	

It does not seem necessary to recapitulate in full the provisions of the Notification Act, but a short summary of them may be useful in this place. The Act provides that wherever it is in force—

"Every medical practitioner attending on or called in to visit the patient shall forthwith, on becoming aware that the patient is suffering from an infectious disease to which this Act applies, send to the medical officer of health for the district a certificate stating the name of the patient, the situation of the building, and the infectious disease from which, in the opinion of such medical practitioner, the patient is suffering."

and also that—

"The head of the family to which such patient belongs, and in his default the nearest relatives of the patient present in the building or being in attendance on the patient, and in default of such relatives every person in charge of or in attendance on the patient, and in default of any such person the occupier of the building shall, as soon as he becomes aware that the patient is suffering from an infectious disease to which this Act applies, send notice thereof to the medical officer of health of the district."

The penalty for default is a fine not exceeding forty shillings.

The only exemptions are Crown buildings, vessels belonging to foreign governments, and hospitals used for the reception of cases of infectious disease.

The Public Health (London) Act is more full in its details, and requires that the certificate shall contain— London, 55.

"The full postal address of the house, and state whether the case occurs in private practice or in practice as a medical officer of a public body or institution, and where the certificate refers to the inmates of a hospital it shall specify the place from which and the date at which the inmate was brought to the hospital, and shall be sent to the medical officer of health of the district in which the said place is situate."

It is found in practice that private notification on the part of the householder does not take place except in rare cases.

Another important addition in the London Act is as follows:—

"Where a medical officer of health receives a certificate under this section (London, 55), he shall, within twelve hours after such receipt send a copy thereof to the head teacher of the school attended by the patient (if a child), or by any child who is an inmate of the same house as the patient."

This practice, though not compulsory outside London, obtains in many towns where the Notification Act is in force.

A caution may here be added with regard to possible prosecutions under the Notification Act. It is most essential that in taking any case into court, medical evidence of the nature of the disease should be forthcoming; no bench of magistrates are likely to accept either the statement of an inspector of nuisances or of an unqualified practitioner on such a fact.

In view of a recent decision in Lancashire, it is possible that the L.A. will do well to supply medical practitioners within their district with stamped forms of certificate, so as to ensure the due and regular forwarding of notifications; but it is not quite clear that medical men can recover the cost of postage after they have once paid it.

Sections 121 and 122 of the Public Health Act provide for the destruction, when necessary, of infected bedding, &c., with due compensation, by the direction of the L.A.; as also for the disinfection of such articles in a proper place and proper apparatus; the L.A. may charge or not as they please. P.H.A., 121, 122.

These powers are further extended by the Prevention Act, which permits the M.O.H. to direct such disinfection by notice I.D.P., 6.

in writing, and adds a penalty for non-compliance; compensation for any damage done in the process of disinfecting is limited to unnecessary or avoidable damage.

In places where **Hospitals** are provided for infectious diseases under sections 131-132, and also an ambulance (section 123), the question of removal becomes important; this is provided for in section 124, thus:—

"Where any suitable hospital or place for the reception of the sick is provided within the district of a local authority, or within a convenient distance of such district, any person who is suffering from any dangerous infectious disorder, and is without proper lodging or accommodation, or lodged in a room occupied by more than one family, or is on board any ship or vessel, may, on a certificate signed by a legally qualified medical practitioner, and with the consent of the superintending body of such hospital or place, be removed, by order of any justice, to such hospital or place at the cost of the local authority; and any person so suffering, who is lodged in any common lodging-house, may, with the like consent and on a like certificate, be so removed by order of the local authority.

"An order under this section may be addressed to such constable or officer of the local authority as the justice or local authority making the same may think expedient; and any person who wilfully disobeys or obstructs the execution of such order shall be liable to a penalty not exceeding ten pounds."

The difficulties of working this section are considerable. Great difference of opinion exists as to the meaning of "proper lodging and accommodation"; and even where it is manifest that the case cannot be adequately isolated the medical man in attendance is very unwilling to certify in many instances. Even after a certificate has been obtained considerable obstruction may take place and resistance be offered to the inspector or other officer who comes to remove the patient; the only remedy in such a case is to summon the obstructor before the justices, and proceed again to remove; if he again obstructs, summon him again; the court cannot give absolute power to take the case away. Further, the court cannot question the accuracy of the certificate of the medical practitioner or the validity of the justice's removal order.

P.H.A., 125. The next section (125) gives power, under regulations, to remove persons to hospital, and detain them, if brought within the district infected with a dangerous infectious disorder.

I.D.P., 12. The power of detention given by this section in the case of persons coming into a district by boat or ship, is further extended by the 12th section of the Prevention Act:—

"Any justice of the peace acting in and for the district of the local authority, upon proper cause shown to him, may make an order directing the detention in hospital at the cost of the local authority of any person suffering from any infectious disease, who is then in an hospital for infectious disease and would not on leaving such hospital be provided with lodging or accommodation in which proper precautions could be taken to prevent the spreading of the disorder by such person. Any order so to be made by any such justice may be limited to some specific time, but with full power to any justice to enlarge such time as often as may appear to him to be necessary. It shall be lawful for any officer of the local authority or inspector of police acting in the district, or for any officer of the hospital, on any such order being made to take all necessary measures and do all necessary acts for enforcing the execution thereof."

This power is conferred upon guardians of the poor in the case of patients in a workhouse, suffering from contagious or infectious disease under the Poor Law Amendment Act, 1867 (30 and 31 Vict., c. 106, sec. 22). It may be necessary for the inspector of nuisances, under certain circumstances, to apply to a Justice for such an order, in the place of the manager or resident at the Hospital.

In connection with these sections, must also be observed C.B., 4-5. sections 4 and 5 of the Canal Boats Act, 1877, which empower sanitary authorities to take the necessary steps to prevent the spread of infectious disease, and detain a boat if needful, and give power of entry on board canal boats, and provide penalty for obstruction.

The sections relating to infectious disease occurring in common lodging-houses and in houses let in lodgings, have already been mentioned, and are here supplemented by penalties for letting houses in which infected persons have been lodging, and for P.H.A., making false statements about infectious disease when letting 128-129. houses.

Further provision is made by the Prevention Act, section 7, I.D.P., 7. as follows :—

"Every person on ceasing to occupy a house or room in which infectious disease has been known to exist within six weeks without having it disinfected, and producing a medical certificate to that effect, shall be liable to a penalty, and also for giving a false answer when questioned as to the facts."

Section 126 of the Public Health Act, deals with the exposure P.H.A., of infected persons and things, and is given here at length :— 126.

"Any person who—

1. While suffering from any dangerous infectious disorder wilfully exposes himself without proper precautions against spreading the said disorder in any street, public place, shop, inn or public conveyance, or enters any public conveyance without previously

notifying to the owner, conductor or driver thereof that he is so suffering; or

2. Being in charge of any person so suffering, so exposes such sufferer; or

3. Gives, lends, sells, transmits or exposes without previous disinfection any bedding, clothing, rags or other things which have been exposed to infection from any such disorder,

shall be liable to a penalty not exceeding five pounds; and a person who, while suffering from any such disorder, enters any public conveyance without previously notifying to the owner or driver that he is so suffering, shall in addition be ordered by the court to pay such owner and driver the amount of any loss and expense they may incur in carrying into effect the provisions of this Act, with respect to disinfection of the conveyance.

"Provided that no proceedings under this section shall be taken against persons transmitting with proper precautions any bedding, clothing, rags or other things, for the purpose of having the same disinfected."

I.D.P., 11. This section is further completed by section 11 of the Infectious Diseases Prevention Act, which provides that

"The body of any person who has died from an infectious disease must not be conveyed in any public conveyance other than a hearse, without due notice to the owner or driver, and he shall, under a penalty at once cause the conveyance to be disinfected."

A public conveyance is understood to be one which plies openly for hire.

This section removes any doubt as to the duty of the owner or driver, after conveying infected persons or bodies, to proceed at once for disinfection.

It may be necessary for an inspector of nuisances to enforce the provisions of this section (126), as it is not an uncommon thing to find breaches of it during epidemics of small-pox, &c. It needs little comment, and its provisions are completed by the following section (127), by which

P.H.A., 127.

"The owner or driver of any public conveyance, after conveying an infected person, is required under penalty to have the same disinfected, and is permitted to make an extra charge for conveying such a person."

There now remain those provisions of the Infectious Diseases Prevention Act to which no allusion has yet been made, and which may be taken in connection with sections 141, 142, and 143 of the Public Health Act, 1875.

P.H.A., 141.

Section 141 gives power to local authorities, whether urban or rural, to provide a mortuary or to make bye-laws for its use, and to provide for the decent and economical interment of any dead body received into it.

The next section (142) is here quoted in full:—

P.H.A., 142.

"Where the body of one who has died of any infectious disease is retained in a room in which persons live or sleep, or any dead body which is in such a state as to endanger the health of the inmates of the same house or room is retained in such house or room, any justice may, on a certificate signed by a legally qualified medical practitioner, order the body to be removed, at the cost of the local authority, to any mortuary provided by such authority, and direct the same to be buried within a time to be limited in such order; and unless the friends or relations of the deceased undertake to bury the body within the time so limited, and do bury the same, it shall be the duty of the relieving officer to bury such body at the expense of the poor rate, but any expense so incurred may be recovered by the relieving officer in a summary manner from any person legally liable to pay the expense of such burial. Any person obstructing the execution of an order made by a justice under this section shall be liable to a penalty not exceeding five pounds."

The inspector of nuisances, or mortuary keeper, must observe that the obligation of burial applies to the relieving officer of the district in which the mortuary is situated, but only in cases where the removal has been ordered by a Justice. In the memorandum issued with the Model Bye-laws for mortuaries, attention is called to the fact that the obligation of the guardians to bury, is applicable only when the body is upon premises under their control; it will, however, be quite right for a mortuary keeper to admit bodies from any source without question, as, unfortunately, in many districts it is almost impossible to get the inhabitants to make proper use of such buildings.

The next section (143) provides for the establishment of a proper place (otherwise than at a workhouse or mortuary) for making post-mortem examinations, and is unimportant here. P.H.A., 143.

Section 142 is supplemented by the Infectious Diseases Prevention Act, as follows:— I.D.P., 8.

"No person without the sanction in writing of the medical officer of health or of a registered medical practitioner, shall retain unburied elsewhere than in a public mortuary or in a room not used at the time as a dwelling-place, sleeping-place, or workroom, for more than forty-eight hours, the body of any person who has died of any infectious disease."

This section only applies where a separate room cannot be provided for the corpse, and its provisions are completed by section 10, under which any corpse so retained may be made the subject of an application by the medical officer of health to any Justice, who may order the body to be removed by the local authority to a mortuary and buried within a specified time, or, if necessary, buried immediately. I.D.P., 10.

If the friends do not bury the body as directed, it shall be the duty of the relieving officer from whose district it was removed to do so.

I.D.P., 9. Section 9 further provides that the bodies of persons dying in hospital, or other place of temporary accommodation for the sick, shall not be removed therefrom except for burial or conveyance to a mortuary.

Section 13 of the Infectious Diseases Prevention Act provides that :—

I.D.P., 13. "Any person who shall knowingly cast, or cause or permit to be cast, into any ash-pit, ash-tub, or other receptacle for the deposit of refuse matter any infectious rubbish without previous disinfection, shall be guilty of an offence under this Act."

By infectious rubbish is to be understood the excreta of fever patients, rags, poultices, &c.

I.D.P., 14. Inasmuch as the Act provides (section 14) that, where sections 7 and 13 (*supra*) are adopted, the L.A. shall give notice of the provisions thereof to occupiers, it will be well for the inspector of nuisances to advise his committee to have a leaflet printed setting out and explaining the clauses referred to, and defining the nature of infectious rubbish.

I.D.P., 15. Section 15 empowers L.A. to provide temporary shelter for any family who may have to leave their dwellings for disinfection purposes under section 5.

The provisions of the Public Health (London) Act, 1890, incorporate the Notification Act with certain extensions (*vide supra*) and the Prevention Act, and also the leading provisions already detailed.

London, 69. There is an important addition in section 69, which prohibits an infected person from picking fruit, milking animals, or engaging in any occupation connected with food, or carrying on any trade or business in such a manner as to be likely to spread the infectious disease, under a penalty not exceeding ten pounds.

I.D.P., 4. One other clause in the Infectious Diseases Prevention Act requires notice, and is repeated with slight alteration in the London Act; it is new and of considerable importance, and is therefore given here, *verbatim* :—

London, 71. "In case the medical officer of health is in possession of evidence that any person in the district is suffering from infectious disease attributable to milk supplied within the district from any dairy situate within or without the district, or that the consumption of milk from such dairy is likely to cause infectious disease to any person residing in the district, such medical officer shall, if authorised in that behalf by an order of a justice having jurisdiction in the place where such dairy is situate, have power to inspect such dairy, and if accompanied by a veterinary inspector or some other properly qualified veterinary surgeon to inspect the animals therein, and if on such inspection the medical officer of health shall be of opinion that infectious disease is caused from consumption of the milk supplied therefrom, he shall report thereon to the local authority, and his report shall be accompanied by any report furnished to him by the said veterinary inspector or veterinary surgeon, and the local authority may thereupon give notice to the dairyman to appear before them within such time, not less than twenty-four hours, as may be specified in the notice, to show cause why an order should not be made requiring him not to supply any milk therefrom within the district until such order has been withdrawn by the local authority, and if, in the opinion of the local authority, he fails to show such cause, then the local authority may make such order as aforesaid; and the local authority shall forthwith give notice of the facts to the sanitary authority and county council (if any) of the district or county in which such dairy is situate, and also to the Local Government Board. An order made by a local authority in pursuance of this section shall be forthwith withdrawn on the local authority or the medical officer of health on its behalf being satisfied that the milk supply has been changed, or that the cause of the infection has been removed. Any person refusing to permit the medical officer of health on the production of such order as aforesaid to inspect any dairy, or if so accompanied as aforesaid to inspect the animals kept there, or after any such order not to supply milk as aforesaid has been given, supplying any milk within the district in contravention of such order, or selling it for consumption therein, shall be deemed guilty of an offence against this Act. Provided always, that proceedings in respect of such offence shall be taken before the justices of the peace having jurisdiction in the place where the said dairy is situate. Provided also, that no dairyman shall be liable to an action for breach of contract if the breach be due to an order from the local authority under this Act."

A "Dairy" is defined as including :—

"Any farm, farm-house, cowshed, milk-store, milkshop, or other place from which milk is supplied or in which milk is kept for purposes of sale."

"Dairyman" includes any cowkeeper, purveyor of milk, or occupier of a dairy.

A Veterinary Inspector, is one appointed under the Contagious Diseases Animals Act, 1878; the provisions of which Act are further safeguarded in this Act, (section 24).

The remaining sections of this portion of the principal Act deal with the power of the L.G.B. to make regulations for the prevention of diseases as regards the interment of the dead, house-to-house visitation, the provision of medical aid and hospital accommodation, and the promotion of cleansing, ventilation, &c. These and certain other regulations are of no special interest here, and this mention must suffice. P.H.A., 134-140.

There is also the Public Health Act of 1889, which is entitled "An Act to remove doubts as to the power of the Local Government Board to make regulations respecting cholera." In this Act will be found directions to port sanitary authorities and other authorities, including, or abutting on, any part of a customs port, and also to officers of customs, respecting the treatment and removal of persons affected with cholera, and the prevention of the spread of the disease both on land and water.

P.H.A., 144-172. Part iv. of the Public Health Act, 1875, relates to **Highways and Streets,** and to markets and slaughter-houses. The clauses relating to the licensing, &c., of slaughter-houses, have already been fully dealt with; of the remainder, the following summary will suffice:—

Sections 144-148 deal entirely with highways. In sections 149-160, streets and buildings are regulated. All public streets (*i.e.*, streets repairable by the inhabitants at large) are vested in the (urban) S.A., and must be levelled, paved, and repaired as occasion demands; private streets may be required to be sewered, levelled, paved, &c., and lighted, and in the default of the owners whose property abuts on such a street doing the work, the S.A. may carry out the work and recover the expenses, except from religious bodies. Power is given to declare private streets when properly sewered, &c., to the satisfaction of the urban S.A., to be highways, and in consequence of certain rulings, this section (152) may now be replaced by the adoption of section 41 of the Act of 1890; for the details of these and other powers in respect of street-making, the reader is referred to the Acts themselves.*

P.H.A.A., 41.

P.H.A., 157, 158, 159. Bye-laws may be made for **new streets** and **new buildings,** and penalties imposed for the contravention of such bye-laws. A new building is defined thus:—

"For the purposes of this Act the re-erecting of any building pulled down to or below the ground floor, or of any frame building of which only the framework is left down to the ground floor, or the conversion into a dwelling-house of any building not originally constructed for human habitation, or the conversion into more than one dwelling-house of a building originally constructed as one dwelling-house only shall be considered the erection of a new building."

P.H.A., 160. Section 160 incorporates the provisions of the Towns Improvement Clauses Act, 1847, sections 64-83, which deal with the naming and numbering of streets, the line of building in a street, dangerous buildings, and precautions during construction and repair of sewers, streets, and houses; to these may now be added section 34 of the Public Health Acts Amendment Act, which supersedes section 80 of those incorporated here; and also section 35, which amends section 73. In addition to the special points alluded to above, provision is also made for the proper maintenance of rain-pipes and gutters, where houses abut on a public street, under a penalty for default, notice to be served on owner *or* occupier.

P.H.A.A., 34, 35.

* Section 156 of the Public Health Act has been replaced by the Public Health Act of 1888.

The sections relating to **recreation grounds, public clocks** P.H.A., 164-165.
and **markets** require no notice here, nor do the amending sections in the Act of 1890, 45, 46. P.H.A.A. 45-46. Provisions follow from the Towns Police Clauses Act with respect to obstructions, fires, P.H.A., 171. places of public resort, hackney carriages, and public bathing, and require no comment. T.P.C.

The Act contains a number of important sections relating to the **appointment of officers** and the **conduct of legal proceedings.** The position and duties of an inspector of nuisances have been detailed at the commencement of this Appendix, and very few additional remarks are here necessary. Householders and others will do well to remember that the P.H.A., 191. Medical Officer of Health may exercise any of the powers with which an inspector of nuisances is invested under this Act.

An officer of a Local Authority may not be concerned or P.H.A., 193. interested in any bargain or contract made with the Authority, nor may he receive or accept any fee or reward other than his proper salary, wages, and allowances.

Officers cannot be too careful not to infringe this regulation even inadvertently or by permission of their L.A. In any case where the slightest doubt as to the legality of any payment exists, the advice of the clerk should be asked. A study of the cases quoted on this section amply proves the necessity for this advice.

With regard to legal proceedings, the following extracts will be found useful :—

1. *Authentication of notice and method of service.* P.H.A., 266-267.

"Notices, orders and other such documents under this Act may be in writing or print, or partly in writing or partly in print; and if the same require authentication by the local authority the signature thereof by the clerk to the local authority or their surveyor or inspector of nuisances shall be sufficient authentication.

"Notices, orders and any other documents required or authorised to be served under this Act may be served by delivering the same to or at the residence of the person to whom they are respectively addressed, or where addressed to the owner or occupier of premises by delivering the same or a true copy thereof to some person on the premises, or if there is no person on the premises who can be so served by fixing the same on some conspicuous part of the premises; they may also be served by post by a prepaid letter, and if served by post shall be deemed to have been served at the time when the letter containing the same would be delivered in the ordinary course of post, and in proving such service it shall be sufficient to prove that the notice, order or other document was properly addressed and put into the post.

"Any notice by this Act required to be given to the owner or occupier of any premises may be addressed by the description of the 'owner' or 'occupier' of the premises (naming them) in respect of which the notice is given, without further name or description."

With regard to the authority required for the service of a notice, see *supra*, p. 251, section 94. A form of notice is provided in the schedule to the Act which should be accurately followed.

2. *Proceedings in a court of summary jurisdiction.*

Where a notice, properly authenticated, is without effect, the next step is to lay an information before the clerk to the justices. This must take place within six months of the time when the matter of such complaint or information arose.

A form of summons is given in the schedule to the Act, and

P.H.A., 259. "Any local authority may appear before any court or in any legal proceeding by their clerk, or by any officer or member authorised generally or in respect of any special proceeding by resolution of such authority, and their clerk, or any officer or member so authorised shall be at liberty to institute and carry on any proceeding which the local authority is authorised to institute and carry on under this Act."

Although the section provides for the authorisation of any officer, it has been held that the justices might refuse to determine a complaint unless the clerk attends in person, or by counsel or attorney. Where the sanitary inspector has been authorised by resolution, either at his appointment or specially, to appear and conduct cases, he will do well to have an authority in writing, containing a copy of the resolution as entered on the minutes.

In selecting a day for the hearing of the case, the inspector must be careful to ensure the presence of at least two magistrates P.H.A., 258. not members of the L.A.; for, although at first sight section 258 would appear to render such precaution unnecessary, it is not so, as the rulings of the high courts abundantly prove.

In the case where proceedings are taken to enforce the provisions of an adoptive Act the inspector should provide himself with proof of its adoption, *e.g.*, by a copy of the resolution, a public handbill, or a newspaper.

It is hardly necessary to say that a case should never be taken into court unless it is almost absolutely certain a conviction can be obtained; nothing is more fatal to the prestige and the usefulness of an inspector than, having induced his committee to undertake a prosecution, to fail in obtaining a conviction.

In giving evidence the simplest language is always the best;

slow and distinct utterance, avoidance of technicalities, and the absence of any appearance of argument are also valuable qualities in a witness; it must not be forgotten that justices are often subject to deafness and ignorant of any technical sanitary knowledge, and that the justice's clerk requires time to take down one sentence before another is commenced.

It is, however, most desirable that appeal to the police court should in all cases be avoided; it may be necessary for the sake of example or in enforcing a new Act, but more quiet good can be effected without legal proceedings.

Not a little difficulty is frequently experienced in pointing out to Local Authorities the provisions of this Act and the necessity for enforcing them. It should, however, be remembered that the L.G.B. have power to make such inquiries as they see fit in relation to any matters concerning the public health in any place; and that they have power also to compel the L.A. to carry out certain works. Representation may also be made to the L.G.B. by the County Council if action in such matters appears to be deficient or negligent.

Bakehouses.

The inspection of **retail Bakehouses** being one of the duties of the Sanitary Authority, some reference to the law governing them is necessary.

The control of Bakehouses, which was originally in the hands of the S.A., was transferred to the Factory Inspectors by the Factory Act of 1878, and restored to the S.A. by the Act of 1883. **F., 1883, 17.**

For definition of a retail bakehouse, see p. 237, *supra*.

By section 34 of the Act of 1878, in all towns of more than 5,000 inhabitants, every bakehouse must have the whole of the interior, walls and ceilings, and all the passages and staircases painted or varnished or lime-washed; if painted, to be renewed every seven years, and washed every six months; if lime-washed, to be renewed every six months. **F., 1878, 34.**

The following section prescribes that under similar conditions no sleeping-place shall be permitted on the same level as a bakehouse, unless completely separated from it by a partition from floor to ceiling, and effectively ventilated by a window 9 square feet which will open. **35.**

New Bakehouses are subject to the following regulations:— **F., 1883. 15.**

"It shall not be lawful to let or suffer to be occupied as a bakehouse, or to occupy as a bakehouse, any room or place which was not so let or occupied before the first day of June, one thousand eight hundred and eighty-three, unless the following regulations are complied with :—

1. No water-closet, earth-closet, privy, or ashpit shall be within or communicate directly with the bakehouse ;
2. Any cistern for supplying water to the bakehouse shall be separate and distinct from any cistern for supplying water to a water-closet ;
3. No drain or pipe for carrying off fæcal or sewage matter shall have an opening within the bakehouse.

"Any person who lets or suffers to be occupied or who occupies any room or place as a bakehouse in contravention of this section shall be liable, on summary conviction, to a fine not exceeding five shillings, and to a further fine, not exceeding five shillings, for every day during which any room or place is so occupied after a conviction under this section."

F., 1883, 17. For the purpose of enforcing any of the above provisions, the M.O.H. has the powers of a factory inspector as to entry, inspection, and taking legal proceedings ; the sanitary inspector

F., 1878, 4. has *ex officio* no power of entry under the earlier Factory Acts, but the M.O.H. may, by these powers, take with him any officer of the Sanitary Authority. The powers given to factory inspectors are set out in the Act of 1878, sec. 68 ; they include power of entry, at all reasonable times, to a factory or workshop, and, by day, to any place which he has reason to believe is a factory or workshop, taking with him, if he thinks fit, a constable, to make such examination and inquiry as may be necessary to ascertain whether the enactments for the time being in force relating to public health are complied with, and to exercise such other powers as may be necessary for carrying the Act into effect.

F., 1891, 3. Up to 1891, these regulations applied to bakehouses, which were the only form of workshop under the control of the S.A. ; but by the Act of 1891, several important additions have been made ; section 3 of this Act removes workshops from the operation of section 3 of the Act of 1878 (*supra*, p. 241) and hands them over to the S.A. :—

"1. Sections three and thirty-three of the Factory and Workshop Act, 1878 (which relate to cleanliness, ventilation, and overcrowding in, and lime-washing of, factories and workshops), shall cease to apply to workshops.

"2. For the purpose of their duties with respect to workshops (not being workshops to which the Public Health (London) Act, 1891, applies), a sanitary authority and their officers shall, without prejudice to their other powers, have all such powers of entry, inspection, taking legal proceedings or otherwise, as an inspector under the principal Act.

"3. If any child, young person, or woman, is employed in a workshop, and the medical officer of the sanitary authority becomes aware thereof, he shall forthwith give written notice thereof to the factory inspector of the district."

In order that the S.A. may have proper notice of the workshops under control provision is made as follows :—

"Every person shall, within one month after he begins to occupy a factory or workshop, serve on an inspector a written notice containing the name of the factory or workshop, the place where it is situate, the address to which he desires his letters to be addressed, the nature of the work, the nature and amount of the moving power therein, and the name of the firm under which the business of the factory or workshop is to be carried on, and in default, shall be liable to a fine not exceeding five pounds." F., 1878, 75.

"1. Section seventy-five of the principal Act (which requires notice to be given of the occupation of a factory) shall apply to a workshop (including any workshop conducted on the system of not employing any child, young person, or woman therein) in like manner as it applies to a factory. F., 1891, 26.

"2. Where an inspector receives notice in pursuance of this section with respect to a workshop, he shall forthwith forward the notice to the sanitary authority of the district in which the workshop is situate."

New duties of considerable magnitude are thus imposed upon the S.A. and its officers, and it remains to be seen whether in large manufacturing towns the staff hitherto employed by the S.A. will be sufficient to perform them properly, or whether some addition or modification will be required. Bristol has already taken the lead in this matter. It may also be noted that under the Act of 1891 any officer of the S.A. may examine the lists of outworkers, which every occupier of a factory or workshop is bound to keep ; this is important in enquiries into the spread of infectious diseases. F., 1891, 27.

Housing of the Working Classes Act.

The Acts relating to the **Housing of the Working Classes** were consolidated in 1890 into a single Act, the operations of which are here briefly indicated. The only material unrepealed portions of previous Acts are sections 7, 9, and 10 of the Act of 1885, see above, p. 249, under the heading of *Nuisances*.

The consolidated Act deals first with **unhealthy areas**, and this portion applies only in urban districts. The main features of it consist in the power given to a local authority to prepare an improvement scheme for unhealthy areas. It is the duty of the M.O.H. to make an official representation when he finds that in a certain area there are not only (*a*) houses and courts unfit for habitation, and (*b*) defects of ventilation, and houses too closely grouped, but, further, that nothing short of an improvement scheme will remedy this condition. The remainder of this portion of the Act contains details for the working out of such H.W.C., 1890, Part i., secs. 1-28.

schemes, such as the obtaining of the sanction of the L.G.B., the methods of compulsory purchase, valuation, compensation, &c., and provision for displaced populations; its details are not of practical importance in this place.

Part ii. Part ii. of the Act deals with **Unhealthy Dwelling Houses,** and applies to all authorities, whether urban or rural; its provisions are of great importance to owners and authorities, and are therefore dealt with more in detail.

29. Section 29 contains definitions which differ from those previously quoted in sanitary enactments; *e.g.*:—

"The expression 'street' includes any court, alley, street, square, or row of houses.

"The expression 'dwelling-house' means any inhabited building, and includes any yard, garden, outhouses, and appurtenances belonging thereto or usually enjoyed therewith, and includes the site of the dwelling-house as so defined."

Thus the word "street" is here restricted to a road, &c., with houses built in it, and does not include highways or roads without houses.

It will be noticed that the word "site" here means the whole of the premises belonging to the dwelling-houses, including yards and gardens.

Section 30 commences by defining the duty of the M.O.H.

30. "It shall be the duty of the medical officer of health of every district to represent to the local authority of that district any dwelling-house which appears to him to be in a state so dangerous or injurious to health as to be unfit for human habitation."

31. By section 31 the information is laid before the S.A., and a similar complaint may be made by any four or more householders to the M.O.H., who *shall* thereupon inspect and report; and if no action is taken within three months the householders may then complain to the L.G.B., if in an *urban* district.

The next section directs the action of the S.A., and is as follows:—

32 (1). "1. It shall be the duty of every local authority to cause to be made from time to time inspection of their district, with a view to ascertain whether any dwelling-house therein is in a state so dangerous or injurious to health as to be unfit for human habitation, and if, on the representation of the medical officer, or of any officer of such authority, or information given, any dwelling-house appears to them to be in such a state, to forthwith take proceedings against the owner or occupier for closing the dwelling-house under the enactments set out in the Third Schedule of this Act."

These enactments are:—1. For the country. Public Health

Act, 1875, sections 91, 94, 95, 97. These provisions have been fully set out in their proper place, pp. 249-52, *supra*.

2. For London. Public Health (London) Act, 1891, sections 2, 4, 5, 6. See also the Public Health (London) Act, section 142.

The first step in proceedings under this Act is to give notice by the authority of the sanitary authority to the owner or occupier to execute the works necessary to put the house in proper condition; notice under these sections should specify the work required to be done, since, when the L.A. elect to proceed under this section they contemplate the possibility of the house being rendered fit for human habitation. They may, however, decide to apply merely for a closing order, and here sub-section 2 applies:—

"2. Any such proceedings may be taken for the express purpose of causing the dwelling-house to be closed whether the same be occupied or not, and upon such proceedings the court of summary jurisdiction may impose a penalty not exceeding twenty pounds, and make a closing order, and the forms for the purposes of this section may be those in the Fourth Schedule to this Act, or to the like effect, and the enactments respecting an appeal from a closing order shall apply to the imposition of such penalty as well as to a closing order." 32 (2).

In proceeding under this section the L.A. are entitled to serve a preliminary notice on the owner or occupier, without stating what works are required, and then to apply for a summons for a closing order. A closing order when granted remains in operation until, in the opinion of the court, the premises are rendered fit for human habitation. There is no appeal from a closing order to any higher court.

If this closing order is not determined by a further order of 33.
the court, and nothing has been done to remedy the condition of the house or houses, the S.A. may pass a resolution that it is expedient to order the demolition of the building. Notice of this resolution shall be served on the owner at his usual residence,
or by registered letter, or in charge of the occupier, provided the 49.
owner cannot be found, or on the owner's agent, and must be 86.
signed by the clerk to the S.A., or his lawful deputy; not less than one month later the S.A. shall consider this resolution, when the owner may attend and state his objection; the S.A. may then, if they still decide that it is expedient, order the
demolition of the building. An order must be under seal of the 35.
L.A., and is open to an appeal to quarter sessions.

These are the main provisions relating to unhealthy dwellings; the Act now deals with **obstructive buildings.**

38. "1. If a medical officer of health finds that any building within his district, although not in itself unfit for human habitation, is so situate that by reason of its proximity to or contact with any other buildings it causes one of the following effects, that is to say,—

"(*a.*) It stops ventilation, or otherwise makes or conduces to make such other buildings to be in a condition unfit for human habitation or dangerous or injurious to health; or

"(*b.*) It prevents proper measures from being carried into effect for remedying any nuisance injurious to health or other evils complained of in respect of such other buildings;

in any such case, the medical officer of health shall represent to the local authority the particulars relating to such first-mentioned building (in this Act referred to as 'an obstructive building') stating that in his opinion it is expedient that the obstructive building should be pulled down.

"2. Any four or more inhabitant householders of a district may make to the local authority of the district a representation as respects any building to the like effect as that of the medical officer under this section."

On such a representation the S.A. shall make an enquiry into the facts, and the cost of acquiring the land and demolishing the building; they can then, if they so decide, proceed by order for demolition, subject to appeal as before; the compensation to be paid by the S.A. to the owner, and the amount, if any, recoverable from owners of adjoining property for the improvement caused by the demolition, is to be settled by arbitration.

The owner may, under certain conditions, retain the site; but the L.A. are entitled to regulate what building he shall place upon it.

39. Further than this, the S.A. may prepare a scheme for the improvement of a given area, by dedicating a highway, erecting working class dwellings, or exchanging or selling the site of houses demolished as above, and such scheme shall be presented to the L.G.B. for sanction.

The remainder of Part ii. deals with certain special powers of County Council, &c., and is not of material importance, except where such a scheme is about to be prepared, and it should then be referred to. Part iii. is adoptive and gives power to any L.A. to erect or purchase lodging-houses for the working classes, subject to the sanction of the L.G.B. (urban), or of the county council (rural), and to make bye-laws for the management of the same.

Pollution of Rivers.

The **Rivers Pollution Prevention Act** of 1876 may, in some instances, come under the notice of the sanitary inspector.

In it sanitary authorities and private individuals are given power to institute proceedings in respect of the pollution of streams by solid matters, or by sewage; and further, power is given to S.A.'s only, and with the consent of the L.G.B., to take proceedings in the case of trade or mining effluents.

The provisions of this Act have been added to by the Local Government Act of 1888, section 14, which makes county councils sanitary authorities for the purposes of this Act, and provides for the establishment of joint boards.

The Act is largely inoperative owing to the extensive safeguards it contains, but it may here be pointed out, that, by its provisions, the discharge of solid or liquid sewage, or of any solid matter into streams, is illegal. It is, therefore, within the duty of an inspector of nuisances to guard against the common practice, both in towns and villages, of allowing the surface washings of stables and pigstyes to flow into any water-course, and he should endeavour to have removed all privies or latrines overhanging running streams, and to prevent as far as possible the choking of small water-courses with animal and vegetable house refuse or ashes. The discharge of sewage-farm effluents into rivers is a special question, which demands no notice here.

Efforts are now being made by the Joint Board of the Mersey and Irwell in a private bill, and by the County Council of Warwickshire, who are drafting a general bill to amend and improve the statute law relating to rivers, more especially as regards the removal of weirs and the prevention of floods.

Canal Boats.

The inspection of **Canal Boats** devolves upon all sanitary authorities under the Canal Boats Act of 1884; by section 4 of that Act, they are required to appoint one or more inspectors to carry out the Acts of 1877 and 1884. These inspectors may enter any canal boat at any time during the day, *i.e.*, between 6 a.m. and 9 p.m., may examine every part of it, and may, if need be, detain the boat, for such time as is necessary.

C.B., 1877-1884.

The main provisions of the Acts to be enforced are given below:—

"The expression 'canal' includes any river, inland navigation, lake, or water being within the body of a county, whether it is or not within the ebb and flow of the tide.

"The expression 'canal boat' means any vessel, however propelled, used for the conveyance of goods along a canal, and not a ship registered under the Merchant Shipping Acts, 1854, and the Acts amending the same."

No canal boat may be used as a dwelling, unless registered with the Sanitary Authority whose district abuts on the canal on which the boat is intended to ply; and it must be registered as belonging to some place within the registration district which is also a school district.

The master of every canal boat must carry with him a certificate (being one of two received from the authority at the time of registration), and must produce it when properly demanded.

The L.G.B., under the powers conferred by this Act, issued a memorandum of regulations, which provide among other details that—

"The interior of any after-cabin intended to be used as a dwelling shall contain not less than 180 cubic feet of free air space; and the interior of any fore-cabin intended to be so used shall contain not less than 80 cubic feet of free air space.

"If the boat is intended to be ordinarily used for the conveyance of offensive cargo, there shall be two substantial bulkheads provided, between the cargo and the dwelling-part, with an interspace of not under 4 inches, open to the external air, provided with a pump for the removal of liquid, and water-tight on the side next the cargo.

"Should a person in a canal boat be 'seriously ill, or evidently suffering from an infectious disease,' the master must notify the facts to the sanitary authority within whose district the boat happens to be, and on arriving at his destination, to the authority within whose district it is."

C.B., 1884, 3 The L.A. must report annually to the L.G.B. within twenty-one days of December 31st in each year, which report must come through the L.A. and not direct from the inspector; it must contain among other information a report upon the following points:—

"1. The arrangements made for the inspection of boats, and the remuneration of the inspector:

"2. The number of boats inspected in the year, and the condition of the boats and their occupants as regards the matters dealt with in the Acts and regulations:

"3. Any infringements of the Acts and Regulations with respect to (*a*) Registration; (*b*) Notification of change of Master; (*c*) Absence of Certificates; (*d*) Marking; (*e*) Overcrowding; (*f*) Separation of the Sexes; (*g*) Cleanliness and Ventilation; (*h*) Removal of Bilge Water; (*i*) Notification of Infectious Disease; (*j*) Refusal of Admittance to Inspector:

"4. Legal proceedings taken in respect of any such infringements, and penalties inflicted:

"5. Any other steps taken to secure compliance with the Acts and Regulations as regards such infringements:

"6. Cases of infectious disease dealt with, and measures of isolation adopted:

"7. Detention of boats for cleansing and disinfection: and, in the case of Registration Authorities:

"8. The number of boats on the Register:
"9. The number registered in 1889, distinguishing the cases in which fresh registration has been rendered necessary by structural alterations in boats previously registered."

Food and Drugs.

The duties of inspector under the **Food and Drugs** Acts are often combined with those of inspector of nuisances. These Acts are the Food and Drugs Acts of 1875 and 1879, and the Margarine Act of 1887.

The following are the definitions in these Acts:

'Food' includes every article used by man for food or drink, except water and drugs.

'Drugs' include medicine for external as well as internal use.

'Butter' is the substance usually known as butter made exclusively from milk or cream, or both, with or without salt or other preservative, and with or without the addition of colouring matter.

'Margarine' includes all substances, whether compounds or otherwise, prepared in imitation of butter, and whether mixed with butter or not.

The provisions of the Acts forbid any person to mix, colour, stain, or powder any article of food or any drug so as to render it injurious to health or to sell such an article; penalties and punishments are provided. It is also forbidden (sec. 9) to sell any article from which some part has been abstracted, without notice to the buyer, *e.g.*, milk which has been skimmed.

No person shall sell to the prejudice of the purchaser, any article of food or any drug not of the nature, substance, and quality demanded, and it shall be no defence to allege that the purchaser is not prejudiced by the sale of adulterated articles on the ground that he bought it for analysis only.

It shall, however, be deemed no offence in the following cases:—

"1. Where any matter or ingredient not injurious to health has been added to the food or drug, because the same is required for the production or preparation thereof as an article of commerce in a state fit for carriage or consumption, and not fradulently to increase the bulk, weight, or measure of the food or drug, or to conceal the inferior quality thereof.

"2. Where the food or drug is a proprietary medicine, or is the subject of a patent in force, and is supplied in the state required by the specification of the patent.

"3. Where the food or drug is compounded and not labelled as mixed at the time of sale.

"4. Where the food or drug is unavoidably mixed with some extraneous matter in the process of collection or preparation."

The defendant is to be discharged if he proves to the satisfaction of the court :—

"1. That he bought the article which is the subject of prosecution as being the same as that demanded, and with a written warranty.

"2. That he had no reason to believe it otherwise at the time of sale.

"3. That he sold it unaltered."

The Acts further provide for the appointment of a public analyst, and specify certain forms to be observed in purchasing articles.

The purchaser must, after completing the purchase, notify the seller of his intention to have it analysed, and offer to divide the article into three parts, to be there and then sealed up, one part to be retained by the seller, another to be sent to the analyst, and the third to be retained for future reference.

With regard to the **Margarine Act**, it is provided that—

"Every package, whether open or closed, and containing margarine, shall be branded or durably marked 'Margarine' on the top, bottom, and sides, in printed capital letters not less than $\frac{3}{4}$ of inch square; and if such margarine be exposed for sale, by retail, there shall be attached to each parcel thereof so exposed, and in such manner as to be clearly visible to the purchaser, a label marked, in printed capital letters not less than $1\frac{1}{2}$ inches square, 'Margarine;' and every person selling margarine, by retail, save in a package duly branded or durably marked as aforesaid, shall in every case deliver the same to the purchaser in or with a paper wrapper, on which shall be printed in capital letters, not less than a $\frac{1}{4}$ of an inch square 'Margarine.'"

All margarine factories must be registered with the sanitary authority by whom the analyst is appointed, and all substances not marked "margarine," are presumed to be exposed for sale as butter.

The remaining provisions resemble those of the principal Acts already quoted.

Dairies, Cowsheds, and Milkshops.

The regulation of these buildings was formerly in the hands of the Privy Council, but has since been transferred to the Local Government Board.

They are governed by the L.G.B. Orders of 1885 and 1886, which are issued in pursuance of section 34 of the Contagious Diseases (Animals) Act of 1878, and section 9 of the Amending Act of 1886.

The essential parts of these Orders are here quoted *in extenso*, as they are of very great importance :—

Every cowkeeper, dairyman, or purveyor of milk, must in future register himself with the sanitary authority of the district within which he carries on business, and a sanitary authority cannot refuse to register any person so applying for registration, even though there may be objections to the premises occupied by the applicant, or though he may not occupy any premises within the district. This registration is one of persons, not of premises, and, (outside the metropolis), is not of the nature of a licence. As already noted, local authorities have at present no powers to make regulations prescribing conditions to be fulfilled before registration. Defects of premises must be dealt with separately as breaches of the regulations. Section 6.

An exception to the necessity for registration is made in the case of persons who only make and sell butter and cheese, or who sell milk of their own cows, in small quantities, to their workmen or neighbours for their accommodation.

"1. It shall not be lawful for any person following the trade of cow-keeper or dairyman to begin to occupy as a dairy or cowshed any building not so occupied at the making of this order, unless and until he first makes provision, to the reasonable satisfaction of the local authority, for the lighting and the ventilation, including air-space, and the cleansing, drainage, and water-supply of the same, while occupied as a dairy or cowshed. Section 7.

"2. It shall not be lawful for any such person to begin so to occupy any such building without first giving one month's notice in writing to the local authority of his intention so to do.

"It shall not be lawful for any person following the trade of cowkeeper or dairyman to occupy as a dairy or cowshed any building, whether so occupied at the making of this order, or not, if and as long as the lighting, and the ventilation, including air-space, and the cleansing, drainage, and water-supply thereof, are not such as are necessary or proper— Section 8.

(*a*) For the health and good condition of the cattle therein; and

(*b*) For the cleanliness of milk-vessels used therein for containing milk for sale; and

(*c*) For the protection of the milk therein against infection and contamination."

The order goes on to forbid, under penalties, the occupier himself or any other person to be concerned in the production, distribution or storage of milk, either when suffering from any dangerous infectious disorder or having been recently in contact with any one so suffering, until all danger of infection has ceased. It prohibits any water-closet, earth-closet, privy, cesspit or urinal, being in communication with a milk-store after one month's notice from the L.A.

It prohibits the use of a milk-store or a milkshop as a sleeping apartment, and the keeping of swine on milk-premises, and it also prohibits the sale and use for human food of the milk of diseased cows. Further, it authorises local authorities to make regulations :—

(*a*) For the inspection of cattle in dairies.

(*b*) For prescribing and regulating the lighting, ventilation, cleansing, drainage, and water-supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers or dairymen.

(*c*) For securing the cleanliness of milk-stores, milkshops, and of milk-vessels used for containing milk for sale by such persons.

(*d*) For prescribing precautions to be taken, by purveyors of milk and persons selling milk by retail, against infection or contamination.

These are the principal provisions of the order and, in addition, attention may again be called to the Infectious Diseases Prevention Act, 1890, section 4, and the 71st section of the London Health Act, which are fully dealt with at p. 268.

Unfortunately, at the present time, these orders are not adequately enforced; the custom of combining the duties of inspection of dairies, &c., with that of inspectors under the Contagious Diseases (Animals) Acts, and appointing police officers to undertake them, cannot lead to satisfactory results. Further than this, the power to make regulations is very inadequate, and L.A.'s must be careful not to exceed their powers. No authority is given by which milksellers can be compelled to put notice boards or number boards over their doors.

With regard to disease among cattle, the present state of the law is very unsatisfactory; "disease" is defined (C.D. Animals Act, 1878), as meaning—

> "Cattle plague, contagious pleuro-pneumonia, foot-and-mouth disease, sheep-pox, or sheep scab."

Modern science would add tubercle; the discovery of tubercle-bacilli in milk has rendered a further extension of the definition very necessary.

London.

London. These are the principal Acts under which the Public Health of the provinces is governed: the **Public Health (London) Act** passed in 1891 now consolidates the law in the metropolis, and requires short notice here. The main points in it have already received notice in the foregoing pages, where striking points of difference or amendment have occurred.

A reference to the fourth schedule of this Act shows that no less than thirty-six Acts of Parliament have been either wholly or mainly repealed by it, and in this connection it is worthy of mention that it is provided, that any reference to repealed Acts 142-7. or sections of Acts in previous Acts of Parliament, *e.g.*, the Housing of the Working Classes Act of 1890, apply now to the substituted clauses provided in this Act.

The London authorities under this Act comprise the Commissioners of Sewers who act for the City of London, the vestries, the district boards and the Local Board of Woolwich. All these authorities are under the control of the London County Council, except the Commissioners of Sewers, the district over which they have control being exempt from the operation of the County Council bye-laws.

The London County Council who succeeded to the position of the Metropolitan Board of Works, acquire under this Act con- **London,** siderably extended powers; they can now make bye-laws for 16. many purposes, *e.g.*, for prescribing the times for the removal or carriage by road or water, of fæcal or offensive or noxious matter or liquid, in or through the administrative county of London; for the closing, &c. of cesspools and privies; for the removal or disposal of refuse; and also for the regulation of **19.** any offensive trades lawfully carried on in London.

These bye-laws must be sent to every sanitary authority before being confirmed, and objection may be made to them; they are also subject to the provisions of the Public Health Act, 1875, 182 to 186.

The County Council further have power to take action (except **100.** in the City of London) in the event of any default made by any sanitary authority; they must receive an annual report from every district board and vestry in June every year, to which must be appended the report of the district medical officer.

The provisions with regard to offensive trades and nuisances have already received notice, and the consolidation of the Acts relating to the consumption of smoke, may be dismissed with a simple mention. The regulations for dairies, &c., are made similar to those enforced in the country generally, and have already received full notice. Owners and occupiers are relieved of the duty of cleansing the footpaths and water-courses adjoining their premises in time of snow, &c. A sanitary authority may now require a house to be provided with as many water-closets as they may think necessary; they may also provide public lavatories. The law relating to unsound food is extended as in the P.H.A.A., Act of 1890, and includes all articles intended for the food of 28. man: while any person convicted twice within twelve months London, 47.

London, 49. may, in addition to other penalties, be liable to have a notice affixed to his premises of the facts upon which he has been convicted.

In future a water company, whenever they cut off the water supply of a dwelling-house, must give notice to the sanitary authority within twenty-four hours and, by section 50, sanitary authorities are ordered to make bye-laws for securing the cleanliness and freedom from pollution of all tanks, &c., used for storing water for domestic purposes.

London, 96. The law relating to cellar dwellings, (*i.e.*, any room the surface of the floor of which is more than 3 feet below the surface of the footway of the adjoining street, or of the ground adjoining or nearest to the room) is considerably strengthened, and several new requirements added—*e.g.*, effectual drainage of area and subsoil, effectual provision against the rising of any exhalation, and additional window space. These provisions do not apply to cellars or underground dwellings when occupied in conjunction with rooms on a higher floor.

The details of procedure, appointment of officers, &c., and the remaining powers of the London County Council over sanitary authorities may best be learned from the Act itself.

Bye-Laws.

A brief mention must be made of bye-laws; in the detailed consideration of the Acts relating to public health, mention has been made of numerous objects for which L.A. have power to make bye-laws.

Bye-laws are intended to amplify, but not to vary or supersede, the statute law; they must be reasonable and in no particular repugnant to the provisions of the general law, and in nearly every case they require the approval of the L.G.B. for their confirmation.

For the guidance of local authorities the L.G.B. have issued a series of Model Bye-laws on many of the matters for which bye-laws may be framed. The following have been issued up to the present time:—

1. The cleansing of footways and pavements. Removal of house refuse. Cleansing of earth-closets, privies, ash-pits, and cesspools.

2. The prevention of nuisances arising from snow, filth, dust, ashes, and rubbish. Prevention of the keeping of animals so as to be injurious to health.

3. Common lodging-houses.
4. New streets and buildings.
5. Markets.
6. Slaughter-houses.
7. Hackney carriages.
8. Public bathing.
9. Public baths and washhouses, and open bathing-places. Duties of the officers and servants.
10. Pleasure grounds.
11. Horses, ponies, mules, or asses, standing for hire.
12. Pleasure boats and vessels.
13. Houses let in lodgings.
14. Cemeteries.
15. Hop-pickers.
16. Mortuaries.
17. Offensive trades.

These are all applicable to urban authorities; rural authorities have powers only with respect to private scavenging (1), common lodging-houses (3), houses let in lodgings (13), hop-pickers (15), fruit-pickers (Public Health Act, 1882), tents and vans (H.W.C., 1885, 9), and mortuaries (16); and also in common with urban authorities, certain powers under the Public Health Act, 1890, which have been fully mentioned above.

There is no necessity to enter more fully into the suggestive provisions of the Model Bye-laws, since the principal points requiring notice have been dealt with in their appropriate places.

APPENDIX B.

SUPPLEMENTARY.

Water Waste-preventer.

There are many kinds of water waste-preventers. The drawing (Fig. 91) represents one which discharges by syphon action; it is simple in design, and requires little description. The water supply is regulated by a ball-tap, and syphonage takes place when the plug is raised by pulling the handle. When once syphon action is started the whole of the water will be discharged, whether the handle is liberated or not.

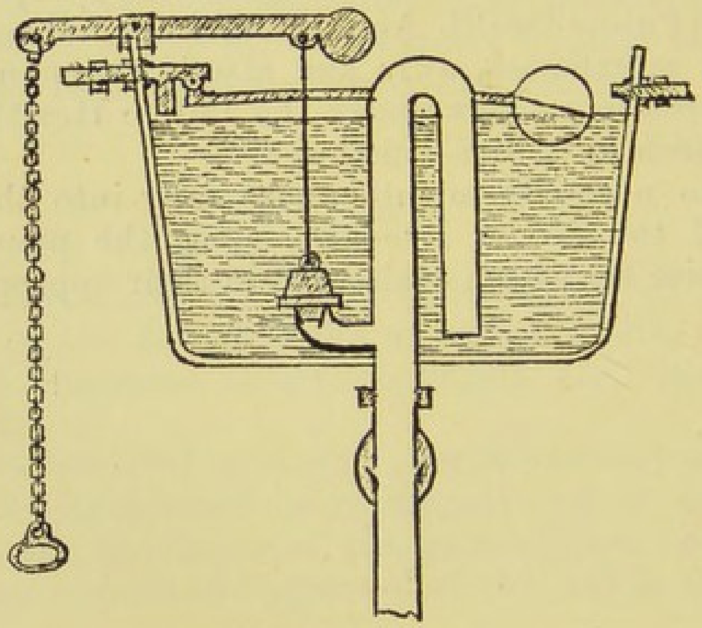


Fig. 91.

Junction of Soil-pipe with Drain.

The making of this junction is by no means an easy matter. The usual practice is to introduce the plain end of the soil-pipe into the socket of the drain-pipe, the joint being made with cement in the ordinary way; this, however, is not sufficient.

The accompanying drawing (Fig. 92) shows a good method of making this joint. It will be noticed that the soil-pipe is prolonged for a little distance into the drain-pipe, and it has a lead flange attached to it which rests on the floor of the socket, the joint being made with cement. The drain-pipe which receives the soil-pipe should rest on a solid foundation of concrete.

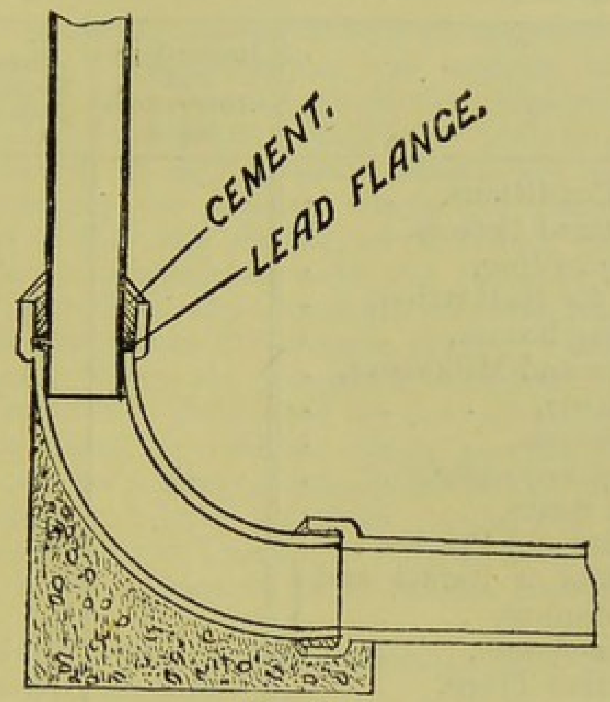


Fig. 92.

Drain Joints.

The drawing (Fig. 93) illustrates a good method of making a drain joint. Hemp-spun yarn, free from tar, is first steeped in fluid cement (cement grout), and then well rammed into the joint, so as to fill it about half. The joint is then completed with stiff cement.

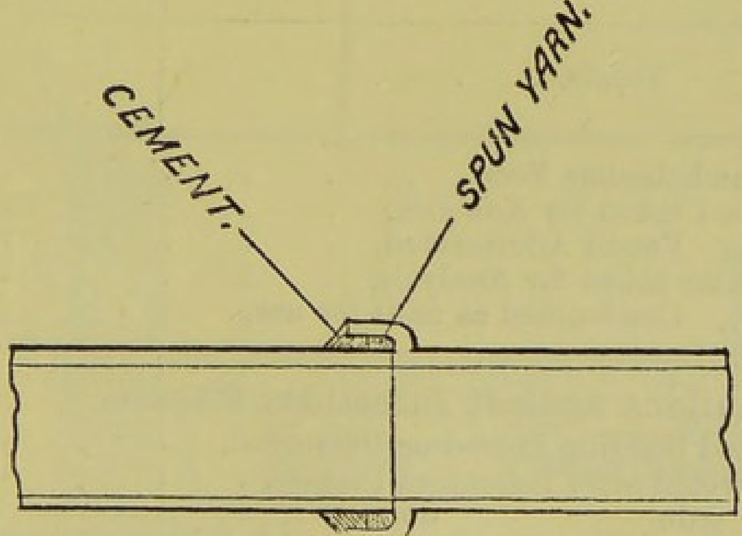


Fig. 93.

Sanitary Inspectors' Returns.

The following Table is suggested as a convenient form for adoption by sanitary inspectors in making their returns of the year's work to their authorities. It has been drawn up by the author, in conjunction with Dr. Bostock Hill of Warwickshire, and Dr. Barwise of Derbyshire, and it has been in use in the three counties for two years :—

SUMMARY of SANITARY WORK done in the Inspector of Nuisances' Department during the year......, in the......... Sanitary District of..........*

		Inspections and Observations made.	Formal Notices by Authority.	Nuisances Abated after Notice.
Dwelling-houses and Schools.	Foul Conditions, . .			
	Structural Defects, . .			
	Overcrowding, . .			
	Unfit for Habitation, .			
	Lodging-houses, . .			
	Dairies and Milkshops, .			
	Cowsheds, . . .			
	Bakehouses, . . .			
	Slaughter-houses, . .			
	Canal Boats, . . .			
	Ashpits and Privies, .			
	Deposits of Refuse and Manure, . .			
	Water-closets, . .			
House Drainage.	Defective Traps, . .			
	No Disconnection, . .			
	Other Faults, . . .			
	Water-supply, . .			
	Pigsties, ...			
	Animals improperly kept,			
	Offensive Trades, . .			
	Smoke Nuisances, . .			
	Other Nuisances, . .			
	Totals, . . .			

	Nos.
Seizures of Unwholesome Food, ...	
Samples of Food taken for Analysis, ...	
,, ,, Found Adulterated, ...	
,, of Water taken for Analysis, ...	
,, ,, Condemned as unfit for use, . . .	
Precautions against Infectious Disease.	
Lots of Infected Bedding Stoved or Destroyed, . . .	
Houses Disinfected after Infectious Disease, ...	
Schools do. do.	
Prosecutions for not Notifying Existence of Infectious Disease,	
Convictions do. do.	
Prosecutions for Exposure of Infected Persons or Things, .	
Convictions do. do.	

Note.—Where an Inspection or Notice embraces more than one defect, it may be enumerated separately as regards each of such defects.

Date,........................ *Signed*,..................................

* Urban or Rural.

Disinfection by Steam.

What is said to be an improved form of steam disinfecting apparatus, on the Washington Lyon principle, has recently been brought out by Manlove, Alliott & Co., the makers of the original Lyon's steam disinfector. It is claimed for the new disinfector (Alliott and Paton's Patent), that the advantages of high-pressure steam are secured without the possibility of wetting the articles which are being disinfected. The principle feature of the new disinfector is that a vacuum-producing apparatus or air-pump is connected with the chamber, by which the air is exhausted, not only from the chamber, but also from the clothing and bedding which is about to be disinfected, thereby facilitating the penetration of the steam. When the process is completed, the steam which has penetrated the articles is exhausted by the air-pump, and thus no deposit takes place when the cold air enters on the doors being opened. The apparatus can be used as a hot-air disinfector when furs or leather articles, which may be injured by steam, require to be disinfected. Dr. Boobbyer, Medical Officer of Health for Nottingham, who has had practical experience of this new apparatus, is of opinion that it is far in advance of the older one.

It is possible to have the exhaust apparatus fixed to an ordinary Lyon's disinfector at a moderate cost.

Day's Slop-closet.

The drawing (Fig. 94) represents Day's slop-closet, a form of closet which, like Duckett's and Allen's (see page 122), is automatically flushed

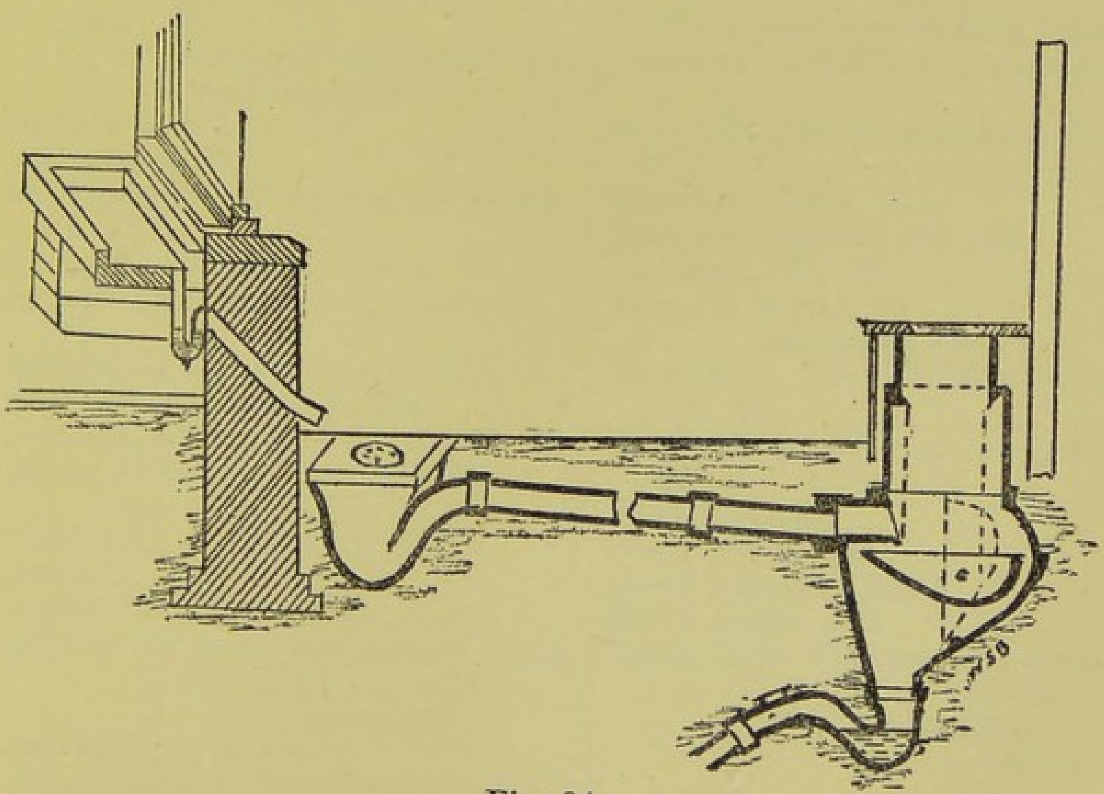


Fig. 94.

by the waste-water of the house. The author has not yet had much experience of the practical working of this closet, but what he has seen of it has impressed him favourably. The chief features of the apparatus are :—(1) the tipper is the receiver for the excreta, and it discharges directly over the syphon-trap; and (2) each section of the connecting shaft between the pedestal and the container for the tipper has an increased diameter from above downwards, an arrangement which lessens the risk of matter adhering to the sides. Many of these closets have been fixed in Wolverhampton.

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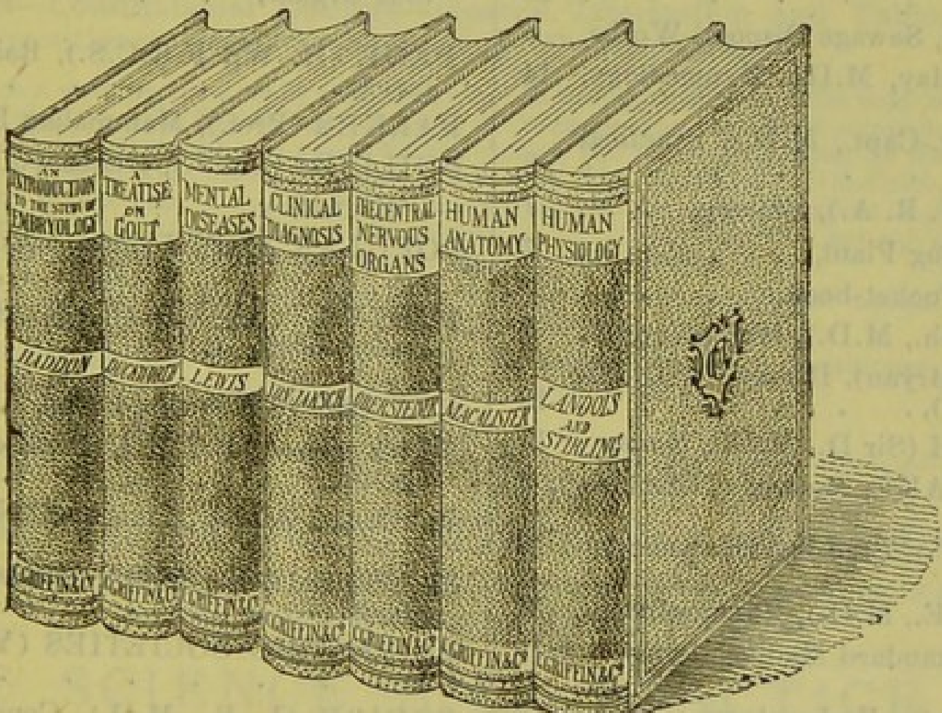

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