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SALUS GENERIS HUMANI.

A HEALTHY HOME.

A

HEALTHY HOME.

ILLUSTRATED.

BY

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PREFACE TO FIRST EDITION.

In the course of recent lectures given at several provincial towns, on the sanitary requirements of a modern dwelling-house and allied topics, I could not fail to notice the keen interest taken by many in all matters relating to the healthiness of the home. The questions put to me after the lecture hour showed sometimes much intelligence and sometimes deficiency in elementary knowledge, but always that a strong desire for further information had been awakened. Yet when asked to refer the inquirers to a convenient handbook, giving the necessary particulars about a healthy house, and how to maintain it healthy, I was unable to do so. My own little book on *Sanitary Defects in Plumbing and Drainage Work* was thought too technical, other works suggested were too large, while the popular manuals on hygiene, though full of useful instruction, did not specially treat of healthy houses.

"Supposing," says an inquirer, "one of us is thinking of building a house for himself, he would want to know a little about bricks and mortar, wood and stone, a little about site, foundation, and construction—where is such information to be got, in perfectly intelligible language?" "Or if," says another, "one were merely moving into a ready-built house, one would wish to be able to judge if it were likely to prove dry and airy, warm and free from nuisance—what little book can I rely on to guide my judgment?" A third suggests that the house he occupies is being overhauled, and asks how he is to post himself up in sanitary matters so as to know that this is being done efficiently, and that the work recommended when carried out will really make the premises healthy.

Of course the answer to questions of this nature is that too much must not be expected from a little superficial reading, and no book, big or little, will make a man an expert.

An amateur cannot train himself to be a competent clerk of the works when building is going on, or to amend a sanitary authority's specification of alterations required. Still it did appear to me that those who had taken the trouble to attend sanitary lectures and voluntarily submitted themselves for examination on the subjects taught, had given proof of their interest in hygiene, and that the request for a brief digest of what I and others had told them was not unreasonable.

Thus the following papers, having the unpretending title, "A Healthy Home," have come to be written. They are intended for all who are concerned to read them—landlords, householders, and lodgers; women as well as men. No previous knowledge of the matters referred to is assumed, the simplest language is used throughout, and no scientific or technical term is employed without explanation.

PREFACE TO SECOND EDITION.

THE demand for a Second Edition of this little book is some indication that it has met a need. In particular, the information given seems to have been appreciated by householders and those about to become householders, and also by young men and women who are commencing the study of elementary hygiene.

The work has been very carefully read through for the press, and such alterations and additions as appeared desirable have been made. It is hoped that the second edition will prove up to date in the matters dealt with, and trustworthy and helpful to those consulting it.

As regards the illustrations, two of those in the first edition have been replaced by others, giving further detail, and fourteen additional illustrations have been inserted. The illustrations now number thirty-seven.

BIRKENHEAD,
March, 1901.

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A HEALTHY HOME.

CHAPTER I.

Introductory.

The health of the individual and family: how shall they be housed wholesomely?—A question for all—Principles and practice—Subdivision of subject.

A late Professor in the University of Edinburgh was in the habit of introducing the subject on which he lectured to his class by saying that the Chair of Clinical Medicine was, as it were, the sun-chair of the faculty, round which all the other chairs might be represented as revolving. Hygiene, regarded as a study or a science, includes many studies and portions of many sciences; but the subject of subjects towards which all that it includes converges is the health of the individual and the family.

What environment shall the individual and family have? or, in other words, how shall they be housed wholesomely? is the constant question presented to the medical officer of health for solution, the sun-question round which most of the inquiries he has to conduct, and the work he has to control, may be said to revolve. Hygiene, in the words of Dr. Parkes, aims at rendering growth more perfect, decay less rapid, life more vigorous, and death more remote. It is surely an object of personal interest to all; and its sun-question—What goes to make the healthy home?—is not for medical officers of health and experts only, but for all.

The principles which should guide one in determining the requirements of a healthy dwelling-house are scarcely in dispute. It is admitted that the house should be built in a thorough workmanlike manner, of sound material, on a clean foundation, that it should be well aired and dry, well lighted and warmed, that it should have a pure water supply, conveniences for bathing, washing and cooking, that efficient sanitary accommodation should be provided, and last, not least, that all drains should be external to the house, and all direct connection therewith should be broken. However, general principles alone are not a sufficient guide, and do not satisfactorily answer the inquiry—What constitutes a healthy home? It is necessary to advance from principles to practice, and practice implies entering into what may appear rather minute particulars, and specifying details as to which there is not the same unanimity of opinion. The best way of giving effect to principles, in this as in other matters, has been taught by experience, and practice varies with the experience; still, practice in most details, as regards the building of a healthy house, is sufficiently in agreement to admit of its being studied with profit by any intelligent man or woman.

It is proposed, therefore, to answer the question—What constitutes a healthy home?—by explaining what would appear to be the approved practice:—

(1) In respect of the selection of site (*a*) the necessity of its being clean, and (*b*) the importance of avoiding, or, efficiently draining, soils in which the ground water is high, the distribution of the disease known as consumption being influenced by the wetness of the ground on which people live.

(2) In respect of the selection and preparation of materials ordinarily used in house-building.

(3) In respect of construction.

(4) In respect of the planning and general arrangement of the house.

(5) In respect of warming, lighting, and ventilation

(6) In respect of hot and cold water service.

(7) In respect of the house drains and so-called sanitary fittings.

(8) In respect of decoration and furniture.

(9) In respect of stables, cow-house, &c.

(10) In respect of keeping the house clean.

It is proposed to devote a chapter to each of these topics, and to conclude with a chapter on the obligations of the householder, and (a matter on which every householder should be well informed) the duties of the local sanitary authority.

CHAPTER II.

SITE. SOIL. ASPECT.

Conditions required as regards site—Temperature: how modified—Ground temperature—Surface soil and subsoil—Constituents of soil—Geological formations and their relations to healthiness—Ground water and moisture—Rainfall: how disposed of—Ground air—"Made land"—Ground air drawn into house—Summary of desiderata as regards site—Diseases connected with ground water—Choice of aspect.

A PRIMARY necessity of the really healthy home is that it shall occupy a healthy site—a site where the air is pure, the surface soil and subsoil clean, and where wholesome water is obtainable. The healthiness of a site will depend upon its nature, position, and environment. It should be fairly dry, within reach of the sun, not unduly exposed to wind and rain, and any defects it may have should be limited to those which art can remedy.

Temperature.—As climate determines the relative suitability of various districts for the support of man, and the most important factor in the determination is the temperature of the air, I propose to consider first what is to be sought for as regards temperature in choosing a site. It is not a high temperature that is desirable, even for the weakly and for convalescents, and certainly not a low temperature, but an equable, limited temperature, with slight yearly and diurnal variations. Other things being equal, the healthy locality is that in which there is no excessive summer heat and no extreme winter cold.

Any mean temperature coming within 40 degrees and 60 degrees Fah. may be considered temperate. A mean of from 47 degrees to 50 degrees Fah. is probably best suited to English people. The mean temperature of a place is lowered nearly 1 degree Fah. for each degree of latitude added. Of course, also, the temperature decreases with the altitude, each 300 feet above the sea level lowering it about 1 degree Fah. Nearness to the sea, as is well known, tempers the air, preventing at least extreme cold. It may further be noticed that a valley is a less satisfactory site than a hill; not merely because it gets less sun and air, but because air cooled through contact with the ground on the hillside flows down the slope, displacing the air in the valley.

The daily temperature of the air does not affect the ground to a greater extent than three or four feet, and though in temperate climates the line of uniform yearly temperature is from 57 to 99 feet below the surface, for practical purposes the temperature at eight feet from the surface may be said to be fixed all the year round. Ordinary earth allows the sun's heat to pass rapidly downwards, and in varying degree chalk and clay and rock are fair conductors of heat. Sand, on the other hand, is a bad conductor, and retains heat. Generally, soils cool more rapidly than they heat. A covering of grass greatly decreases the heat-absorbing power of soils, and makes radiation therefrom more rapid.

Soil, in its large sense, includes all portions of the crust of the earth which can in any way affect health. For convenience it is referred to as surface-soil and subsoil, but there is no defining where the one begins and the other ends. Soil consists of mineral, vegetable, and sometimes animal substances. The vegetable matter may occur as deposits of considerable thickness, as in submerged forests, or the *débris* from the decay of plants may be washed into the soil, and penetrate to great depths. That there is some animal matter in most surface-soils goes without saying, and there are traces of it in all but the oldest rocks. What is most prejudicial to the healthiness of a soil to be used for a building site is the animal and vegetable refuse thrown out in the neighbourhood of habitations, the soakage from which may pollute a considerable thickness of earth.

The mineral matters of which the soil consists are very numerous. The most important are the compounds of silicon, aluminium, calcium, iron, carbon, chlorine, phosphorus, potassium, and sodium.

It has been remarked that, in examining the constituents of the soil round a house, or of a building site, local conditions are of more importance than the geological formations. Still, the geological formation has much to do with the healthiness of a site. According to Dr. Parkes, the following formations are relatively healthy as building sites in the order given :—

(1) Primitive rocks, clay slate, and millstone grit (a hard sandstone used for millstones).

(2) Gravel and loose sands with permeable subsoils.

(3) Sandstones.

(4) Limestones.

(5) Sands with impermeable subsoils.

As regards chalk, it is a healthy soil when pure. If marly, or clayey, it becomes impermeable, and is unhealthy.

Clays, marls, and alluvial soils are, as a rule, unhealthy. They often contain vegetable impurities, and water neither runs off nor through them. Loam sands coated over with a film of vegetable matter, or held together by a vegetable sediment, or charged with water, may make very unhealthy sites.

Limestones vary much in their relative healthiness. The hard "oolite" (composed of small rounded grains, compact or crystalline) is best, and magnesian limestone is worst.

Primitive rocks are liable to become disintegrated, and then should be looked on with suspicion.

Ground Water.—The healthiness or unhealthiness of a soil used, or to be used, as a building site depends largely upon its aëration and moisture and ground water. Water present with air is moisture only. When all the interstices are filled with water, so that, except so far as it is separated by solid portions of soil, there is a continuous sheet of water, ground water is said to be present. The moisture of the soil is derived from rain and ground water, and the amount depends on the supply and the power of the soil to absorb and retain water. Power to absorb water varies much: thus earth will take up from 40 to 60 per cent., and chalk about 15 per cent.

The ground water is at different depths below the surface—it may be two feet, it may be hundreds of feet. This depends on what outflow there is, and on the permeability of the soil, but most of all on the incidence of the rainfall. Rainfalls at a great distance off, and long after date, will affect the level of the ground water. This water is always flowing as the land inclines, and generally toward the river or the sea, but the rate of flow is slow—often only a few feet daily. Some change in level is always taking place.

The rainfall varies in amount and frequency, and rate of fall. Thus, while the average annual rainfall in England is 32 inches in some localities (in the Lake district) it is upwards of 175 inches a year, and in others (in the Eastern Counties) as low as 15 inches a year. Occasionally, in a limited area, as much as 5 inches of rain have fallen in a single hour. The time of year in which the rain falls is also a point of great sanitary importance, and the quality of the soil and its capacity for heat, and the extent and nature of the vegetation covering it. The greatest percolation takes place when the soil is saturated. In summer there is scarcely any percolation, the rainfall being all evaporated or absorbed by vegetation. How the rainwater is disposed of depends much on the nature of the soil. Thus, in this country the evaporation from sand is 17 per cent., percolation through it 83 per cent.; while, with clay and loam, the evaporation is 73 per cent., and percolation 27 per cent. As long as there is water sufficiently near the surface of the soil to keep it moist by attraction, evaporation will continue. But this power of capillary attraction varies much: thus a bed of sand will be quite dry about 12 inches above the point where water is standing in it. Again, the capacity of soils to retain moisture varies greatly. Sandstone rock will hold 8 per cent. of its weight when dry, sand 17 per cent., Oxford clay 30 per cent., and London clay 50 per cent. The importance of the question of ground water and its direct connection with unhealthiness of site are largely due to the level of water in the subsoil regulating the amount of ground air, its quality and humidity. Ground water is not itself necessarily dangerous.

Air finds its way into the interstices of the ground only where water is not, and ground permeated with fairly dry air is the only healthy ground on which to build. Ground air is not stagnant, but always kept in motion by the wind and air pressure and varying temperature. If the ground water be at a permanent level of five feet or less from the surface, the ground air is cold and damp, and the site is unhealthy. If the water level fluctuates considerably it is yet more unhealthy, especially when the fluctuations are rapid. A permanently low water level of about 15 feet may be termed healthy. Where this does not exist it may often be obtained by draining, and when the ground water cannot be maintained permanently at a low level it should be kept at a nearly even level.

It is scarcely necessary to point out that the soil to be used as the site of a house should be clean as well as fairly dry. The ground must not be fouled in any way, as by buried animal or vegetable refuse, or the ground air will be charged with the products of decay or putrefaction, and the freer the movements of the air the more rapid will be the decay. Yet so-called "made land"—land brought up to the required level with the contents of ashpits and midden-steads—has been frequently used as a site for dwelling-houses. It has been stated that such land cleanses itself by a process of slow combustion in from twelve to twenty years, but there is no proof of this, and excellent reason for disbelieving it. As there is nearly always carbonic acid in the ground, its presence in ground air is no proof of a foul site.

The evil effects of a damp or unclean site are increased in the winter, when the air in the house is so much warmer than the air outside. The ground air is drawn into the house, and no foundation provided (even though it be concrete) is sufficiently impermeable to prevent this.

To sum up as regards choice of site, what should be sought for is as follows:—

(1) A locality with an equable temperature, the mean being rather below 50 degrees Fah. than above.

(2) A fairly elevated site sheltered from the north and east, the shelter not being near enough to cause stagnation and humidity of air. The ground immediately round the house should slope from it on all sides.

(3) The site should have a good fall for drainage,

sufficient drainage outlets should be available, and, except in rare instances, the site should be under-drained.

(4) A hard rock site, or a gravelly or sandy soil, porous enough to admit air freely, and a permeable subsoil.

(5) Any ground water should be at least 12 or 15 feet from the surface, and the level should not be subject to considerable or rapid fluctuations.

(6) Whatever the surface soil and subsoil, they should be clean, not fouled with sewage or decomposing refuse. The best sites available being often most pervious, are most easily polluted.

(7) There should be nothing contiguous to cause an effluvium nuisance. The irrigation of land adjoining may make a site less healthy, but this would probably be due to the irrigation being imperfectly carried out. Bringing adjoining land under cultivation often improves the healthiness of a site.

(8) If there be higher ground contiguous, the drainage water from it should be cut off.

Finally, remember that a site in a valley is nearly always damp and cold and unhealthy, and that any shut-in position is bad. Of building on such a site, wrote Lord Bacon: "He that builds a fine house upon an ill site, committeth himself to prison."

The little cut—Fig. 1—which has been borrowed from Galton's "Observations on the Construction of Healthy Dwellings," shows a healthy and unhealthy building site. It may serve to emphasise a portion of what has just been said as to sites and soils.

The diseases which are connected with ground water and moisture are "colds," neuralgia, and rheumatism, as well as phthisis and ague. Deep drainage, lowering the level of the ground water a few feet, has in many instances reduced the disease and mortality in a district enormously, and made an unhealthy area healthy. The drainage of land is effected by means of unglazed earthenware pipes laid at the required depths, broken stone or pebbles being placed on the top to act as strainers and prevent the pipes being choked with earth. They should admit air freely, and not deliver into a house drain, sewer, or cesspool, but into a watercourse.

Aspect, it may be thought, is a matter of no great importance if the house be detached, as in the course of the day most of the rooms will get the sun in turn. Still, houses

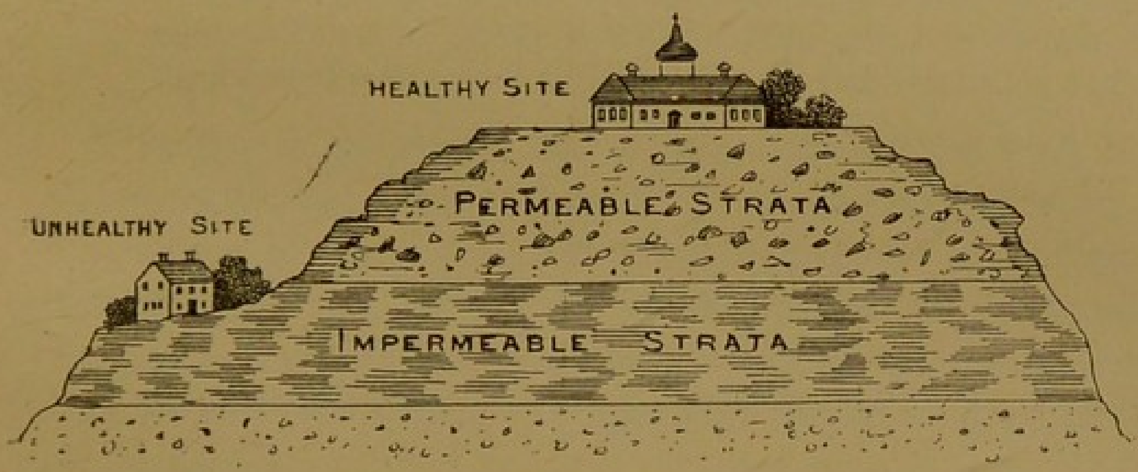

FIG. 1.

facing the south and west are usually preferred to those facing north and east, and, other things being equal, let more readily. It may often happen, too, that there is no choice as to aspect, the house has to face in a given direction ; but then the aspect of each apartment has to be considered. If there be a view at all interesting, the front windows will probably look in that direction, and if the site be on a slope the front of the house will face down the slope.

Planning that the sides of a house face the four points of the compass is to be avoided, as it would make two sides of the house cold and almost sunless. The breakfast-room or morning-room may be conveniently placed on the S.E., the dining-room (which is the breakfast-room in most houses) also S.E. The library is, I think, best placed on the N.E. or N.W. The most suitable outlook for drawing-room and boudoir is probably the S.W., while the kitchen, scullery, larder, &c., should look to the N.E. Bedrooms may look all ways. The night nursery I should prefer to look S.E., and the day nursery S., S.W., or W., perhaps the latter is better. Box rooms, lumber closets, and vacant rooms may be on the N.E. side.

CHAPTER III.

Building Materials.

Brick—The earth used—Preparing the earth—Moulding and drying—Burning: Kilns and clamps—Colour of brick—Facing bricks and cutters—Heavy brick—Light brick—Hollow brick—Ventilating brick—Firebrick—Brickmaking by machinery—Sound bricks—Stone—Sandstone—Limestone—Magnesian limestone—Oolite—"Freestone"—Mortar—Lime—Cement—Tiles—Moulding and drying—Burning—Terra-cotta—Slates—Tests of quality—Wood—Pine and hard woods—Characteristics of good timber—"Sap" and "heart."

It is fully as necessary that a house should be built of sound materials as that it should have a clean healthy site. The nature of the materials to be used is often a question of taste and expediency. As far as possible they should be such as are obtainable in the vicinity, or quite needless expense will be incurred. In any case they should be good of their kind.

Everyone proposing to build or rent a house, and indeed every householder, should have some general information as regards building materials. Certainly he will find a little knowledge of such things useful. It is proposed, therefore, in the present chapter to treat, necessarily very briefly, of the materials ordinarily used for building dwelling-houses in this country, that is to say, brick, stone, mortar, cement, tile, slate, and wood.

Bricks.

The Earths used.—There are three kinds of argillaceous earth ordinarily used for brickmaking. These are pure clays (composed chiefly of alumina and silica, but containing also a little lime, iron, &c.), marls (which are earths containing a considerable proportion of lime), and loams (which are light sandy clays); but it is seldom that earths are suited for use as found. Pure clays require the admixture of sand or loam, &c., while marls and loams need the addition of lime to flux and bind the earth. Even when the brick-clay will work up well as found, the difference in two beds of it in the same field may be so great, it is advisable to mix them to get uniformity in size and colour.

Preparing the earths.—Though the whole process of brickmaking now often occupies but a few weeks from the first turning of the clay, this is not the approved way. The brick-earth should be uncovered and dug and heaped up in the autumn, and left through the winter for the frosts to break it up. This is called weathering. In the spring, the earth is turned over, freed from stones, and tempered by spade labour or in a pugmill, sufficient water being added to make it plastic. A pugmill is a wooden tub having an upright revolving shaft passing through its centre, to which are keyed a number of knives, which by their motion cut and knead the clay, and force it through the mill, whence it issues fit for the moulder's use. When the brick-earth contains bits of limestone or ironstone it requires grinding with iron rollers.

Moulding and drying.—The process of moulding consists in dashing the tempered clay into the mould with enough force to fill it (the mould being a box without top or bottom, placed upon a board), after which the superfluous clay is taken off with a "strike." The mould is made of brass or wood and iron, and wetted or sanded from time to time to prevent the clay adhering. The bricks are then taken to the drying floor, spread out and sprinkled with sand, and when sufficiently hard to handle without injury are built up in low walls—technically "hacked"—where they remain from one week to three weeks, till ready for burning. In some places no drying floor is used, and the bricks are built into hacks at once. The hacks are always protected from sun, wind, rain, and frost, and in some districts drying sheds are used. Superior qualities of bricks are generally "dressed" when half dry, to correct any twisting or warping.

Burning.—Bricks are burnt in kilns and in clamps. A kiln is a chamber in which the just dried bricks are loosely stacked and baked by fires placed either in arched furnaces under the floor, or in fire holes formed in the side walls. Clamps are employed in burning bricks containing fuel. When the clay or marl is very fusible, sifted "breeze"—made from cinders, small coal, and ashes—is incorporated with it, so that each brick contains in itself the fuel required for its vitrification. The bricks are closely stacked that the heat to which they are exposed may be uniform. The cinders at the lower part of the clamp serve only to ignite the lower tiers, from which the heat spreads to the whole.

A main practical difficulty in brick-making is to obtain a sufficient degree of hardness without risking running together. Great care is required in firing as well as in preparing and mixing the clay. When lime and other fluxes are present in the proper proportions, the silica in the clay becomes fused at a moderate heat, enough to cement the mass together.

Colour of bricks.—The red colour of bricks is due to the iron in the clay; but bricks which when burnt in the ordinary way are red, are rendered blue, as in the case of Staffordshire brick, by longer firing at a greater heat. The addition of lime changes the red to cream brown, while magnesia brings it to yellow. Some fine clays burn to a clear white, as that used for Suffolk brick. By employing metallic oxides, &c., ornamental bricks may be made of any colour.

Facing bricks.—Special care is used in preparing the clay and freeing it from stones, and it is nearly always ground between rollers. Sometimes it is left to ripen for a year or more before it is tempered enough for moulding. Facing bricks are also moulded with greater care, and made "true" before burning.

Cutters.—Bricks which will bear cutting and rubbing to any required shape are specially made from fine sandy loams, freed from stones by washing. Ordinary bricks are too tough to cut well.

Heavy brick.—When bricks are required of denser texture, harder and stronger, they are moulded under great pressure. Where great strength is required such bricks are useful, but their smoothness prevents their adhering well to mortar or cement.

Light brick.—Bricks about one-sixth part the weight of common bricks, and so light that they will float in water, are made of an infusible earth called fossil meal, found in Southern Italy and elsewhere. Such bricks are strong and of great use for vaulting, roofs, and similar purposes.

Hollow brick.—Bricks may be made with a hollow in one or both beds to form a key for the mortar. In hand-moulded brick the hollow is only in the under surface.

Ventilating bricks are made with a view to offering facilities for the warming and ventilating of buildings. They are made in various forms. Some of them (as broad as two ordinary bricks) having a bay at each end, as shown in Fig. 2.

Fire-bricks, for use in furnaces and fireplaces, where the heat would destroy ordinary bricks, are made of fire-clays, which are comparatively free from lime, magnesia, metallic oxides, and all substances acting as fluxes. The clays (Stourbridge clay is considered the best) are ground and well kneaded and pressed into moulds by hand. Powdered burnt clay is often mixed with the clay, as much as two parts by weight to one of clay being added. The bricks are dried in stoves and burned at a high temperature in closed kilns. They are made of various shapes and sizes.

Brickmaking by machinery.—Brickmaking is now very largely done by machinery. The machines are of two kinds. In one class a column of well-tempered clay of the

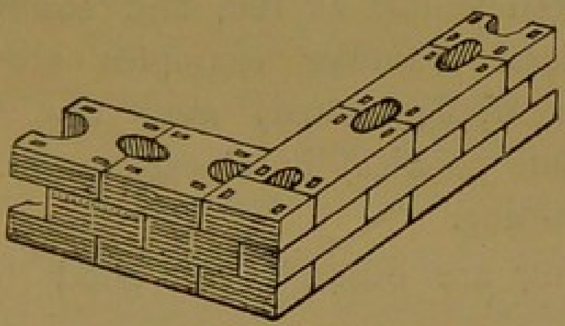

FIG. 2.

required depth and width is divided into bricks by means of wires moved across. In the other class of machines a fairly stiff clay is compressed into moulds, or the clay is dried and reduced to powder, and then pressed into moulds.

Sound bricks should be well burnt, of uniform colour, and when struck together should ring with a clear metallic sound. They should not be warped or twisted, but regular in shape. They should not absorb more than one-fifth part of their bulk of water and part with it readily at ordinary temperatures. They should bear weight well and not crack or scale on exposure to frost. A brick should measure 8¾ inches long, 4¼ inches broad, and 2¾ inches thick—

thus the length exceeds twice the breadth by the thickness of a mortar joint. A brick should weigh from 6¾ pounds to 7 pounds. Bricks are made in a great variety of shapes to suit particular purposes.

Stone.

The stones ordinarily used for house-building will class under the two headings—sandstone and limestone.

Sandstone may be described as consolidated sand, the particles being held together often by lime, clay, and oxide of iron. Owing to their being for the most part stained with iron, they are called by geologists red sandstones, but they are as often yellow as red, and sometimes grey or almost colourless. Familiar examples are the "water-stones" (often ripple-marked) and the "pebble-beds" (containing small pebbles) in Cheshire, which are largely quarried for building.

The following are examples of good building sandstones:—

Craigleith stone is quarried near Edinburgh, whitish grey in colour, and weighs about 146 pounds per cubic foot. It has been extensively used in public buildings in Edinburgh—for example: the College, the Law Courts, Custom House, Register Office, and Royal Exchange. It varies in quality, and the best quality is dear. It consists of fine quartz grains (crystallized silica), with a siliceous cement, is slightly calcareous, and has occasional plates of mica.

Heddon stone is quarried near Newcastle, is light brown ochre in colour, and weighs about 130 pounds per cubic foot. It has been used for nearly all the stone buildings in and about Newcastle. It varies in quality, but the best is cheap. It consists of coarse quartz grains and decomposed felspar, with an argillo-siliceous cement and ferruginous spots.

Bolton's quarry stone is from Aislaby, Yorkshire, in colour warm light brown, and weighs about 127 pounds per cubic foot. It was used for the New University Library at Cambridge, Scarborough Pier, St. Katherine's Docks, &c. The top beds are used for house-building, the bottom beds for docks, &c. The price is about equal to the Heddon stone. It consists of moderately fine siliceous grains, with argillo-siliceous cement, plates of mica, and spots of carbon disseminated.

Abercarne and Newbridge stone is quarried near Newport, Monmouthshire, of dark bluish-grey colour, and weighs about 168 pounds per cubic foot. It has been used for many buildings in the vicinity, and for the new docks at Newport and Cardiff. It costs less than half the price of the best Heddon stone. It consists of quartz and siliceous grains, moderately fine, with argillo-siliceous cement and mica.

Limestone is the name given to all varieties of hard rocks, consisting chiefly of carbonate of lime.

The following are examples of good building limestones:—

Hopton Wood stone is quarried near Wirksworth, Derbyshire, warm light grey in colour, and weighs about 158 pounds per cubic foot. It is used at Chatsworth, Belvoir Castle, Trentham Hall, &c. It is of excellent quality, but dear. It consists of compact carbonate of lime, with fragments of encrinites abundant.

Chilmark stone is quarried near Salisbury, of light greenish-brown colour, and weighs about 153 pounds per cubic foot. It is used in Salisbury Cathedral and Wilton Abbey, and many buildings in the vicinity. It costs about half the price of Hopton Wood stone. It consists of carbonate of lime, with a moderate proportion of silica, and occasional grains of silicate of iron.

Totternhoe stone is quarried near Dunstable, Bedfordshire, greenish-white in colour, and weighs about 116 pounds per cubic foot. It is used in Woburn Abbey, Fonthill House, and many churches in Bedfordshire and Hertfordshire. The price is about the same as Chilmark stone. It consists of calcareous and argillaceous matter in about equal proportions. The structure is fine.

Magnesian limestone is a term indicating any limestone containing 20 per cent. of a salt of magnesia.

The following are examples of good building magnesian limestones :—

Bolsover stone is quarried near Chesterfield, Derbyshire, is light yellowish-brown, and weighs about 152 pounds per cubic foot. It is used iu Southwell Church, and numerous buildings in the vicinity. It is cheaper than any of the limestones referred to, and about the price of the best Heddon sandstone. It consists chiefly of carbonate of lime and carbonate of magnesia, and is semi-crystalline.

The stone from the Huddlestone quarry, near Sherburne, Yorkshire, is whitish-cream coloured, and in composition similar to that obtained from Bolsover. It weighs about 138 pounds per cubic foot. It is used in York Minster, Selby Cathedral, Westminster Hall, &c. It is about double the price of the Bolsover stone.

Oolite.—Limestone made of small rounded grains, compact or crystalline, like the roe of a fish, is called oolite.

The following are examples of good building oolitic stones :—

Portland stone, from various quarries in the Island of Portland, is of a whitish-brown colour, and weighs from

135 pounds to 150 pounds per cubic foot. It is used for St. Paul's Cathedral, Goldsmiths' Hall, and very many public buildings in London. The price varies much according to quality. It consists of oolitic carbonate of lime with fragments of shells.

Ketton stone, quarried near Stamford in Rutlandshire, is dark cream coloured, and weighs about 128 pounds per cubic foot. It is used in the modern work of Peterborough and Ely Cathedral, and many buildings at Cambridge. It is rather a dear stone. It consists of oolitic grains of moderate size, slightly cemented by carbonate of lime.

The term "freestone," so often used by contractors and others, means simply any rock which can be readily cut for the builder. It is more usually applied to sandstone.

Mortar.

Mortar is compounded of 1 part of lime to 2½ or 3 parts of clean sharp sand, or 1 part of lime to 2 of clean sharp sand and 1 part of blacksmith's cinders, ground up, or if sand cannot be obtained, 1 part of lime to 2 of ground cinders. The water used to slake the lime and in making up the mortar should be fresh (salt water injures the adhesive qualities of the mortar). Mortar should be thoroughly well worked up.

Lime.—The purest limestones burn to a white rich lime, which dissolves fully in water, and remains a long time without hardening. It increases from 2 to 3½ times its original bulk. Limes usually contain less than 10 per cent. of impurities. Lime absorbs in slaking about 2½ times its volume of water.

Hydraulic limestones are those which contain iron and clay, so as to enable them to produce cement which becomes solid when under water.

Limes are rendered hydraulic by admixture of pozzolana or trass. Hydraulic mortar is made from hydraulic lime and sand.

Cement.

Portland Cement is made in England and France from an argillo-calcareous deposit, which is burned and ground up for cement in its natural state without the addition of lime.

Strong Portland cement is heavy (weighing 110 pounds to the bushel), of a blue-grey colour, and sets slowly. Weak cement is light, of brownish colour, and sets quickly.

Roman Cement is made from lime of a peculiar character found in England and France, derived from argillo-calcareous kidney-shaped stones termed septaria, and when mixed thick it solidifies in a few minutes, whether in air or water. Roman cement is about one-third the strength of Portland cement.

The less water used in mixing cement the stronger it will be. For most purposes for which cement is used, it is first mixed with from one to four or five times its weight of clean sharp sand. Of course the strength of neat cement is thus diminished.

Tiles.

Tilemaking is very similar to brickmaking. The clay or marl is dug, weathered, tempered, mixed, and ground, being even more carefully prepared than for brick. The clay when ready for moulding is stiffer than in brick-making.

Moulding.—The moulder takes a lump of clay and works it by hand to the rough form of a tile, rather less than the size of the tile wanted. The mould is placed upon the bench and well dusted with fine coal dust, and the tile-shaped lump thrown in with considerable force. The moulder next cuts off the surplus clay level with the mould, using a brass wire strained upon a bow, and finishes the tile, adding a little clay if needed, and smoothing it with a wooden tool. Then he takes a thin board, about the size of the moulded tile, dusts it with coal dust, and turns out the tile. This seems to be the process ordinarily followed in this country, the details varying in different districts. In Holland it is usual for the tile to be rough-moulded larger and thicker than the subsequent size, and nearly dried. Each tile is then placed on a table dusted with sand, and struck two or three times with a rammer of wood larger than the tile, compressing it to the required thickness. A mould with sharp iron edges is then well wetted and pressed upon the tile, cutting it to size.

Drying is in this country usually begun on a drying-floor out of doors, weather permitting. The tiles are then placed close together and walled up in a dry situation. The "set" or curve, if required, is given to tiles (when they are partly dried) on a three-legged stool, called a horse, the top of which is curved. Six tiles are put on the horse, and they are struck several times with a wooden block curved to correspond with the surface of the horse

Burning.—Tiles require much more careful firing than bricks, especially roof tiles, which are the thinnest. The circular oven is found to answer the purpose best. At the bottom are placed 2000 bricks, and on them 7000 tiles, forming a square, the spaces between the tiles and the curved sides of the oven being filled in with bricks. The tiles are placed edgeways, the nibs on the tiles serving to space them off from each other and support them in the vertical position. Outside the oven is a wall about six feet high, to prevent the fires on one side being urged unduly by the set of the wind. There is space for the fireman to work between the wall and oven. The fires are kept slow at first and then progressively increased, and when the required heat is obtained, before the fires burn hollow, the mouths are stopped with ashes, and the oven suffered to cool gradually.

Pantiles, ridge tiles, and hip tiles are moulded with specially-shaped blocks and tile moulds, and the surface smoothed with a roller. The moulder works with very wet hands, and greater skill is required than in moulding ordinary tiles. Paving tiles require to be specially well burnt, like blue bricks. Oven tiles have to be made from specially-prepared clay, so that they may stand oven heat.

Chimney-pots, garden pots, and drain pipes are commonly manufactured at tileries. Glazed stoneware drain pipes and sanitary appliances of the same ware are, however, made in potteries or special factories.

Tiles are made red, brown, grey, and blue, and often glazed on one side. The beautiful encaustic tiles for which Minton's Works are celebrated, are made from clays in the immediate neighbourhood that will burn buff, red, &c., or manganese is added to stain them black, or cobalt to stain them blue, and so on. In any case the clay is refined and some additions made to it, as in preparing clay for porcelain. These tiles are slowly dried and fired, and generally covered with a vitreous glaze.

Paving tiles are often made to the Dutch size, 8½ inches square by 1 inch thick, but they are also made larger and smaller, and some of hexagon shape. Tiles for roofs measure from 14 inches × 10 inches to 10 inches × 6 inches, and from ½ to ¼ of an inch thick.

Terra-cotta is made from clay prepared and mixed with other ingredients, as used for fine facing bricks or tiles. It is pressed into moulds, and fired in an oven. During the firing it is apt to get twisted from unequal shrinkage, and this is difficult to prevent, especially when the pieces are large. It is chiefly used for external ornament.

Slates.

Good roofing slate should be even-grained and hard, free from streaks or flaws, and should give a clear, metallic ring when struck. Slates of inferior quality are coarse in texture, brittle, and prone to scale off, readily absorb moisture, and break away at the edges. To test the quality of a slate, breathe on it enough to moisten it, and smell the surface. If it give off the odour of clay it is of poor quality. A more direct test is to leave a slate for hours half immersed in water: if it remain dry down to the water line it may be generally relied on to resist the action of the weather.

Slates are cut at the quarries to various sizes, usually twice as long as broad. The thickness is from one-sixth to one-eighth of an inch. The different sizes have been oddly named. Thus, slates 24 inches × 12 inches are termed Duchesses; the next size, 22 inches × 12 or 11 inches, are Marchionesses; and the next, 20 inches × 10 inches, are Countesses. The largest sizes are about three feet long, and only exceptionally required. The smallest sizes in ordinary use are 14 inches × 7 inches, and 12 inches × 6 inches.

Slates are used for many purposes besides roofing. They are hung on the outside of a wall or built up inside a wall to render it damp-proof, and they are often used to make a damp-course. Slabs of slate are used for cisterns, baths, larder-shelves, mantel-pieces, &c.

Wood.

There is a great difference in the weight of the various kinds of wood used in house-building, and as the heaviest woods are generally the strongest, this is of importance. Thus ash, beech, and English oak are from 52 to 53 pounds per cubic foot, elm is 42 pounds per cubic foot, plane is 38 pounds per cubic foot, and poplar only 24 pounds per cubic foot. There may even be great difference in the weight of various descriptions of the same wood—thus, common pine is 26 pounds per cubic foot, red pine 40 pounds, and pitch pine 45 pounds.

The timber used in joiners' work and house-building is for the most part pine or fir, and the nearly allied larch. The trees are tall and straight, and the wood fibre is straight, and all but the pitch pine (which contains much resinous matter) are easily worked. The so-called hard woods—oak, ash, beech, teak, elm, walnut, &c.—are less easily wrought and less flexible. They differ from the pine woods in being free from turpentine.

Oak. elm, larch, beech, teak, and plane have the useful property of durability under water.

Oak, larch, teak, plane, walnut, mahogany, chestnut, ash, poplar. and all pine woods are durable in dry places.

Good timber should not be too young, for its density will be in proportion to the time it has had to grow. It should be from the trunk rather than from the limbs, for the lower part of a tree is the strongest.

It should be close-grained and straight-grained, and sound, free from cracks and dead knots, and of the quality contracted for. It should be well seasoned, not too fresh or too recently sawn up, and should be clear of "sap" or "heart." The term "sap" is applied to the newly-formed wood of a tree next the bark, through which the sap flows; and it is for the purpose of getting larger timbers than the tree should yield this newly-formed wood is encroached upon. The timber is by so much the weaker, and when the newly-formed wood decays (as it soon will), the decay may spread to the sound wood. The term "heart" means the centre of a tree, and this also is exceptionally liable to decay. The accompanying diagram (Fig. 3) may make

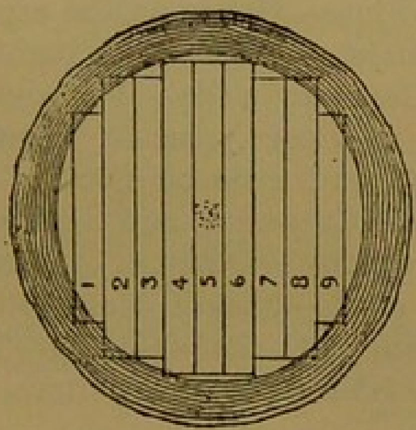

FIG. 3.

this plainer than words. A trunk is shown in section sawn into planks. It will be seen that the boards marked 3, 4, 6, and 7 are sound; those marked 1, 2, 8, and 9 are defective through sap, and the board marked 5 is defective owing to heart. The soundness of beams and floor-joists, as these are the weight carriers, is even more important than the soundness of boards.

A scantling cut 11 or 12 inches wide × 3 inches thick, is called a plank; cut 9 inches wide × 3 inches thick, it is called a deal; cut 4½ inches wide × 3 inches, or from 2 inches to 7 inches wide × 2 inches thick, it is called a batten. Similarly, boards 12 inches wide are planks, 9 inches wide are deals, and 7 inches wide are battens.

CHAPTER IV.

CONSTRUCTION.

Foundations—Exploratory borings—Making a solid Foundation—"Footings"—Concrete in basement—Walls—Damp-course—Hollow basement walls or areas—Damp-proof coating—Brick-setting—Bond—Flues—House wall in exposed places—Regulations as to thickness of walls—Brick backing to stone—Natural bed of stone—Concrete walls—Half timber walls—Floors in basement—Size of floor joists—"Trimmers"—Laying floor boards—Tongued and grooved flooring—Skirting—Construction of staircase—Casement and sash windows—Ventilating boards for sash windows—Amount of window-space required—Construction of doors—Size of doors—Roofing—Inclination of roof—Construction of roof—Slating—Tiling—Metal-covered flats—Flashing—Rain-pipes and gutters—Minimum height of chimneys.

CONSTRUCTION is rather a comprehensive term, but in so far as it relates to the use of building materials a little information may be conveniently given here, preparatory to the discussion of such topics as design and general arrangement.

The subject naturally divides itself, and will be considered under the following headings:—Foundations, walls, floor, stairs, windows, doors, and roofing.

The **Foundations,** it is needless to say, are as important as any part of a house, yet (except in the case of specially heavy buildings) but little attention is given to them, perhaps because they are to be quickly covered up, and defects will not be seen for years.

Rock ordinarily makes a sound foundation, but it is not always possible, without boring, for the builder to be sure that he has got down to solid rock. To test this, when a length is excavated, bore in two or three places three feet deep. What looks like solid rock may be merely a thin shell resting on loose stuff. Again, if the rock is stratified, that is, arranged in layers, and the layers are not horizontal, when the weight of the building comes on it there may be a slide. When the ground is soft, and a solid foundation

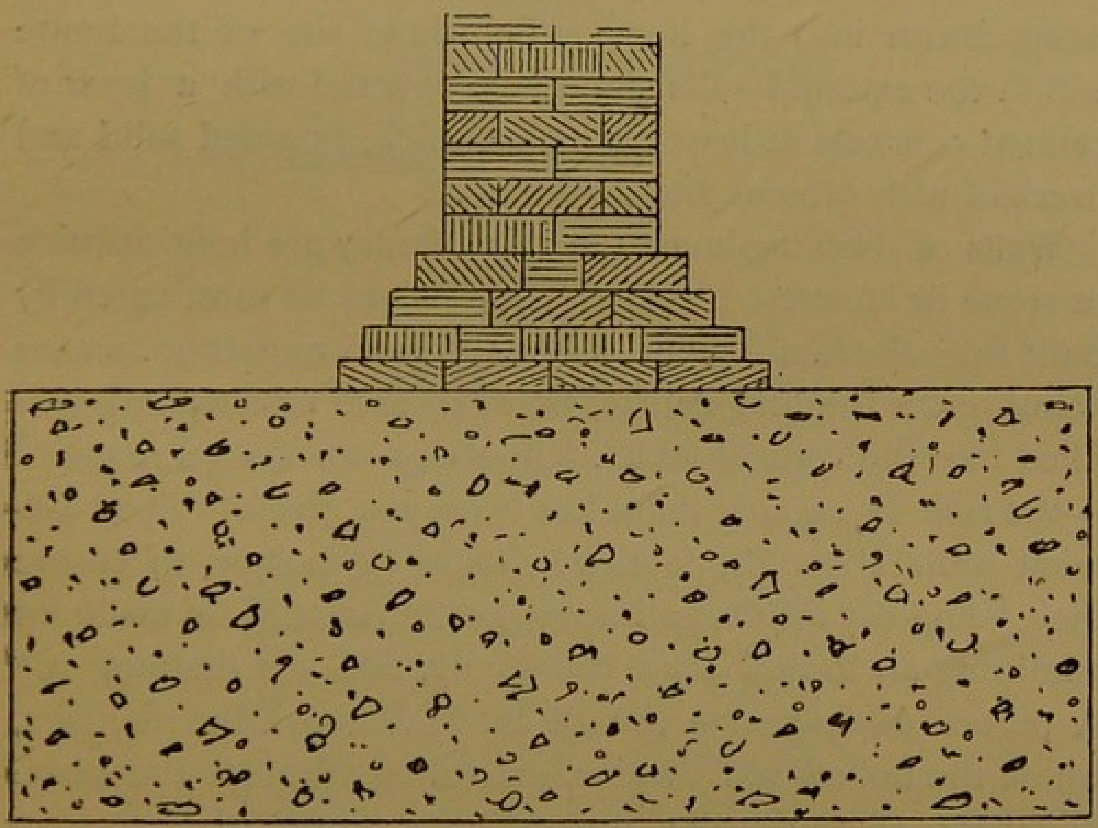

FIG. 4.

cannot be reached, the walls should be made to rest on a broad platform of good concrete or stone, five or six times as broad as the walls. For a heavy building it may be necessary to make this concrete three feet thick. (See Fig. 4.) This shows not only the concrete foundation, but the "footings," that is, the brick base on which the wall rests. The height of the footings should be not less than two-thirds of the thickness of the wall. The lowest course of the footings should project on each side not less than half the thickness of the wall at its base. In any case where footings rest on concrete, it should be at least a foot wider than the widest part of the footings. A foul foundation should not in any case be used for a dwelling-house, as there is no way of entirely getting rid of the danger therefrom. If, however, there is any fear of cold, damp air being drawn into the house, the whole site of the house within the external walls should be covered with a layer of cement concrete at least six inches thick, rammed solid and overlaid with cement and asphalted.

Walls of dwelling-houses in this country are built of brick or stone or concrete blocks. They should be most carefully built from the foundations, a layer of good mortar or cement being under the first course, between each course, and well filled into the vertical joints. Footings are always required —the rule as regards them has been just given. The basement walls above the footings should be hollow, to ensure their being dry inside, and arrangements should be made for admitting air to and from the cavity, and for draining it.* A proper damp-course should be laid above the footings, where the hollow wall begins, extending through the entire thickness of the wall; and another proper damp-course should be laid at a height of not less than 6 inches above the ground adjoining, also extending through the entire thickness of the wall. The first, or lower, damp-course should be beneath the level of the lowest timbers. The hollow or cavity in the wall reaches from damp-course to damp-course. (See Fig. 5.) The damp-course may be of

* In some instances draining and ventilating this cavity may present exceptional difficulties, and security against damp may be best obtained by filling in the cavity with asphalt.

sheet lead, asphalt, or slates laid in cement, or of other durable material impervious to moisture. Another way of preventing damp coming in from the external ground is by making an area round the house, as shown in Fig. 6. In

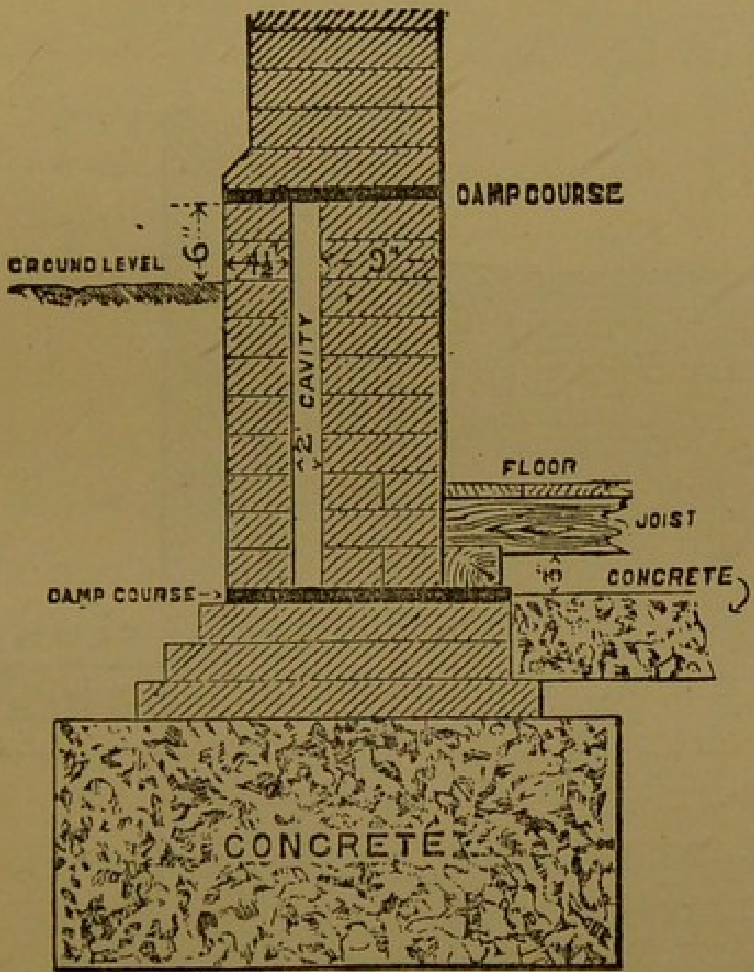

Fig. 5.

this case only one damp-course is required. The area should be covered, ventilated, and provided with a drain.

In dealing with an old house, the walls of which are not hollow, if the owner will not incur the cost of forming an area, the walls next the ground may ordinarily be made impervious to wet by being overlaid with cement, covered with a mixture of pitch and tar. But if there be no damp-course, water will still be admitted from the footings.

Bricks are laid in beds or courses, and bonded together. English bond (which is the strongest) is a course of "stretchers" (each brick showing one side) alternating

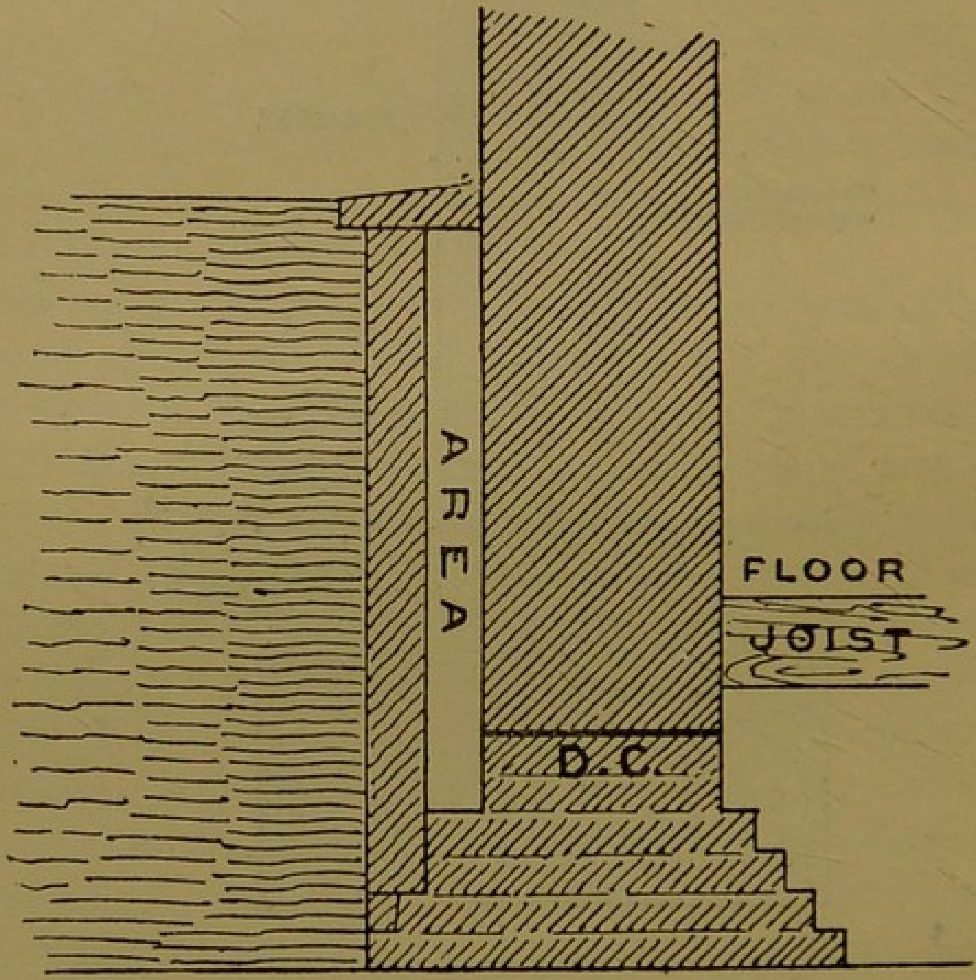

Fig. 6.

with a course of "headers" (each brick showing the end). Flemish bond is a stretcher and header laid alternately in the same course. Fig. 7 shows part of a wall in English bond; Fig. 8 part of a wall in Flemish bond.

The strength of walls is sometimes increased by bonds of hoop iron, but this is not often required in dwelling-houses. If used, they should be tarred to prevent their rusting.

Brickwork should be built of good whole bricks, the half-bricks or quarters required (technically called "closers")

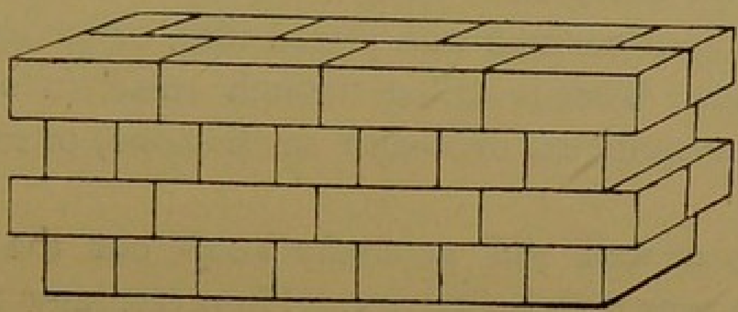

FIG. 7.

being cut to the full size. The mortar-joint in brickwork should not exceed a quarter of an inch in thickness. To throw off the rain, the upper border should be slightly indented, and the lower border even with the bricks.

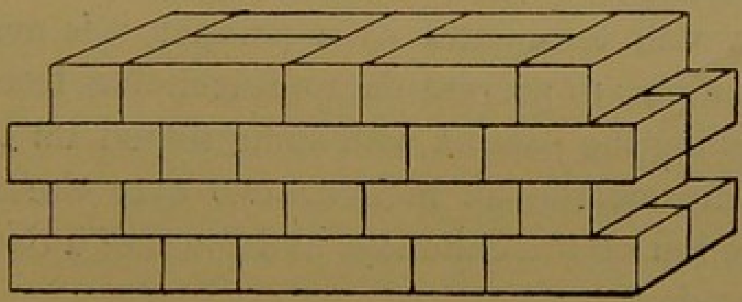

FIG. 8.

In building the walls of a dwelling-house, flues will have to be formed. These are ordinarily made square or oblong in section. Theoretically, a round flue is the best, and may be made by lining a flue with stoneware pipes, the spandril angles being filled in solid. Flues should be built with great care, the surface being well finished and made smooth. No woodwork should cross a flue, or enter into the wall of any part of it. The kitchen flue should be of 9 inch brickwork for 10 feet from the top of the fire-place.

To prevent house walls being damp from rain, they may be slate-hung or covered with glazed tiles, or plastered over with cement. What is called "rough cast" (a surface of good mortar sprinkled over with small stone) often endures well.

Painting a wall will generally keep out the rain, or brushing it over with boiled oil. However, any treatment tending to make the wall of a dwelling-house impervious to air should be avoided if possible. Of course, external walls may be built hollow, not merely just above the footings, but all the way up. Such walls are absolutely damp-proof, and when well tied together with iron or stoneware bonds are quite strong. In exceptionally exposed situations it may be necessary to build up in the wall a vertical damp-course of slate, or pitched cloth or asphalt.

When a wall terminates as a parapet it is necessary to take precautions to prevent damp descending from the top, as by finishing the parapet with stone sloped on the upper surface and projecting an inch or two over the side; also at the junction of the chimneys and the roof a damp-course may be required.

The thickness of the walls of dwelling-houses is regulated according to the size of the building. The minimum thickness required under the "Model Bye-laws" of the Local Government Board is as under:—

"Where the wall does not exceed 25 feet in height its thickness shall be as follows:—

"If the wall does not exceed 35 feet in length, and does not comprise more than two storeys, it shall be 9 inches thick for its whole height.

"If the wall exceeds 35 feet in length, or comprises more than two storeys, it shall be 13½ inches thick below the topmost storey, and 9 inches thick for the rest of its height.

"Where the wall exceeds 25 feet but does not exceed 30 feet in height, it shall be 13½ inches thick below the topmost storey, and 9 inches thick for the rest of its height.

"Where the wall exceeds 30 feet but does not exceed 40 feet in height, its thickness shall be as follows:—

"If the wall does not exceed 35 feet in length, it shall be 13½ inches thick below the topmost storey, and 9 inches thick for the rest of its height.

"If the wall exceeds 35 feet in length, it shall be 18 inches thick for the height of one storey, then 13½ inches thick for the rest of its height below the topmost storey, and 9 inches thick for the rest of its height.

"Where the wall exceeds 40 feet but does not exceed 50 feet in height, its thickness shall be as follows:—

"If the wall does not exceed 35 feet in length, it shall be 18 inches thick for the height of one storey, then 13½ inches thick for the rest of its height below the topmost storey, and 9 inches thick for the rest of its height.

"If the wall exceeds 35 feet but does not exceed 45 feet in length, it shall be 18 inches thick for the height of two storeys, then 13½ inches thick for the rest of its height.

"If the wall exceeds 45 feet in length, it shall be 22 inches thick for the height of one storey, then 18 inches thick for the height of the next storey, and then 13½ inches thick for the rest of its height.

"Where the wall exceeds 50 feet but does not exceed 60 feet in height, its thickness shall be as follows:—

"If the wall does not exceed 45 feet in length, it shall be 18 inches thick for the height of two storeys, and 13½ inches thick for the rest of its height.

"If the wall exceeds 45 feet in length, it shall be 22 inches thick for the height of one storey, then 18 inches thick for the height of the next two storeys, and then 13½ inches thick for the rest of its height.

"If any storey exceeds in height sixteen times the thickness prescribed for its walls, the thickness of each external wall and of each party wall throughout that storey shall be increased to one-sixteenth part of the height of the storey, and the thickness of each external wall and of each party wall below that storey shall be proportionately increased (subject to the provision hereinafter contained respecting distribution in piers).

"Every external wall and every party wall of any storey which exceeds 10 feet in height shall be not less than 13½ inches in thickness.

"Where by any of the foregoing rules relating to the thickness of external walls and party walls of domestic buildings, an increase of thickness is required, in the case of a wall exceeding 60 feet in height and 45 feet in length, or in the case of a storey exceeding in height sixteen times the thickness prescribed for its walls, or in the case of a wall below that storey, the increased thickness may be confined to piers properly distributed, of which the collective widths amount to one-fourth part of the length of the wall. The width of the piers may, nevertheless, be reduced if the projection is proportionately increased, the horizontal sectional area not being diminished; but the projection of any such pier shall in no case exceed one-third of its width."

Walls built of concrete blocks or cut stone laid in regular courses will not ordinarily need to be thicker than brick walls; but walls built of rough stone, not laid in horizontal beds, or of flint or boulders, should be one-third thicker. Flint and boulders are indeed only suited for building very small houses, and the mortar used in constructing such walls requires to be exceptionally good. The combined use

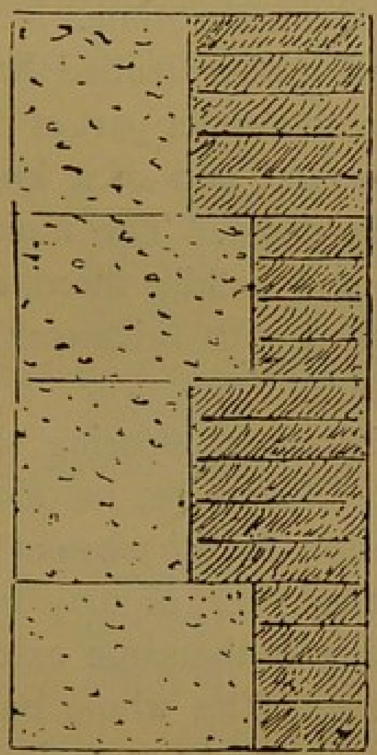

FIG. 9.

of brick and stone is very common. Thus stone dressings are employed in brick buildings, and stone buildings are backed with brickwork. When brickwork is used to back stonework, they should be well bonded together, as shown in Fig. 9.

When stratified stone is used in building it is important that it should be placed on its natural bed, *i.e.*, with the layers nearly horizontal, in the same way in which it was formed. If this is not done the weathering will often cause layers to shell off.

Dwelling-houses are not often built of concrete, but if the material used be good cement concrete, it is well adapted for the purpose. The concrete is put into the wall-frame in layers, and well rammed down. When the concrete is set the frame is removed and re-fixed higher up. Or houses may be built of previously-made concrete blocks, cemented together, like hewn stone.

Walls of brick and timber (called half-timber walls) are usually only used for the upper part of houses. The timber should be well seasoned, and of a kind not liable to be much affected by the damp. The framing should be properly put together and solidly fitted, and the half-timber work should be backed with brickwork at least $4\frac{1}{2}$ inches thick, and bonded to it.

Floors.—In the basement, flooring should be hard and impervious to wet. Concrete, as already stated, makes an excellent foundation for a basement floor. The surface may be flagged or tiled over, or may be made of Portland cement, with a skirting of the same extending 2 or 3 inches up the walls all round. The whole basement floor should have a gentle slope, draining it towards an area.

A suitable floor for lodges and cottages, and houses in which the lowest floor is about the level of the ground, may be made of wood blocks. A foundation of broken rock or clinkers is put in and rammed, and this is covered with asphalt on which are placed the blocks, not less than 3 inches thick, the section forming the tread being across the grain of the wood.

The ground floor of a dwelling-house, when there is a floor below it, is made, like the upper floors, of boards laid on joists. Even when there is no floor below it, a ground floor made in this way is the best, but the space beneath must be thoroughly ventilated by sufficient air bricks or other openings to the external air. It is also necessary that between the under surface of the floor joists and the upper surface of the concrete bed beneath there must be a clear space of at least 3 inches in every part. If such precautions be not taken dry rot will almost certainly attack the flooring.

Beams for supporting floor joists and for other purposes should not be built into the wall, as the ends thus treated

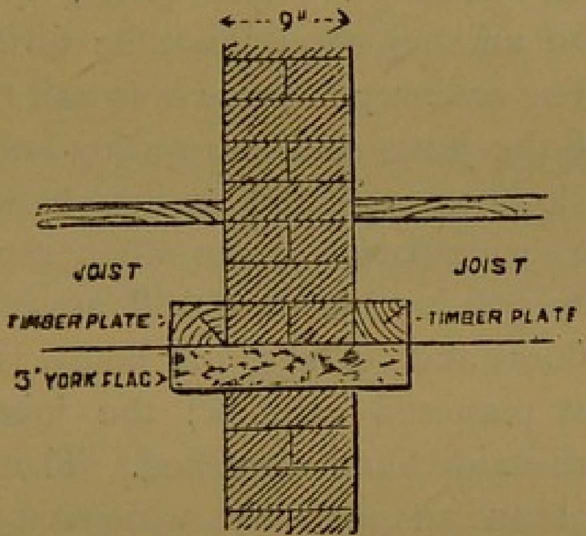

FIG. 10.

are apt to decay. They should rest on stone pads or cast iron boxes or brackets built into the wall. The ends of joists may be conveniently cushioned on a wood plate resting on stone or iron or a brick ledge, as shown in Fig. 10.

Joists are often dealt with as if they were wall ties, which they are not.

The joists, or small beams carrying the floor boarding, vary in depth and thickness with the width between the supports on which they rest. This width is technically called the "bearing." Joists exceeding 7 feet clear bearing, and not exceeding 10 feet clear bearing, should not be less than 6 inches deep by 2 inches thick. Joists exceeding 10 feet, and not exceeding 12 feet clear bearing, should not be less than 6 inches by 2½ inches. Joists exceeding 12 feet, and not exceeding 14½ feet clear bearing, should not be less than 7 inches by 2½ inches. When the supports are further apart than 14½ feet, intermediate supports (termed "girders") of wood or iron not more than 10 feet apart, should be introduced. The strength of the girders must be proportioned to their bearings. The joists, which are fixed parallel to one another, should not be further apart than 12 inches. The ordinary practice is to nail the floor boards to the top of the joists and the ceiling laths to the under side, leaving long unventilated cavities between each joist, in which dust accumulates. Even when separate joists for the ceiling are put in, there are still unventilated cavities between the floors and ceilings. A house is healthier and better without plastered ceilings; the joists and boards being exposed, stained and varnished. That this is necessarily uglier than an ordinary whitewashed ceiling will scarcely be maintained.

To keep the ends of joists at a sufficient distance from flues and fireplaces "trimmers" are used. The position of the trimmer is between the joists on either side the projection for the fireplaces, and about 1½ feet in front. It is mortised to the trimmer joists, and gives support to one end of the joists between them. Trimmers and trimmer joists should be 1 inch thicker than the neighbouring joists. Trimmers are used also at the opening in the floor for the staircase or a trap door.

Floor boards should be planed on both sides and laid as close as possible. As even in seasoned timber there is some shrinkage after the floor is laid, to make a properly tight floor the boards should be tongued and grooved. Sometimes the tongues fitting into the grooves are made of iron, but this is no advantage. The tongue should be nearer the lower edge of the board than the upper, to allow room for the floor to wear down, as shown in Fig. 11. The joints at the end of the boards should also be tongued and grooved, and over one of the joists. Adjoining boards should not end over the same joist. Oak makes the best flooring. When this is too costly deal flooring may be covered with comparatively thin oak boards. Parquetry floors are laid this way in pieces $\frac{1}{2}$ to $\frac{3}{4}$ of an inch thick.

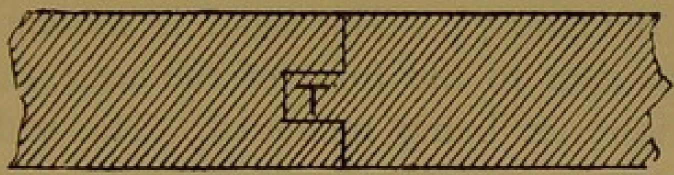

FIG. 11.

The skirting round the floor should not be of wood, but cement or tile. Wood skirting often perishes with dry-rot. When instead of being 8 or 9 inches high it is 3 or 4 feet, it is termed a dado.

Stairs.—Plenty of space should be allowed for the staircase, as the "well" in which it is placed may be regarded as the central ventilator of the house. In dwelling-houses the stairs are ordinarily constructed of wood, but the first flight or first two flights are often of stone.

A wooden staircase is made thus: The "treads" (of boards at least $1\frac{1}{4}$ inch thick) and the "risers" (of boards at least 1 inch thick) are cut to the size required, and united by grooved and tongued joints, and underneath in the angle where they join are glued little wood blocks. These are fixed to the two string boards. The "wall string," about $1\frac{1}{2}$ inches thick, is deeply grooved to receive the ends of the treads and risers, and the "cut string" is cut to receive the ends of the treads, and the risers are mitred to it. If the width of the staircase is greater than 4 feet, between the two string boards is another board cut to carry the steps, and sometimes assisted with little side brackets.

Ordinarily it may be said that from the ground floor to the first floor the tread of each step should be 11 inches, and that the step should rise 6 inches, or that the tread should be 10 inches and the riser $6\frac{5}{8}$. Higher up the tread may be 9 inches and the riser $7\frac{1}{3}$ inches, or the tread $8\frac{1}{2}$ inches and the riser $7\frac{3}{4}$. The tread is measured from the front of one riser to the front of the next, the projection over the riser not being reckoned. The width of tread multiplied by the height of riser should come to about 66 inches.

Balusters supporting the handrail are the better for being quite plain, or they collect dust. The distance between them should not be more than 5 inches. The height of the rail taken from the outer edge of the step should be from 3 feet to $2\frac{3}{4}$ feet—the deeper the stairs the lower the handrail.

Windows are glazed frames of stone, metal, or wood—in dwelling-houses preferably the latter. They may be made, like doors, to open inwards or outwards, but these so-called casement windows are not as satisfactory as sliding sashes. Casement windows need weather-boards at the bottom, and special contrivances to make them tight. The lower two-thirds or three-quarters of a window may be fitted with a casement, and the upper part with a sash hinged at the bottom, or swung just above the middle on pivots, or made to slide down.

The ordinary sash window has two frames sliding up and down in two parallel grooves, the upper sash being external. The sashes are hung on cords, which pass over pulley wheels, and are balanced by weights not quite as heavy as the sashes. The whole frame should be of hard, well-

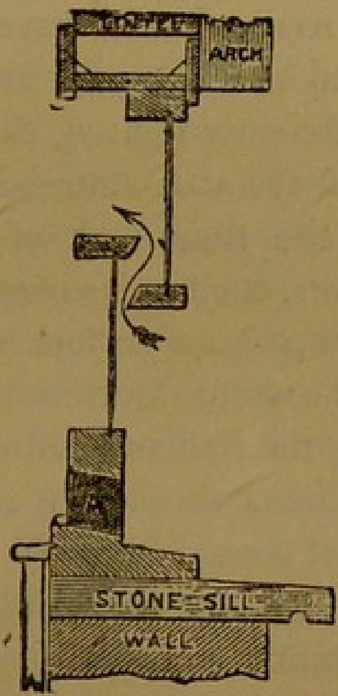

FIG. 12.

seasoned wood. The sill should be of oak, overlap the stone subsill, and be tongued to it. The upper surface of both should slope outwards to throw off the rain. The bottom of the lower sash should slant outwards, and be grooved.

To obtain ventilation without draught a piece of wood extending from side to side of the window, and about 4 inches deep, may be fixed to the oak sill, so that the lower sash may be raised 4inches and admit an upward current of air between the sashes. This plan of ventilation is known as Hinckes Bird's method. Fig. 12, representing a window in section, shows how the piece of wood (A) operates.

A skylight window should be specially tightly fitted, and provided with a channel to carry off the moisture condensing on the glass.

Windows, when practicable, should extend nearly to the top of the room, and it is usually an advantage for them to be $2\frac{1}{2}$ feet from the floor.

Every habitable room should have at least one window opening directly into the external air. In order that the room should be sufficiently lighted, the area of the window or windows, clear of the sash frames, should be equal to at least one tenth of the floor area of the room. Applying this rule, two windows, each measuring 5 feet by 3 feet clear, would just suffice for a room 20 feet by 15 feet.

A window over the front door, swung on pivots, usefully assists in ventilating the hall and staircase.

Doors, like windows, should be made of well-seasoned wood, and every part should be made and ready long before it is needed, so that the risk of shrinking and warping may be reduced to a minimum. House doors are ordinarily framed of two upright pieces (styles) and three horizontal pieces (rails). Sometimes the middle rail is omitted. Midway between the styles is another upright piece (the munting), or more than one. The rails are tenoned into the styles, and the muntings into the rails. The styles, rails, and muntings carry grooves, into which panels are inserted. After putting together, the door is made tight with wedges in each side of the tenons. The centre of the middle rail, lock and handle should be about 3 feet from the floor.

Sitting-room doors should not measure under 3 feet by 7 feet; bed-room doors may be 2 inches less either way. No door in a dwelling-house should be wider than $3\frac{1}{2}$ feet, or narrower than $2\frac{1}{2}$ feet. A door should be so placed that when open the room is screened.

In fixing doors the woodwork of the doorway is usually secured to wood bricks built into the wall, and the joint between the wall plaster and wood covered by a moulding.

When it is desired to provide the means of throwing two rooms into one, sliding doors, hung on wheels, are better than folding doors.

Roofing.—As regards roofs, the desiderata are that the framework shall be strong enough to bear the weight of the covering it is designed to support, together with a reasonable amount of snow, and that the covering material shall be impervious to wet, carry off the rain readily, and be so securely fastened that no part shall be loose or become displaced. It is convenient also, if practicable, to introduce a non-conductor into roofing, making the house cooler in summer and warmer in winter. The roof frame is constructed of wood, rarely iron, and the covering is of slate, tiles, or thin pieces of stone, sheet lead, corrugated iron, &c. If the covering is to be slate, the inclination should not be less than 26 degrees; if tiles or thin stone, the inclination should not be less than 30 degrees. If the roof is to be covered with metal, a very slight slope will suffice.

A wooden roof ordinarily consists of rafters, parallel to one another, fixed at the required inclination to a ridge board, and below to a long wooden piece on either side, as wide apart as the space to be roofed over. The side pieces are tied together to prevent any spreading. If the span exceed 15 feet something stronger is needed, and, in any case, for a well-built dwelling-house nothing less strong than a properly constructed "truss" roof should be provided. A perpendicular placed in the centre of a horizontal beam and two principal rafters supported in the centre by struts to the lower part of the perpendicular should be securely fastened together. To a pair of these so-called trusses, should be fixed a ridge-board and pole-plates to carry the ordinary rafters. If the rafters are longer than 12 feet they should be supported by a cross-piece on either side, parallel with the ridge, and midway between it and the pole-plate. In a "lean-to" roof, which is half an ordinary triangular roof, the rafters may be fastened above to a horizontal wood plate, secured to the wall on iron corbels, and below to the wood plate embedded on the top of the wall. A detached dwelling-house will usually have two triangular roofs, either side by side or at right angles to one another. In a row of houses it is often convenient that the party wall should form the ridge, the roof of each house sloping to a gutter in the centre.

Roofs of dwelling-houses should always be covered with boarding laid at right angles to the rafters. A layer of felt (a good non-conductor of heat and sound) is a great improvement. The slates, if slates be used, should be fastened on with copper, brass or zinc (not iron) nails. Each row of slates should overlap the top of the row next but one below them by 3 inches, and each slate should be laid immediately over the line between the two slates beneath it. (See Fig. 13.)

Slate slabs and rolls are specially made for hips and ridges, and should be screwed down, or hip and ridge tiles may be used, the jointing being done in cement; or hips and ridges may be of lead.

In preparing a roof for tiling, laths are often made to take the place of boards, as they do commonly in slate-roofed cottages. However, a roof thus made is never as satisfactory as a boarded one. Tiles are usually half an inch thick and vary in size. A common size for the flat, or nearly flat, tiles, is 10 inches by 6 inches, or a little larger. Their lower margins are often of an ornamental shape, so as to form a pattern when laid. Pantiles, about 14 inches by $10\frac{1}{2}$ inches, are bent like a long S, and are laid overlapping one another, laterally. Tiles corrugated and variously twisted and shaped are also to be had. Tiles, when perforated for the purpose, are pegged on the wood, but usually they are provided with two little projections

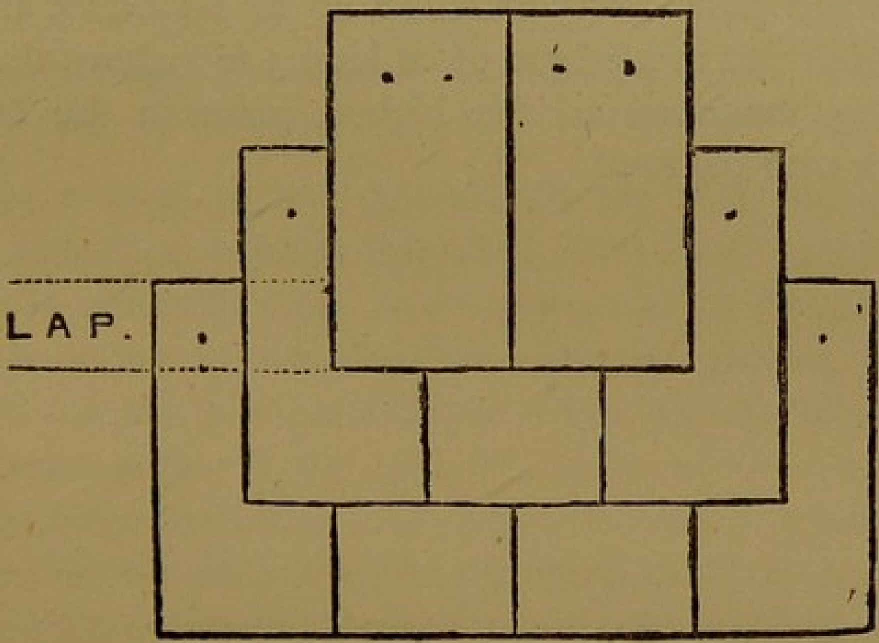

FIG. 13.

called "nibs," for hanging them. The desideratum is to make the tiles so firm and light that rain or snow will not be driven in during a storm.

Stone roofing is exceptionally heavy, difficult to make thi enough for roofing. Zinc weighs from $1\frac{1}{4}$ to $1\frac{1}{2}$ pounds per square foot. Metal is laid in widths, the edges being rolled together or lapping over a wooden roll. Expansion and contraction, the result of varying temperatures, is thus allowed for.

The flashing round the chimneys, or of a parapet or party-wall, should be zinc or lead—preferably the latter—the edge being fastened in the brickwork joints. Cement is not suited for the purpose, as it cracks away from the brickwork.

Rain-gutters and rain-pipes are ordinarily of iron, and the rain-pipes should be designed to stand away about 2 inches from the wall. A coat of zinc will effectually prevent the iron rusting.

Chimney shafts must be carried up in brickwork at least 4½ inches thick to a height of at least 3 feet above the roof adjoining, measured at the highest point in the line of junction with the roof.

CHAPTER V.

Design and General Arrangement.

Architectural Drawings—Plans, Sections, and Elevations—Details, &c., to be shown—Labourers' Cottages—Dwelling-houses for Clerks and Foremen—Minimum Size of Rooms, &c.—Small Villa Residences—Houses Rented at £50 to £125 a Year—Dining-room—Drawing-room—Library—Extra Room—Bedrooms—Nurseries—Kitchen—Scullery—Laundry—Pantry—Larder and Store-room—Linen-room—Cellars.

Having fixed upon a locality for the proposed healthy home, chosen a suitable site, and given some attention to materials ordinarily used in building, and to construction, the next matter for consideration is the design and arrangement of the house. Anyone who contemplates building will have some idea of the size and style of the house he requires before selecting a site, but the house will be all the better for being designed after the site is decided on, so that it may be adapted to the conformation of the land and its environment.

It goes without saying that a capable architect should be consulted. Architectural designing is an art slowly acquired, and proficiency in which is only attained by practice. He who, not being an architect, plans his own house, is likely to have the proverbial success of the man who was his own lawyer and found he had a fool for a client. Still, no one is fit to instruct an architect, or form a useful opinion on an architect's proposals and suggestions, unless he know enough about architectural drawings to be able to study a design for a house intelligently, compare one with another, and judge how far the requirements of health, comfort, and convenience are fulfilled.

How is this most elementary knowledge to be gained? There is, probably, no better way to become familiar with architectural drawings than for a man to measure up the house in which he lives, and draw a plan and section of it to scale. Any intelligent man can measure a room for a carpet, or the walls of it to ascertain the amount of paper-hanging it will require. Measuring a house throughout is almost as simple a matter, and a little practice will enable anyone to sketch a house in miniature from the measurements taken. This little exercise will not lack interest, and the time it occupies will be well spent.

Plans, Sections, and **Elevations** are the names given to certain mechanical drawings which the architect projects, and by means of which he indicates to his clients, builders, and others the form, size, and arrangement of the erection he has designed.

A plan is the representation of the appearance a building would have if cut asunder horizontally—that is, on a plain—or viewed from a point over the centre of the roof.

A section is the representation of the appearance a building would have if cut asunder vertically—that is, from above downwards.

An elevation is the representation of the front or back, or one of the sides of a building.

Plans, sections, and elevations are not drawn to represent objects as they appear to the eye, the portions near the eye being larger than those remote from it; but the drawings show every object in the flat—that is, put in to one scale.

It will thus be seen that to show a house completely there will ordinarily be required several plans (one for the basement, one for each floor, and one for the roof), at least two sections (one from front to back, and one from side to side), and for a detached house four elevations. As regards size, if the drawings are for use in a lecture-room, or f the amateur is drawing for exercise, one inch to a foot is a convenient scale to work to; for ordinary purposes, or for deposit at the local surveyor's office, a scale of one-eighth of an inch to a foot is commonly large enough. When a

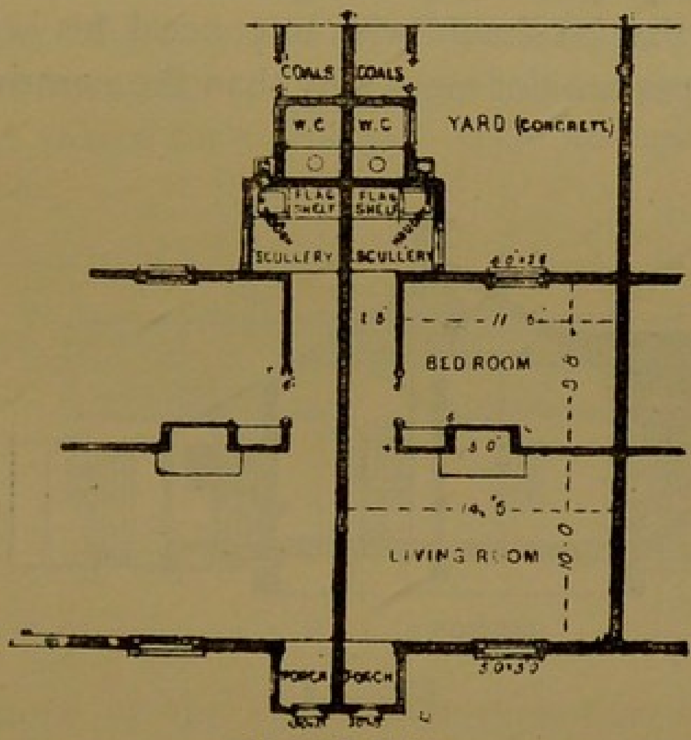

FIG. 14.

design is accepted, and it is decided to build, working drawings are prepared showing every detail; but even the plans, &c., submitted for approval should show everything in the way of fittings, as water-service, cisterns, waste-pipes, soil-pipes, drains, ventilators, &c., the position of which is of first importance.

The great art in planning a dwelling-house, large or small, is to utilise to the full the entire space, affording the tenant all the accommodation, convenience, and comfort attainable. There should be no *cul de sac* in which the air stagnates, no dark corners giving lodgment to dirt. Fresh air and light should have access to every part. No pains should be spared in attention to what appear to be trifling details. As far as possible, everything about a house —beams and girders, gas and water pipes, ventilators, &c.— should be displayed. The designer is not ashamed of his construction that he should wish to conceal his beams; gas and water pipes are not more ugly than the contrivances for

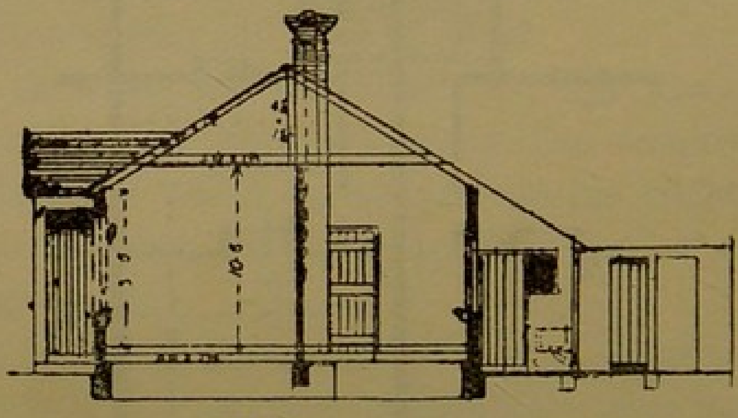

FIG. 15

covering them; and a ventilator hidden behind a cornice is less likely to be kept in good order than if it were exposed.

Labourers' Cottages.—The smallest description of dwelling-house is one suited to the requirements of a single working-man or woman, or a married couple without children or lodgers. Figs. 14, 15, and 16 show the plan, section, and elevation of a pair out of twelve such cottages erected at the Coombe, Dublin, for the Dublin Artisans' Dwellings Company. The accommodation provided is a living-room $14\frac{1}{2}$ feet by 10 feet, and a bedroom two-thirds this size, a scullery and a passage leading to it, a w.c. and a coal bin, a yard in rear 130 square feet clear, and a neat little porch giving access to the living-room. The height of the two rooms is 10 feet. It may be remarked that the bedroom is barely large enough for two adults, but the available air space may be increased by leaving the room door open. Close to these dwellings are sixteen others somewhat larger, adapted to the requirements of a man and wife with a single lodger. The accommodation provided is a living-room, $17\frac{1}{3}$ feet by $12\frac{1}{2}$feet., and two bedrooms above it. The living-room is so large as to suggest that a part of it might have been spared for a scullery. The necessity of putting

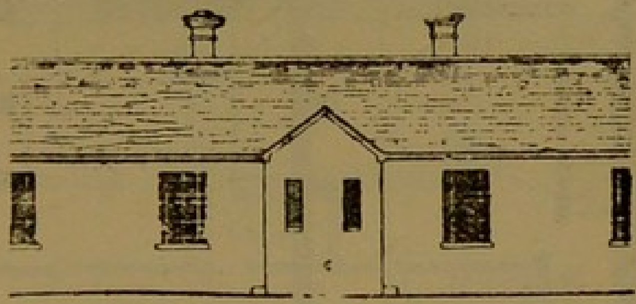

FIG. 16

the sink-stone in the yard would then have been avoided The w.c. is at the further end of the yard. The cost of the two roomed houses, exclusive of site, was £75 each; the cost of the three roomed houses, exclusive of site, was £110 each. These little houses are not furnished with ash-pits—the ashes of each are put into a bucket and collected daily

Dwelling-houses for Clerks and Foremen.—As an exampl of a fairly satisfactory dwelling-house suited to a clerk or foreman earning good wages, the plan, section, and elevation are shown (Figs. 17, 18, and 19) of one of a number of houses erected in Goldschmidt-street, Manchester, for the Oddfellows' Co-operative Building and Investment Company. The accommodation provided consists, as will be seen, of a parlour 12 feet by 12 feet, a basement washhouse of the same size, a kitchen 13 feet by 12½ feet, two bedrooms on the floor above, and a bedroom and attic boxroom on the top story. There is a passage 3½ feet wide leading to the kitchen and stairs; a scullery, water-closet, and ashpit, and

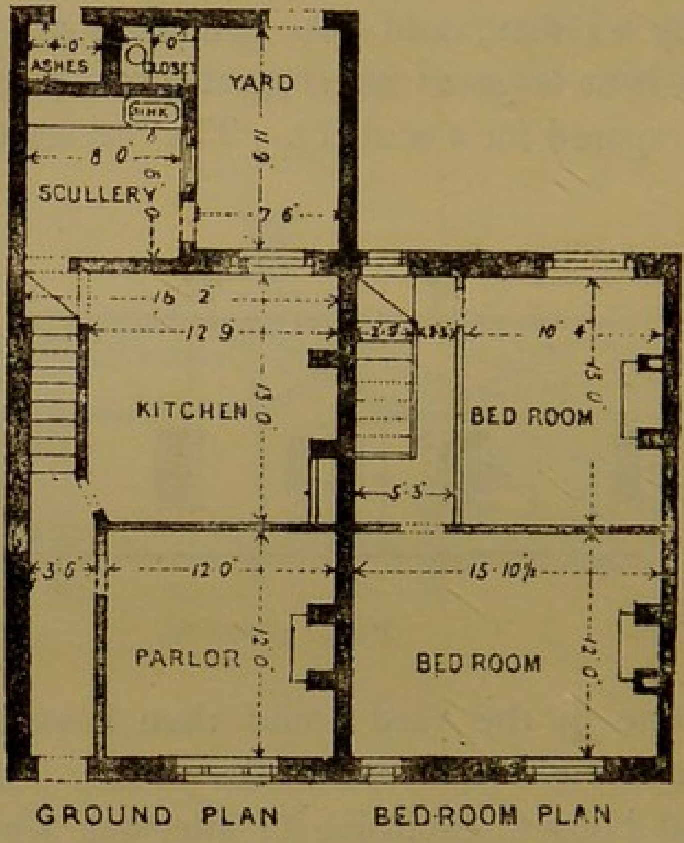

FIG. 17.

a yard 84 square feet clear. Each of the six rooms has a fireplace. The rooms on the parlour floor and next floor have a clear height of 9½ feet. The only defect worth mentioning is the deficiency of yard space. The cost of these houses was £260 each.

In the country, labourers' cottages are ordinarily semi-detached instead of being in rows. Such cottages cost very little more, and space is thus given for a good-sized garden plot—a matter of some importance. The minimum accommodation should be a kitchen which is the living-room; a back kitchen, fitted with boiler and sink, and serving as washhouse and scullery; and above, two or three bedrooms. In the rear should be a wood store and (a little removed from the house) an earth closet.

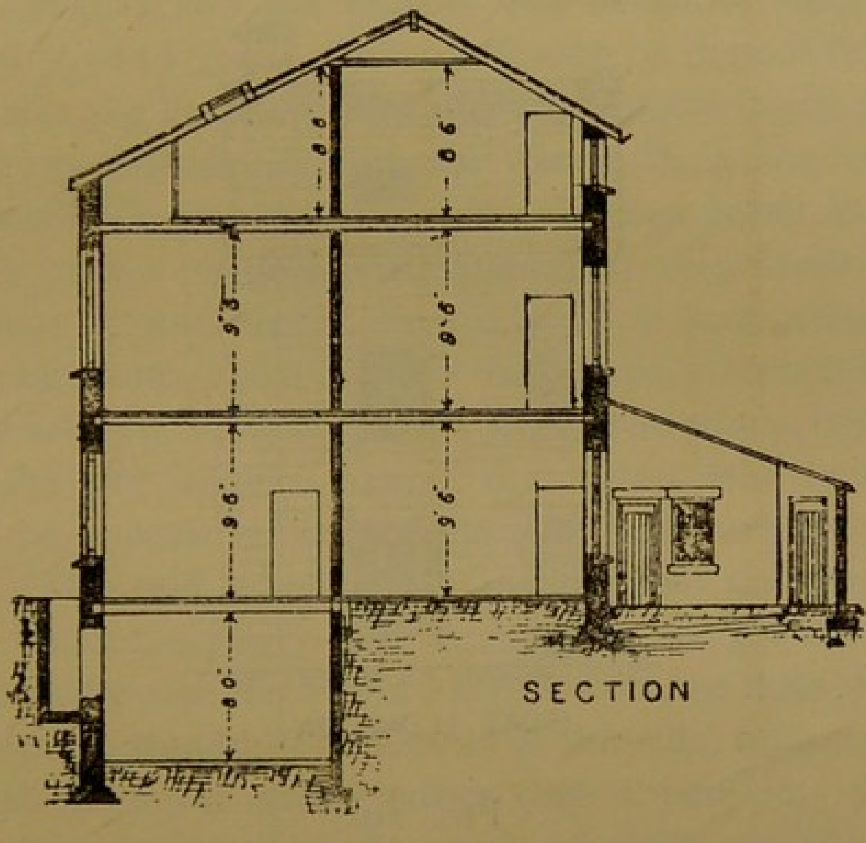

FIG. 18.

As regards size of rooms, it may be laid down as a rule that no habitable room should be of less height than 8 feet, or have less floor space than 64 square feet. Certainly in no case should a habitable room contain less than 500 cubic feet air-space, or a double-bedded room less than 1000 cubic feet of air-space. In planning rooms, the most convenient proportion, ordinarily, is that the width and length should be in the proportion of 3 to 4. A staircase even in the smallest cottage, should not be less than 2 feet wide. As a general rule, it may be said that chimney-flues should be carried up inside walls in preference to outside walls, and that they draw better when two are placed together. The front door should not open directly into the living-room. A lobby, or passage, should interpose. The staircase

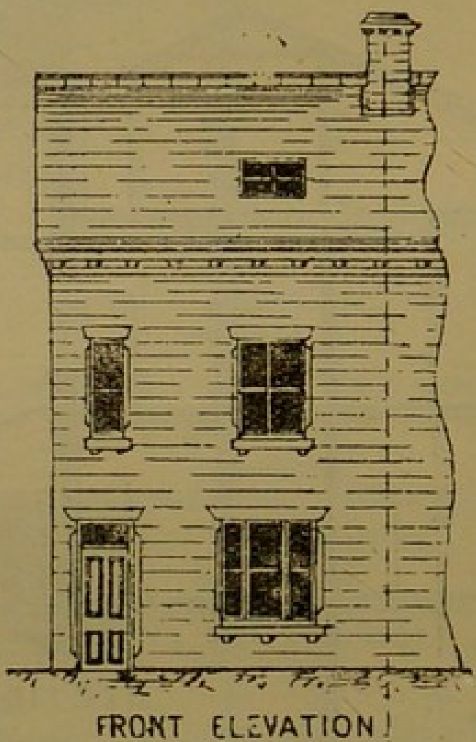

FIG. 19.

should not ascend from the living-room, but from the lobby or passage. The window-space in the smallest cottage should be not less than equal to one-tenth of the floor-space.

The design and arrangement of houses for labourers, artisans, foremen, and clerks are comparatively quite simple matters. It is in the planning of houses which do not come within this description that more scope is given for the exercise of architectural skill and judgment—homes of every shape and size, from the semi-detached suburban villa, letting at from £30 to £40 a year, to the residence of the "comfortably off" family, bearing a rental of from £120 to £130. Houses much larger than this, town or country mansions, where regular departments for servants have to be provided, it is not proposed to discuss in these papers.

Small Villa Residences.—It may be said that the most gifted designer will not plan a very desirable villa for a rental of £30 to £40. Still, much may be done if the aim be to make the house healthy and comfortable inside rather than showy outside, and if not too much in the way of accommodation be attempted. It is always better to provide six rooms of fair size than eight very small ones. What may be, and should be, provided in such a house is two sitting-rooms, three ordinary bedrooms, a servant's bedroom, a kitchen, scullery, pantry, larder, bath-room, and w.c. When the site is large enough it is better that the house should be a little wider and deeper, and have only one storey. This will admit of having the two sitting-rooms, pantry, kitchen, scullery, and larder all on the ground floor, and the bedrooms, bath-room, and w.c. on the floor above. The entrance should be ordinarily at the side, thus opening on a hall (however small) rather than a passage. Where there is room, a vestibule or porch of some sort is a great improvement. Such a house almost arranges itself. One enters a fairly wide hall, and right and left are drawing-room and dining-room. Beyond the dining-room, against the pantry wall, is a passage leading to the pantry, kitchen, scullery, and larder. There is space for a good staircase, which may be lighted from above, and for three good bedrooms. The servant's room may be over the kitchen, and a box-room may be provided in the attic. The place for the bath-room and w.c. is over the scullery, where it can be easily cut off from the rest of the house.

If the villa were detached, instead of semi-detached, the two sitting-rooms would not be placed one behind the other, but both in front, and the kitchen and offices behind them.

Houses letting at £50 a year and upwards.—Having referred as fully as is necessary to the planning of the humbler class of houses, it is proposed now, instead of showing representative plans of town and country houses letting at about £50, £75, £100, and £125 a year, which would make rather a long chapter, to remark briefly on the different rooms and the requirements as regards each. The rooms and offices needed by a family keeping four or five servants are essentially similar to the rooms and offices needed by a family keeping two servants. One family requires larger rooms than the other, and perhaps a few more.

Dining-room.—This room should be regular in shape and about one-third longer than its width. The minimum size is easily calculated. A dining-table is seldom, if ever, made smaller than 3½ feet by 3½ feet, and when the two leaves are put into this table it will measure 7 feet by 3½ feet. In use it will be surrounded by chairs, and the depth of a dining-room chair from front to back is 1¾ feet. The table and chairs will therefore measure 10½ feet by 7 feet. The narrowest gangway necessary for serving is 2½ feet wide all round; thus a dining-room should not be less than 15½ feet by 12 feet. The sideboard, unless there be an embayment for it, will project into the room not less than 2 feet; and the fireplace, fender, &c., will project into the room not less than 2 feet. If the sideboard be at one end and the fireplace at the other, this would give 19½ feet by 12 feet—not a well-proportioned room. If the fireplace be at the side, the space needed would be 17½ feet by 14 feet; but as a little extra space should be allowed for serving just in front of the sideboard, the minimum may be reasonably set down at 18½ feet by 14 feet. The window may be at the end opposite the sideboard, or at the end opposite the fireplace. A dining-room is better lighted from the side than from the end, but much might depend on the aspect. If the aspect of the end window would be S.E., and the aspect of the side window N.E., then it would be better to light the room from the end. The entrance may be at the side or end, but it is desirable that it should be near the sideboard. The gas or electric lighting of such a room may consist of four sconce lights affixed to the sides or ends.

Drawing-room.—There is no occasion for this room to be regular in shape; indeed, some irregularity of form often improves a drawing-room. Thus it may be L-shaped (being composed of two rooms joined at right angles), or it may have a deep bay at the end or middle of one side. As regards dimensions, these should be governed by the size of the dining-room; that is, as a general rule, the drawing-room should be rather larger than the dining-room. The minimum dining-room, just referred to, contains 259 square feet; the floor space of the drawing-room in the same house should therefore be a little in excess of this. Thus the dimensions might be 22 feet by 12 feet, giving 264 square feet. Indeed, a long room like this, with three handsome windows along one side, looking out S. or W., and properly screened by sun blinds or otherwise, would make a pleasant country drawing-room. In a town house the room might more nearly approach the shape of the dining-room. Any shape is allowable except a square. If the room be L-shaped it is usual to treat it as two rooms, and provide two doors and two fireplaces. Ordinarily, except the drawing-room be very large, one fireplace is sufficient. Fifty per cent. more sconce lights would be required for a drawing-room than for a dining-room of the same size.

Library.—A square or nearly square room is often well adapted for a library. As it is of all things necessary that it should be dry, and one does not want a hot room to read and write in, the window may look to the north-east. It may be at the side or back of the house (out of the way of noise), and its size should not in any case be less than about 14 feet by 14 feet. The door may be opposite the window. On one side will be the fireplace, with fittings for books on either side of the chimney projection, and on the side opposite this the bookcases.

Extra room.—A fourth sitting-room, whether under the name of morning-room, boudoir, sewing-room, or business-room, is a great convenience. Its size, position in the house, and aspect, will, of course, depend upon the use to which it is proposed to put it. Ordinarily it will not be assigned a prominent position in the house.

Bedrooms may be of all shapes and sizes. The proportions of the principal bedrooms should be, as in the dining-room, the length one-third more than the width. In planning a bedroom the position of the bed or beds should be considered. A bed should not be put in a corner, but with the head against a wall or a little removed from the wall. The window or windows should be at right angles to the bed-head. The door should generally be on the side opposite the window, and so arranged that it will screen the bed when partly open. The best position for the fireplace is usually in the side opposite the bed. Of course, the bed must be quite clear of draughts from doors or windows. At least one bedroom in a house should be accommodated with a dressing-room leading from the landing to the bedroom, such bedroom having also a separate entrance. Finally, it is very desirable to have one bedroom in a remote part of the house cut off by a lobby, so that it may be used—should occasion require—for isolating an infectious patient. In a large house two rooms, with a separate w.c., might be thus cut off.

Servants' bedrooms are very often defective, even in houses having plenty of spare room. The attic appropriated to the use of two or three servants has rarely enough air-space, commonly no fireplace or efficient ventilation, and, being just under the roof, is unduly hot in summer and cold in winter. Servants may reasonably expect that at least one properly constructed bedroom at the back of the house should be given to them.

Nurseries.—Both day and night nurseries will be required in most houses. The day nursery should be bright and cheerful, having preferably a S. or W. aspect. The windows should be fitted with sun-blinds. The night nursery may look S.E., and catch the morning sun. The fireplaces should be fitted with guards the children cannot displace, and each nursery doorway should have a gate with a spring catch.

Kitchen.—It has been frequently stated that the best place for the kitchen is in the top storey. This arrangement is, however, rarely practicable. The best position is on the N.E. side of the house, not far from the dining-room. A ready escape for all cooking smells must be provided, as by carrying the windows up to the ceiling and making louvred ventilators at the top. A kitchen should not be much smaller than about 18ft. by 16ft. There is no objection to its being square. The floor may be of tiles laid on concrete, the walls of glazed brick; or the surface of the floor and the walls may be made with hard cement. The cement wall should have a rather high painted dado. Inlets for fresh air should be provided just above the floor. Generally the position of the range should be at right angles to the window. It is sometimes a convenience to shorten the distance to the dining-room by means of a serving-hatch.

Scullery.—This room is mainly used for washing plates and dishes and cooking utensils, cleaning fish, trimming vegetables, &c.; it must therefore be next the kitchen. Floor and walls should be impervious. It should be especially well ventilated and lighted. The sink should be placed under the window, with draining-board at its side.

Laundry.—A good laundry should consist of a receiving-room, washhouse, drying closet, and ironing-room. The receiving-room need not be large, but should have space sufficient for sorting the clothes. The washhouse should be most carefully ventilated, giving free escape to the steam and hot air at the top. The floor should slope to a channel leading to a gully outside; and floor and walls should be impervious and washable. The fittings and furniture will consist of a boiler, washing tubs or trough on a stand water service, standing boards, and a wringing-machine. The drying closet is a specially-made oven fitted with "horses" moving in and out on runners. The ironing-room should be exceptionally well lighted, and may have a wooden floor. It will contain an ironing table, a mangle, and a small stove.

Ordinarily a washhouse only is sufficient for a private house; but fitting up a boiler in the scullery is not a suitable arrangement, except for the cottage of a labourer or artisan.

Pantry.—This room, where the silver and glass are cleaned and put away, should be on the ground floor near the dining-room. It will require a sink, which must be under a window, and water service, and the necessary shelves and cupboard.

Larder and Store-room.—The great desideratum as regards the larder (where meat and cooked food are kept) and the store-room (where groceries are kept) is that both rooms should be cool, dry, and well ventilated. They should have a N. aspect. The store-room should have wooden shelves and a small table. The floors and walls of the larder should be impervious and washable. The cement-covered ceiling should be provided with hooks. The shelves should be of slab slate. The upper parts of the window frame should be fitted with perforated zinc or wire gauze, and air should be admitted to the other side of the larder, near the floor, to ensure a through draught.

Linen-room.—A room for storing the household linen, blankets, &c., is a great convenience. If space cannot be found for it, a fair-sized closet must be provided instead. It may be placed on the bath-room floor, and artificially heated by hot-water pipes. It should have a cupboard and shelves and a sorting table.

Cellars should ordinarily be under the whole house, except the kitchen and scullery. They should be thoroughly ventilated, and have concrete floors with a smooth top of cement, tiles, or flags. A small well-lighted cellar may be fitted for cleaning knives and boots and brushing clothes.

CHAPTER VI.

WARMING, LIGHTING, AND VENTILATION.

Temperature required Indoors—Heat obtained by Combustion—The Open Grate, the Close Stove, and the Gas Stove—Radiation, Convection, and Conduction—Grate to have supply of external Air—Flue and Draught—How to prevent Down-draught—Defects of the Open Grate—Utilising the Back Heat—Galton's Grate—The "Low-pressure" and "High-pressure" Systems of Heating by Hot Water—Steam—Lighting—Relative Cost of Illuminants—Electric Lighting—Incandescent Electric Lamp—Hydrocarbons—Gas—The Meter—Water in Pipes—Gas-leaking—Argand, Bat-wing, and Fish-tail Burners—Governors for regulating Pressure—Treatment of Dry Air—The "Globe" Light—Gas-light fed by external Air—Ventilation—Impurities in Air from Respiration, &c.—Amount of Fresh Air Required—Minimum Air-space to be allowed an Adult—Forces effecting Natural Ventilation—Sherringham Valves and Tobin's Tubes—Air admitted may need Filtering—Outlets—Dr. Arnott's Valves—MacKinnel's Ventilators—Ventilation of Hall and Staircase-well.

THE topics to be discussed in this chapter have an obviously important influence on the healthiness and comfort of any house, large or small. It will be convenient, first to consider warming, then lighting, and finally ventilation. But all these are so intimately connected that, practically, they form one subject.

Warming.—Dwelling-houses in this country all need some artificial means of warming them. The amount of warmth healthy adults, properly clothed and fed, require indoors depends on the individual and the temperature of the external air. A temperature of from 50 deg. to 60 deg. Fah.

is ordinarily felt as comfortable. However, very young children and old persons need a temperature of from 65 deg. to 75 deg. Fah.

Heat for warming houses is always obtained by means of combustion—that is, the union of what will burn with the oxygen of the air. What is required, therefore, is sufficient fuel, sufficient air, and a suitable appartus in which to effect the union of the combustible with oxygen. There are three kinds of suitable apparatus in ordinary use—the open grate, the close stove, and the gas stove. The grate or stove as usually fitted up is designed to heat the room or hall in which it is placed; but parts of the house remote from the combustion apparatus may be heated by pipes conveying hot air or in which circulates hot water or steam.

Heat is communicated by radiation, convection, and conduction. The latter is so slow a process it may almost be disregarded. Communication by radiation means that the rays of heat strike objects impeding their progress, and these objects, according to their properties, absorb more or less heat, which is afterwards communicated to the air around them. Communication by convection means that the air next the hot fuel and hot apparatus, becoming heated, diffuses and ascends, giving place to other air to be heated and diffuse and ascend in turn.

The open grate warms chiefly by radiation; close stoves and hot pipes warm mainly by convection. Radiant heat makes the walls and furniture warm, and leaves the air relatively cool. Close stoves and hot pipes warm the air and leave the walls and furniture relatively cool. Radiant heat has been generally held to be healthiest and best suited for warming occupied rooms, as it directly warms room and occupier; but the room is better warmed if also partially heated by convection.

The amount of heat given off during combustion depends largely on the quantity of oxygen combining with the combustible in the fuel, and, as air expands with heating, cold air will bring to the fire more oxygen than a similar amount of heated air. It follows, therefore, that it is better to feed the fire with a current of fresh cold air from outside the house than from the partly-warmed less pure air in the room.

As in the process of combustion oxygen is taken from the air and carbonic acid and noxious vapours are added to it, the air fed to the fire, having done its work, must be carried off rapidly by means of a good flue. In practice it is often found useful to have the throat of the flue somewhat contracted, to ensure more complete combustion. But even when the combustion is nearly complete, and little or no smoke is observed, a good flue and good draught up it are still necessary. The draught is the result of the difference of the temperature inside the flue and the external temperature, and this is often enough to cause a movement of air equal to 10 feet per second, which in a flue 14 inches wide and 9 inches deep would mean the abstraction of 31,500 cubic feet of air from the room hourly.

Care should be taken that flues are not so planned that one when drawing causes a down-draught in another. However, this is not likely to happen if the chimney-shafts are carried up to an equal height, and higher than any adjoining building; and, if each fire is provided with a sufficient and independent air supply, wire gauze fastened over the top of the chimney, or some form of cowl, may check the down draught.

Long experience in this country has certainly shown that the pleasantest way of warming a room is by the open grate. Its irremediable defect is that radiant heat is so weak at a distance. The effect produced lessens as the square of the distance. Thus, whatever the effect is a foot from the fire, at 4 feet it will be sixteen times less, and at 8 feet it will be sixty-four times less. An open grate is not therefore, sufficient of itself to warm a large room. Another defect is that the open grate does not sufficiently utilise the heat generated. The amount of heat utilised is about 42 per cent., the amount carried up the chimney is about

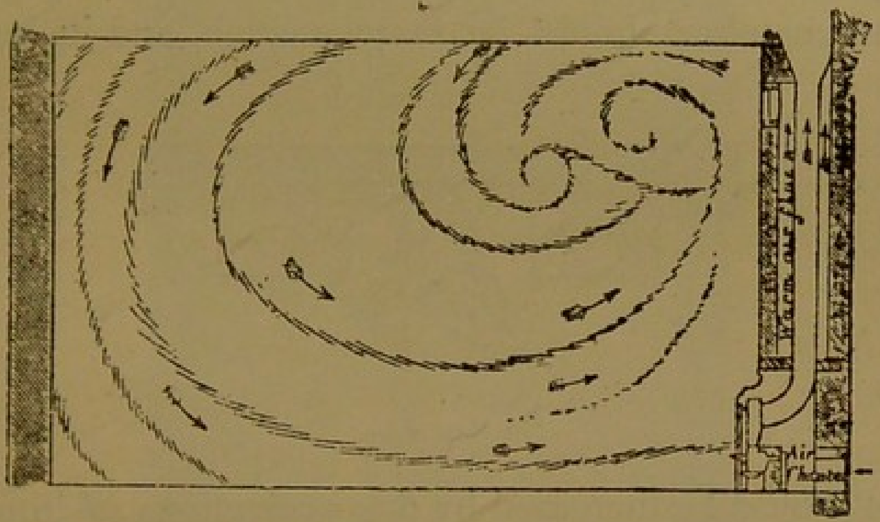

FIG. 20.

43 per cent., and the amount lost by conduction externally and by imperfect combustion is about 15 per cent. A third defect in the open grate is that it abstracts oxygen unnecessarily from the room it is warming. Very much has been done to remedy both the remediable defects. The utilisation of the back heat is provided for in the grate originally designed by Galton for use in barrack-rooms. "Fresh air is admitted to a chamber formed at the back of the grate, where it is moderately warmed by a large heating surface and then conveyed by a flue, adjacent to the chimney flue

to the upper part of the room, where it flows into the currents which already exist in the room. The effectual combustion of the coal is obtained by limiting, to a certain extent, the draught at the bottom of the grate, and supplying warmed air to the top of the fuel at the back of the fire." Fig. 20 is a reproduction of the inventor's illustration. "Section of a room with a ventilating grate and warm-air flue, showing action of fire in producing circulation of air."

A plan of this excellent grate is given (Fig. 21) and an elevation of the same (Fig. 22).

Many forms of grate are now made on Galton's principle. The air-chamber should be large enough, and its heating-

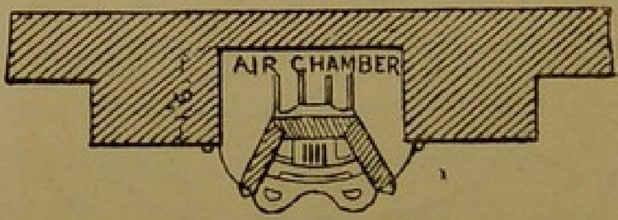

FIG. 21.

surface should be increased by flue projections of iron from the grate-back. It should be continued up round the flue to the point where it is delivered into the room. Facilities should be given for cleansing the chamber, or it will be choked with dust.

To prevent the currents of air at any time being reversed and heat being driven out, a valve may be provided. As gases pass through red-hot cast iron so readily, the back and sides should be lined with fire-clay or made of wrought iron.

The fault of most open grates, that they abstract air needlessly from the room, is got rid of by feeding the fire with external air through a pipe opening in the hearth, fitted with a damper to regulate the current. The inlet to the pipe should be protected by an iron grating. Even if the grate be against an inside wall, it may easily be supplied with external air.

Of course the air heated at the back of grates similar in construction to Galton's may be conveyed to the adjoining room or rooms above instead of being discharged into the

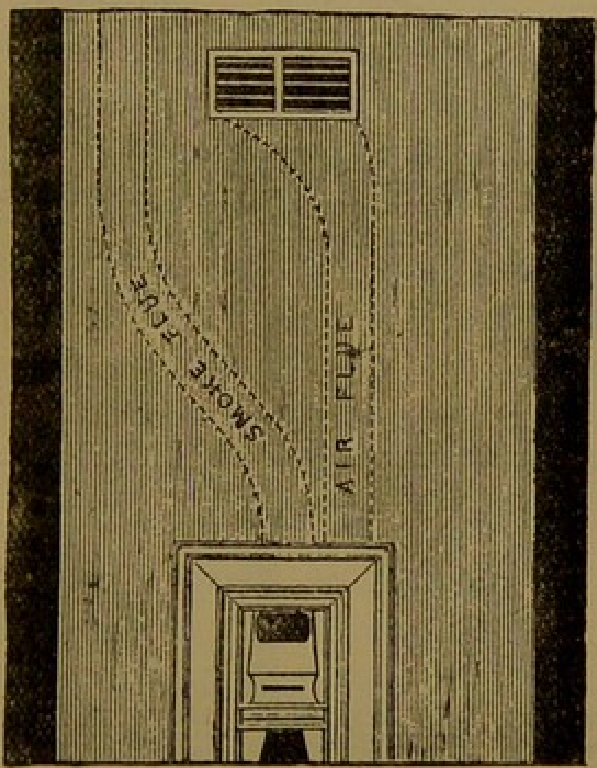

FIG. 22.

room where the grate is. Again, the back heat of a grate may be utilised by means of a boiler and circulating pipes, which will carry heat where it is wanted. Thus, in houses where the rooms are too large to be sufficiently heated by open grates, the required additional heat may be obtained by hot-water pipes.

In a hot-water circulating system there is nothing gained by having the pipes so small as those often fitted. If pipes are three or four inches in diameter, a comparatively large heating surface is provided, and the water need only be a moderate heat. Fig. 23 shows an arrangement of pipes and coils for heating two rooms. The black pipes are the flow-pipes from the top of the boiler. The coils and the return

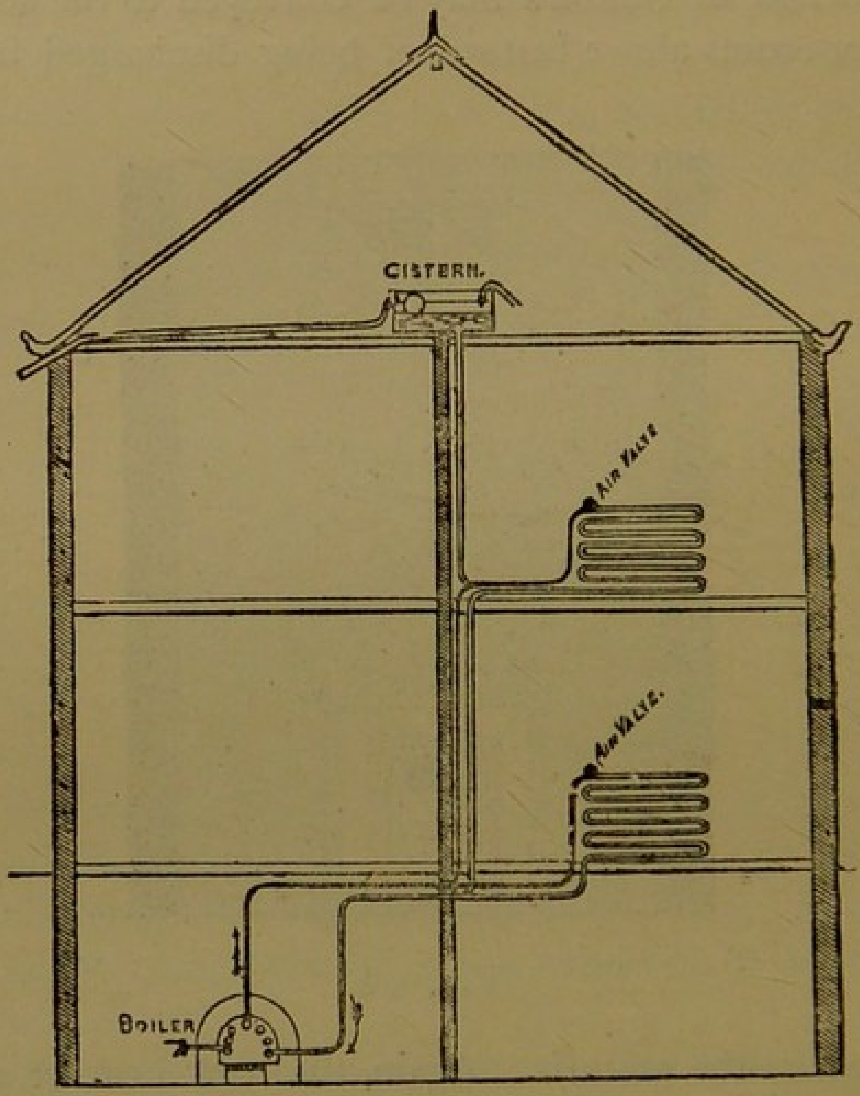

FIG. 23

pipes terminating at the bottom of the boiler are in white Note that the pipe from the cistern is connected with the flow-pipe. The air valves are at points where it is possible for air to accumulate, but small open pipes extending upwards to just above the level of the cistern are better than valves, and much less likely to get out of order. The water is kept in circulation, because, when heated, it expands, and is lighter, and therefore ascends, the colder and heavier water in the descending pipe taking its place at the bottom of the boiler. The velocity is governed by the difference in the temperature between the ascending and descending columns.

Dr. Parkes states that, in dwelling-houses, for every 1000 cubic feet of air space 12 feet of 4-inch pipe should be given, and this will heat to 65 deg. Fah. The heat of the warming surface should be from 120 deg. to 140 deg. Fah. Too hot a warming surface gives the air heated a burnt smell, and makes it too dry for health. If the temperature of the room does not exceed 75 deg. Fah., the air will not smell burnt or be unduly deprived of its moisture.

This is the "low-pressure" mode of heating—the pipes are large and begin and end in a boiler, the water is never heated above 200 deg. Fah., and outlets are provided for the exit of air.

There is another method of heating by hot water—a method not free from danger, the pipes being subjected to a "high pressure." No boiler is provided, but a portion of the endless tube in which the water circulates passes through the fire. The pipes forming the endless tube have thick iron walls, the inside diameter being about half an inch, and the water is heated to 300 deg. or 350 deg. Fah.

In dwelling-houses, heating by hot water is better than hot air, and the low-pressure system is preferable to the high-pressure system.

Warming by steam is a satisfactory method if waste steam be available (which rarely happens in a dwelling-house), but if not is more costly than warming by hot water.

For warming, gas appears to be relatively more expensive than coal fires and water heated thereby. The one great advantage gas stoves possess is that their heat is always at command—they can be lighted and extinguished at any time. Gas stoves are made in every variety of form and size. For instance, there is a small cooking-stove, which would prove useful as an auxiliary in most kitchens; and a stove with jets behind a coloured glass screen and a metal reflector below, suited for heating a hall not otherwise warmed.

The little open grates, also, fitted with asbestos or otherwise, give radiant heat, and are often most convenient in bedrooms or dining-rooms.

Every gas-stove in use should have a flue-pipe to carry off the products of combustion.

Lighting.—Artificial lighting is needed in all houses in this country, and unless done by electricity, it assists also in warming the house. In old times, the provision for lighting consisted of lamps, oil, and candles, and formed part of the furniture and stores of the house; but gas is now so convenient, and gives so little trouble, that nearly all urban and suburban houses, and a large proportion of rural ones, are provided with fittings for lighting by gas.

Candle-light is, indeed, relatively so much dearer than the light from gas or lamps that houses (with rare exceptions) are no longer lighted by candles alone. As regards the relative price of the illuminants ordinarily in use, it may be said that colza oil (a vegetable oil, chiefly derived from rapeseed) is three or four times as expensive as gas, and petroleum is rather cheaper than gas. However, it is quite probable that the cost of replacing broken lamps and chimneys often makes petroleum-lighting quite as dear as gas. If the price be the same, there is really no reason for preferring petroleum. The risk of accident is greater with petroleum than with gas; petroleum gives more trouble, and usually burns more imperfectly, giving off smoke, and making a disagreeable smell. Gas-light is, therefore, ordinarily considered better than lamp-light for a dwelling-

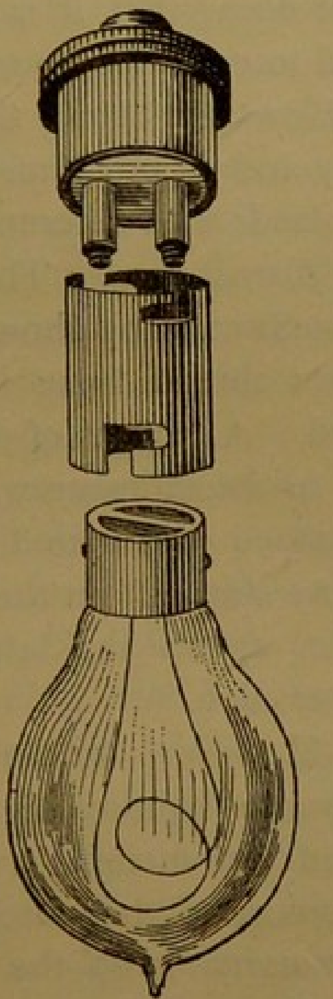

FIG. 24.

house, unless the householder is prepared to pay a rather extravagant price for lamps and oil. When gas cannot be had, light can be obtained from lamps equal to any given by gas.

It has been already stated that heat for warming houses is obtained by means of combustion, and that combustion is the union of what will burn, with the oxygen of the air. Lights for artificial illumination may be produced in two ways—by combustion, or by the impeded conduction of an electric current.

Electric Lighting.—The advantages of the electric light are that it is clear and white, and closely resembles sunlight, which no other light does; that it is only slightly heating, and can be arranged to consume no oxygen and give off no noxious vapours. However, before this method of lighting is available generally and at moderate cost, many problems will have to be solved with reference to the supply of electricity and its distribution. The incandescent lamp ordinarily in use (the Swan lamp shown in Fig. 24) consists of a delicate carbon thread hung in a glass globe, from which air is excluded. A current of electricity sent through this thread heats it to incandescence, but does not destroy it owing to the absence of air in the globe. The Swan lamp is made in many sizes—from the tiny globe giving the light of one candle, up to the larger globes of several hundred candle-power each.

Other Lighting.—However, where electric lighting is not available, in house lighting as in warming, what is required is fuel and air enough, a suitable apparatus in which to effect the union of the combustible with oxygen, and due facilities for carrying off the products of combustion.

The fuel is a compound of hydrogen and carbon (called a hydrocarbon), and both, being combustible, unite with the oxygen of the air. The hydrogen and oxygen form water; the carbon and oxygen, ultimately, carbonic acid. And, as gas and oils are never quite pure, the impurities get oxidised too, producing gases and compounds more or less noxious. The process of combustion is the same whether the fuel be gas, or oil, or fat. The oil or fat (liquefied by heat) ascends the wick by capillary attraction, and, in the flame or its immediate vicinity, is volatilised, or converted into gas. Thus, what is burnt is just as truly gas as if it had been distilled from coal and supplied under pressure for use at a burner. However, while gas and mineral oils are (without taking count of slight impurities) composed of hydrogen and carbon only, vegetable and animal fats and oils all contain some oxygen also.

Gas is a mixture of light and heavy carburetted hydrogen and other hydrocarbons, distilled from coal in retorts and purified with more or less care. Ordinarily, the householder has no choice as to the manufacturer of his gas. If he requires it, he has to take it from the Company supplying the district, and generally it i of fair quality and purity. When it proves unsatisfactory it is probably due to the fittings, and over these he has control.

First, as to the meter. This should be dry There is more than one ground of objection to the wet meter, but one will suffice. During cold weather the water therein may become frozen, and cut off the supply of gas altogether.

Next, to prevent water from lodging in the pipes, a small pipe should be taken down from the lowest part of the domestic service and fitted with a cock to draw off any accumulation of water. Gas is stored in contact with water in the reservoir, and readily absorbs it, and, when its temperature falls, deposits it again. This runs down to the lowest part of the pipes, and the gas can only get through it in bubbles, causing the too familiar flickering of the flame. A little water like this in frosty weather may form a solid obstruction.

In the third place, to prevent leakage, the householder should insist on al fittings being tested (a very simple matter) before being fixed. As the sliding pendants commonly seen in kitchens always leak after a little use, fixed pendants should be used instead. In gasaliers sliding up and down, the water-tube should be filled nearly to the top with water, and a little oil added to prevent the water evaporating.

Fourthly, much attention should be given to the selection of good burners. At least two kinds of burners can be recommended:—(1) The Argand burner, consisting of a ring (commonly $\frac{3}{4}$ inch in diameter), with numbers of fine openings at the top, and (2) the bat-wing burner, which consists of a tube having a rounded top of porcelain (or

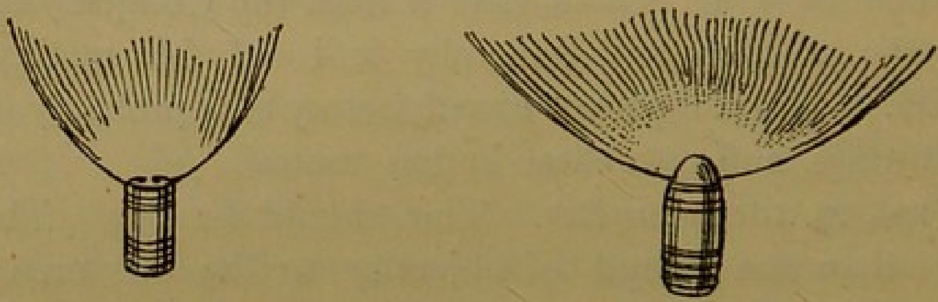

FIG. 25.

similar material), in which is a vertical cut for the gas to come through. There is a third form of burner, which is, perhaps, more used than either of these. It is a tube having a top of porcelain (or similar material), with a depression in the centre, in which are two pinholes directed obliquely towards one another. This is known as the fish-tail burner. It gives a flat flame like the bat-wing, but the flame is less broad. The difference between a fish-tail and a bat-wing burner are well shown in Fig. 25. When a large flame is wanted and gas is burnt at low pressure, the bat-wing seems better than the fish-tale. The Argand burner requires a chimney to regulate and steady the supply of air.

It is adapted for a room requiring a central pendant light or more than one, or for a gas reading-lamp. The bat-wing and fish-tail burners need no chimney, but the flame is usually surrounded with a globe for safety and ornament, and to tone down the light of the naked flame and shield it from side draughts. Such burners are suitable for brackets and gasaliers. All these forms of burners have been recently improved. For instance, Messrs. Sugg and others have much improved the Argand. Mr. Silber's "Concordia" burner is a vast improvement on the old fish-tail, and a bat-wing burner is now made with two very fine slits instead of one.

In the fifth place, something should be done to regulate the pressure. Of course, the Companies try to equalise pressure by increasing it in anticipation of the demand in the evening, and lowering it when the chief demand has ceased. Still the pressure, which is expressed in inches of a column of water, varies from about $1\frac{1}{2}$ inches to $3\frac{1}{4}$ inches or more. The result of a considerable increase in pressure is to set every light or jet in the house "singing," or "boiling." The gas, rushing out so strongly, does not find oxygen enough for its complete combustion, so that the flame is less luminous, and part of the carbon is given off unoxidised, causing a fall of "blacks." For the prevention of this nuisance, what are called "governors" are used. A governor should not be, as it often is, merely something interposed to break the force of the pressure; but its action should vary with the pressure. For instance, an excellent governor consists of a chamber under the burner, containing a disc of metal or other suitable material, which is raised by the gas current, diminishing the outlet. Increased pressure causes the disc to be raised higher. However, a governor for every burner is not needed. One governor placed upon the house main, just inside the meter, is sufficient in a house of moderate size.

In the sixth place, as gas (if much be used) heats and dries the air unduly, and very dry air is unhealthy and irritating to the lungs, it is often desirable in a gas-lit house to restore to the air some of the moisture it has lost. For this purpose two or three large saucers of water may be put on the top of a bookcase, or cabinet, or super-mantel. The water should be renewed every evening. A better result is

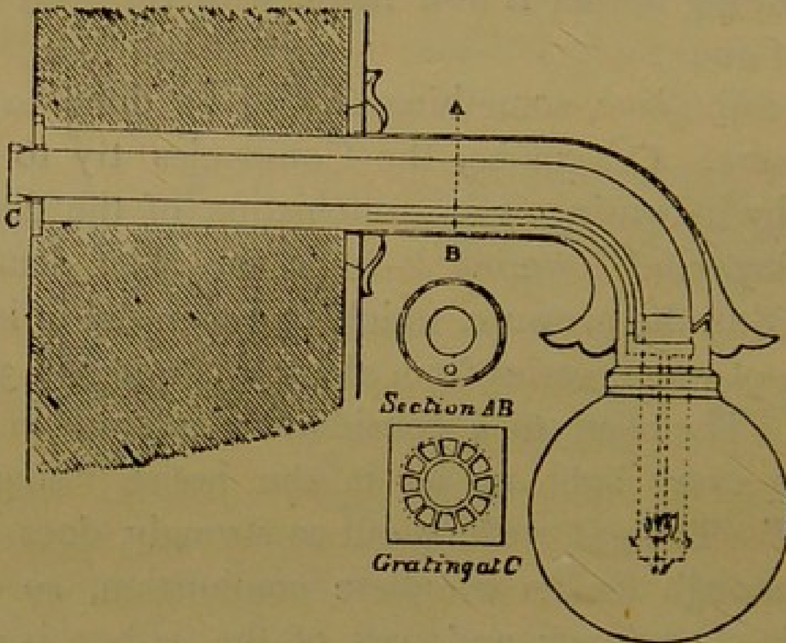

FIG. 26

produced if the saucers be charged with lime-water, as this will gather out of the air some of the carbonic acid and sulphurous acid produced by the combustion of the gas.

Finally, as householders are generally satisfied with less light from lamps or candles than from gas, when gas is fitted there is need of increased ventilation. The simplest way of obtaining the required ventilation is to fix above each burner a tube with an expanded mouth to carry the products of combustion directly to the external air or to a flue. However, the best way of getting rid, not only of the foul air from the gas flame, but the foul air exhaled by the occupants of the room, is by burning the gas in a "Globe" light or other ventilating burner. In the "Globe" the gas-pipes come down from the ceiling through a tube. The burner (similar to the Argand) and lower part of the tube are surrounded by a white glass or ground-glass globe. The air is drawn in at the top of the globe, feeds the flame, and is then carried up the tube to a horizontal tube into the chimney of the room. The horizontal tube and the upper 10 inches or 12 inches of the perpendicular tube are surrounded by another tube, which it warms, and through this is drawn the impure air at the top of the room.

If the room be otherwise efficiently ventilated, and there is no objection to lighting it from the external wall only, the most perfect method of lighting is to place the gas burner in a globe entirely cut off from the room, supplied with air directly from the external air, the products of combustion being also carried off directly. The arrangement, as depicted in Galton's "Observations on the Construction of Healthy Dwellings," is shown in Fig. 26. The fresh air comes through the grating at C, passing along the outer tube to the globe; and the foul, heated air passes away through the inner tube.

Ventilation—literally, causing a wind—may be defined as the operation of supplying confined places with the necessary fresh air. In principle it is simple enough, but in practice often very difficult.

The air in a room is affected by human beings as much as it is by burning fuel to light or warm the room. The oxygen is diminished and the carbonic acid increased. Thus in 10,000 parts of ordinary pure air it has been calculated that there are 2081 parts of oxygen and 4 parts of carbonic acid; whereas in the same quantity of expired air there are 1603 parts of oxgyen and 438 parts of carbonic acid. The quantity of air inhaled and exhaled by an adult in twenty-four hours is about 360 cubic feet, or 2000 gallons. An adult also gives off watery vapour into the air by skin and lungs, the amount being about a pint and a-half daily; and animal matter (particles of skin, fatty matter, &c., in a more or less active state of putrefaction), which causes the disagreeable odour in close, crowded rooms. The amount of this animal matter varies—the average amount given off by an adult is from 30 to 40 grains daily. Indeed, the animal matter coming from the lungs is of more importance even than carbonic acid, but, as the latter is practically in constant ratio with other impurities, the amount of carbonic acid is determined, and taken as a convenient index to the amount of other impurities of the air in occupied rooms. The carbonic acid an adult adds to the air of a room is $\frac{3}{5}$ of a cubic foot in an hour.

Good ventilation implies that anyone coming from the pure air into a room should perceive no difference between the air in the room and outside air in point of freshness Taking the carbonic acid as the index of impurity, the organic impurity of the air is not in the least perceptible to the senses till the carbonic acid in the air is raised from 4 to 6 per 10,000 volumes. The permissible maximum of carbonic acid in an inhabited room being 6 in 10,000, the question is, what quantity of pure external air should pass through the air of a room vitiated by respiration, &c., per head per hour, in order to keep the carbonic acid in this ratio? The quantity, according to Dr. Parkes, is 3000 cubic feet. The next question is, what should be the minimum size of air space for each adult through which this air has to pass? This depends, of course, on the rate at which air can be taken through this space without the movement being perceptible or injurious.

If proper mechanical means are employed the air of a room may be changed six times hourly without draught. Thus under these conditions the minimum air space for an adult would be 500 cubic feet. If the mechanical means used are of an inferior kind, and certainly if natural ventilation is relied on, a change equal to four times an hour is generally all that can be borne, and at least 750 cubic feet of air space should be allowed for an adult.

However, much will depend on the size of the room, for it is easier to change the air of a large room five or six times an hour without draught than to change the air of a small room five or six times an hour without draught. Much also depends on the warmth of the moving air introduced. At a temperature of from 55 deg. Fah. to 60 deg. Fah. a rate of $1\frac{1}{2}$ feet per second is not perceptible; whilst at about 70 deg. Fah. a greater velocity is not perceptible. In ordinary houses, where perfect mechanical ventilation is out of the question, yet where natural ventilation is assisted by the powers of extraction obtained by utilising the sources of warming, &c., the minimum air space may be fairly taken at 600 cubic feet. This is the amount of authorised regulation space allowed for each soldier in barracks, and in practice it is found to be adequate. Of course, sick persons require more air space, and children less.

As 1 cubic foot of good coal-gas produces about 2 cubic feet of carbonic acid, besides other noxious gas, when burning, and an ordinary gas-burner will burn nearly 3 feet per hour, the necessity of providing special ventilation for gas-lights will be apparent.

The forces affecting natural ventilation are: (1) Diffusion, which is always going on through brick and stone walls, through ceilings and wood floors, and the crevices in joiners' work; (2) the winds, which are powerful agents, but difficult to regulate; and (3) the difference in weight of air of unequal temperatures.

The only arrangements necessary to allow full play to diffusion are to build with proper materials, to keep the house dry, and to paint, varnish, &c., sparingly.

Much may be done, and is done to utilise the action of the winds. A moving body of air sets in motion air in its vicinity. It drives the air before it, and at the same time causes a partial vacuum on all sides of it, towards which the neighbouring air flows. Thus, air blowing over a chimney causes a current up the chimney, and advantage is taken of this aspirating power to cause a movement up a tube. On the other hand, a tube may be made to terminate in a large cowl turning to the wind, and bring air into the house to be distributed to the rooms, usually after being warmed in the basement.

The difference in the weight of air of unequal temperatures is a great force, the wind itself being caused by it. The ventilation caused by a fire in a room is due to this, and it is a power much utilised in systematic ventilation.

Extracting air by means of a screw or steam jet, or driving it in with a large fan, are not methods of ventilation ordinarily resorted to in domestic buildings. In this climate it is usually possible to ventilate a house sufficiently by utilising the forces acting in natural ventilation, and, as already stated, the sources of warming and lighting.

What is to be done then as regards ventilating the home, large or small? In every room, and certainly also in the staircase-well, provision must be made for the admission of a sufficient supply of fresh air, and the passing out of foul air.

Two fresh air inlets have already been referred to: the cold air supply to the grate, and the window inlet, obtained by placing a board on the sill under the lower sash, thus allowing the passage of an upward current of air between the meeting rails of the two sashes. Two other approved inlets are Sherringham's ventilators and Tobin's tubes. The Sherringham ventilator or valve, as represented in Fig. 27, is usually placed at the upper part of a room. It is an iron frame, about the length and height of a brick, fitted with a hopper-shaped valve opening. The air passes to it

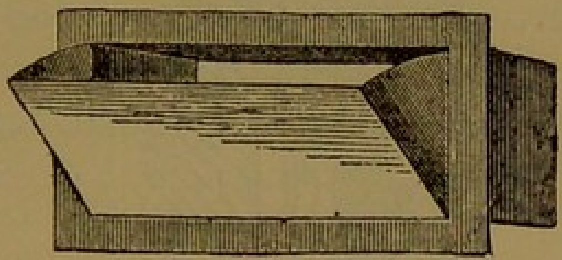

FIG. 27.

through a perforated iron plate, and then is directed upwards. The valve opening can be closed. The tubes ordinarily called Tobin's are vertical, opening to the outer air through gratings near the floor, and carried up to a height of not less than five feet, where they deliver the air upwards. The form of one of these tubes is shown in section in Fig. 28. Sufficient fresh cold air is readily supplied through inlets of either pattern, if enough be provided. If both were provided the Sherringham ventilators would act as outlets. The inlet for air warmed at the back of the grate (already referred to) is most useful, and should be given in addition to the inlets by Tobin's tubes or Sherringham's ventilators.

It is important to note that in arranging fresh-air inlets they should be so placed that the purest air obtainable near the house should be drawn in. Town air commonly requires to be freed from blacks by passing it through a filter of cotton wool half-an-inch thick, placed lightly between wire frames, and changed two or three times a month. The inlets should deliver not less than five feet from the ground, and as far as possible from foul-air outlets.

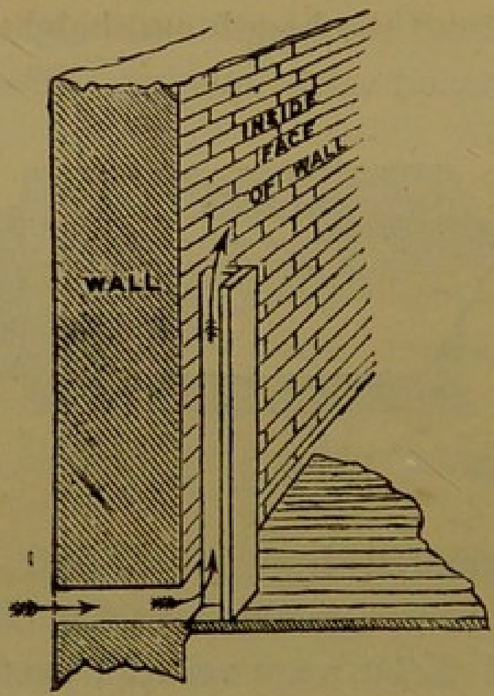

FIG. 28.

Hopper ventilators in windows and louvred panes are not inlets well adapted for the ventilation of rooms in a dwelling-house.

All rooms having open fire-grates possess good foul-air outlets in their chimney flues. The "Globe" gas-burner fittings provide another excellent foul-air outlet. However, every room should have an opening in the upper part of the room into a chimney flue, or, better still, a special ventilating tube capped with a cowl arranged to move round and present its back to the wind. If the opening be into the chimney flue it should be protected by Dr. Arnott's valve (*vide* Fig. 29), which consists of an oblong metal frame,

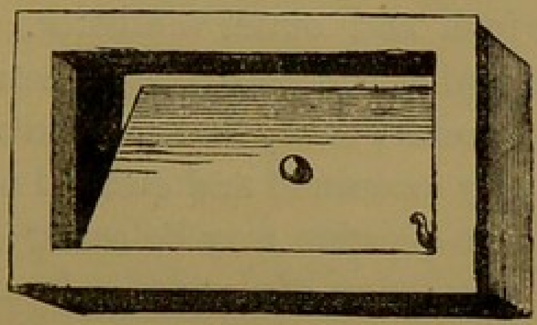

FIG. 29.

inserted in the flue near the ceiling, and having a light flap to prevent down-draughts of smoke, or by Boyle's improvement of Arnott's valve, which is provided with a talc flap and is self-acting.

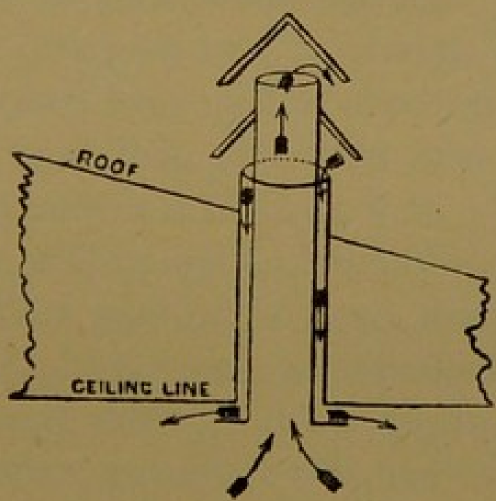

FIG. 30.

A fanlight of good size over the front door affords ingress to the fresh air enough to ventilate a small hall and staircase wells. Additional ingress may be given by Tobin's tubes. In some convenient place near the top of the stairs should be fixed and carried through the roof a divided tube (Watson's ventilator), or two tubes, one within the other (Mackinnel's ventilator), or a tube divided into four parts, having louvred sides all round at the top (Muir's ventilator), or some similar contrivance. Perhaps Mackinnell's ventilator is the best inlet and outlet ventilator. A diagram is given (Fig. 30) showing this apparatus in action.

It is scarcely necessary to say that all ventilating appliances need to be regularly examined and cleaned out.

In conclusion, the question may be asked: How is one to be sure that the ventilation of a room or house is sufficient? There is no better way, as already indicated, than by entering it from the external air. If there be any difference between the indoor air and the outside air in point of freshness the room or house is not well ventilated. Provided there be no over-crowding, the ventilators are not acting properly, or they are insufficient.

CHAPTER VII.

Hot and Cold Water.

Power of Selection Limited—Sources of Supply—Rain Water—River Water—Spring Water—Shallow and Deep Wells—Pollution in Transit: mineral and organic—Cisterns, their position, construction, and size—Expansion and Contraction of Water—The Ball Tap—Filtering—Filters and Cleansing—Hardness, temporary and permanent—Softening Hard Water—Service Pipes—Danger from Lead Pipes—Substistutes for Lead Pipes—Taps from Mains to be so marked—Hot-water Service—Arrangement of Pipes.

Comparatively few householders can exercise any powers of selection as to their water supply. They must accept what the local Company or Corporation delivers them. In this respect it often happens that dwellers in towns are more fortunate than rural folk, who often draw their supply from shallow wells or collect it from the roof. The water supplied by a Company or Corporation ordinarily comes from one of the best available sources, is freed from gross impurities, stored in a cleanly manner, and periodically analysed, so that the best and worst of it are apparent. The receiver, therefore, has some guarantee that the water is potable, any defect in it (such as undue hardness) is known, and can usually be remedied, and his duty in respect of it is commonly limited to seeing that it is not polluted after delivery. Not so the country householder. His duty is to inquire into the source from which his supply is derived, and get it analysed from time to time. It may also become his duty to search for and obtain purer water. It is thus convenient to consider first the—

Sources of Supply.—As all water comes from the clouds, it is originally pure, but in falling it washes the impurities out of the air, and soot, dust, and other solid dirt off the roofs and trees. On the ground and under ground it parts with some of its impurities, but takes up others. Water not only dissolves salts and holds solid impurities in suspension, but absorbs ammonia, nitric and hydrochloric acid, sulphurous and sulphuric acid, and the gases of the atmosphere. Thus rain when collected from clean rock in thinly-populated districts, where the air is free from noxious vapours and gases, and solid impurities, may be as pure a water supply as is attainable. In towns, and especially in large towns, rain is not a pure supply. However, rain-water, owing to its softness, is so convenient for washing, that it is generally worth the trouble of collecting. There is an appliance by which the first washings of the roof are rejected, but even then what is collected is so impure that it should be received into a settling tank, and from that passed on through a strainer of gravel and sand into the cistern from which it is drawn. The settling-tank must be cleaned out, and the strainer renewed from time to time.

As regards river water, it is ordinarily more impure than rain. The rain going through porous strata is given out in springs, but commonly only a small part of the river is spring water, the greater part is rain drained from the land, and carrying with it impurities from the soil. In towns, rivers are liable to be polluted in three ways. Rain may drain into them from a surface soil and subsoil saturated with impurity, sewers and house drains may deliver into them, and trade waste products may be discharged into them.

Natural springs come from an underground reservoir of water, and when available, are likely to yield the best and purest supply. It is, of course, preferable for the spring to be well above the level of the house, so as to save the cost and trouble of pumping.

If no spring be within reach, the best source is ordinarily a well, and if there be no well ready to hand, a capable geologist should be consulted as to where good water can be obtained at a reasonable depth, and when a well is sunk clean material should be used in its construction, and the surface soil water cut off from the deep water by carefully casing the well and puddling behind the casing. Naturally the water obtained will vary in purity according to the nature and amount of the soluble matters in the ground through which the well draws its supply. Shallow wells are always liable to be contaminated by animal and vegetable matter in or on the surface soil. Deep well water is generally good, but is not of equal purity all the year round, and the upper portion may differ from that which lies below. Thus the water drawn up in a bucket may be bad in colour and contain many impurities, while water pumped from the bottom of the same well may be colourless and pure; the latter would represent the real well water, the former a layer of lighter water from the surface drainage which should have been kept out. Well water is also sometimes soft near the top and hard near the bottom.

If the householder obtains his supply from a private well, or a spring or stream, it is important to have a sample analysed from time to time that he may be assured of its purity, as clear, bright-looking spring water may be quite unfit to drink.

Water delivered by Companies or Corporations is obtained from deep wells or rivers or gathering grounds, in some instances very large impounding reservoirs being made. It is freed more or less completely from suspended matters, stored, and raised to a sufficient height for distribution by gravitation.

The quantity of water required is estimated to be not less than fifteen gallons per head per day.

Pollution in transit.—Water pure at the source may in transit to the consumer be polluted with mineral matters, or with animal or vegetable substances classed together as organic matter. Both kinds of impurity are to some extent dissolved, but in large proportion merely suspended in the water. In open conduits water is specially liable to be contaminated. A species of purification goes on, however, at the same time by means of subsidence, the action of plants and oxidation. Water conveyed in pipes may be fouled by contiguous leaking sewers or gas pipes, by the material used to caulk the joints, or by the lead or iron of which the pipes are made.

To prevent pollution reservoirs should be covered and kept clean, and the inner surface of metal pipes should be coated with something that water will not act on. Many materials, as pitch, will effectually protect iron. The best lining for lead pipes is glass. Neither hemp nor any organic matter should be used in jointing the pipes. To prevent sewer gas or coal gas being sucked into the pipes they should be tight, and the water service should be constant.

Cisterns.—Every house, whatever the source of supply, should have a store cistern. Even if the service be constant, as it should be, there will be times (as while repairs are in progress) when no water can be obtained from the main. A store cistern, therefore, may be regarded as a necessity, and the questions to be discussed next are:—

Where shall it be placed? What shall it be made of? and How large shall it be?

Water stored above ground varies much in temperature, which is a disadvantage; stored under ground it is readily maintained at a low, even temperature. If the cistern be above ground the water may get quite warm during the day. giving off oxygen, &c., and when at night it cools and its capacity for absorbing gases is much increased, it may absorb ammonia from the stables, or sewer gas from a contiguous sewer ventilator. Water in cisterns above ground has been found to vary from 71½ deg. to 33½ deg. Fah., when water in a well has been found to range merely between 51½ deg. and 50½ deg. Fah. If, as is commonly the case, it is not practicable to place the cistern underground, it should be put in as cool a place as possible, accessible, of course, sheltered from the sun, and provided with a cover. It is well to set apart a small room on the north side of the house as a cistern-room.

As regards construction, the cheapest good material available is said to be wrought iron or steel. It may be coated inside with oil paint made with magnetic oxide of iron, or, better still, with a vitreous glaze (enamelling), and the outside may be pitched. Probably the strongest and most durable cisterns are made of slab slate, cement-joined, and bolted together with iron. Excellent cisterns are now made of glazed stoneware. The material is well adapted for cisterns of no great size. These stoneware cisterns are always tight, unaffected by the water, easily cleansed, and not dear.

The size of the cistern should be carefully considered with reference to the requirements of each household. The difference in the amount of water required depends mainly upon the number of baths taken. A family using baths frequently may need a supply of 60 gallons a head daily, but this is quite exceptional. It has been stated that the allowance per head per day should be not less than 15 gallons. Supposing there were six persons in the house the supply for a day would be 90 gallons, and as the water might be cut off for five consecutive days, a cistern for such a household should hold not less than 450 gallons. Now a cubic foot of water contains $6\frac{1}{4}$ gallons, so the cistern should have a holding capacity of 72 cubic feet, that is, should be about 5 feet by 4 feet by 4 feet, as a cistern would only be filled to within about 5 inches of the top. A hundredweight of water occupying a space equal to $1\frac{2}{3}$ cubic feet, a cistern constructed to hold 72 cubic feet of water must be strong enough to carry a weight of two tons.

As to expansion and contraction, it is useful to remember that water in cooling becomes denser until it reaches 39 deg. Fah., and after this it expands till it freezes. In the act of freezing it expands considerably, as the frequent bursting of water pipes in frosty weather attests.

The regular systematic cleansing of cisterns must be attended to. How often this will be needed depends on the position of the cistern and the nature of the water therein. Generally, if the cistern is kept covered, it will be sufficient to clean it once in three months.

It is a well-recognised rule that no store cistern should serve a water-closet direct. Separate service cisterns are provided, and these deliver a measured flush of two gallons or more as required. It would be better if the minimum flush were fixed at three gallons.

The supply of water to a cistern is, as is well known, regulated by a ball-tap. The householder should give attention to this, as all self-acting apparatus needs some attention. The ball should be large and weighted to float nearly half immersed. The tap should be easily turned and open fully at a light lowering of the ball, and to prevent noise when the the water is delivered the nozzle of the tap should be continued to near the bottom of the cistern, and syphonage prevented by an air-hole.

An overflow pipe should be provided for the cistern, and this must not be connected with any drain or waste-pipe. It should be a short pipe terminating externally, so as to give immediate warning if waste occurs.

Filtering.—The question is often asked—Ought we to filter our water? And it is not possible to give an answer generally applicable. If really good water is supplied, water that would fall under class 1, as defined by Dr. Parkes,* it certainly does not need filtration. If it contain suspended inorganic impurities, such as clay, &c., filtering through a sponge and fine sand will generally remove them. If it contain organic matter in suspension and solution, beyond mere traces, it becomes a question whether the supply is sufficiently good for drinking purposes. However, there may be, and often are, waters of usable quality, which constitute a fairly efficient supply, and yet contain enough organic matter to make domestic filtration desirable. A good filter in such a case is that known as the silicated

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* It should be transparent, without suspended matters, smell, or taste, and be well aërated. The total solids should not exceed 8 grains per gallon, of which only 1 should be dissipated by heat, unless it be a chalk water, in which case the total solids should not exceed 14 grains per gallon of calcium carbonate, and should contain only traces of calcium sulphate. The matter destructible by heat (allowance being made for the decomposition of calcium carbonate) should be under 1 grain and should scarcely blacken; the indications of nitrites should be absent; of nitrates and free ammonia extremely slight; the amount of albuminoid ammonia should not be more than ·0056 grains per gallon.

carbon filter, and another is the spongy iron filter. If under any circumstances the householder were compelled to use a really suspicious water, no filter short of M. Pasteur's could be considered safe. When there is any reason to fear the supply may be contaminated, it is wise to take the precaution of boiling all water to be used for drinking. As boiled water is flat, it is improved by being passed through a filter of gravel and sand to freshen and aërate it. Again, should the only supply even for drinking purposes be rain water, it is improved by filtering through sand and animal charcoal.

It is most important to impress upon householders that a filtering medium will only retain its power for a limited time—the time depending on the amount of impurity in the water and the rate of filtration. No filter can possibly act month after month without losing its efficiency. The organic matter it gathers out of the water is putrescible, and if this be left week by week to clog the filter, the water passed through it becomes fouler instead of purer. The apparatus, as has been aptly said, ceases to be a *water filter* and becomes a *water filther*. Some filtering materials can be cleansed by fire, others in running water, others when once foul require to be renewed. Certainly it may be laid down as a rule that no filter should be used that does not admit of being thoroughly cleansed.

Softening hard water.—The terms "hardness" and "softness" refer to the soap-destroying powers of a water. Soap is an alkaline stearate, palmitate, or oleate, and the addition of lime, magnesia, etc., decomposes it. As hard water contains these it is difficult to obtain a lather with it, much of the soap being decomposed and wasted. Hardness is described as temporary or permanent. Temporary hardness is due to the presence of carbonates, which are almost insoluble in pure water, but freely soluble in water containing carbonic acid. When the water is boiled the carbonic acid is driven off and the carbonates are thrown down. So temporary hardness is the hardness which is removed by boiling the water. Permanent hardness is chiefly due to sulphates, and is not removed by boiling. The amount of hardness is tested for by ascertaining how much of a solution of soap of known strength is required to form a lather which will last for five minutes. Hardness is expressed in degrees, each degree theoretically representing a grain of carbonate of lime (or its equivalent in soap-destroying power) in a gallon of water. A sample is first tested to ascertain the initial hardness, and then a sample is tested which has been boiled briskly for half an hour, made up to the original bulk with distilled water, and filtered and cooled, to ascertain the permanent hardness. The difference between the two gives the temporary hardness. Chalk waters are notoriously hard waters, and may be cheaply and easily softened by adding lime.

Chalk is carbonate of lime, and if a pound were burnt 9 oz. of lime would remain, and 7 oz. of carbonic acid would be driven off. The 9 oz. might be dissolved in 40 gallons of water, but the pound of chalk could not be dissolved in a hundred times as much water. However if 7 oz. of carbonic acid were added to the pound of chalk in water, it would be changed into bicarbonate of lime and become readily soluble. Suppose the quantity of water containing the 1 lb. of chalk and 7 oz. of carbonic acid were 400 gallons, the mixture would be similar to the hard well water from the chalk. To soften this add the 40 gallons of water containing the 9 oz. of lime, and the result will be the formation of 2 lb. chalk. This is but slightly soluble, and about ten-elevenths of it would be thrown down, and a hard water converted into a soft one. As all the hardness of water from the chalk is not due to chalk, more than one-eleventh part would remain, still by means of this process 18 degrees of hardness in water may often be reduced to three or four degrees. Water more than twice as hard as this would not be objected to on the score of hardness.

Service pipes.—Reference has already been made to the material of which pipes are made. Lead should not be used for conveying a water having a solvent power on lead. Water containing oxygen acts on lead, forming oxide of lead, which is to some extent soluble in pure water. Carbonic acid, however, if present in sufficient quantity, makes the oxide into carbonate of lead, which is but slightly soluble. Rain water and most soft water take up lead. Hard water, on the other hand, does not act on lead, but coats the pipes with a protective lining. Peaty water also leaves a deposit on the pipes protecting them. Lead has yet other defects. It is very heavy and has no stiffness, so that if fastened to the wall with metal clasps it "bags' between the clasps, and it is also much affected by variations of temperature. Lead-encased block tin pipes (not tinned lead pipes) are an improvement on lead pipes, and do not affect water injuriously, but great care is needed in jointing, and this should be done by means of screw couplings. Glass-lined pipes, already noticed, are stiff, and present a smooth inner surface unaffected by water. If they could be readily bent they would leave nothing to be desired. Good serviceable pipes for both hot and cold water are made of copper, the only bar to their more general use being their relatively high cost. Iron pipes, which may be tar-varnished (Angus Smith's method) or bi-oxidised (the Bower-Barff process) to prevent them rusting, are safe and economical.

Wrought iron pipes are better than cast iron pipes, and are easily cut, bent, and jointed.

As regards the position of pipes, it is a first necessity so to place them that they will not be exposed to frost. Open spaces, cold cellars, and outside walls should be avoided, and when pipes must be put in exposed places they should be carefully packed round with felt or some other good non-conductor of heat. It is obvious also that the pipes should be so placed that the sound of the water coming in will not prove an annoyance. Again, there should be as few branches as possible, and these as short as possible, and each branch should be given off at an acute angle—never at a right angle. Cold water will be required for the scullery sink and pantry sink, bath and lavatory, store cistern and the separate service cisterns for flushing the closets. The service to the scullery sink and pantry sink should be from the main ; there should also be a tap from the main in the upper part of the house, or the servants will fill the bedroom carafes from a bath-tap served from the cistern. Every tap from which water is drawn from the main should bear the word **MAIN** stamped on it.

The supply pipe should be taken up to the house at least 2 feet under ground to protect it from frost, and should (after it enters the house) be fitted with a screw-down arrangement or stop valve for cutting off the water during repairs.

Horizontal pipes should be laid on continuous wooden supports with a regular slope, enough to drain the water from the pipes when it is desired to empty them on the approach of a severe frost. Vertical pipes should be screwed to wood rather than directly to the wall. They should be fastened by lead flaps (technically "band tacks") passing over the pipes.

Hot-water service is needed for the kitchen, scullery sink, pantry sink, bath, and lavatory. The water is ordinarily

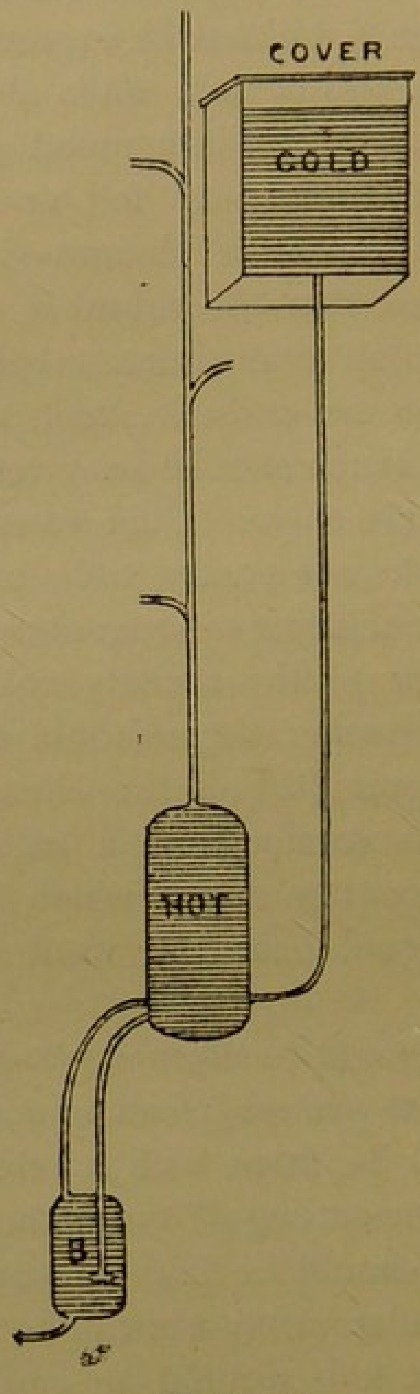

FIG. 31.

heated by means of a suitable boiler at the back of the kitchen fire, and stored in a hot-water cylinder connected therewith by circulating pipes.

The boiler should be quite smooth inside, the angles and corners being rounded off so that no air may lodge within. Iron soon roughens from the action of the water, and copper is therefore a better material for this boiler. In every case an access hole for cleansing, properly protected, should be provided. A pipe, securely stopped with a screw cap, should be taken from the lowest point, for emptying the boiler previous to repairs. The outflow pipe to the cylinder should be taken from the very lowest point. The return pipe may be entered at the top or back, and should be continued within the boiler by a short length of pipe. The hot-water cylinder (a copper one is preferable) should be fixed not far from the boiler, but of course on a higher level, and access to every part of it and to the outside should be provided. The boiler outflow and return pipes should be connected at the bottom of the cylinder, and the supply of cold water from the store cistern should also be led in here. At the highest point of the cylinder the expansion pipe should be connected and go right up. It may terminate over the cold-water cistern, or above the roof, the end being against the kitchen chimney, so that it will not get blocked with snow or ice. Indeed, care should be taken that every part of the hot-water system is protected from frost. From the expansion pipe the hot-water service pipes required can be branched. The arrangement as described will, perhaps, be more readily understood by reference to the illustration, Fig. 31.

Noise occurring in connection with the hot-water service is commonly due to air in the boiler, or deposit, choking one of the pipes between it and the cylinder. It may indicate danger, and it is certainly not safe to neglect the warning.

The shape of the boiler, instead of being like an upright box, often roughly resembles a very broad boot, the toe coming forward into the fire. This is a convenient shape when the space at the back of the fire is very limited, and a somewhat larger surface is thus presented for heating.

All boilers need cleansing from time to time, and often their not heating properly is found to be due to the thick incrustations all over the inside.

All pipes, especially those conveying hot water, should be allowed plenty of room for expansion and contraction.

CHAPTER VIII

SANITARY REQUISITES.

Drainage—House Drains—Minimum Fall—Drains beneath Buildings—Drain Joints—Testing the House Drains—Disconnection of House Drains from Sewers—Fresh-air Inlet—Disposa of Rain-water—Soil-pipe—Ventilator for Soil-pipe—"Containers" and "D Traps" condemned—The Simplest Form of Closet—The Valve Closet—Boxing-in objectionable—Separate Service Cisterns—Baths and Lavatories—Scullery and Pantry Sinks—Grease Traps—Gully Traps.

THE sanitary requirements of a house may be conveniently considered under two headings: (1) The drainage, and (2) the sanitary fittings.

Drainage.—Some reference was made in Chapter II. to draining the subsoil of the site of a house, when the dampness of the site renders such a precaution necessary. The subsoil drain is constructed of earthenware field pipes, and designed to take in water at every joint. It has been ruled that the fall, or slope, of this drain should not be less than 1 in 220, but, if practicable, it is well to give a fall of at least 1 in 120. The subsoil drain must not be connected directly with any sewer or cesspool, or with any drain to be used for conveying sewage.

House Drains must be laid outside the house as far as possible. They should be made of glazed earthenware pipes, provided with flanges, and tightly jointed all round with cemént and should be laid in a bed of good concrete. When a connection has to be made a suitable junction-pipe should be used, so that one drain shall join the other at an acute angle. The internal diameter of the pipes is usually

6 inches; but in the case of small houses, pipes having a diameter of 4 inches may be used. Great difference of opinion exists as to the minimum fall or slope which should be required in constructing a house drain, as the "Model Bye-laws" merely direct that such a drain shall have "a proper fall." For instance, one authority gives the minimum fall as follows:—

For 4 inch pipes	1 inch in	12 feet	= 1 in 144
For 6	,, ,,	18 feet	= 1 in 216
For 9	,, ,,	27 feet	= 1 in 324

It is calculated that if drains with this very slight fall were running half full, or full, their speed of flow would be 144 feet per minute, which would be sufficient to keep them free from deposit. However, it rarely happens that drains are running half full, or even a quarter full, so that to be self-cleansing they must have a much greater fall than this. The distance from the house to the sewer (at least in urban districts) is, as a rule, not very great, and it is of the utmost importance that it should be kept clean, so that it scarcely seems unreasonable to require a fall, if possible, of 1 in 48. A drain pipe is 2 feet long, therefore each pipe should be laid with the end directed towards the sewer, half an inch lower that the other end.

When it is not practicable to take the drain outside and it has to pass under the basement, it must be laid in a direct line for the whole distance beneath the building, and be completely embedded in and covered with good concrete, at least 6 inches thick all round. A drain thus passing under the basement must be ventilated at each end of the portion under the house. Of course no basement floor may in any case be at a level below that of the outfall of the drains. The basement floor, as already stated, should be drained by being made to slope to an area, the drainage delivering by a channel on a trap in the area.

Great care is required, in making the drain joints, to prevent the cement projecting inside. Some skilled pipe layers make a sort of piston of cloth at the end of a stick to rub off projections. When the pipe is in position the piston is put in, and the pipe socket cemented over. The next pipe is passed over the piston-rod or stick, and the joint finished. Finally, the piston is drawn through the new joint, clearing away any cement from the inside.

There is a patent bituminous joint, much in use at present, that seems quite satisfactory. Pipes are prepared with the ends fitted with collars of the preparation. The collar is slightly softened by wiping it with an oily cloth, and the pipe ends are then pushed together. The joints are perfectly water-tight, and remain tight even after slight settlement of the ground.

There is no objection to iron pipes being used for house drains instead of glazed stoneware pipes. When thus used, the iron should be coated with a preparation to prevent rusting.

After the house drain is laid it should be carefully tested, or the householder has no security that all the joints are tight. There are three recognised methods of testing a drain. The lower end and outlets may be closed and the drain filled with water. If the level of the water sinks at the upper end, leaking of one or more of the joints is indicated. The ventilators and both ends of the drain may be closed and the drain filled with smoke. Any of the joints penetrated by the smoke are imperfect. Oil of pepperment poured in at a closet in the house should not be perceptible to smell anywhere along the drain.

Every house drain directly communicating with a sewer must be fitted with a suitable trap (to prevent the passage of sewer gases into the drain) at a point as distant as practicable from the house, and a fresh-air inlet must be provided on the house side of the trap. In planning the drains of a large house it is better that this fresh-air inlet should be a properly-constructed manhole, going down to the drain and forming a disconnecting chamber into which branch drains

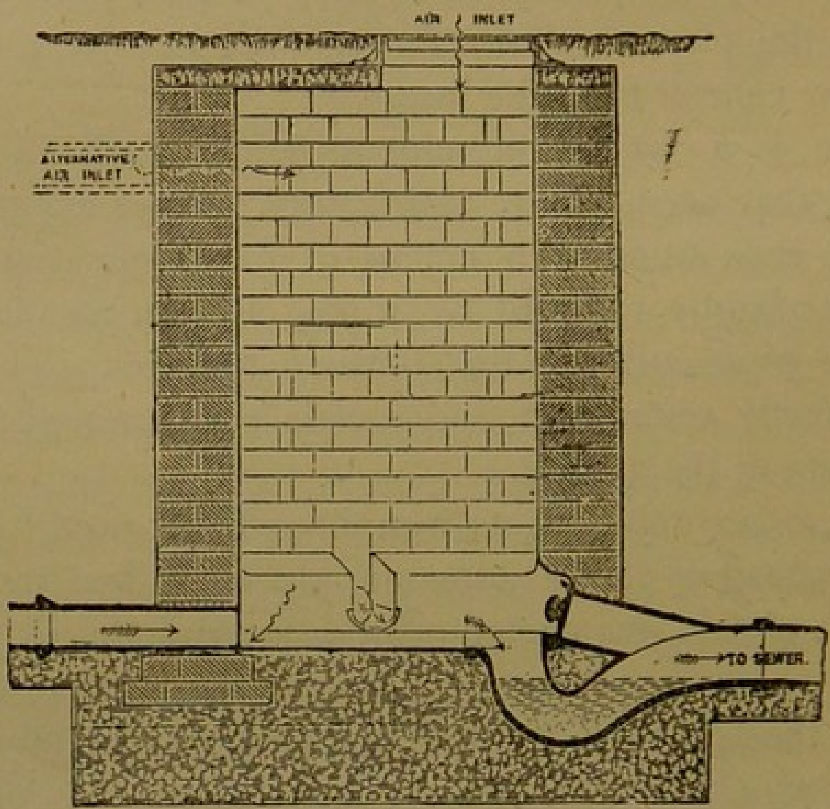

FIG. 32.

can deliver. Figs. 32 and 33 show a suitable disconnecting chamber in section and plan, with a branch drain delivering into the open channel which traverses the floor of the chamber. Such a disconnecting chamber is ordinarily covered with a grating so as to afford the necessary air communication with the drains for purposes of ventilation; but if under exceptional circumstances it is thought necessary to use a solid cover, an alternative opening for drain ventilation may be formed by a pipe through one side communicating with an air shaft above ground.

In small houses it is commonly sufficient to insert in the course of the drain near the boundary of the premises, a

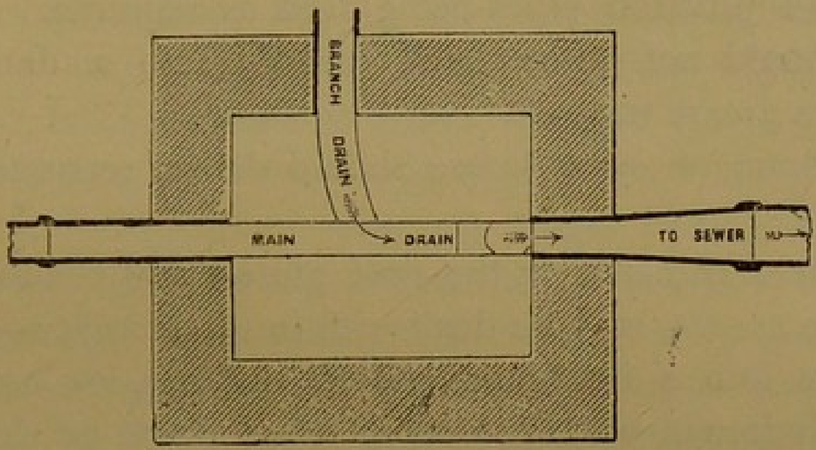

FIG. 33.

trap similar to the one shown in Fig. 34. The sewer inlet, it will be noticed, is well above the outlet of the trap, increasing the force of the flow through the trap. The fresh-air inlet is just above, and is to be continued by pipes

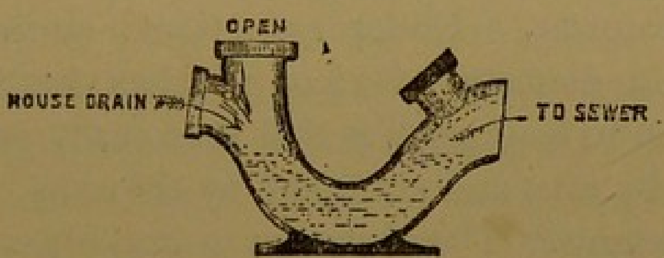

FIG. 34.

to the ground level. It also gives access to the trap, enabling it to be cleaned. The opening just over the outlet is for cleaning the drain between the drain and the the sewer. Ordinarily the opening is kept closed. The flat bottom of the trap goes far to ensure its being fixed level.

Every inlet to the drain which is not an opening for the ventilation of the drain must be properly trapped.

Soil-pipes and traps receiving yard drainage, waste water, &c., must have their weight properly supported, and be properly connected with cement joints, suitable curved pipes and junction pipes being used as required. Greasy water should not be received directly into a drain, but through a grease trap.

The drain of every house should deliver separately into a sewer.

The rain gathered in the roof gutters and conducted in the down spouts, may be dealt with in three ways:—It may be taken into a catchment cistern for use, or conveyed separately into a water-course or other place, or delivered on or in a suitable trap discharging into a house drain.

Water-closets and Soil-pipes form the only direct communications between the inside of a house and the house-drains.

The soil-pipe should pass directly from the closet trap through the wall, and down the outside of the house to the house drain. It should be made of lead or iron, and four inches in diameter. Under exceptional circumstances a pipe having a diameter of $3\frac{1}{2}$ or 3 inches may be allowed. The objection to lead pipes is that they easily get bent, and are gnawed by rats, and corroded by chloride of lime and other disinfectants. The objection to iron pipes is that it is difficult to coat them so as effectually to prevent rust, and the joints do not remain perfect like well-made wiped joints on a lead pipe. To ventilate the soil-pipe a pipe of the same diameter should be taken up without bends from the highest point where it comes through the wall, and terminate at least two feet above the roof eaves, care being taken that the end is not near any dormer window or opening in the roof. The soil-pipe ventilator end should be protected to prevent birds nesting in it. Soil-pipes and their ventilators should be securely fastened to the wall, or by their weight they may drag open a closet trap, or the connection therewith. The fresh-air inlet on the house drain enables the soil-pipe ventilator to act, the air current will generally be from the inlet along the drain, and up the soil-pipe and ventilator, but sometimes it will be reversed.

Water-closets and their fittings should be of the simplest description practicable. All pan-closets having so-called "containers" interposed between the basin and trap are objectionable. The container and pan which it contains soon become foul, and the only way of efficiently cleansing them is by taking them out and heating them sufficiently to burn off all impurities. The trap, which in time past used ordinarily to be placed under the pan-closet, was equally objectionable. It consisted of a leaden box in the form of a D, with a pipe dipping in from the top at one side, and a pipe leading out at the other. It was always foul, and the contents often acted upon the lead and penetrated it. The simplest form of closet apparatus is a basin and trap all in one piece, made of glazed stoneware. The basin, indeed, forms the upper part of the S trap, the lower end of the trap being continuous with the soil-pipe. The flushing water is delivered straight into the trap, and on the other side of the water seal is a hole for fixing a short ventilating pipe between the stoneware trap and the soil-pipe ventilator. This ventilates what would be a "dead end," and acts as an anti-syphonage pipe preventing the unsealing of the trap. In most houses now the old pan-closet has given place to the valve-closet, and the old D trap has been replaced by a properly made S trap. Such an apparatus answers well, with the help of a good flush and a little attention. Indeed, a trap beneath the basin is not an absolute necessity. The bottom of the basin may be closed by a valve, enabling it to retain the required quantity of water. When the valve is open, the contents of the basin pass into the soil-pipe. This simple form of closet apparatus is undoubtedly in use, and working satisfactorily in some houses. However, dispensing with the water-closet trap is scarcely safe, and not to be generally recommended. Moreover, the closet described, with the basin and trap all in one piece, is simpler and cleaner than any valve-closet.

Boxing-in of the apparatus with woodwork is needless and uncleanly. An oval ring of hard wood should be provided to cover the margin of the basin, and this should be hinged at the back, so that it may be lifted up when the basin is used as a urinal.

Each closet should be flushed with a separate service cistern, delivering three gallons rapidly at each flush. Though the basin and trap of a closet should be as far as possible self-cleansing, they should have attention daily, and be kept clean.

Of course, every closet in a house should be against an external wall, and be ventilated by one or two air bricks built into the wall. A window opening directly to the external air should be provided, the dimensions of which should not be less than 2 feet by 1 foot.

Baths and Lavatories.—Baths may be made of slab slate, lead, copper, iron, or glazed stoneware. If slate be used, it must be made as carefully as a slate cistern, and jointed with cement. Lead is weak and very heavy, and soon gets out of shape. Copper makes an excellent bath, and owing to its good conducting powers warms readily above the level of the warm water. Iron well painted or—better—enamelled, makes a good bath, and it is comparatively cheap. For cleanliness and durability there is probably nothing superior to a glazed stoneware bath of the best quality.

The bath should have a service of hot and cold water delivered through screw-down taps. The waste-pipe should be from 2 inches to 2½ inches in diameter, and should be trapped with a S trap. The overflow pipe should be connected with the waste pipe between the bath and the trap. The waste pipe should be carried down outside the house, and deliver on a gully trap.

Lavatory basins are ordinarily made of glazed earthenware or enamelled iron, and are similar to baths in their requirements. Each basin should have two screw-down taps for hot and cold water. The waste pipes (a pipe of 1 inch diameter is large enough) should be trapped with a S trap. The overflow pipe should be connected with the waste pipe between the basin and trap. The waste pipe should be carried down outside the house, and delivered on a gully trap.

Baths and lavatories should be in rooms against an external wall, and should be properly ventilated and lighted. It is better that the apparatus should not be boxed in with woodwork.

Sinks, perhaps, hardly come within the description of sanitary fittings as ordinarily understood, but it is convenient to consider them here. There is commonly one situated in the scullery and one in the pantry.

The sink in the scullery is often made of soft stone, which soon becomes foul with grease, and cannot be cleansed. There are many suitable materials for scullery sinks, as slate, enamelled iron and glazed stoneware. The last-named makes the best and cheapest slopstone.

The sink in the pantry is not often made of slates or stone, but of lead, enamelled iron, or glazed stoneware. Lead gets dirty and soon out of shape. Iron or stoneware sinks are liable to break the china when it is being washed. Probably the best material is copper or sheet block tin, laid over a strong wooden casing made to the shape required not too deep and well rounded off at the corners. The table round the sink should be covered with the same metal.

Both scullery and pantry sink should be placed against an external wall under a window. They should both have a

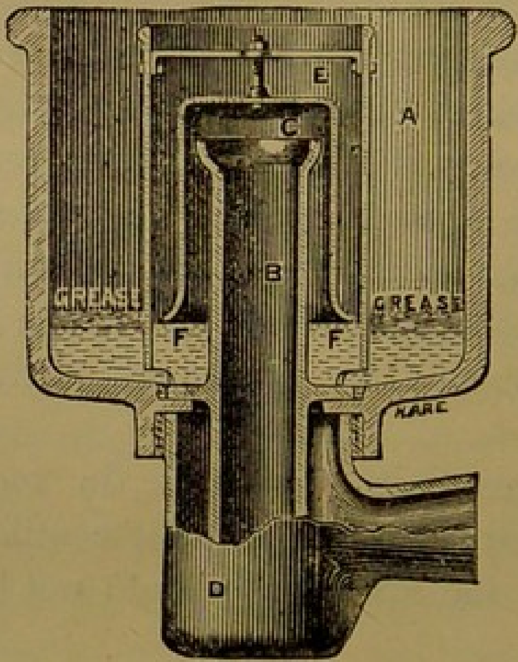

FIG. 35.

pair of screw-down taps, one for hot water and one for cold water *from the main*. The waste pipe should be at least 1½ inches in diameter, trapped with a S trap, having an access hole, to cleanse it, provided with a screw stopper. The waste pipe should be taken through the external wall, and deliver on a gully trap.

It has been already pointed out that greasy water should not be directly discharged into a drain. A grease-trap is a very simple apparatus, and if cleaned once a day (as it should be) gives very little trouble. Such traps are made in various forms. The one ordinarily in use consists of a chamber, which may be about a foot square and 15 inches deep. It has an inlet pipe delivering near the top, and an

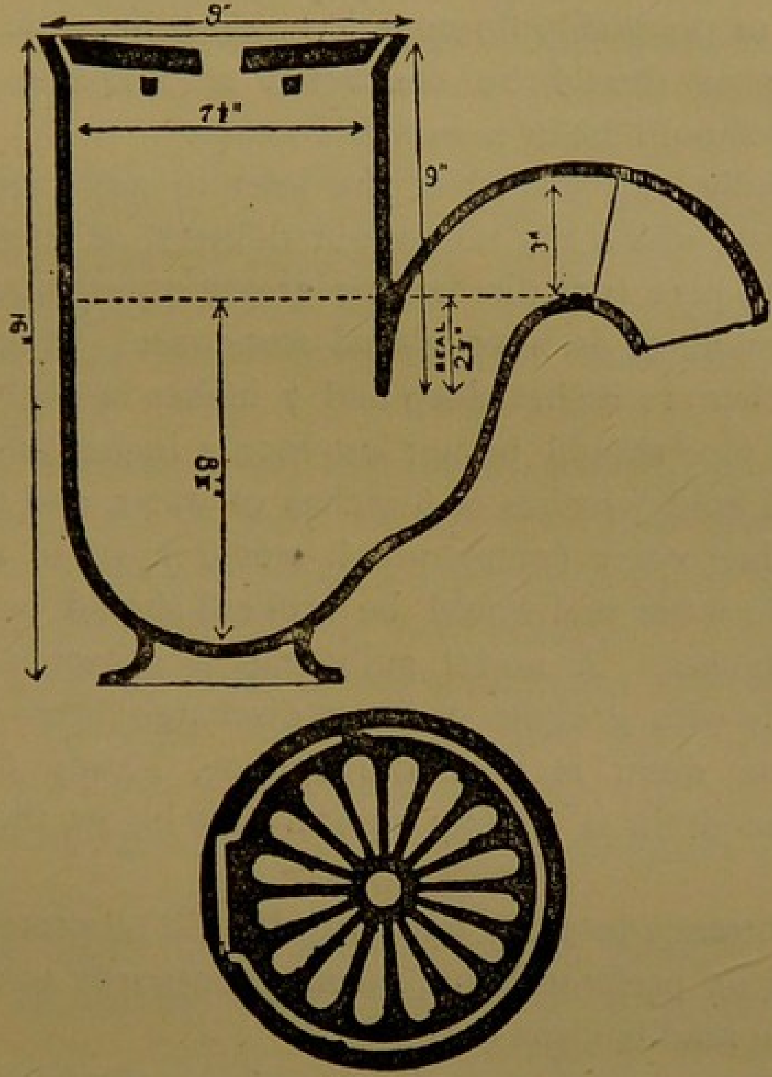

Fig. 36.

outlet opposite and at the same level, but the mouth of which is turned down to near the bottom of the chamber. For large establishments grease traps are made much larger, and provided with Field's arrangement for automatic flush ing. Of this kind is the stoneware trap made by Doulton shown in section (Fig. 35). A is the body of the trap, where the grease is retained; E the inner chamber, where the water, free from grease, rises; C and B form the self-discharging annular syphon; and D is the basin into which the end of the syphon dips, forming a trap. A grease trap may be used to receive the discharge from the waste pipe directly, or preferably through a small gully trap. A ventilating pipe should be connected at the side, and the chamber should have a movable cover.

The gully trap placed at the inlet to any yard or area drain, or on which any rain spout delivers, or on which any sink waste pipe (not discharging greasy water) may deliver, is to be made of iron or glazed stoneware. It should be not less than 12 inches deep and 7 inches in diameter, and its outlet pipe should be not less than 3 inches in diameter. It should hold 7 inches or 8 inches of water, and the depth of trapping water (water which would have to evaporate before the water seal would be broken) should be not less than 2½ inches. A useful gully trap is shown in Fig. 36. It is made with a short or long discharge pipe—for areas, where the drain is near the surface, *short*; for yards, where the drain is usually several feet below the surface, *long*.

The entrance to every gully trap should be protected with a grating or perforated lid, opening outwards to allow the trap to be readily cleansed.

Every trap should be set level, and securely jointed to the drain it is to guard.

CHAPTER IX.

Decoration and Furniture.

Decoration of Room Walls—Panelling—Colouring in Oil and Distemper—Hanging with Fabrics—Paper-hangings—Design and Colour—Varnished Papers—Poisonous Papers—Flock Papers—Putrid Paste and Size—Floors—Parquetry, Floorcloths, and Mattings—Carpets and Rugs—Ceilings—Cornices and "Centres"—Ceiling Papers—Furniture for Use rather than Ornament—Rooms not to contain too much—Pictures—Furniture required for Hall, Living-rooms, and Bedrooms—Curtains.

In a well-decorated and well-furnished room no colour or object should force itself on the attention with undue emphasis. Especially should the decoration of walls, ceiling, and floor be modest and retiring, that they may take their place as a sort of background to the objects in the room. If walls, ceiling, and floor are loaded with colour, or the pattern on them is too large and staring, they will destroy the good effect of beautiful furniture and well-chosen works of art.

Walls of rooms, halls, staircases, and passages may be decorated in various ways. They may be panelled with oak, pitch pine, or other ornamental wood. They may be painted in oil-colour, or in distemper (the colour being mixed with size, glue, white of egg, &c.). They may be hung with some decorative fabric, or covered with a paper-hanging.

Panelling is well suited for the hall and dining-room, but the woods used for the purpose are commonly too dark. As the mouldings afford lodgment for dust, panelling requires exceptional care to keep it clean. The hard woods best adapted for panelling being costly, rooms are sometimes lined with deal or other soft wood, which is stained and varnished or painted, but such woodwork is far more liable to perish, and the result is not satisfactory. Colouring in oils or distemper cannot be recommended generally. The rooms of a new house may be coloured in distemper for a year or two till they are thoroughly dry, but a surface thus treated has somewhat of an unfinished look. The objection to oil colour is that it interferes with the porosity of the walls, and forms a surface on which, under certain conditions, the moisture condenses. Then a single flat tint is not pleasant for the eye to rest on, and seems to require to be well covered with pictures or otherwise. Hanging with ornamental fabrics is, perhaps, from an artistic point of view, the best embellishment for a wall. It does not interrupt ventilation, as there is a passage for air through it and behind it; it is as easy to dust as any other wall covering, and from time to time it can be taken down and cleaned thoroughly. These fabrics are not unhealthy. Indeed, it is difficult to account for their not being in more general use. Their day may come yet.

In nineteen houses out of twenty the wall decoration of the rooms in the first instance is coloured paper-hanging; and most people are well satisfied that it is so. Before entering on the consideration of the selection of paper, it may be necessary to caution incoming tenants that, before occupying a house, they should see that all old papers are thoroughly removed and the walls washed down. However artistic and clean-looking the last tenant's paper may be, there is no security that it may not harbour disease germs; it must be stripped off, and the walls beneath must be washed, along with the floor, woodwork, and ceiling.

In choosing a wall paper one takes note of patterns and colours. In respect of patterns there is little to be said. The paper should be well covered, yet the design should not be too intricate, and the objects, curves, and lines forming it should be of themselves beautiful. Nothing in the designs should be too obtrusive, as rounds and lozenges that seem to want counting. The pattern also should bear some relation to the size of the room—even a moderately-large pattern requires a moderately-large room, and a bold handsome design suitable to a large room will dwarf a small one. There are as good small patterns as large ones, and there is no reason why a design on a small scale should not have fulness of vigour.

What is to be the guide as to colour? Nature, obviously. Does she use pure primary colours? But sparingly. Mainly the colours she uses are modified and subdued by shadows and by the effect of the interposing atmosphere. Then the broad range of vision, when one looks on Nature, takes in so many hues that they tone down each other. The colours of a wall paper should therefore be subdued, and, like all Nature's colours, harmonious. For most rooms light-reflecting colours are required, not light-absorbing colours; that is, having but little sun in this country, it is desirable to make the most of it. A good wall paper may have many tints; that in which the warm tints predominate is best suited to the cool room; that in which the cool tints predominate is best suited to the warm room. In town houses, surrounded as they are by dull grey, stone colour, and dirty white, a fairly bright wall paper is generally desirable. In colouring a dado or freize, the shades and tints occurring in the wall paper should be used and should be in nearly the same proportions.

Varnished papers, sometimes advocated as being washable and on this account specially sanitary, are not to be commended. They interfere with the ventilation through the walls of a room as no other papers do, and moisture condenses on them.

Poisonous Paper-hangings are not now anything like so common as they were some years since, when the danger to health incurred by their use was pointed out and discussed in the daily papers. The pigment in paper hangings which appears to have been most injurious was emerald green (aceto-arsenite of copper), and modern taste does not favour the use of colours as bright as this. There were also other bright pigments only slightly less injurious, such as the beautiful colour known as king's yellow (sulphide of arsenic), vermilion (sulphide of mercury), and a form of cobalt blue (arseniate of cobalt). But some of the tertiary colours and subdued shades most affected at present may be produced by combining pigments, some of which are poisonous, as red lead (oxide of lead), chrome yellow (chromate of lead), flake white (a mixture of carbonate of lead and hydrate of lead, verdigris (acetate of copper), and perhaps also verditer and green verditer (both being hydrate and carbonate of copper). Indeed, there are few tints, not excepting lilacs and greys, that may not contain arsenical or other poisonous colours. However, most good manufacturers of wall-papers avoid the use of all such colouring matter, and guarantee that their goods are innocuous. If there should be any doubt a strip of paper can be easily tested. A paper good in design and colouring need not be dear. On the other hand, some of the papers proved to contain most injurious pigment have been very high-priced ones.

Flock papers are not much in vogue now, but householders are sometimes tempted to buy them, as they look warm and seem to clothe the walls better than other papers. They are objectionable for two reasons—the pattern stands out in relief, attracting dust, which is difficult to remove, and the flock becomes tainted, absorbing the watery vapour from the breath. Most flock papers being dark, absorb the light as well as the breath, making the room dark as well as stuffy.

The paper-hanging of a room may be unwholesome from yet another cause—the workmen who put it up having used putrid paste. It is a familiar experience that the paste is often sour and commencing to go bad, occasionally it is in a state of active decomposition. If the adhesive material employed is size or blood-albumen, its being bad causes an effluvium there is no mistaking. Any putrefactive odour in a newly-papered room should at once arouse suspicion. Cases are on record where violent sickness and prostration have arisen from this cause. There can be no excuse for using paste or size not sound, for the addition of a little boracic acid or other simple antiseptic will keep them in good condition.

Floors.—The decoration of floors is a far simpler question than the decoration of walls. For dining-rooms especially, and also for most sitting-rooms, there is no floor decoration to surpass oak parquetry. It may be laid down on any floor at about the cost of a good carpet. A parquetry floor, or a plain oak floor, is the most cleanly and healthy, and is easily kept in good condition with turpentine and beeswax. There is no reason, however, why floors of pine, larch, or even deal should not be polished with the same materials. A smooth polished floor is non-absorbent, and turpentine is itself a good disinfectant. As such floors are slippery, it is well to cover the centre with some light material, even in summer. For a dining-room the old-fashioned linen crumb-cloth, in patterned buffs or greys, is suitable. For most other sitting-rooms nothing looks better than Indian matting, with simple designs in self-colour and red or self-colour and blue.

In the winter something warmer is required, but in no case should the floor-covering be a carpet fitted to every corner of the room and nailed down. The best winter carpets for comfort and decoration, and the most cleanly, are the Eastern rugs and central carpets. The finest quality of such goods are costly, but not dear, for they wear so well. A good quality can be obtained at very moderate prices. The patterns are always in good taste, and the pigments are never raw or vulgar, and will harmonise well with artistically decorated walls and good furniture.

Ceilings.—It has been already stated that a really healthy house is better without ceilings—that the wooden joists with the under surface of the floor above (polished or painted) form a cleanly and suitable roof to a room, and that this, if not beautiful, is less ugly than the conventional whitewashed ceiling. The objection to the ceiling is that it is like a whited sepulchre, covering a cavity full of uncleanness. However, as most houses are constructed with ceilings, and it must take many years before public opinion is enlightened enough to get rid of them, a few words on ceiling decoration may not be out of place. The decoration ordinarily consists of a cornice with floral design in deep relief, and a central piece—an arrangement of acanthus leaves or similar device, in deep relief. Both these afford abundant lodgment for dirt and dust. The central piece should be done away with, and the cornice should be moulding of the simplest pattern. The whitewashing, which is inartistic and trying to the eyes, should be toned with buff or light red, or should not be used at all, the ceiling being papered instead. Special papers are now designed for ceilings. The colour and design should be less pronounced than in the wall paper, and harmonise with it. The cornice may be coloured in two or three light tints selected from the wall and ceiling papers.

Furniture.—It will not be practicable to enter much into detail with reference to furniture. Still, a few guiding principles may assist the householder in choosing wisely. Remember, first, that furniture is for use rather than decoration; therefore it is essential that it should be strong and well made and serve that use effectually. The several parts must not be merely glued together, but mortised, or dovetailed, or screwed together. It must be of sound material, have no flaws or cracks, and be made and finished in a workmanlike manner. It should not be merely coated with French polish, but hand polished, so that it may be washed and rubbed up periodically. Recesses and spaces beneath the windows may be utilised for seats, and corners for cupboards, thus reducing the amount of movable furniture required and economising space. The defect in most rooms, both as regards comfort and appearance, is that they are overcrowded with furniture, and to make matters worse, little, trivial, useless things are added year by year, till in the drawing-room every surface is covered with gewgaws, and in the dining-room is a medley of meaningless *bric-à brac.* This is not decoration in any true sense. Some, doubtless, think that because they no longer decorate their rooms with wax flowers and fruit under glass shades, and stuffed birds and large sea-shells, they show better taste than their parents; as if anything could be uglier than large models of insects (made of gum and wool in staring colours) on the mantelpiece, and the cup and saucer, mounted on plush, fastened to the wall! Such childish trifles should be relegated to the nursery, and a few pieces of artistic furniture of good design, and made for use, will have some chance of being effective. Of course, they should be in proportion to the size of the room, and the best position for them should be carefully thought out. If it be found that the walls look bare in any of the rooms, and are amply lighted, there is the place for pictures. A room may be thoroughly well furnished and decorated without pictures, but there are no other objects which give such breadth and interest to a room. For a dining-room pictures in oils are well suited, in other rooms water-colour drawings or prints are more appropriate. Indeed, a room well furnished and decorated should be like a picture—it should be in proportion, the objects in it should be beautiful, they should form masses of light and shade, giving due value to the whole, the colours should harmonise, and the composition should be artistic. Such an apartment is pleasing to the eye, restful to the mind, grateful to the whole man or woman, as well as cleanly and healthy in no ordinary degree. Nor is it the money spent in furnishing and decorating that makes a room as described. It may happen that where most money has been expended, the least satisfactory results have been obtained. There is no reason why a room in a small villa or a working man's cottage should not be a picture. If the tenant has the taste and knowledge he can make it so at an outlay of a few pounds.

The furniture required for a hall will generally be a "settle" or form, a small table, and an umbrella stand. If the hall be large, a couple of chairs may be required as well. A hat-stand is not needed, and having one leads to hats and coats being always left in the hall.

The furniture for a dining-room is ordinarily a table, with leaves to lengthen it, a side-board, and a dozen chairs. A corner cupboard is a convenience, and, if there be space for them, two easy chairs add much to the comfort of the room. In very small dining-rooms a light buffet or dinner-wagon may take the place of the sideboard.

The furniture in the drawing-room should include one sofa, and not less than a dozen other seats (unless the space be too limited), a piano, a cabinet, a writing table, and one or two small occasional tables. A folding screen is ordinarily required now, and the room is often improved by a supermantel.

The library needs little furniture besides the bookcases. A writing-table with drawers, four chairs, and two easy chairs, will usually be furniture enough. How the *boudoir*, or morning room, should be furnished will depend on how it is to be used.

The furnishing of the bedrooms deserves a little special attention. Iron or brass bedsteads are preferable to wooden ones, being more cleanly, and occupying less space. The best mattresses are of woven wire or similar material, and over them should be placed thin beds stuffed with curled hair. The bedclothes should be warm and light, and should not extend over the side of the bed more than ten or twelve inches. No boxes or boots or other things should be put under the beds. There should be a free passage for air under every bed. A washing-stand, wardrobe, and chest of drawers are furniture enough for any bedroom, and the wardrobe should not have its height increased by a tall cornice having behind it a receptacle for dust most difficult to clean. A dirty-clothes basket should not form part of the furniture of any bedroom.

Curtains in all rooms should be of rather light material, and should never trail on the ground. In bedrooms they should be dark enough in colour to keep out the light, and only slightly longer than the window. Curtain fabrics should be of a colour that will stand the sun and wash well. They should be fastened to the rings in some simple way, to allow of their being taken down frequently for cleaning.

CHAPTER X.

Stables, Cowhouses, &c.

Stable Space required for each Horse—Lighting and Ventilation—Walls, Flooring, and Drainage—Fittings—Coach-house, Harness, &c.—Washing-yard—Cowhouse—Space Required for each Cow—Arrangement in Large Cowhouses—Drainage—Lighting, Ventilation, &c.—Dairy and Scullery—Piggery—Space Required for Swine—Fowl-house—Pigeon Cote.

Not far from the healthy home, in the rear, there will often be stables and perhaps other houses for the accommodation of animals or fowls. A short chapter on the conditions required in respect of such outbuildings may therefore be useful. In all it is important that space enough should be provided, good ventilation and lighting, and drainage, so that the inside of the building may be kept free from effluvium nuisance.

Stable and Coach-house.—The minimum superficial space which should be allowed for each horse has been set down as 100 square feet; and the minimum air space has been set down as 1200 cubic feet; but this seems rather excessive. A stall is commonly made 9 feet long by 6 feet wide, and except it is intended for a very large horse, there is no advantage in having it larger. Giving access to the stalls is the gangway, which is certainly large enough if 5 feet wide. Thus, a stable having 84 square feet floor for each horse to be accommodated is not unreasonably small, and if the mean height of the stable be 12½ feet there would be 1050 cubic feet of air space for each horse—a fair minimum amount.

Stables should never be built of wood, but of brick or stone. They should be lighted by cross windows, the lower part of the windows being 5½ feet from the ground. A convenient size for a window is about 3 feet by 3 feet. This may be swung in the centre or divided into an upper and lower sash, each swung in the centre. Besides the windows, air bricks should be inserted in the walls just above the floor and just below the eaves of the roof, and there should be a ventilator at the top of the stable, extending from end to end, made by raising the upper part of the roof on supports, and introducing louvre boards on either side.

The handsomest lining for a stable is glazed tiles or glazed brick. However, the material should not be white, but buff or grey. Similarly, when the stable is built with ordinary brick and lime-washed, a little colouring should be added to tone the dead white, which is trying to the horses' eyes. The best flooring for a stable is made of very hard brick or stone setts. The drainage should be by means of channels on the surface. The main channel should run along the back of the stalls, and a channel down the centre of each stall deliver into it. The contents of the main channel should be conducted through a hole in the wall on an open gully outside. The stable floor should be made to fall to the channels, which may be of hard stone or iron. The doorway should not be less than 4 feet wide and 7½ feet high.

The fittings should be of iron, painted or coated to prevent rusting. The troughs and mangers should be enamelled inside. The boarding between the stalls should not reach to the floor. An inch or so of space below improves the ventilation and facilitates the cleaning of the stable. If one of the stall divisions be made to remove, a loose box can be readily extemporised.

The coach-house should be of brick, glazed inside or plastered. Cement probably makes the best floor. If there be a loft above, the floor should be tongued and grooved to keep the dust from coming through. The harness-room should be boarded round and provided with a stove. Coach-house and harness-room should be ventilated with air-bricks. By the coach-house should be a paved yard for washing, draining to a properly trapped drain. There should also be a water-supply pipe near at hand. A stable midden should be provided, made of brick or stone, lined with cement and drained. The bottom should be on a level with the ground, and the whole area of the midden-stead should not be more than 4 feet by 4 feet. The situation chosen for it should be as remote as practicable from the door or windows of the stable, coach-house, &c. No room should be placed over a stable, and no sleeping-room should adjoin a stable.

Cowhouse and Dairy.—The minimum superficial space usually allowed for a cow in regulations made by local authorities under powers given them by the Dairies, Cowsheds, and Milkshops Orders, has been about 54 square feet, and the minimum air space has been about 600 cubic feet. A stall should be made not less than 8 feet long by $4\frac{1}{2}$ feet, and the passage along the cowhouse giving access to each stall should be not less than 4 feet wide. This would allow 54 square feet for each cow, and if the mean height of the cowhouse were $11\frac{1}{2}$ feet, there would be 621 cubic feet of air space for each cow. This may seem rather a small minimum amount, and is so, yet it is double the amount actually provided in many old-fashioned cowsheds still in existence. Latterly, in many districts, the minimum air space for each cow has been fixed at 800 cubic feet.

Cowhouses should never be built of wood, but of brick or stone, and should have a passage through and entrance at each end, to facilitate ventilation.

The double cowhouse with two parallel rows of stalls is sometimes arranged so that the cows have their heads to the wall, and sometimes so that they have their heads towards the central passage. If the cows have their heads to the central passage, another gangway at each side against the wall is required, and the floor would drain right and left to a channel by each gangway. If the cows have their heads away from the centre, the floor would drain to the centre. The channel or channels should be open, and the contents conducted through a hole in the wall on an open gully outside. Not as much light is required as in the case of horses. Long windows, 2 feet broad by 1 foot high, seem suitable. Wide doors at each end, which can often be left open, will help to keep the cowhouse well aired, but there should also be a roof ventilator near the ridge extending from end to end, as in a well-ventilated stable.

The flooring should be of very hard brick or other non-absorbent material. The walls should be whitewashed and the under part of the roof, and it is well to have the lower part of the walls, to a height of 4 or 5 feet, coated with tar. The fittings are generally of hard wood. Iron troughs enamelled inside are the best. If two of the stall partitions be made to remove, two stalls double the ordinary width may be arranged for cows during and after calving.

If a dairy is required it must be well ventilated and sheltered from the sun. It should be built of brick, if possible, with glazed lining. The floor may be of flags, or tiles, or cement. Shelves of slab slate should be provided. Adjoining the dairy should be a scullery for cleansing the dairy vessels, having a service from the main, and a hot-water boiler. A stand-pipe should be provided for the supply of the cows. A middenstead should be provided of brick or stone lined with cement and drained. The situation should be as remote from the dairy as practicable.

The manure should be removed at least once a month.

Piggery.—This, like the cowhouse, should be substantially built of brick or hard stone, and the low enclosing wall should be of the same material. The sty may be conveniently ventilated by several holes, the size of half a brick, back and front, and placed high up. The floor and enclosure adjoining each sty should be paved with some hard impervious material, having a smooth surface, and draining to a channel delivering on a gully trap. The trough should be of stoneware or enamelled iron. The sties and enclosing walls should be lime-washed at regular periods.

The air-space in pig-sties is often very small, and relatively much smaller than the air space allowed for other animals. The entrance to the sty having no door, if the ventilating holes at the back are sufficient, the air in the sty is soon changed. Still no amount of ventilation will justify overcrowding. Generally, it may be said that a pig of a year old or upwards should be allowed not less than 30 cubic feet of air-space.

Thus, a sty measuring 4½ feet by 4 feet, and 3½ feet high, would be suited for the accommodation of not more than two swine.

Fowl-house.—Commonly some small wooden erection is made to serve for lodging poultry, or a house is built of rough boards for the purpose, and the fowls put therein are not kept in a cleanly or wholesome manner. The fowl-house should be built of brick or hard stone, ventilated by a louvre-ventilator at the top of the roof and by air-bricks in the walls. The floor should be of cement or other impervious material, having a slight slope to a channel delivering on a gully trap outside. The walls inside should be lime-washed at regular intervals of time, and the floor should be washed and sanded one or twice a week. The poles placed across for perches should be of hard wood, and so arranged that the perched birds shall not foul one another. Fowls should be liberally supplied with clean water in a glazed or enamelled trough. A separate compartment should be provided for sitting hens, properly supplied with comfortable nests.

Pigeon-cote.—Something might be said about housing pigeons in a more cleanly, healthy way than is usual, but pigeons being kept at all is almost necessarily an insanitary practice, except when there is room enough round the house to give the pigeons accommodation a very long way off. Even when the pigeon-cote is at some distance from the dwelling-house, the pigeons foul the walks round the house, the yard in rear, the linen hung to dry or spread to bleach, and the roof, choking the gutters and rain-spouts. It is therefore not unreasonable to hold that he who would have a healthy, cleanly house should not keep pigeons.

CHAPTER XI

HOW TO KEEP THE HOUSE CLEAN.

Methodical Supervision—Where Dirt comes from—Cleaning Bedrooms—Morning Airing—Dusting—Cleaning Sitting-rooms—Sweeping—Cleaning Hall, Passages, Staircase, &c.—Cleaning Kitchen and Scullery—Cleaning Saucepans, Knives, and Forks, &c.—Blackbeetles—Cleaning Larders, Cellars, &c.—Spring Cleaning.

A GOOD deal has been already said incidentally on the necessity of keeping every part of the house clean. However well planned and constructed the healthy home may be, however well warmed, ventilated, fitted, and furnished, unless it be kept clean it cannot remain healthy. This business of cleaning is for the housewife to attend to; and to be done well the housewife must have full knowledge of what is required, and must work and supervise methodically, regularly, and almost continuously. Keeping the house clean is a very different thing from having a periodical cleaning of a dirty house. Whether the staff under her be large or small, the housewife must utilise to the full all the skill and labour at her command, like a practised general, assigning each task to the person who can best perform it. She will then know who is responsible in case of neglect or failure. Since prevention is better than cure, much will be accomplished in preventing dirt being deposited by inculcating cleanly habits.

In answer to the preliminary question—whence comes the dirt in a house?—it may be said that it is mainly derived from three sources, viz.—

(1) From living human beings,
(2) From fires and artificial lighting, and
(3) From outside the house.

It follows that the occupied parts of a house get more dirty than the unoccupied parts; that, other things being equal, a house gets dirtier in winter than summer, and dirtier in towns, where the outside air is impure, than in the country. It is scarcely necessary to point out that the dirt from living human beings is the most injurious, and that therefore the rooms which require to be kept most scrupulously clean are the bedrooms. The first consideration for the housewife is—

How to Keep Bedrooms Clean.

The occupant should turn the bed-clothes, one after the other, over a pair of chairs, and open one window at least (top and bottom) before leaving the room. A housemaid should be instructed to go to each bedroom as soon as vacated, and if the occupant has not done his duty in this respect to do it for him. The bedclothes will thus be aired and dried, especially the two sheets, which, coming next the body, absorb much of the moisture given off by it. Once or twice a week, on a sunny morning, the bed should be turned over on chairs, and aired for two or three hours. It has been wisely said that people are fidgety enough about the danger of *clean damp* when the sheets come from the wash, weekly or fortnightly, but indifferent to the danger from *dirty damp* which menaces them every day.

When, after breakfast, the maid begins to put the bedrooms in order, the room and bedding will be aired. She brings with her a slop pail, which, if scalded after use, and kept dry and open, is not offensive; a can of hot water with a little soda or potash or dry soap; a small scrubbing brush, and three cloths—one for the carafes and tumblers, one for the basins, ewers, &c., and one for the chambers. It is well to have these cloths of different colours (say, pink, buff, and blue), so that there is no possibility of mistaking one for the other. Carafes, tumblers, basins, ewers, sponge bowls, brush dishes, soap dishes, waste pails, baths and chambers, should be washed daily. For the chambers hot water and soda, potash, or dry soap should be used, and if cleansed carefully they will not become furred or offensive in any way. When all slops are removed, and all utensils cleansed, the housemaid washes her hands and changes her apron, and proceeds to make the beds. The thin bed or mattrass of curled hair, which is all that is needed if a woven wire mattrass be used, should be turned daily. It should be buttoned up in a cotton cover, which can be washed when necessary, and will keep the tick clean. Sheets and pillow cases should be changed once a week, or at least once a fortnight. Blankets, inasmuch as they are well covered, and not actually in contact with the body, will not need washing more frequently than once a quarter. The iron bed should be dusted daily with a damp cloth, and thoroughly washed with soap and water once a quarter. The room should not be dusted till after the bed is made.

The requisites for dusting are a dry cloth, a damp cloth, and a dusting brush. The housemaid should go right round the room and over it, dusting every article she comes to. In dusting a mantelpiece or table, all articles on it must be removed to permit it to be dusted thoroughly, and then the articles must be dusted one by one and replaced. Having one cloth damp is to ensure that the dust is really taken up and not sent flying to some other part of the room. The dry duster, which is used after the other, or for things a damp duster should not touch, should be well shaken out of the window from time to time. The polished or painted floor should be dusted with a damp cloth all over; and the one or two light rugs on the floor should be shaken daily—of course outside the house. Once a week the walls should be carefully rubbed down, and the room swept. The last duty of the servant with reference to the bedrooms is to fill the ewers and carafes, and close the doors. It is absolutely essential that the carafes be filled from the *main* tap, and it is desirable that the ewers also be filled from this tap.

It is well to give the blanket an airing once a week in the open air. The curtains also, which should not be sewn but hooked to the rings, should be taken down, brushed, and shaken once a week. If bed curtains and vallances are provided they should be treated in the same way; but neither bed curtains nor vallances are needed or useful.

As ordinarily the bedroom fireplace is not in use it will not need to be black-leaded oftener than once a month. Of course, it and the fire-irons and fender should be dusted daily, and the flue should be left open.

How to keep Sitting-rooms clean.—Sitting-rooms should be aired the first thing in the morning. As soon as the shutters are opened the windows should be opened, above or below, except when, owing to a thick fog or heavy rain, this would not be expedient. It is a good practice to begin the cleaning at the fireplace. The housemaid should spread her canvas cloth in front of the hearth, and after moving the fender and fire-irons on this, the hearth should be swept, and cinders and ashes raked out and put in a pan to be sifted. The hearth should then be wiped over with a damp cloth, and the fireplace black-leaded. The lead should be well wetted, and very little put on. The polishing should be done with a separate brush. The fender and fire-irons require rubbing up and some parts require black-leading. When the fireplace is not in use it will only require an occasional blackleading. However, it is well to rub it up with a polishing brush two or three times a week.

Sitting-rooms often have central carpets and rugs which are too heavy to be shaken frequently. About once a month will be often enough. These will require to be carefully swept daily with a carpet brush. Tea leaves rinsed in clean water and gently squeezed may be scattered over the carpet. The housemaid should sweep in one direction (as regards some carpets there is only one direction in which they can be swept properly), taking up the dust in a dust-pan, and burning it at the back of the kitchen fire. Wet tea-leaves should not be thrown into the ash-pit. The polished or painted part of the floor should be carefully dusted with a damp cloth. At the same time the whole room and contents should be carefully dusted. One of the most troublesome things to dust is a venetian blind. Inasmuch as it is almost impossible to keep these blinds clean, and they are heavy and costly and soon get out of order, it is better to provide simple blinds made of linen or glazed cotton, which may be had printed in neat artistic patterns. Curtains should be unhooked from their rings weekly, and dusted and shaken.

Gasaliers, pendants, and brackets should be dusted daily, and if in use will require washing with soap and water once a month. Globes should be wiped daily with a damp cloth, and washed with soap and water fortnightly. To keep lamps clean and in order requires a great deal of attention, and as long as they are in use this will take considerable time daily. Mineral oil is so penetrating that it comes through glass and through some metals. In cleaning colza oil lamps a little paraffin is very useful.

In rubbing up the furniture, let the housemaid be sparing in the use of "cream" or any other preparation. It is the rubbing rather than the stuff rubbed on that makes the furniture look well. Furniture should be washed with soap and water once a quarter. Mirrors should be washed once a fortnight. A little spirits of wine will remove the fly-marks.

Windows should be cleaned with wash-leather at least once a fortnight. This should not be done on a windy or rainy day, or in very bright weather. Of course, the woodwork of the windows should be cleaned as well as the glass.

How to keep Hall, Passages, and Stairs clean.—The hall is generally tiled or covered with linoleum or oilcloth, and this is very easily kept clean by rubbing it over with a wet cloth, and afterwards with a dry one, the first thing every morning. Door-mats should be shaken outside the house daily, and strips of cocoa-matting or other passage-covering should be so treated weekly. The hall and passage should be well dusted daily, and the walls rubbed down once a week. The knocker, bell-handle, door-handle, &c., if of brass, should be polished at least every other day—pieces of flat metal cut out to fit round the mounting being used to keep the polishing paste from soiling the door. All the doors and panelling should be dusted daily, and regularly washed once a month.

The staircase should be swept from the top downwards before the hall is dusted. The housemaid should sweep into a dust-pan, using a short-handled staircase brush with tufts at the end for reaching out-of-the-way places. The stair-rail and banisters should be dusted daily. Stair carpets should be shaken and beaten outside once a month, and the rods cleaned and the stairs washed.

Water-closets, though designed to be self-cleansing and work smoothly, will yet require some attention daily. It must be someone's duty to see every morning that all the apparatus, especially the basin, is scrupulously clean; that the flushing cistern is in good working order, and that the closet is well aired. No trust should be put in deodorants or disinfectants—a properly kept closet requires nothing of the kind.

Baths should be washed every time they are used.

All brushes and dusters must be regularly washed Brushes should be put away with the hair upwards.

How to keep the Kitchen and Scullery clean.—The first duty every morning is to remove and sift the cinders and ashes, and clean the range. The flue should also be cleaned with a brush as far as possible. The oven should be brushed out, and the oven floor and shelves scraped and washed when soiled with food. The hearth should be washed and whitened, and the fender and fire-irons should be rubbed bright, emery paper being used when necessary.

The range boiler should be cleaned out weekly, and the boiler in the fire-back (which requires a workman to clean it) should be cleaned once a year. Unless this is done, its capacity for heating will be very much diminished by fur The kitchen and scullery floors should be swept daily, and washed twice a week. Any rug or matting thereon should be shaken daily, and once a fortnight scrubbed with soap and water, and rinsed and hung to dry in the open air. It is better to do without matting in the kitchen. The kitchen table and scullery table should be washed daily; the dresser shelves and cupboards once a week. Sand is of great assistance in washing the kitchen and offices, and where there are grease stains a little fuller's earth may be used. The sinks should be scrubbed daily with soap and hot water, and the brasswork regularly cleaned every second day. As soon as the morning cleaning is over, the kitchen should be well aired.

The walls should be rubbed down every fortnight, and the surface of walls and ceiling should be re-coated every year.

With regard to kitchen utensils, knives, forks, &c., the main rule is to clean them as soon as possible after they are soiled. If attention is paid to this, things will clean easier and wear longer. Saucepans or jugs or tins that cannot be cleaned at once should be filled to the brim with water and remain full till attention can be given them. Plenty of hot water should be used in washing them, with the addition of a little soda when grease has to be removed. Knives and steel forks should be wiped and put in a jug of hot water and soda (the handles not being immersed) for a few minutes, and then taken out and cleaned with bath brick or other material till bright. The handles should be cleaned with a wet cloth and dried at once. Silver and plated goods should be washed clean after using, and regularly cleaned with whiting or plate powder once a week.

Plates, dishes, &c., should be washed first with hot water and soda, and then well rinsed in clean water. Glass should be washed with warm water, carefully dried, and polished with a leather. All dish-cloths, &c., should be washed after use and hung in the open air.

No blackbeetles should appear in a kitchen supervised by a cleanly housewife. Every little hole in the wall and floor should be filled up, so that blackbeetles shall have no way in and out of the kitchen. When any are found, a little powdered hellebore scattered in the corners and in cupboards will soon get rid of them.

Larders, and any cellars or rooms in which food is kept, should be visited daily, so that portions of unsound food may be noticed and destroyed. The floor and shelves of the larder should be washed weekly, and the walls and ceiling should be lime-washed at least once a year. Cellars also should be visited once a week and cleaned out when necessary. They should be lime-washed once a year.

Cisterns should be thoroughly cleaned out once a quarter.

The traps round the house on which the rain-spouts and waste-pipes discharge should be carefully cleaned out and refilled with fresh water at least once a week. Grease traps require to be cleansed daily. Once a year the valleys of the roof and the gutters and rain-spouts should be examined, for sooner or later they are sure to get choked.

Spring Cleaning, when a house is kept clean all the year round, is divested of much of its importance; still it should not be neglected. However exact the rules laid down for daily cleaning, however industrious the servants and intelligent the supervision, it is well that a house should be overhauled from cellar to attic at least once a year. Facilities for emptying any room and cleaning and airing are given, and extra service is hired, and the most should be made of the opportunity. It is impossible to lay down any rule as to how often chimneys should be swept, so much depends on the number of the fires and the nature of the coal used. Still one rule is safe to insist on—that at the spring cleaning (just when fires are for the most part to be discontinued) every chimney in the house shall be made clean. Then if the rooms have ceilings, they should be repapered or whitewashed at the spring cleaning. Wall-papers at this time should be thoroughly cleaned all over with the crumb of bread. Floors, wainscots, panelling, doors, and all woodwork should be well washed. Cup-boards, drawers, boxes, &c., should be emptied and washed. Bedsteads, if of wood, should be taken to pieces. Stuffed seats should be well beaten and freed from dust. Carpets, after being beaten and shaken, should be drawn over clean grass with the face downwards. Cellars and attics should be thoroughly cleaned out, and all accumulations of lumber got rid of. It is quite possible to get the spring cleaning done with the family at home, not more than two or three rooms being cleaned at a time. However, the work is perhaps better done when the family is away for a short holiday.

CHAPTER XII.

OBLIGATIONS OF HOUSEHOLDER AND SANITARY AUTHORITY.

Rates and Taxes—Gross Value and Rateable Value—Poor Rates, Boro' Rates, &c.—Gas and Water Rates—Land Tax and Property Tax—Landlord and Tenant—Taking a House—Warranty—Examination by Sanitary Expert—Conditions of Tenancy—Leases—Yearly Tenancies—Fixtures—Some Provisions of the Public Health Act—Right of Drainage into Public Sewers—House Drains. Drains, &c., to be properly kept—Examination of Drains, &c.—Removal of Refuse—Quine's House - refuse Receptacle—Filthy Houses to be Purified, &c.—Abatement of Nuisances.

THE legal position of a person taking a house, the usual conditions of tenancy, &c., and some of the more important duties of the local sanitary authority with reference to him, are subjects in which every householder is bound to be interested. It may be well, therefore, that they should be touched on briefly in this final chapter. A few words on house rates and taxes, and the principle on which they are assessed, may also furnish useful information, and appropriately introduce the other subjects.

Rates and Taxes.—Imperial taxes represent moneys exacted from the individual for the service of the State; rates represent moneys exacted for the purposes of the locality in which the individual lives or occupies premises. However, many State charges are paid for out of the local rates, and many local necessities are paid for out of the Imperial taxes.

Gross Value and Rateable Value.—The gross value, on which Imperial taxes are assessed, is the rent without rates and taxes, even though they are paid by the landlord. The rateable value, on which local rates are assessed, is the gross value, less repairs, and insurance. If, however, the rent paid, as may often happen, under a lease for a long term, is less than the fair rental value of the premises at the present, the authorities, in making their assessment, will be guided by the actual value of the property rather than the rent paid.

Poor Rates, Borough Rates, &c.—The money raised by the poor rates not only provides for the relief of the sick and aged poor and the maintenance and education of destitute children, but for the registration of births and deaths, &c., and the enforcement of compulsory vaccination. By means of poor rates, borough rates, county rates, police rates, &c., the principal advantages of civilised life are obtained: that is to say, lighting and watching, water supply, paving, sewering, cleansing, and repair of roads and streets, the execution of sanitary regulations, the supervision of the food supply, the provision and maintenance of public baths and wash-houses, hospitals for infectious diseases, disinfecting houses, mortuaries, public cemeteries, &c.

Lighting and Water Rates are not really rates, but charges made for goods supplied. Gas rate is merely the price per 1000ft. the gas is charged in the district. In some districts the water also is charged for in quantity, as measured by meter, but usually the charge is assessed upon the annual value of the house supplied. From a sanitary point of view this is a more satisfactory way of charging for water than by meter. Services for a garden, a carriage hose, &c., are commonly charged extra.

Land Tax and Property Tax.—Though the tenant is bound to pay both these taxes in the first instance, he is entitled to deduct them from the rent. However, if a tenant binds himself to pay all taxes generally, or to pay his rent free and clear from all manner of taxes, he will not be able to deduct money paid for land tax from his rent.

Landlord and Tenant.—The landlord is the person receiving the house rent, the tenant the person who pays. Thus the landlord may be, and often is, tenant of the real owner of the house, or there may be several persons who are thus both landlords and tenants between the actual owner and the actual tenant.

Taking a House.—If a tenant takes a house with sanitary defects he does it at his own risk, and when the defects cause injury to him or his family it by no means follows that the landlord is liable in respect of the injury, or that the tenant can cease to occupy without giving the usual notice. Decisions have been given that the landlord, in letting a dwelling-house, is presumed to let it in a habitable condition, and other decisions have been given that the landlord incurs no responsibility for the sanitary condition of his house. The tenant of a furnished house is in a somewhat better position, as it is held that anyone letting a furnished house does so under the implied condition that the house is fit to be inhabited.

Warranty. — If the landlord gives a warranty that the house is fit for habitation, he is responsible. It follows that the tenant should always require such warranty, and lest there should be any doubt with reference to the terms of the warranty, it is better to have it in writing. Still, as the most a warranty can do is to enable a tenant to recover damages for injury, and a tenant's main object will be to prevent the injury, he should, if possible, obtain a *certificate from the local authority* that the sanitary condition of the premises is satisfactory. Only a few local authorities grant such certificates, and if there is no means of getting the landlord's warranty supported by the official certificate, the tenant should get the house examined by a competent independent expert.

Examination by Sanitary Expert.—Of course the expert employed can only obtain access to the premises by consent of the landlord. Whether the report be favourable or otherwise, the tenant must pay the cost of the examination. If the expert specify that before the house is in a sanitary condition certain work will require to be done, a statement of the requirements should be furnished to the landlord, and the tenant will do well to refuse to sign any agreement or enter into possession till the expert he has consulted certifies to him that the work required has been done. If it were required that all dwelling-houses without distinction should be reasonably fit for human habitation, tenants would be in a much more satisfactory position than they are.

Conditions of Tenancy.—The bases of agreements between landlord and tenant are that the landlord gives possession in consideration of rent, and that the tenant pays rent. Who is to keep the premises in repair and pay insurance, and who is to pay rates and taxes, is according to agreement. Usually, when the property is let by the week or month the tenant makes himself liable for nothing but the rent. In an annual tenancy, or a tenancy for a period not exceeding three years, the tenant usually pays the rates and taxes, and the landlord keeps the premises in repair and pays insurance. In leases for longer periods than three years it is common for the tenant to agree to keep the premises in repair and pay insurance, rates, and taxes. However, this is not a covenant a tenant should enter into, as he thus binds himself to have the premises in repair at all times during the term, and if they are out of repair any single day he may be made liable for breach of covenant, and perhaps also have to pay a claim for dilapidations. Indeed, a tenant being under a covenant to repair and keep in repair the house he occupies, if it should be burnt down would have to re-build it at his own cost, and continue to pay the rent as if no fire had occurred. When the tenant is willing to agree to keep the premises in repair his covenant should contain such words as "reasonable wear and tear and damage by fire excepted," and the landlord should agree to rebuild the premises if burnt down, and not charge rent during the re-building.

Leases are commonly granted for seven, fourteen, or twenty-one years, and may be determined at the end of either of the first two periods at the option of the person accepting the lease. To prevent disputes at the end of the term for which the house is taken, the lease should contain a schedule of fixtures to be surrendered with the house. An agreement for a year, or for two or three years, the tenant having the option of taking a lease at the same rate, is a good way of renting a house, as the tenant can thus test the wholesomeness and suitableness of premises before taking them for a long period. When a landlord leases his property his whole interest is demised, subject to some conditions. However, a lease must be in writing, in the form of a deed, sealed and delivered. The leaseholder then becomes liable for the repairs and maintenance of the premises, even if the house be uninhabitable. If a lease be lost the tenant's term therein will not be prejudiced, if he proves the term was not expired. When there are several under-leases between the freeholder and the proposed tenant, the latter before signing the lease should ascertain the extent of his liability under the intermediate leases, and take care he does not make himself responsible for covenants he is ignorant of.

Yearly Tenancies.—A common way of taking a house is by yearly tenancy without written agreement. The tenant can leave at the end of the first year, or by notice to quit at the end of each succeeding year, but notice must be given before the beginning of the six months ending the year. However, a tenancy for a year, and so on from year to year, differs from a yearly tenancy, as the tenant has no power to give six months' notice to quit during the first year. A so-called "tenancy at will" is really to all intents and purposes an annual tenancy, as the payment of any portion of a yearly rent makes it a yearly tenancy. When a house is thus held without written agreement, or even under an agreement in the absence of express covenants, there is no obligation on the landlord to keep the premises in repair. He may in his own interest see that the roof and outer walls are watertight, but he is not bound to do even this.

In taking a house for any term of years, the tenant should see that the house is habitable and in good repair, and that the adjoining roads and sewers therein are made and adopted. In taking a house for from one year to three years the tenant should have a regular agreement drawn up, binding the landlord to keep the roof and walls in good substantial repair. If the house is in good repair when the tenant enters on possession, it is not unreasonable for the landlord to require the tenant to keep up the interior, including the doors, windows, and all fixtures upon the premises, so that at the end of the tenancy the premises will be given up in as good a state as when the tenant entered on possession, fair wear and tear excepted. The tenant can force the landlord to do what he undertakes to do, but failure of the landlord to execute a covenant does not release the tenant from his liability for rent or any part thereof. Before taking possession the tenant should inquire at what sum the house is assessed, and see if the rates and taxes are paid to the date of the beginning of his tenancy, for some taxes may be enforced from the tenant in possession, though due prior to his becoming tenant. In no case should a tenant agree to pay all outgoings, as this might make him liab'e for some quite exceptional expense that ought to be borne by the landlord.

Fixtures erected by a tenant by way of ornament or convenience may be taken away before the term expires, provided they are not permanent improvements and can be removed without material damage to the property. Thus, ornamental chimney-pieces, grates, ranges, stoves, fixed tables, window blinds, bookcases or brackets screwed to the wall, cupboards and pumps, have been held removable, but only if removal occasions no substantial injury to the walls.

Some Provisions of the Public Health Act.—The duties and obligations of the local sanitary authority are best illustrated by some of the provisions of the Public Health Act, 1875. The more important of those relating to the householder appear to be the following :—

Right of Drainage into Public Sewers.—Under Section 21, owners and occupiers of premises within a district have the right to drain into the public sewers. The right is not limited to sewers within any particular distance, but no express power is given to owners or occupiers to carry connecting drains through the private land of other persons.

House Drains.—Under Section 25 it is not lawful, in any urban district, to build or rebuild any house, or to occupy any house so built or rebuilt, unless and until a proper covered drain or drains be constructed. By Section 23 of the same, when any house within the district, urban or rural, of a local authority is without a drain sufficient for effectual drainage, the local authority have to require the owner or occupier, within a reasonable time, to make an efficient covered drain or drains, and if the work is not done within the time required, the authority may do it, and recover the expenses incurred from the owner.

Drains, &c., to be properly kept.—Under Section 40 the local authority is required to provide that all drains, water-closets, earth-closets, privies, ashpits, and cesspools within its district be constructed and kept so as not to be a nuisance and injurious to health.

Examination of Drains, &c.—A local authority, under Section 41, receiving a written application from any person stating that any drain, water-closet, earth-closet, privy, ash-pit, or cesspool, in or belonging to any premises within their district, is a nuisance or injurious to health, may empower their surveyor or inspector of nuisances, after twenty-four hours' notice to the occupier, or in case of emergency without notice, to enter the premises, with or without assistance, to cause the ground to be opened, and examine the drains, &c. If the drains, &c., be found in proper condition, the ground must be closed, any damage done made good, and the cost defrayed by the local authority. If the drains, &c., on examination appear to be in bad condition, or to require alteration or amendment, the local authority are required forthwith to cause a notice in writing to be given to the *owner* or *occupier*, requiring him within reasonable time specified to do the necessary work; and if such notice is not complied with, the person to whom it is given is liable to a penalty not exceeding ten shillings for every day he continues to make default, and the authority may execute such work and recover from the *owner* the expenses incurred. The power to determine the nature and extent of the works required is vested in the local authority. The occupier is *primâ facie* liable for the repair of drains and sewers of the premises in his occupation, but in some cases the owner is liable, as, for instance, if he let a house requiring particular care to prevent the occupation from being a nuisance, and the nuisance occur from want of that care on the part of the tenant.

Removal of Refuse.—Under Section 42 the local authority may, and when required by the Local Government Board shall, undertake or contract for the removal of house refuse from premises, the cleansing of earth-closets, privies, ashpits, and cesspools for the whole or any part of their district, and undertake or contract for the proper cleansing of streets or for the proper watering of streets. Under Section 43, if a local authority who have undertaken, or contracted for, the removal of house refuse, &c., fail to do the work, without reasonable excuse, within seven days after notice in writing from the occupier of any house, the authority is liable to pay to the occupier a penalty not exceeding five shillings a day while the default continues. If the local authority do not undertake this duty, they may, under Section 44, make by-laws imposing the duty on the occupier of the premises.

The removal of house refuse is a very important matter, and its being neglected or ill-done is a frequent cause of nuisance. In rural districts, what is in the midden and cesspool is commonly disposed of on a garden or field belonging to the house, or removed by a neighbouring farmer; but where water-closets are provided, house refuse has practically no value as manure, and its removal and destruction should be undertaken by the local authority. It is usual for the authority to arrange for this work being done by contract under the supervision of their Surveyor or Inspector; but it is probably better carried out when done by the authority's men, with the authority's appliances, without the intervention of a contractor. As to frequency, it will be generally admitted that house refuse should be removed at short intervals, but in practice receptacles are seldom emptied till they are full or nearly full. It is thus preferable to have receptacles for house refuse no larger than necessary. The brick ashpit, measuring inside 3 feet by 3 feet and 3 feet deep, and therefore holding 27 cubic feet, is an abomination; and yet many brick ashpits are

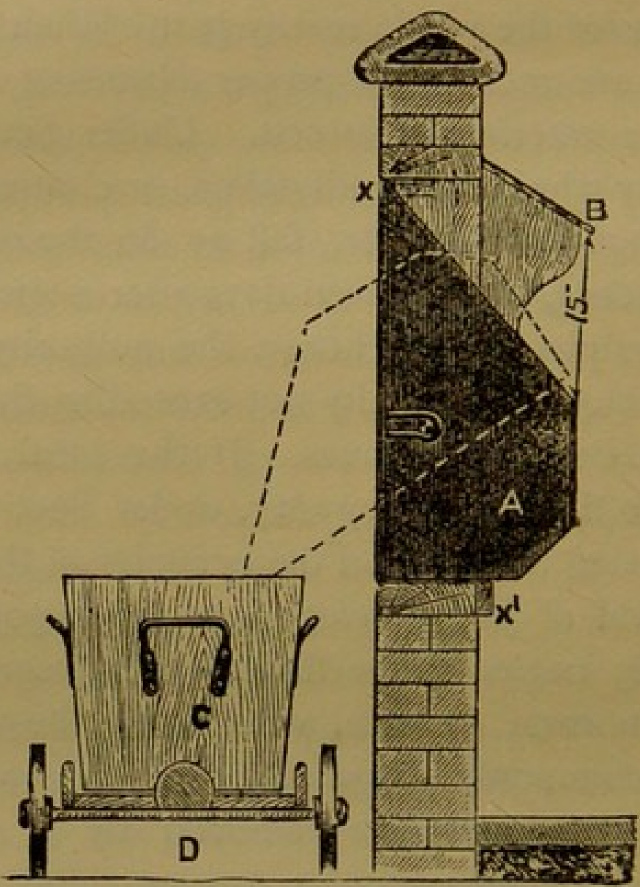

FIG. 37.

much larger than this. The system adopted in many towns, where each house is provided with a covered dust-box or dust-pail, to be emptied by dustmen early every morning, is a great improvement on the ashpit system. When the local authority cannot be induced to undertake a daily collection of refuse, covered dust-boxes or dust-pails large enough to hold the house refuse of three days or a week should be provided. The house-refuse receptacle invented by Dr. Quine appears to be well adapted for the purpose. This apparatus consists of a box fitting in a hole in the back wall of the premises, as shown in Fig. 37. The box is hung on pivots, so that the dustman can empty the contents into his truck in the back passage with great expedition. In the illustration A represents the box, B a roof with sides to keep off the rain, C the dustman's truck, and D the back passage.

Filthy Houses to be purified.—When (Section 46) on the certificate of a medical officer of health or two medical practitioners, it appears to a local authority that a house or part of a house is in such a filthy or unwholesome condition that the health of any person is affected or endangered thereby, or that the white-washing, cleansing, or purifying of any house or part thereof would tend to prevent or check infectious disease, the local authority are required to give notice to the owner or occupier of such house or part thereof to whitewash, cleanse, or purify the same as the case may require. Failure to comply with the terms of the notice renders the person to whom the notice is given liable to a penalty of ten shillings for every day he continues to make default.

Section 120 makes it the duty of a local authority to cause any house or part of a house, and any articles therein likely to retain infection, to be cleansed and disinfected, where they are of opinion, on the certificate of their medical officer of health or any legally-qualified medical practitioner, that doing so would tend to prevent or check infectious disease. Notice is to be given to the owner or occupier to do the work within a time specified. The person to whom notice is given is liable to a penalty of not less than a shilling, and not more than ten shillings, for every day he continues to make default.

Abatement of Nuisances.—A nuisance has been defined as anything that renders the enjoyment of life or property uncomfortable, but generally the word is applied to something that causes a continued annoyance. Section 47 inflicts a penalty on any person in an urban district who is guilty of creating nuisances by swine-keeping, allowing stagnant water in cellars, &c. However, nuisances are commonly discovered and their abatement obtained under the 92nd and following sections.

In Section 91 nuisances are thus defined :—

(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 a nuisance or injurious to health.

(3) Any animal so kept as to be 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 com bustible used therein, and which is used for working engines by steam, or in any mill, factory, dye-house, brewery, bake-house, 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.

All these are nuisances affecting the public generally, and under Section 92 it is the duty of the local authority to cause inspection of their district for detection of such nuisances. If the local authority make default in enforcing the provisions of this Section, the Local Government Board may compel them to enforce the provisions, or appoint a person to enforce them at the expense of the authority.

Under Section 93 information of nuisances may be given the local authority by any person aggrieved thereby, or by any two hundred inhabitant householders of the district, or any officer of the authority, or by the relieving officer or any officer of the local police.

Under Section 94 the local authority have to serve notice requiring abatement of any nuisance reported to them, if satisfied of its existence. The notice has to be served 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 do whatever may be necessary for that purpose. However, when 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 must be served on the owner. When the nuisance does not arise or continue by the act, default, or sufferance of the owner or occupier, and the person causing the nuisance cannot be found, the local authority may themselves abate the same.

Under Section 95, if a person on whom a notice to abate a nuisance has been served fails to comply with any of its requisitions within the time specified, or if the nuisance, though abated since the serving of the notice, is, in the opinion of the local authority, likely to recur on the same premises, the local authority are required to cause a complaint relating to such nuisance to be made before a justice, and the justice has to summon the person to appear.

Section 96 empowers the Court of Summary Jurisdiction before which the person is summoned to appear, if satisfied that the alleged nuisance exists or is likely to recur on the same premises, to make an order requiring such person to comply with all or any of the requisitions of the notice, or otherwise to abate the nuisance within a time specified, or prevent its recurrence. The Court may also impose a penalty not exceeding five pounds on the person on whom the order is made, and give directions as to the payment of costs incurred.

Under Section 98, if this order of the Court be not obeyed, a penalty not exceeding ten shillings a day will be incurred, and the local authority may themselves execute the work necessary to abate the nuisance. A person knowingly and willingly acting contrary to an order of the Court is liable to a penalty not exceeding twenty shillings per day during such contrary action.

As regards the costs of abating a nuisance, it may generally be said that for this the person causing the nuisance is liable. For instance, if the landlord's defective sanitary appliances have caused the nuisance, he should pay for abating it; but if the tenant's want of cleanliness or negligent use of good appliances have caused the nuisance, he should pay for abating it. If the nuisance is due to both landlord and tenant, then they should share the expense of abatement.

When a person appeals against an order to the Court of Quarter Sessions, there is no liability to penalty,, nor can proceedings be taken on work done under such order till the termination of the appeal, unless it ceases to be prosecuted.

The tenant may be called upon to pay to the local authority expenses for work done on behalf of the landlord, being allowed to deduct from his rent what he so pays. But the tenant cannot thus be called on to pay more than the rent then due. If after notice from the authority to the tenant to pay them the rent, the landlord before such payment puts in a distress for the rent, the rent must be paid to the landlord and not the authority.

If local authorities are negligent of their duty in putting down a nuisance, any person suffering therefrom may call the authorities' attention to the nuisance and request them to set the law in motion. If this is not effectual, complaint should be made in the form of a memorial to the Local Government Board, Whitehall, London, that the local authorities have made default in their duty in respect of a certain nuisance. The memorial may be accompanied by a report or statement by an expert, as evidence that the nuisance really exists, but this is not necessary. The Local Government Board have powers to require the local authorities to abate the nuisance, or they can employ persons to abate it and recover the costs from the authorities. Or a person affected by a nuisance may complain to a justice and obtain a summons against the owner or occupier of the premises in which the nuisance exists, and the Court, if satisfied there is a nuisance, will order the same to be abated. All costs can be recovered.

When a nuisance on premises, proved to exist, is such as to render the house unfit for human habitation, the authority may serve a notice on the owner requiring him to put the house in a habitable state within a certain time. If he neglects to do so they may summon him before a justice, and the justice may prohibit the using of the house till it is rendered habitable.

THE END.

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