SANITATION IN THE MODERN HOME

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A suggestive guide to the architect
and house owner in designing
and building a residence
providing a healthful
comfortable and
convenient
home.

Edited by

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FOREWORD

The architect is a many-sided man,—but not more versatile than the requirements of his profession demand. To his ability to interpret and express artistic sense, he must add practical knowledge and even more,—he must possess technical skill in many lines of constructive work. He must be a master of architectural history and at the same time have a practical knowledge of the composition of a satisfactory plaster; he must know tone values and also be able to calculate strains; he must have the gift to understand the meagerly expressed needs of his clients and formulate them into a structure which will meet those needs in an appropriate manner; and he must also possess a knowledge of practical structural details which will combine, with an artistic exterior, comfort, safety and utility within.

There is little need for additional publications which present the artistic side of architecture. Sumptuous architectural publications in book and periodical form fully supply this demand. But the home builder of today demands far more than an artistic structure; he requires a home in which health shall be assured, convenience studied, and comfort provided.

The American people are accumulating material wealth so rapidly that they now demand many conveniences which a generation ago would have been considered unnecessary, and others which even ten years ago would have been considered luxuries which only the very rich could afford. The modern American home must have a perfect system of cold and hot water supply; an inoffensive and sanitary system of disposing of household wastes; an adequate system of automatically controlled heating combined with ventilation, and a convenient and complete scheme of artificial lighting.

The demands made upon the architect by the home builder for all these accessories to a model modern residence have been prodigally met by the enterprising and resourceful American manufacturers. They have studied every need, have foreseen every demand and present the necessary means to insure every home, humble or luxurious, a water supply and sewerage system and a heating and lighting plant which may almost be said to be beyond criticism.

Twenty-five years' journalistic experience in sanitary work has led me to suggest the preparation of this volume, which will prove useful, I trust, to the home builder in the fond study which precedes the services of the architect. It should furnish the non-technical reader many ideas which, when incorporated into the home structure, will add greatly to its usefulness, healthfulness and comfort.

JNO. K. ALLEN.

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SANITATION IN THE MODERN HOME.

Chapter I.

SELECTION OF A BUILDING SITE.

Things to be considered. Present and future value. The lot the only real security for present or future loans. Its value is the basis for rentals. Its selection with reference to light and air. Engineering and sanitary conditions.

IT VERY often happens that Destiny has made the choice of the home site before we have had a chance to get in a word on the subject. We are placed in the position of the man who was upbraided for not having chosen more wisely his ancestors. But if the irrevocable has not been done we may have many helps in modern ideas of what a home site should be.

The ideal home site for a family of moderate income would be within half an hour's ride from the husband's place of business, upon a side street half a-block to two blocks from the line of transportation, so as to be away from the noise of traffic. If a spot can be found a few feet higher than the surrounding land it should have unhesitating preference. Such a place is certain to have better drainage and a better circulation of air. Good drainage under the modern conditions of sanitary plumbing insures a speedy removal of all filth from which noisome and injurious gases might arise. The free circulation of air has the effect of diluting such gases as do escape from drains, sewers or decaying organic matter. While foul smells serve as a warning that an enemy is abroad, not all foul smells appear to have a serious effect upon the health of human kind. The most that can be said against disagreeable odors as a whole is that they are not esthetic, and the ideal home must have a situation where they are not too much in evidence. Such a home should be in a strictly residence neighborhood, where the streets are kept tidy, the lawns pretty, and the garbage is collected regularly from fly-proof cans.

Quiet is a health essential quite forgotten by many people. Complete relaxation with sound and undisturbed sleep in a quiet neighborhood is the best restorative for the man who spends six days a week up to his armpits in the tide of business affairs. Therefore, choose the home site as far from the all-night noises as conditions will permit.

STUDY THE NEIGHBORHOOD.

New neighborhoods are to be preferred rather than old ones because all the new houses are likely to have the latest and best in sanitary plumbing and one is less likely to suffer from the laxities of his neighbors. The spirit of a new neighborhood is more likely to be that of today while the old locality is in the straggling and irregular part of the procession of progress. People who own the houses in which they live are more painstaking in the care of their properties, and the ideal homesite would be among such neighbors. Before purchasing a lot in a newly opened part of a city it is best to ascertain if sewers, water, gas and paving are all in and to find out the amount of local assessments standing against the property. It is well also to look out for the cost of possible street extensions which sometimes add considerably to one's taxes. Disregard for these things often leads to paying too much for a lot.

On which side of the street shall I build? Individual preferences appear to make full use of all four possibilities. The prevailing direction of the wind influences many. In the northern part of the United States the east or west side of the street, if the streets are closely built, would provide best for a good circulation of air, the prevailing wind being from the west. In St. Louis and the south generally the prevailing wind is from the south or a little to the southwest, so that the north or south side of the street would give the advantage of a freer circulation of air through the house. If one desired to have a plant-room the south side of the street would be most convenient. Then the conservatory could be made a part of the living or dining room at the back and not disturb the architectural harmony of the facade facing the street. If placed upon the south side of a house facing east or west, unless the lot were unusually wide, the neighboring house would obstruct too much the slanting rays of the winter sun. On account of the considerable litter from such a feature of a home, the conservatory should be at or near the back of the house where the refuse may be handled and disposed of without making the process a public affair. It was the fashion in the old days to have in the front yard of the southern home a whitewashed cabin, the home of the house servant. No matter how small the yard the sign of the slave ownership was where custom placed it. But the aristocratic spirit of today expresses itself in flowers and lawn and unimpeachable tidiness.

The probable increase in the value of a lot is to be considered. A new locality, particularly if one is a pioneer, has distinct advantage in this regard, although the cheapness of the lot may debar one from securing a satisfactory loan. Lenders of money are reluctant to take risks in uncertain suburbs. The lot value, it will be seen, is a governing factor in securing a loan. Money is easier to secure, interest rates are more favorable and a larger loan on the investment may be obtained in a residence district where the conditions are established and the future of the locality is not in doubt. In fixing the rentals of dwellings the lot value enters into the calculation. The value of the lot may increase while the house deteriorates from age and use, and will furnish a reason for the maintenance of rentals as high or higher than when the house was new. New and better lines of transportation coming into the district may increase the rental value and therefore the value of the whole property. No such revolution of real estate values ever took place in American cities and suburbs, in fact, in all progressive countries, as followed upon the installation of electric transit lines in the years 1887 to 1895. The electric car lines have been great levelers of real estate values in and about cities, where a five-cent fare will take a passenger one block or a hundred. A town a mile square has 640 acres or about 6,400 small city lots. Add one mile all around and you have 5,760 acres or 57,600 city lots, nine times as many as in the single square mile. Yet, with good transportation, the outlying portions are in many respects more desirable for a home than the parts close in, assuming that the business district is in the central portion. When buying a lot it pays to go shopping to find the best locality, the best transportation, best drainage, best neighbors and best bargain that one's funds will command.

The suburbs around Chicago present a greater variety of land elevations than are to be found immediately within the city. The high ground at Blue Island is occupied by many beautiful homes, and on account of its sightliness, one almost wonders that a vacant lot remains. Chicago has one of the most difficult problems in drainage in America, solved for a time at least by the great canal, which sends its sewage gulfward. In New Orleans, which is below the level of the river in the flood season, the difficulty is one degree worse, drainage being accomplished only by forcing the sewage by machinery into Lake Pontchartrain, Lake Bogue and the lower Mississippi river.

Many of the older cities of the east, such as Albany, N. Y., and the places along the Hudson, are almost entirely on sloping ground, and instead of problems in drainage they have the problem of keeping within bounds the surface water after heavy storms. While the side-hill site has its inconveniences of inaccessibility it is invariably a healthful one with sightliness as an added attraction. All about upper New York it is the aim of housebuilders to have one or more windows commanding a view of the Hudson or the Sound. There is lack neither of good drainage or good air, for soft coal is taboo in New York and the air is as clear as that of a mountain village. Individual preference expresses itself in a variety of ways. Karl Bitter, the famous sculptor, mindful no doubt of his boyhood scenes on the Danube, has built him a home at the top of the palisades above Hoboken. He had to restore the top of the crag with a wall of cement and stone to make a wee bit of a back yard. Nobody can see his ash barrel unless he is so prying as to ride by in an airship. Mr. Bitter has no drainage or fresh air problem.

Out on the desert of southern Idaho, when laying out one of the cities that shall grow as the result of irrigation, upon the entire square mile of the town-site the intersecting streets were so planned as to be at diagonals with the geographical parallels and meridians. This arrangement has no other purpose than to have the houses present their corners to the four cardinal points of the compass and to insure a liberal amount of sunshine for all rooms. There are thus no north rooms in Twin Falls, Idaho, this, too, in a region where the climate is far more mild in winter than in Chicago, zero weather coming but rarely.

In the extremely humid region of the Pacific Northwest another problem is presented but often disregarded. One may see the moss growing thriftily upon the northern slopes of shingle roofs. This might have been avoided and much dampness within the houses prevented by the simple expedient of facing the houses or building the roofs so that the slopes were east and west, where the sun could dry them and kill the sprouting mosses. Better yet would be the use of metal roofs.

Californians, who are principally only eastern folk transplanted to the Golden State, are fond of the bungalow, a one-story house in ten thousand shapes. It is generally vine covered and always low and spready. Bungalows are often perched on round barren knolls, on hillsides and even on the dry desert with only a small orchard of orange trees around them, supplied with water by means of individual pumping plants. In the cities and towns they have all the advantages of organized, modern sanitation.

In the rural districts anywhere the greatest need of a careful selection of the home site exists. With appalling frequency we see the stables and pig sties, the hen houses and cattle yards on ground higher than the family dwelling, the surface water running dangerously near the family well and the earth becoming saturated by years of use with the liquids from the animal quarters.

The country home should be on high ground, well away from sources of possible pollution, for purposes of drainage and for the pleasurable view such a situation affords. Even the farmer, under the influence of modern thinking and the more general appreciation of the esthetic, is coming to regard a good view of the landscape as something of an asset in his farm possessions. It is a part of the same broadening of mind that induces him to put into his house the modern plumbing. To be on high ground with one's house is like being up a good, healthy tree if a pack of wolves found you alone in the woods. You are out of reach of prowling effluvia that might bring sickness to some susceptible member of the family and you are sure that all waste will be taken quickly to a safe distance from the house. That dangerous pest, the *anopheles,* or malaria-breeding mosquito, which thrives in stagnant pools of water, is less likely to make a successful attack if the house is so situated that the evening breeze sweeps all around the dwelling. Big trees should not grow too thick near the house, however welcome their summer shade. A dry cellar is quite as desirable as a proper grade in the drainage pipes.

Many of the old farm houses are found in sheltered hollows, where in fact it is colder than on the knolls. Cold air drains to the low places and fog and dampness linger in the hollows. Modern methods of building, with cheap devices for giving great warmth to houses, permit the construction of houses in exposed places. The entrances may be so disposed and protected that winter winds shall not interfere with family comfort and storm windows will prevent the too rapid radiation of heat from the window panes. The rural home may have, and thousands of them do have, all the comforts and conveniences of city dwellings and it is in the country that a vast field for future business in home improvements lies in all the lines concerned with domestic engineering.

Chapter II.

PREPARATION OF THE SOIL.

Surface drainage. Sub-soil drainage. Laws of flow of sub-soil waters. Catch basins. Care of storm waters. Roof guttering and rain water leaders.

INDIVIDUAL preference steps in so frequently with its ideas and fancies that no hard-and-fast rules safely may be promulgated by any authority. Most rules are susceptible of variation in their application, while still having as their foundation the established principles on which well informed men in the several branches of domestic engineering agree. The purpose of these chapters is to present so near as may be done the best practice of the times, with full recognition of the fact that there exist many points of controversy.

If the prospective house-builder can be made to feel that the family plumber is quite as much a health necessity as the family doctor the propaganda of correct plumbing and scientific sanitation will be appreciably advanced. The question of drainage, so vital in the house itself, should extend to the grounds surrounding the house, that they may be kept sweet and healthful. Therefore certain laws governing the drainage of soils should be understood.

The water in the soil, whether resulting directly from storms or flowing down from higher elevations, may be considered as of two kinds, the film water and the free water. The film water is that which surrounds each particle of the soil. When the earth is damp, yet crumbles easily and is in perfect condition for easy cultivation, it contains film water only. The free water is the surplus. When there is more than enough to surround each particle of earth with a film then the soil is said to contain free water. The purpose of farm drainage and of drainage as applied to the premises surrounding a dwelling is to get rid of this free water before it can become stagnant and sour the earth or penetrate the cellar walls to the detriment of the family health. Gravitation tends to take the free water down to the non-porous strata or the water sheet, while the capillarity of the soil tends to bring it back to the surface there to dispose of it through evaporation from the surface of the soil itself or through the roots and thence through the leaves of plants and trees. The free water fills the air spaces that would otherwise exist in the soil and has the effect of smothering the useful plants whose roots must have air in greater quantity than that supplied by the free water. Free water contains a certain amount of oxygen but not enough for the habits of the more useful plants. The habits of water plants need not be considered in this connection.

Certain soils require no artificial drainage for the disposition of surface or storm waters. Their porous character makes them readily absorbent of all surplus water, which is soon carried beyond the depth of plant roots. The gravelly and sandy soils present no problems in drainage but rather vex us with the difficulty of retaining enough moisture for a thrifty lawn and healthy shrubs and trees for the yard. The ideal soil for the yard is a loam with plenty of humus or decaying vegetable matter well mixed through it. Humus is extremely retentive of moisture in the form of film water, and is the best component of the soil for carrying the growing plants through seasons of drought. A heavy clay soil may be made tillable and productive by mixing with it an abundance of sand, humus, in the form of loose stable compost, or coal ashes. The sand and coal ashes do not add much to the richness of the soil but they so change the mechanical structure as to make more readily available for the plants the plant foods contained in the clay. With the question of soil fertility, however, we are not here concerned. By improving the mechanical structure of the soil we improve its natural drainage. The close texture of heavy clay tends to hold storm waters long on the surface while the lighter soils, with their open texture, convey the surplus water quickly to the sub-soil and to the yard or sub-soil drains, if provided.

When the cellar has been excavated it may be determined whether or not it is necessary to have drains placed below the wall foundations. If the natural conditions appear to require such drains they should be made of common drain tile laid with open joints placed at least six inches from the wall outside. They should discharge into a water-tight catch basin and thence through a properly trapped vitrified pipe drain to the main sewer connection.

Protection should also be secured against bad ground air. Changes in barometric pressure alternately pump air into and out of the ground, and unless the ground air is kept free from contamination, or is, by air-tight foundations, kept from entering the house, undesirable conditions may be found to exist.

Much future trouble will be saved the householder if the space between the finished walls of the cellar and the surrounding earth be kept free, during the construction of the house, from shavings and other rubbish and, when the walls have seasoned, packed with firm, clean earth. Storm water may keep the walls of a cellar perpetually wet if this precaution is not taken, especially when no effectual provision is made for the underdrainage of the walls or carrying away storm waters.

After the construction of the walls comes the grading of the grounds. This should be so planned as to throw the storm water and the water from hydrants and waste pipes toward one or more common centers, each provided with catch basins. The catch basins for surface drainage should be at least 12 inches in diameter, water tight, with a 6-inch discharge pipe effectively trapped below the frost line. The trap should be accessible so that it may be cleaned. The catch basin should be protected with a screen cover. If placed in a driveway or court where traffic occurs and the cover is liable to injury the frame and screen should be of heavy cast-iron to resist the impact of heavy wheels.

Another form of surface catch basins consists of two large sections of vitrified pipe set on end upon a four-inch stone or cement foundation, which should extend at least three inches beyond the pipes. It should be water tight and the discharge should be effectively trapped as in the case of the basin described in the foregoing paragraph. Inasmuch as the purpose of a catch basin is to arrest the flow of sediment and prevent that which is not soluble from entering the sewer the discharge pipe should be placed well above the bottom of the basin, the distance depending upon the dimensions of the basin and the area draining into it.

In the subsoil drainage of the yard the common tile drain pipes are laid with open joints two to three feet below the surface, leading to common centers and there discharging into catch basins which in turn are connected with the sewer with proper trap and clean-out. These latter connections should be of vitrified pipe or metal. Seepage water gathering in tile drains rarely carries sediment in appreciable quantity but usually flows clear into the catch basin and sewer. Such drains if carrying much water sometimes become stopped by the fine roots of trees growing into them, but serious damage is not likely to result from such a cause.

The disposal of storm waters from the roof requires consideration. Roof gutters are made of sheet tin, galvanized iron, brass and copper. Tin, unless kept painted, will rust sooner or later. Heavy gauge tin of certain makes has a record of durability that recommends it for ordinary uses. The common bright tin or sheet iron should never be used where durability is required. The real choice, perhaps, lies between galvanized iron which should be of heavy gauge and copper, with the preference in favor of the latter if it is not necessary to consider present expense. It will last a lifetime or several of them if not misused. Especially disappointing is tin when leaves or washings from the shingles clog the gutters or spouts, retaining dampness from one storm to another. The tin soon rusts and breaks down, while even the galvanized iron cannot perpetually resist such an attack of corrosive influences. The copper or brass, however, shows no marks of corrosion.

The vertical leaders or conductors connecting with the eaves troughs should have abundant capacity for the roof water during the heaviest storms. Rain water leaders should be run as straight as possible, horizontal runs being avoided. The heads to rain water leaders should not be tapering or conical. When these pipes are upon the exterior of the house they may be galvanized iron, copper or brass, the galvanized iron serving the purpose most generally and with satisfaction, there being little chance of its rusting. Where the pipes are in exposed places and liable to injury they should be connected with the house drain by means of an extra heavy length of cast iron pipe extending at least 4 feet above the ground. In protected corners and unused places the connection may be made not less than three inches above grade, using oakum and cement in the hub end of the pipe to make the seal. When vitrified pipe is used in place of cast iron for this purpose it is usually broken by accident or by the action of frost soon after its installation, a sufficient reason for its disuse. On account of exposure to frost the exterior conductors or down spouts need to be of larger caliber than when they are placed inside the building. If constructed of cast iron sections and placed within the building the size should not be less than 3 inches, and if made of galvanized iron, brass or copper the size should not be less than 2 inches in diameter. A large roof area requires large sizes.

Good practice forbids that the roof drains shall connect with the ventilating stack of the house drain system or that either shall be used for any other purpose than that for which it was particularly constructed.

When the exterior conductors are placed in alleys or adjacent to drive ways where they may be liable to injury from passing wagons they should be placed in niches in the wall or protected with effective wheel guards.

Chapter III.

THE IDEAL HOME.

The modern housekeeper's view. It must be sanitary. Easily kept in condition. Household operations guided by scientific laws and not by chance. General considerations as to dryness, light, floors, interior arrangement and furniture.

WITH the twentieth century has come to the modern housekeeper a new ideal—a sanitary ideal—or, perhaps, not a new, but an old ideal which the light of modern science has so illuminated as to almost revolutionize modern housekeeping. We would not say that the social and ethical sides of home life are stressed any the less, but science goes back of this and says: "The efficiency of each of us depends upon our health, and our health upon the conditions under which we live." Here then may be seen the aim of the modern housekeeper. It is to so plan and care for the home that its sanitary conditions may be of the best, and be most conducive to the health and the consequent efficiency of the inmates of the home.

She realizes that the life of the family with all that it means to the race is absolutely dependent upon the household life. The conditions of the household determine largely the development of a race. Look at the homes of a people and you can tell much as to their place in the process of civilization. We have been hampered and are still hampered in racial progress by the primitive conditions which exist in many of our homes. We cannot expect to develop as we should so long as this condition exists. This condition the modern housekeeper is overcoming by applying to her home the modern conveniences and scientific principles, which put the household processes on a par in their development, with the intellectual and industrial life of our race. The home, she realizes, is a place of rest and development for the family, and must provide for all those processes which are necessary to the life and well being of the family.

In the planning of a home she has two points of view. First she wants a home that is sanitary to begin with, and, what is just as important, a home that is convenient and is easily kept in a sanitary condition. It is only necessary to glance at the furniture in a modern home to see how this last idea is carried out. It is simple and we think it beautiful, but back of it all stands the idea of ease in caring for it and convenience, which mean so much to the modern housekeeper. Have not these facts done much to shape public opinion in their favor? We look now with much disfavor upon the heavy carved furniture so popular not many years past. Back of this disfavor probably lies the thought of how much time it takes to keep it in the proper condition, and how this time might be spent to better advantage in other ways. Thus in numberless other ways we might illustrate how standards of beauty in the past have been broken down by modern science, and in their places we have standards whose keynotes might be said to be simplicity, convenience, and health.

In deciding what is a sanitary home the modern housekeeper calls to her aid all the scientists, or specialists, shall we call them. An expert on soils selects for her a suitable site, or if a suitable site is not to be had, so fills in or drains the one to be had as to make it suitable. Next the architect is called in. He draws up the plans and specifications according to the ideas given him by the housekeeper. He gives advice as to construction and choice of building materials. Thus as each expert is called in, he gives advice upon the subject that he knows best. It is the business of the housekeeper to harmonize these views, and adapt and apply them to the life and operations carried on in the home.

She possesses a clear idea of the essentials of a sanitary home. She knows just why these essentials are necessary, and what they mean in terms of the health of the home. But she goes further than this. It is for her to see how this standard of health is to be mantained. She alone it is who can decide how this can best be done. Experience has taught her how each of the household tasks can be performed most efficiently and with the least expenditure of energy. She sees how some detail in the construction of her home can be changed so as to make some task easier, or improve the healthful condition of her home. These ideas are formulated and carried to some technical worker, in whatever line it may be, who works out the ideas for her.

She has a breadth of view possessed by few others. There is no science which she cannot call to her aid. The technical part it is impossible for her to know, but if she understands just what she wants and the principles involved, she can easily tell whether the technical product is or is not what it is desired to be. The first question with which she concerns herself is, "What are the essentials of a sanitary home?" The soil expert tells her that she must have a dry site, and straightway selects one for her, or else drains the one selected so that it will be dry or permit of no excessive amount of moisture. Not because the moisture is in itself harmful, but because it leads to conditions which are harmful.

But all is not ended here, when a suitable site is selected. The foundation and wall of the house must be so constructed as not to hold the moisture. Many of our best building materials are those in which just this thing happens. They are desirable because the amount of air which they contain makes them poor conductors of heat, but just this condition of porosity makes them capable of absorbing and retaining moisture. When used they should be glazed on the outside so as to keep out the moisture, while still preserving their function as poor conductors of heat.

There should be free access of sunlight to every room in the house at some time during the day. The importance of sunlight as a germicide, and the necessity for it as one of the conditions of health, she fully realizes. Instead of keeping her windows closely barred for fear of injuring some gaudy furniture, the modern housekeeper throws open her windows to the free, fresh sunshine, and discards as undesirable that furniture which is likely to be injured by it.

Trees and grass are desirable, not only from a standpoint of beauty, but also from one of health. They should not, however, stand so close to the house as to prevent a free circulation of air, or the access of sunlight. They serve to protect the house from the cold winter winds, temper the hot glare of summer, drink up the moisture from the ground and give it out to the atmosphere, and above all, to absorb the carbon dioxide resulting from the life and operations of the home, and give back the oxygen so necessary for these operations.

The house should always be surrounded by a circulation of fresh, pure air. This serves both as a source of air for the ventilation of the house and also to carry away the impure air resulting from the operations carried on in the home. Combined with this should be an efficient system of ventilation. The most desirable systems are probably those in which heating and ventilating are combined, though in such a system one must be careful to remember that it is to serve two functions, both heating and ventilating. Lack of heat is so much more apparent, and the discomforts from it are so much more readily recognized, that we are apt to stress that side of the question. It is a great temptation, in order to lessen expenses, to bring in a more difficult problem. If the house is heated with steam or hot water directly, there must be some smaller amount of air heated to such a temperature as to raise the temperature of all the air in the room to that desired, while the necessary amount of fresh air is not brought in.

The air brought in should be screened through cotton cloth, or some other material, in order to rid it of any solid impurities. The frequency with which this screen must be changed and cleaned, shows just how much this screening is needed.

In natural ventilation the housekeeper has a means of natural ventilation provided. When a fireplace is in the room, this is easily and simply done. A small fire, or simply a lighted lamp, placed in the fireplace will create draught enough to ventilate the room, provided there is an opening for the heavier cold air to come in and force the circulation. When windows alone are to be used for ventilation, there are many devices which may be used. The object of them all is to get in the desired amount of air without in any way creating a draught in the room which will be perceptible to the occupants. At best they are only makeshifts, and should only be used where a mechanical system of ventilation is not possible.

Last but not least in importance we come to the water supply and disposal of wastes. The house must have a sufficient supply of pure water for domestic purposes, and there must be means provided for the perfect and instant removal of all fluid or semi-fluid organic wastes. In the city this is a municipal problem, but if the housekeeper knows the water supply of the city to be polluted she must take some means to purify that portion which is to be used for drinking purposes, or else get her water from some source that she knows to be pure.

As to the plumbing, this is distinctly a problem of the household. The principles involved are simple and are thoroughly grasped by the modern housekeeper. She demands a high grade of work and insists upon the use of the best materials. Even though the cost at the beginning is greater, she knows that the lessened repairs and the improved health of the family will make it more economical in the end. In every place she insists upon the simplest designs possible to accomplish the desired purpose. Wherever possible the pipe, and always the fixtures, are left exposed, and where the pipes cannot be actually exposed, they are so placed as to be easily accessible. In this way is the danger of any concealed trouble avoided, and the trouble once located is so much more accessible as not to be continually put off on account of the difficulty it may cause. The traps must always be in perfect condition, the height of water in them always being deep enough to effect a perfect seal, yet not so deep that there will not be sufficient force to carry the waste materials over. The traps should all be vented to prevent siphonage, and all the pipes should be thoroughly ventilated.

The question of disposal of garbage is in many places a serious one. In cities it is usually taken charge of and disposed of by the city. Where it is not, it should if possible be burned. There are many devices for this purpose which may be attached to the ordinary kitchen range.

All these facts being realized and put into practice, the housekeeper knows that she has a sanitary home, but this does not satisfy her. It amounts to little for her to start out with a perfectly sanitary home unless it may be kept in that condition, and it should be easily so kept. She realizes the manysidedness of life. She must not only give to her family a clean, healthy home, but must give something of herself. She cannot spend all of her time keeping things as they should be. There are other things in life which she must enjoy or else she will become one-sided and narrow. This is an age of advancement and she must have time to keep up or else she will be left behind in the race.

The servant problem has done much to emphasize this phase of the subject. Oftentimes it is possible to have only one or possibly no maid. While doing her own work the housekeeper is much more apt to view the situation from the standpoint of the maid, and everything possible to lighten her work is done. In this way much time, energy, worry, and money may be saved which can much more profitably be spent in other directions.

The next point which concerns the housekeeper is, "How is this to be done?" First of all by a careful drawing up of the plan of the house much can be done toward this end. Too long have women submitted to anything the architect would offer, little realizing that they were more competent than he to judge of the general plan and arrangement, while to him might be left the technical and constructive details.

In the making of the plan she takes into consideration the surroundings, location, climate, sun plan, for those rooms most used should have the most sunshine, cost, and particularly the adaptation to the special needs of the family and the operations carried on in the home. It is the housekeeper and the housekeeper alone, who is able to see these needs and how the plans may be worked out so as to best satisfy them. It is she who lives chiefly in the house and knows the processes carried on there. The modern housekeeper realizes this and refuses to accept the type the average architect brings to her, but works out for herself those details of which an architect would never think, but which mean so much towards the convenience, comfort and healthfulness of a house.

The house must first of all furnish individual privacy to the various members of its household. The sleeping rooms should be conveniently arranged according to the special needs of the occupants. All should have plenty of light and fresh air, with bathroom near-by. All should be easily accessible in such a way as not to interfere with the privacy of any other room. Plenty of closet space should be provided and all closets and halls should be well lighted, for where dark corners are, it is much more difficult to clean and dust is much more likely to accumulate. The stairs should be broad and easy, while straight back stairs should be provided for the carrying up of luggage, and the carrying out of household wastes.

In the planning of the lower floor much in the way of convenience can be gotten in the arrangement of the connection of the kitchen with the dining-room and other portions of the house. These will be considered in detail later with the furnishings of that portion of the house.

In the planning of the reception rooms of the house, it is well to remember that the home is built for the comfort of the family and not for outside show. No more reception rooms are provided than the needs of the family call for, and the means authorize. Beyond this they either make impossible some more private feature, or entail an unnecessary responsibility upon the care taker.

Not only in the choice and arrangement of the rooms may time and unnecessary work be saved, but also by the convenient arrangement of the furniture and fixtures within the rooms. Both of these features will be taken up and discussed in detail later. Now we will consider the attitude of the modern housekeeper toward the furnishing and interior finish of the house.

As to the floors, she has some choice in deciding the way in which they shall be finished. All have in view the same ends—healthfulness and ease of care. Carpets she has long ago discarded, as both troublesome and unhealthy, serving, as they did, as a trap for dust and particles of disease. They have been superseded by rugs and polished floors. A polished floor is any floor finished smoothly and stained, oiled, varnished, waxed or painted. Which method is used is determined by the use to which the room is to be put and individual preference. Hardwood floors are of course the most desirable, but where they are not to be had on account of the cost, soft woods can often be so treated as to make very good substitutes.

The daily care of these floors is perhaps greater than that of the carpet, but this daily care is so simple and the outlay of time and strength is so small that it is very little compared with the amount of time and strength one must give to a carpeted room in the course of a year. Above all this, though, it is the healthfulness, cleanliness, and the knowledge that they really are the most sanitary which recommends these floors for use in the modern homes.

The woodwork is chosen with reference to the same standards, ease in cleaning, and affording no facilities for the lodgment of any impurities. It should harmonize with the finish of the floor, and should in most cases be smooth, for the carved woodwork affords a lodging place for dust and requires much more time to keep it in the proper sanitary condition. The baseboard should meet the floor with a curved joint,—thus doing away with the crack, which is apt to serve as a dust trap. The same precaution should be taken in the corners of the room. If these are built curved instead of the sharp angular corners the cleaning is much facilitated.

When we come to wall coverings, none in common use are very easily or very successfully cleaned. So here the standard is one of beauty and cheapness. Beauty, because one cannot help but realize the effect of the wall covering upon the appearance of the room, and consequently upon the lives of those people who live within that room. Cheapness, because the most effective mode of cleansing it is complete removal and replacing by new. The special kinds of wall coverings will be considered in the light of their application to the different rooms.

Furniture and draperies are chosen with reference to their usefulness. In every case is the need of an article of furniture of prime importance, and any article which does not fulfill some purpose should be discarded. To furniture and draperies the same standard must be applied, "Is it easily kept in a sanitary condition?" This being kept in mind, much of the useless, fussy furniture, even now often seen, will be entirely replaced by plain, easily cared for furniture, each piece specially adapted to some purpose, and no superfluous pieces present.

Draperies fill a distinct need and are not to be discarded in the modern home. They are of such a character as to be easily cleaned, and are not hung so as to interfere in any way with the ventilation or free circulation of air.

More and more are the modern conveniences coming to be applied to the affairs of the home. The woman of today is able to sift out from those brought before her attention the ones that are worth while. But more than this, woman has left the path of literature and language and is now entering upon the field of the sciences so long denied to her. Here she is able to see the practical applications of the various sciences to the operations in the home as no man ever could, and she is quick to apply them to these operations. No longer are these operations a matter of chance and guesswork, but they have applied to them the same laws that are applied in the chemical and biological laboratories.

Last of all, she has systematized the household-work. With the breadth of vision of a college woman the various tasks of the household are brought together and organized, just as the work of any business is organized. There are certain set duties at certain times for each servant or each of the servants. By thus organizing and planning for the daily work, the household tasks are put on more of a business basis and much is being done to solve the servant problem, which now seems to be so perplexing.

Summing up, the ideal of the modern housekeeper is a sanitary ideal. In order to realize this ideal she applies the various scientific and biological laws to the home. These laws are applied in such a way as not only to have a sanitary home, but one that may be easily kept in that condition. These laws are applied not only to the construction of the house itself, but also to its interior finish and furnishing. Then, too, these laws are applied to the operations carried on in the home. Putting on a scientific basis what has been largely a matter of chance, all these operations have been so organized as to put them on a firmer, more business-like basis and thus help to solve the servant problem. This is what the modern housekeeper must do, and it is to her we must look for the future advancement of our homes, and consequently of our race.

Chapter IV.

WHAT A MODERN HOUSEKEEPER WANTS.

The porch. The vestibule. The hall. Reception room. The parlor. Living room. The library. The den. Dining room. Butler's pantry. The kitchen. The cellar. Wine closet. The laundry. The nursery. The chambers. Bath room. The garret.

THE housekeeping routine, even in a dwelling of moderate size, entails a vast amount of work upon the housekeeper whether she be the wife and mother or whether employed for the purpose. Whatever may be provided by forethought and modern invention to lighten the housekeeper's tasks surely is needed by every woman concerned with such a responsibility. Often she is not aware of the short cuts possible in household work. Indeed it may be said that few of the whole number of housekeepers have an opportunity to consider the question from a scientific standpoint. They look upon housekeeping as an inherited duty and go about it in the way their mothers taught them.

Lack of means compels many to deny themselves the fruits of invention which have so materially lightened household tasks. But in spite of tradition and practice from times immemorial the housekeeper has made notable progress. A knowledge of the available helps in household work, gained from many sources, has made her more alert to reduce in a measure the drudgery of her daily routine.

The architect to whom is entrusted the planning and equipment of a house with modern available appliances of the best type will perform his duty best by considering the housekeeper's point of view and conforming his plans to the best household economy. He may throw upon the housekeeper an amount of work impossible of accomplishment or he may so arrange the house and supply it with conveniences at moderate cost that what was drudgery will often become a pleasure. Many a devoted housekeeper has died in harness rather than complain of an overburden of household duties. To make such sacrifices unnecessary is the aim of modern invention and today we find ourselves at the pinnacle of achievement in this direction. The universal adoption of available household conveniences today would save the lives of numberless overworked women. The problem presents no serious complexities. It is a simple one from beginning to end, requiring only a reasonable amount of forethought and an expenditure commensurate with the advantages secured.

The architect will serve his own interests best who secures the co-operation of his clients and sets about the planning of their new home with as full a knowledge of their desires as he may readily acquire. Two or three evening conferences upon the subject will not interfere with the day's business and may give him a new viewpoint on home construction. Intending builders usually have studied the subject well and have made scores of tentative plans which have been thrown away upon the dawning of some fresh idea, new, yet old or impossible. The architect with definite ideas about what is best or desirable in a family dwelling, who is able to take the point of view of the housekeeper, is truly an ornament to his profession. His higher aspirations will be rewarded, for already he has the grasp of a master. No branch of architecture is so important as the correct planning of dwellings, yet each unit is so small and the fee relatively so little that architects generally are seeking the larger work and correspondingly larger returns to be found in public buildings and great business blocks. It is this condition, the indifference of architects, that compels so many home builders to adopt published plans which are placed in the hands of builders who have no deep conviction of what should or should not be and who modify the plans to suit their convenience or to reduce the cost. When they are through with the work the most that can be said of the house is that it is a shelter containing ten rooms. A little neglect or false economy, for example, the sparing use of building paper, or the careless fitting of windows and doors may make the house a very poor shelter in winter. A saving of five dollars in building paper will cost ten dollars in coal the first winter, with a considerable amount of discomfort added.

Before making a plan for a new home it were well to answer analytically the question: "What is the house for?" To eat in, sleep in, receive our friends in and to entertain them in; to rest in—and, in short, to live in. To the mother of the family it is the place in which to work. It is the source of inspiration, the place of rejuvenation for the husband and father, and the place for the children to grow up in. Therefore the home should be as attractive as it may be made, and to make it so the mother should not become a drudge. The saving of labor is the vital point in the arrangement of the house, which may be likened to a factory in its systematic organization.

In modern manufacture system is the keynote. In the home as in the factory are routine processes which, for economy's sake, the economy of effort if not of money, should be done with system. In the factory the raw material is received at a certain point and passes from machine to machine and from workman to workman until it emerges in the form of a finished product, boxed or barreled and ready for shipment. At certain points in the process the by-products are taken away. The material passes through the factory with as little rehandling as possible and without taking a backward course at any point if it can be avoided. The aim of the whole system is to produce goods at the lowest consistent cost. Hand labor is one of the most expensive elements in the cost of goods in most manufactories. To reduce hand labor to the minimum, high salaried experts are employed to study and perfect the factory systems. It is just as vital in the home to reduce the labor of the domestic routine and it is a study worthy of the best architects upon whose advice homes are built and their equipment installed.

Present day practice is to use every part of the house, a custom following the heating of the entire dwelling. There is no longer the stiff and unused parlor with its treasure of heirlooms. Its doors are wide open and it stands ready for use without ceremony. The rambling structures built by former generations are succeeded by houses of closer design. The compactly arranged house we are told, is the result of a desire for economy in heating. It is also an important step in the economy of labor in its care. Every argument for economy favors the compact dwelling, free from long halls and long rooms, long stairways or high ceilings. In a compact house the related parts may be brought closely together convenient for the purposes intended, resulting in the saving of many steps and much strength, without any sacrifice of beauty. Manifestly the square built house may possess four facades, each attractive in its design and each conveying some hint of the convenient arrangement and beauty within.

In planning a new home one of the first thoughts concerns the veranda or porch. In the South it is called a gallery. In New England it is still the piazza, the development of the stoop and the portico. The veranda in its modern use possesses such attractive possibilities in the way of social pleasures that no house should be without one. It is the outdoor room of the house, always inviting, with its hammock or swinging settee and easy chairs, its table of current magazines and decorations of growing plants along the balustrade. A good location for the veranda is at the corner of the house, where it serves the purpose of a portico and a summer room and avoids shading all the front windows. The narrow, shelf-like piazza, conspicuous on rural dwellings and old houses everywhere, is a poor apology for the wide, room-like creation of later architecture. If situated at the corner of the house it is certain to have a better circulation of air, and air is what is wanted during the summer or veranda season. The veranda should conform to the general architecture of the house and may be made a thing of beauty in harmony with the house. Many new verandas on old houses violate all rules of good taste and architectural harmony. Opposing schools of architecture give daily battle to each other, while the helpless public looks on in amazement.

In some elaborate houses the veranda takes the form of a loggia within the wall lines of the house. A row of heavy pillars or piers, or perhaps an arcade, supports the walls. The effect is classical and dignified in the extreme. The loggia is necessarily enclosed on three sides but nevertheless serves the purpose of an outdoor room, useful for the entertainment of friends or an agreeable place for the family to meet in an evening chat. Second floor verandas are much in demand by those who like to sleep in the open air during summer months. Verandas when used thus are screened against flies and mosquitoes.

The careful architect devotes much attention to the front entrance of the house. No feature of the street elevation is more conspicuous. The eye of the passer-by is directed to it as naturally as the eye of a listener is directed to the lips of one who is speaking. It is one of the features of expression upon the face of the dwelling. The architectural ideal in a front entrance might demand double doors but convenience and economy favor a single valve of extra width, having upper panels of beveled clear glass in plain or fancy shapes. This door should open into a vestibule which should be different from vestibules as commonly known. It is here that the housework begins. The veranda is not a part of the house that can be neglected but it offers its compensation in preventing much dirt from entering the house. The mat before the front door and the rug in the vestibule should still reduce the amount of litter brought in with hastening feet. To be over nice or finical about the question of dirt robs the home of its ease and relaxation, but there is a happy betweenity in which all members of the household may join, to the increased comfort of all. Such checks upon invading litter at the entrances are inexpensive and help to keep down the work within doors.

The vestibule may be 3½ or 4 feet by 6 or 8, so as to have a recess at the left or right. In this recess, which may be curtained from the place of entry, are to be the hall rack or hooks around the walls, an umbrella stand and mirror. It is here that one may divest himself of extra wraps and hat, put aside his umbrella and overshoes and take a glance at himself to see that the clothing is in order. A vestibule thus arranged relieves the hall and renders it more suitable for use as a room.

The hall should be of such shape as to make it an attractive feature. As a mere passageway or corridor it is robbed of the charm that it might otherwise possess. If given the shape of a room, with mantel and grate in one corner it becomes a beautiful and useful part of the house. A stairway is prettiest and easiest to ascend when made with a landing half way up. No part of a stairway that is much used should have a spiral turn. Such construction is continually the cause of accidents. The stairs should lead toward the center of the house. If the hall is on the west side of the dwelling the stairs may go up on the west wall to a landing, then turn at a right angle toward the center. An ornate window at the landing with leaded cathedral glass, not too dark, adds to the beauty of the hall.

The reception room is placed by general preference nearest the vestibule, or the hall itself may be so furnished and arranged as to meet such requirements. When so used the hall should have one or more windows upon the level of other windows of that floor to give it the effect of a reception room.

The smallness or amplitude of the parlor depend upon the habits of the family for whom it is designed. If there is to be much entertainment, with dancing, a large parlor is wanted, that is to say, large in proportion to the other rooms. Where the rooms are so arranged that they may be thrown together by means of double sliding doors the necessity for a large parlor is removed. To have a large parlor unless the house be large, means a corresponding cramping in the sizes of other rooms. Convenience demands certain dimensions for the other rooms and it were unwise to cramp them. The arrangement of rooms with double doors between removes the necessity for small rooms and on occasion provides space for an afternoon or evening party.

The living room should be ample in its dimensions and should be at the front of the house, with the best available outlook. This is the gathering place of the family and it should be the best in its appointments for comfort and cheerfulness that the house affords. In addition to other heating equipment it should have an open fireplace on account of its ventilating value and the cheer that an open fire of wood, coke or hard coal can give. A substantial wire-cloth screen should at all times be a part of the fireplace equipment.

The term library is often only another name for the living room, containing a few movable shelves or cases on which are the family books. It becomes the family reading place and to a considerable extent the family sewing room. But if the library is to be a place of study and retirement for quiet reading it should be so situated as not to be used as a passageway to other rooms. The ideal library for study and writing should have but one door, opening from the hall, so that no one may have occasion to enter it except for the purposes for which it is intended.

The den, as its name indicates, is a little room. The head of the house may use it for his home business office. It may contain his desk and one or more easy chairs, a table for newspapers, his smoking materials, his easy jacket for house wear, his slippers and canes. The name suggests a place of retirement and relaxation. It may contain a couch overladen with pillows with which one may bolster himself into all sorts of easy attitudes for reading or smoking or for a visit with a congenial companion. The den may open off the hall on the first or second floor or off the living room or dining room, as convenience in the construction of the house may place it. It is a room utterly without dignity, a place for a romp with the children, where formalities are forgotten and quite an important adjunct to the home whose occupants do not lead a stilted existence.

The dining room is the housekeeper's especial pride. Convenience requires that this room be not less than 13 feet wide and 15 to 20 feet long. These dimensions provide space for a sideboard and serving table, a china cabinet and extra chairs. An open grate gives forth a cheerful flicker on a frosty morning but if possible should be at the corner of the room where it will not make it necessary for persons at the table to toast their backs during the meal. The grate should not be depended upon as the sole heating apparatus, except as it may be used to take off the chill upon cool mornings, because it does not heat the room uniformly. It should be considered, as in other parts of the house, merely as an adjunct to the other heating equipment. It is desirable that the dining room be somewhat isolated from other parts of the house. Its front entrance should be in the rear part of the hall and it is preferable that it should not be connected with the living room with double sliding doors. The swing door, shutting tightly against the jamb and strip, is a more effectual barrier against noise and odors than sliding doors. In the placing of its furniture the room should be so arranged with reference to its principal entrance as to give a pretty vista when seen through the open door. The places for the sideboard and serving table are near the door leading to the kitchen. This arrangement gives increased facility to the serving of the meal. Sometimes the sideboard may be placed between the windows at the end of the room with a high, ornamental window of colored glass above it. The sideboard is variously used, sometimes for the display of choice and dainty ware, sometimes as a buffet and as the carving or serving table. These things are minutiæ for the housekeeper to determine.

The isolation of the kitchen should be as complete as possible. Two doors should separate it from the dining room, the passageway leading through the butler's pantry. No shelves, tables or other furniture should front upon this passage, which should be kept free of obstructions. The china closet may be placed in this apartment, but should occupy an alcove opening into the passage, while that part of it used for the temporary placing of food before going to the table should constitute another alcove where one or more persons may stand without obstructing the passage. These alcoves may be closed with light sliding doors when not in use. The doors from the dining room to the passageway and thence to the kitchen should be of light construction so hinged as to swing in either direction. A pane of thick glass at the proper height in each door will prevent collisions.

The kitchen is the principal center of household activity. It is a workshop in its strictest sense. Formerly the kitchen was also dining room and sitting room. Now it is all kitchen and should be arranged like other well arranged work-shops, with full regard for the tasks carried on therein. What the kitchen equipment should be, according to the modern view is stated in detail in Chapter XIV, which treats of that important department of the home.

The cellar has so many uses that the following chapter (V) will treat of that part of the house. The laundry work, still done in many kitchens, should, even in low-priced houses, be relegated to the basement, where additional windows and ventilation, if necessary for additional light and air, should be provided. The alterations need not be expensive, but the kitchen is hardly the place for laundering the soiled clothing and linen of the house, and the basement affords a better place for such work. Here, too, the fruit and vegetable cellars are properly situated, all partitioned and allotted a definite place in home economy.

Convenience and the demand for good ventilation and good air have placed the sleeping rooms in nearly all modern isolated dwellings on the second and third floors. The rooms of the upper floors are certain to be dryer than those below, windows may be thrown open with a feeling of security against intruders and the circulation of the outside air is better among buildings at a height of a few feet from the ground than at the level of the lower floor. Fresh air and sunshine are such effective destroyers of bacteria whose presence is inimical to the family health, that plenty of both are to be sought always. If one may have a second floor veranda at the back part of the house where bed clothing and mattresses may be taken for an airing it will be prized beyond measure and used to an extent unthought of by one who has not had such a convenience.

The nursery should be a sunny room at the corner of the house, if possible, with an outlook where the little ones may have a broad view of what is going on outside. Such a view is educative and sunshine and good air conduce to good health. The nursery need not be an apartment specially constructed for the purpose but its decoration and furnishing will be most happily done if carried out with the idea that the place is for the children. Its location should be next to the sleeping room or rooms of those having the care of the children, so that they may not lack attention to their needs both day and night.

It is desirable to have five bedrooms on the second floor, for families of moderate size, one to be allotted to the housemaid. Her room should be a convenient and attractive one if the best results are to be expected. In a well-planned house there is little waste of space in halls on the second floor. The front staircase should lead to the attic floor and the back stairs should connect with the rear of the upper hall. Two doors, one at the bottom and the other at or near the top of the rear stairs, should separate the kitchen from the upper hall.

The bathroom, which is treated in Chapter XV, seems to find its proper place in most modern dwellings at the back of the house on the second floor. The lessening of cost in bathroom equipment and the greater appreciation of the luxury of the bath room and its sundry appliances has led to the introduction of an extra one or more bath rooms even in dwellings of moderate cost. The thoughtful architect will not fail to suggest this additional luxury to his clients and arrange for it in his plans. The convenience of stationary lavatories in the several chambers is not to be overlooked. They add to the luxury of the home and save their cost in labor.

The garret, if left in the rough, is a place where rubbish gathers in alarming quantity and dust accumulates to an appalling depth. The housewife is ever ashamed of it and is denied one of the things much to be desired in a house, a neat, clean storeroom. One will never have a regret in having the garret floor "done off" with plastered walls into rooms of convenient size, accessible by easy stairs. If the family is of large size some of these apartments will be found useful as sleeping rooms for older members of the family. The possibilities for usefulness in the garret rooms are too important to be overlooked or neglected.

Chapter V.

THE CELLAR.

The walls. Damp-proofing. Cellar floors. Underneath the floor. Soil drainage. House drains. Self-cleansing drains. Soil pipe, and connections to the sewer. Cellar Drainage. Back water gates. Automatic cellar and ash pit drainers. Floor Drains. Fuel storage and conveniences. Vegetable rooms. Wine closets. Tool room. Light in the cellar. Cellar ventilation.

THE cellar is too often a place of mysteries. It is the abiding place of the gas meter. Here is the furnace like a huge spider clinging with great tin legs to the ceiling. Here is the mass of pipes for many purposes, upon the proper arrangement of which depends so much affecting the health, comfort, convenience and general well-being of the family.

The proper construction and arrangement of the cellar begins with laying off the ground for the excavation. Necessity rather than choice may have decided the location of the lot. If situated upon low ground the question of drainage must have immediate consideration. If the lot is a narrow one fronting north or south the house should, preferably, occupy the west side of the lot, not closer than 18 inches to the west line. This leaves the wider space on the east side so that the pleasure of the afternoon shade may be secured in summer. The placing of the veranda has other considerations, however, particularly that of taking advantage of the prevailing wind in summer. If shade is needed it may be secured by means of an awning. A breezy veranda is more likely to be immune from mosquitoes in the evening, as the little songsters fly low where the wind blows, even if the wind be but a light one. The situation of neighboring houses will have a bearing upon the exact position of the house upon the lot.

Having decided upon the wall lines the contractor begins his excavation. The contract should specify that the first twelve inches of top soil shall be put in a pile by itself so that it may be used as the top dressing of the lot when the grading is done. It sometimes becomes necessary to remove from the lot the soil taken from the excavation. This adds materially to the expense. Provision should be made early for bringing in the city water, gas and sewer connections, so that the trenches may be filled and allowed to settle, to be in readiness for finishing the grounds when the house is completed.

Assuming that it is necessary to make the cellar as impervious to moisture as possible, provision must be made for a tile drain laid with open joints in a trench at least six inches outside and below the foot of the wall. Dampness is indeed a scourge to be feared. It may be necessary merely to dig a trench where the foundation wall is to be and fill it with broken stone. The drain, however, is desirable in any locality to take care of the storm waters. In times past pole drains have been used. These are made by laying a dozen poles lengthwise in the trench in place of the drain tiles. Such a drain is undesirable because the wood will decay and the drain eventually become useless. The box drain, made of four pieces of board nailed together so as to form a conduit is objected to for the same reason. All work in and around the foundation should be of an enduring character. Very good drains may be made of flat stones so placed in the trench as to form a triangular channel and then loosely covered with a layer of small stones, before refilling the trench with earth.

Other plans include a similar line of tile encircling the cellar within the wall about two feet from it, and connecting with the outside drains to discharge through the same general outlet. It has been the practice to discharge these drains into a dry well, where possible, but in cities the preferable plan is to lead them to a water tight catch basin made of brick or stone and lined with portland cement, from which they discharge through a glazed tile conduit, securely trapped, to the house sewer and thence to the city sewer. Patented cast iron catch basins of various sizes and of an approved type are now available.

Portland cement is considered the most effective exterior coating for a cellar wall. Care must be taken to have the cement applied to every part and the foundation stones should lie in a bed of the same material.

While Portland cement is, as stated, usually considered the most effective exterior coating for damp-proofing a cellar wall, it must be pointed out that, as usually applied, a cement coating does not secure freedom from moisture. The firm, hard and nearly non-absorbent surfaces usually seen in cement floors and sidewalks, unfortunately are not secured in coatings on foundation walls. This is partly due to the lack of care on the part of the workman as well as to the impossibility of putting as good a finish on vertical cement surfaces as may be put on flat surfaces. It is also exceedingly difficult to cover the edges and corners of foundation walls with a cement coating. It is, however, perfectly possible to damp-proof foundation walls and to lay a damp-proof course under cellar floors, by using several alternating coats of tar and tarred paper. Native stone is generally favored for foundation walls, but is being superseded to a considerable extent by concrete mixtures sometimes reinforced with coarse wire fence and steel or iron rods. Such reinforcement adds very materially to the strength of a wall. A reinforced concrete wall, made with good cement 8 to 10 inches thick, meets every requirement in a good foundation for an ordinary dwelling. Long stretches of such wall should be buttressed by cross walls or specially built buttresses or well braced by the sill timbers of the house to resist the pressure of the opposing bank. Brick walls are objected to for cellars except in very dry localities. The capillarity of the brick continually drinks in the moisture from the surrounding earth and an impervious coating becomes an absolute necessity if the cellar is to be reasonably dry. Of native materials for cellar walls limestone is most favored. It is more nearly impervious than other materials. A skilled mason is careful to have no stone extend entirely through the wall in order that frost may be excluded.

In very wet ground the cellar bottom is spread with a 6-inch layer of broken stone upon which a concrete floor is laid, with a top dressing of portland cement. In place of the concrete, brick is sometimes laid in asphaltum with a portland cement surface applied to the brick. A brick floor in a cellar is far from satisfactory on account of its absorbent character. The ideal cellar floor is one that can be periodically washed or flushed with the hose, and one that will dry quickly after such flushing.

It is useless to attempt to exclude dampness from the cellar by beginning at the inside. Any coating of lath and plaster, hollow brick and tile or other devices on the walls merely covers up the evil. The dampness comes through and will continue to do so. The precaution mentioned in Chapter II against allowing rubbish to fall between the bank and the cellar wall should be heeded. Such rubbish will provide, for years, large cavities into which storm waters and water from melting snow will find easy access, keeping the walls continually wet.

Other devices in damp proofing, some of them of ancient origin, have the merit of effectiveness if not of cheapness. These consist of various forms of dwarf walls and open and covered areas around the outside of the foundation walls. These covered areas need to be ventilated and so carefully constructed as to exclude the small animals that everywhere take advantage of accessible spaces around dwellings. One form of old Roman damp proofing consisted of a tile with rectangular sides, one side open. These were assembled on the outside of the wall, the open side to the wall. The entire exterior of the wall, thus covered, was surrounded with innumerable air spaces. This covering, while stopping the capillary flow of water to the walls, would be ineffective with flood waters.

An approved method of treating old damp walls is to make an excavation four feet wide around the exterior, the bottom of the trench to slope laterally at an angle of 20 degrees from a point near the surface of the ground at the wall to the outside of the trench. Upon this sloping bottom is placed a layer of brick rendered impervious by the use of asphaltum between the joints and a coating on the upper surface. The trench is then refilled. Concrete with a smooth coat of cement may be used instead. The effect is that of a shed roof under ground around the walls, throwing the water well away from them. A cement walk 4 or 5 feet wide around the building, sealed to the walls, would in a measure prevent the flow of water to the walls. The natural course of free water is directly downward, while capillarity takes it in all directions. In brick foundation walls a layer of slate or other impervious material is inserted just above the grade line. Sheet lead of suitable weight is sometimes used for this purpose, cut to the exact width of the wall. The successive sheets should be effectively jointed. Water in its capillary movement is never in haste, but ascends to astonishing heights. Evaporation only prevents it from showing far up on unprotected brick walls whose foundations stand in wet or moist ground. The chemical action of water, its disintegrating influence and the action of frost, are all to be considered in the materials and construction of foundations.

While dampness is destructive to many things usually left in the cellar, causing mold, rust and decay, its principal offense is against the comfort and well-being of the family. The only safe and agreeable cellar is a bright, dry, well ventilated one, into which any members of the family may go with safety and which will not be continually distributing musty odors and deleterious miasma to the upper part of the house through the many crevices that are certain to exist in dwellings as usually built. A case in point is that of a wealthy resident of Chicago whose mansion was supposed to contain everything that could be desired in the matter of safe sanitation. So poorly is his cellar drained, however, that the flues of his ventilating system have been continually wet and the evil is now being remedied at large expense. The foresight of the architect, one of the best, failed to provide against damp cellar air.

Before the cellar floor goes into place the entire system of house drainage should be planned and the construction of the cellar bottom carried out accordingly. Good practice now makes it unnecessary to put anything under the cement bottom except the open-jointed tile drains for the subsoil drainage only. All the horizontal house drains and connections thereto are laid in conduits left in the cement floor. These conduits are afterward covered with cast iron plates laid flush with the surface of the cement bottom, and made continuous with it. This plan leaves everything accessible for inspection and repair and insures the dwelling against lapsing into an unsanitary condition. All drains inside the house should be of cast iron, to agree with the best modern practice. The fragile character of the glazed pipes renders them dangerous for inside use. An unobserved crack may discharge poisonous gases for years before discovery. When necessary to exclude seepage water the conduits for house drains should be sealed against it by the use of cement.

It is sometimes necessary to carry the house drain on brackets or a ledge of the cellar wall. In all cases the alignment should be perfect, the pipes of iron and the support secure. Pipes coated with asphalt, coal tar or any other preparation should not be accepted and the specifications should strictly guard against them. None but pipes free from artificial covering should be accepted. Such preparations, under the plea that they are to prevent rust, are too liable to be merely for the purpose of hiding sand holes, blow holes and other defects. If free from such covering they may be successfully inspected. Iron drain pipes require no covering. In a dry cellar they will not rust at all and in the ground the progress of rust is so exceedingly slow that the matter of repairs will fall to succeeding generations. In passing drain pipes under heavy walls it is the practice to bridge them with masonry, or to cushion them above with a packing of asphalt well rammed or other suitable impervious material. The strain due to the settling of the wall is thus relieved and the liability of fracture of the pipes removed.

The vertical stack should have a solid foundation. The weight of 30 to 40 feet of 4 to 6-inch pipe standing on end is considerable and the stack at its junction with the horizontal line should rest upon a bed of cement or stone of sufficient size to sustain the weight without settling. While allowance is made in the fixture connections for slight changes due to contraction and settling, practice approaches now more nearly than ever to exact and rigid construction.

Scientific house drainage aims toward supplying self-cleansing devices. It endeavors to do away with any contrivance which contains cavities into which sewage may collect and remain indefinitely. The purpose is to take advantage of the scouring action of running water to keep the drains clear of deleterious substances. An evidence of this is a freer use of water in the various sewer sanitary fixtures, the devising of appliances to flush the drains at intervals, and the provision for cleanouts so that every part of the drainage system is accessible. A type of flushing apparatus is that which has a connection with the house water supply which may be turned directly into the soil pipes or branches, either vertical or horizontal, giving them thorough rinsing at each trap.

An ample provision needs to be made in the cellar for drainage from the surface of the floor. Area and cellar drain traps are now made with an effective back-water gate or valve that removes the old objection to open drains whose water seal is liable to be broken through an insufficiency of water. The grade of the floor should be such as to lead to the drains so that when washing the floor the water will run off quickly. In a small cellar one such drain may be sufficient. The laundry may require a separate drain, for convenience and cleanliness. Another type of cellar drain is made to be kept closed with a screw cap except when in actual use.

Frequently it happens that it is necessary to place the furnace in a pit where water may gather, from seepage or otherwise, and unless disposed of cause much annoyance. Invention has provided also against this condition, in the automatic ash-pit or cellar drainers. These may be placed at the bottom of a small sump or shallow well. A type of these has a float which, when the water rises in the sump, opens a valve admitting a jet of steam, compressed air or water from the city mains, which, by syphonage, drains the pit and then closes until again called into action. These are equally serviceable when the sewer level is too low for draining the cellar by gravity.

When the street sewer is too small for the service required of it, or the locality is so low that the danger of water backing up from the sewer exists, a back-water gate or valve is the safeguard against flooding the cellar or fixtures with foul water. Back water pressure is quite certain to find vent if it once gets past the foundation walls of the house, and much depends on the gate. These gates are made of non-corroding metal, securely installed in the drain, with a lid or flap which allows the outflowing water to pass but permits none to return. The seat of the valve needs to be accurately ground so that with a long continued back pressure it may not allow enough sewage to pass to cause trouble.

Late practice is to a considerable extent discarding the trap in the main house sewer connection. We must ever regard the street sewer a public menace. Its thorough ventilation is always a problem. The perforated manholes in the street are the only vents to many of the sewers and it is to provide a more thorough sewer ventilation that the traps are being discarded. If all the traps could be discarded at one time the result would be a complete ventilation of the public sewers and any gases or odors therefrom would be so diluted with fresh air as to be rendered harmless and practically inoffensive. As the matter stands many are reluctant to lead off in the reform, fearing a harmful result to themselves. Practical experience seems, however, to argue for the omission of a trap on the main house sewer, leaving an open duct from the city sewer through the drain and stack to the top of the house. The warm air of the drain will naturally create a continuous current from sewer to housetop. If all fixtures and connections are securely trapped immunity from sewer gas would be secured even if the air were inclined to take other than its natural course and attempt to escape through the fixture traps. The warm current of air through the stack would tend to prevent any accumulation of snow and ice at the opening above the roof and the removal of the trap would give the sewage a clear course to the place of discharge. It is argued that a ventilated main drain, even if ventilated with the air of the main sewer, is better than a drain kept foul by its own contents. The movement may at least be said to be in the direction of better sanitation.

Where the main drain trap is used it is placed inside the cellar wall with a vent beneath the sill to the outer air. This location places it within easy access where the cap of the trap may be removed in the event of any stoppage.

In the cellar also is the water connection with the city or public system of supply with a shut-off, or stop and waste cock. The stop and waste cock may not be used for years. For this reason it should be of a style that will not stick when finally an attempt is made to turn it. In some instances the cock is placed in a box below the level of the cellar bottom to be turned with a key. Sometimes when so turned, with great difficulty, the check is broken. Thereafter it will be difficult to tell whether the water is turned entirely on or off. Later and better practice is to have the stop and waste cock, of a non-sticking type, placed above the floor in plain sight, with handle attached or made to turn with a wrench. The requirement of special tools should be avoided in this as in other things. Such tools too often are missing when most needed.

The basement water closet often is placed in such a dark and poorly ventilated corner that it becomes a nuisance. Inferior fixtures often are used and the penalty is paid sooner or later. Then begins a succession of bills for repairs and an accumulation of patchwork in the despised corner that makes it more despicable. Experience teaches that the basement closet should be of the best sanitary type, of good quality with fixtures that will bear as much neglect as those of any other part of the house. No lead pipe carrying waste should be used in cellars, within the reach of rats, an admonition scarcely necessary to any plumber who has had to deal with such pipes where rats have gnawed through them.

The laundry and the heating and ventilating of the house will be treated in succeeding chapters.

The plans for the storage of fuel too often are left to the discretion of the contractor. If convenient he sends one of his cheapest hands to the vicinity of the furnace to hammer together an assortment of rough boards for coal bins. The ideal bin for the furnace coal should have capacity for 12 tons, for a ten-room house, so that the entire winter supply may be put in at one time. The chute should be located with reference to the street or driveway so that it may be as convenient as possible. The chute, lined with iron and built into the house, if it may be done without sacrificing more valuable room above, should deliver the coal as near the center of the bin as may be. Much labor will be avoided by such construction. If necessary to use the same chute for other sizes of coal it may be pivoted or partitioned so as to carry the coal to the adjoining bin. Usually a cellar window at the side of the coal bin is used for a coal chute, but the idea of a convenient house is not carried out by that practice. The window is broken frequently and generally is opaque with a coating of coal dust. The coal room should be shut away from the other parts of the cellar by a dust proof wall or partition and the ceiling over it should also be made dust proof. Very frequently the fresh air supply for the furnace passes through the coal room or near the coal bin. The processes of shoveling in the coal and taking out the ashes raises little or much dust every day, which escapes into the cold air conduit and goes thence all through the house. It also settles upon everything in the cellar. Here is one of the places where the thoughtful architect can help the housekeeper to keep the house clean.

The cement flooring of the cellar should extend throughout that apartment, including the coal room.

The opening to the bin for the furnace coal should be conveniently at the right or left of the furnace door. While it is desirable to have the floor of the bin hopper-shaped, sloping to the opening, so that the coal by gravity will come to the opening continually, such extra flooring will decrease considerably the capacity of the bin. Besides the bins for two sizes of coal there should be, in the fuel room, space for a supply of hard wood for grate fires. If coal be used in the kitchen range and laundry there will be much rekindling of fires and provision needs to be made for the storage of kindling, which may be placed in a third bin adjacent to the bins for coal. Convenience will suggest that the out-door entrance to the cellar shall be directly to the fuel room or to a passage connecting directly with it. This will simplify the removal of ashes.

A tool room is a convenience usually overlooked in the planning of the basement. A considerable number of tools is required around even the smallest dwelling. A room set apart for these will prove itself worthy of the effort to provide it. Here may be the hoe, shovel and rake, the hose reel and hose fixtures, the wheelbarrow, a shelf for paints, a solid work-bench with daylight from the left and gas light similarly placed. Hammers, saws, nails and other tools and supplies are indispensable about the house and have their proper place in the basement tool room. This room should be, for convenience, near the outside entrance.

The vegetable room, the fruit and wine rooms should be separate apartments with substantial doors, the latter rooms provided with locks to prevent a too free use of their contents. The shelves need to be carefully and substantially made. Ventilation should be sufficient to keep them fresh and sweet, but they may be placed in any dark, cool parts of the cellar. That they shall be cool is especially important.

Light and ventilation are so frequently neglected in the cellar that special emphasis seems necessary in respect of these provisions. Windows should be provided in sufficient numbers to light every corner in order that all parts may be made useful. Vines should not be permitted to obscure the light. Gas jets should also be placed so that any part may be lighted artificially when necessity or convenience requires. All basement gas jets should be securely screened by wire cages and the ceiling above them protected by mica canopies to prevent fire. The ventilation should be sufficient to carry off all odors from any cause and to keep the atmosphere fresh and agreeable. The stairs to the cellar both from outside and from the interior of the house should be substantial and of easy ascent. Outside cellar stairs in open areas should be avoided. Rather, have the entrance at grade with platform inside and with stairs from the platform to the kitchen and to the cellar. Such an arrangement possesses advantages sufficiently apparent to need no advocacy.

Chapter VI.

THE LAUNDRY.

The floor. Laundry trays. Laundry tray connections. Laundry heaters. Laundry dryers. Laundry machinery suited to the home. Hot water supply. Laundry conveniences.

A COMPLETE laundry in the home is a convenience best appreciated by those who have it. Invention has done so much to simplify laundry work at home and to reduce the labor of handling the family washing that the subject takes on a scientific interest. The architect, the plumbing contractor and laundry supply man all unite in guiding the housekeeper to a correct solution of anything difficult that may appear in the question.

The laundry, in most modern dwellings, is situated in the basement. It is here that more space, not required for other purposes, seems available than in any other part of the house. Besides, the basement appears generally to be regarded as an appropriate place for a kind of work in which so much water is used, a considerable part of which falls upon the floor.

The ideal laundry should be upon the first floor. Here it is more convenient, there is more air and sunshine, and all the conditions are more agreeable for carrying on the work of washing, drying and ironing the family clothes and linen. Labor is considerably lessened by having the laundry on the ground floor, and the chief consideration in the making of an ideal house is to reduce labor to the minimum.

The laundry floor should be made of material that is impervious to water, so that it may be mopped and rinsed when the laundry work is done and will dry quickly. It should have a floor drain with trap connection to the sewer. One with a screw cap that shall be open only when in use is a good type for this purpose. Another has a back water gate or valve and seal, which makes an effectual protection against the loss of the seal by evaporation. Floors are made of cement, tile and natural stone. An interlocking rubber tile is also made for this purpose. The use of tile in colors permits a decorative effect which adds to the cheerfulness of the laundry. Both the cement and tile have the desired sanitary quality when they offer no cracks or interstices in which the foul water may gather, but floor tiling is apt to have numerous joints filled with absorbent material, and these joints are unsanitary. The investigating house keeper is no doubt often astounded at the filth which an innocent looking cranny may reveal. A little check in an otherwise clean drain-board at a kitchen sink has been seen to reveal a colony of maggots when scraped out for the purpose of repairing the defect.

A wood floor in a laundry is not to be tolerated if reasonable cleanliness is to be secured. A perfect joint between floor and walls, which likewise should be non-absorbent, should be insisted upon, that no dampness may hide in such corners and furnish a breeding place for water bugs. Do we not owe much to such visible evidences of filth as the little brown and black bugs that infest the plumbing? For in excluding them by means of sanitary plumbing and tight joints we exclude the noxious gases and the disease breeding dampness that are not such visible quantities, but no less active, while a good deal more deadly.

The doors of the laundry should be of a close fitting character, particularly those connecting with other parts of the house. The odor of steaming soapsuds is of such a penetrating character that the operation of the laundry may be too much in evidence in the reception room. One precaution to be suggested in this connection is that the upper end of the clothes chute should not terminate in the upper front hall, but rather should go through the upper back hall to the garret floor and have tightly closing doors at all openings. The chutes should be smooth inside. Lost garments have sometimes been found after a few weeks hanging to a projection, left by a careless carpenter. Stout trap doors fitted into the chute at each floor opening or very narrow openings are a protection against danger to climbing children. A chute is a convenience prized by every housekeeper and should not be omitted in the plans.

The ideal sanitary fixture, in the laundry as elsewhere, is the one which after use is left in a perfect sanitary condition for the next usage. It may be said that no fixture is absolutely sanitary, showing that still we have something to achieve in our construction of sanitary fixtures and appliances. The bubbling drinking fountain at which the drinker stoops and drinks from the top of the spouting column of water is ideally sanitary. The syphon jet water closet leaves no exposed surfaces without a fresh cleansing with clear water and may be said to be nearly or quite ideally perfect in this regard.

A laundry tray, to meet sanitary requirements, must be of a non-absorbent material that may be cleaned easily after use. It should have no sharp edges and preferably should have no square corners inside. Soapstone, slate and some other natural stones are nearly or quite non-absorbent and readily take a polish that has made their use quite general for the manufacture of laundry trays. They are both cheap and durable when properly cemented together. Several manufacturers have on the market trays made of cement, molded with rounded corners inside and rounded edges wherever the worker comes in contact with them. The cement is non-absorbent, smooth and an excellent substitute for the more expensive trays. Tubs with wooden rims are not desirable.

The great progress made in the manufacture of cast iron enameled tubs, both for the bath room and laundry, and in fact everywhere that china and marble and the cheaper materials have been used, has been revolutionary in the laundry. The porcelain lined cast iron tub is no longer an impossible proposition on account of expense. The all earthenware tub for the laundry is necessarily very heavy and expensive, but its beauty and perfection do not admit of criticism. The advantages of the earthenware tub are many. It shares with the enameled tray the quality of whiteness. The white tub reflects the light upon the work, allowing a better inspection of it by the laundress. Its perfect smoothness admits of no injury to the worker's hands or to the materials in the tub, which might suffer in a less perfect tray that is liable to roughness from the action of water or chipping or pitting from any cause.

Any material which may become rough through the action of water or from wear is unsuited for laundry trays. Wood should not be considered as material for stationary trays. The old-fashioned wooden washtub is a portable affair and may be set in the sun to drain and dry. But the stationary laundry tray usually is situated where the sunshine never reaches it. The hot water soon saturates it and it remains permanently damp. After a few months' use it ceases to be the clean and sweet receptacle that a laundry tray should be to receive our table linen and wearing apparel. Its use is contrary to good ideas of sanitation and cleanliness. The presence of water-soaked wooden trays in the laundry cannot add to the sweetness of the atmosphere, but on the contrary may counterbalance our other efforts to have it a thoroughly sanitary place. The battery of wooden trays will never bear close inspection below or behind. There is usually much doing in the way of water-bug activity upon the unseen portions of the tray. There is always dampness and decay, and sometimes mold, with rusting supports and general unattractiveness. It should be possible to reach the laundry trays on all sides, which should be smooth, to wipe them and keep them clean. Backs or splash boards are best when they are an integral part of the tray, such as in the latest types of enameled cast iron and earthenware trays.

The hot and cold water bibbs should be placed where they will interfere as little as possible with the worker. The chain attachment for the waste-pipe stopper and soap cups should not be placed in the central space at the back of the tub, where they are liable to catch the clothes or be in the way of the operator. In the latest types of trays the faucets are just above the shelf-like projection at the base of the integral splashboard, the nozzles projecting just beyond the edge of the shelf.

Various fixtures are provided for trays having round or rolled rims to which the clothes wringer may be attached, to go either between the tubs or at the right side of the last tub to the right.

Laundry trays, when filled with water, are very heavy and should have strong and firm supports. The operation of the wringer is an additional strain. The importance of having the trays well secured to the floor and wall is often overlooked.

The water supply, both hot and cold, should be abundant at all trays. The supply pipes, therefore, should be ¾-inch size. A waste pipe of 1½ inches is ample, and the outlet and strainer should be calculated to fill the pipe. The ordinary S and P traps are most likely to lose their seals through evaporation on account of infrequent use in the laundry unless the seals are of unusual depth. On account of threads and ravelings getting into the waste pipes, syphonage by capillarity is of somewhat frequent occurrence in laundry traps. Other forms of traps are therefore recommended less likely to lose their seals from these causes.

The supply of hot water for the laundry comes usually from the kitchen range boiler. This and other methods of hot water supply will be treated in Chapter XIII, so that we need refer here only to the laundry stove and its attachments. The ordinary laundry stove is a simple affair, with large space for the clothes boiler and a flat surface for the irons. Sometimes it contains a coil or water front with tank attachment, so as to make the laundry independent of the kitchen or to furnish an additional supply. A type of special heater is used also for the burning of garbage and heating of water. The garbage is placed on a grate or coil over the coal and it is soon dry enough to burn quickly. Where a large supply of hot water is required this type of heater fills an important place. Other styles have ledges around the body of the stove with flat surfaces against which the flat irons may be leaned.

A clothes drying room adjacent to the laundry is desirable where possible. The brighter this room is and the better the ventilation, the better the results in drying the laundered goods. Clothes dried in the bright sunshine in the open air have a freshness that every housekeeper appreciates, but frequently the weather makes it impossible to dry them thus and a drying room within the house is quite indispensable. A part of the basement, well lighted with windows that may be thrown wide open will serve this purpose excellently. It should be so finished that it may be kept clean, and the ceiling should furnish no lodging places for dust.

Invention has been very busy for many years devising laundry machinery and the production of laundry equipment is one of the large industries of the country. While attention has been given more particularly to machines and apparatus of large type for the equipment of commercial laundries, public institutions and hotels, the little domestic laundry has not been overlooked.

One piece of equipment specially valuable in the home laundry is a cabinet dryer. One type of these is so constructed as to be heated from the laundry stove. A series of hot air pipes connect with the heating surfaces of a specially constructed stove and gridiron the lower part of the drying cabinet. Thorough and rapid ventilation is an important feature of a good cabinet dryer. The capacity of the air to absorb moisture is greatly increased by heating, but there is a limit to such capacity and a free circulation hastens the drying. Good ventilation makes the clothes sweeter than if dried in a confined space. The cabinet dryers are made in various sizes and cost accordingly. One manufacturer makes a three-rack dryer with racks six feet long and of a height to be reached conveniently, for $104, the price including the stove. One fire is thus made to heat the water for the washing, heat the flat irons, boil the clothes and dry them quickly. The immediate drying of the clothes facilitates and lightens laundry work to an extent that makes such equipment greatly to be desired.

The type of washing machine most effective in general laundry work is the drum or rotary washer. A 24x24-inch washer of this kind, with hand mechanism, is made for the home laundry by several manufacturers. Such a machine as this is offered by one house at $60. This washer requires a steam generating apparatus, which is supplied at $47.50. The clothes are subjected to a high temperature during the entire time of their agitation in the washer and thus receive a very thorough cleansing.

In place of the hand wringer of the rubber roll type, which so often dislodges the buttons on garments, a small rotary extractor is available. This is made to be operated by hand and removes the water from the clothes by centrifugal force. The advantage is that a whole basket of clothes may be thrown in at a time and taken out ready for the dryer without handling each article separately. The cost of such a machine is $45.

Where there is much laundry work the laundry truck has an important use. This is nothing less than a water-tight tub on wheels. Into it the wet clothes may be thrown to be taken from one machine or receptacle to another, and the water may be drawn off through a faucet at the bottom. It costs $12.

A small gas-heated hand mangle is made for family use. In this machine all the flat pieces may be rapidly ironed. The price quoted by one manufacturer is $30.

Still another very useful article is an ironing board upon a strong cast iron pedestal. At one end is a gas stove for heating the irons. A slender finger of cast iron is attached to a sliding rod and may be moved from place to place along the board to lie across the article in hand to hold it securely while being ironed. At the end opposite the stove is a fixture which comes up from below to stretch shirts, skirts and other garments to their proper length while under the ironing process.

Spraying devices are also convenient in preparing clothes for ironing. These throw a fine mist and the clothes are immediately ready for ironing when dampened in this manner.

Other machines, more costly, having larger capacity and suited to larger requirements, are installed in many of the large mansions of the country. The laundry equipment of Senator Clark's mansion in New York is upon a scale in keeping with the magnificence of that great private establishment.

Other things to be supplied in the home laundry are such conveniences as cupboards for clothespins, clotheslines, hampers, soap and soap powders, bluing, borax and other useful chemicals which should be used only with the greatest care and full knowledge of their strength and their effect upon fabrics.

Recently there has come into use a very convenient form of tray for small flats and homes where a separate laundry is impossible. The kitchen sink and laundry tray are combined in one fixture, the drain board of the sink forming the cover of the tray. Another variation is the laundry tub and bath tub combined. Such conveniences meet the limited requirements of a great number of small families whose means do not admit of more pretentious things, and they have an educational effect that will develop into the wider use of the better things later on.

CHAPTER VII.

HEATING BY STEAM.

Its advantages. Types of steam house-heating boilers. Damper regulation. Pipe covering. Radiation. Window radiation. Wall radiation. Radiator valves. Radiator shields. Automatic air valves. Indirect steam heating. Floor and wall registers. Air filtering chambers. Vacuum heating systems.

PERHAPS the chief advantage of steam heating systems, as compared with others, is that the radiators may be situated, without loss of efficiency, in places remote from the boiler. For this reason steam is generally used for heating large buildings. In its adaptability to the private house it has still this advantage. Steam is swift in its movement, through heating pipes as elsewhere, and the most remote radiator is soon hot when the temperature of the boiler's contents goes above the boiling point.

Heating by steam also has the merit of fuel economy, delivering at the radiator 70 to 80 per cent of the heat of the fuel. In this respect it is estimated to be equal to that of the stove, where the combustion takes place entirely within the apartment and the loss of heat is only that which escapes up the smoke flue. A steam heating system, properly installed, defies the severest weather, warming the most remote and exposed rooms equally with those more protected and near the boiler.

Two types of cast iron boilers are used in the installation of steam heating plants, both made of cast sections fitted together. The horizontal type, in which the sections are added longitudinally, has a square fire box and is suited for the use of coke, coal or wood as fuel. This type is recommended for soft coal, which requires to be spread thinly while burning. The arrangement of flues is such as to give the maximum of heating surface in comparison with the dimensions of the grate and show a high efficiency. They have the merit of being strong and simple in construction, with a corresponding low cost, and are as easy to take care of as a steam boiler can be expected to be. The capacity of the boiler and the area of the fire box may be increased by putting on additional sections. On account of its moderate height this boiler is particularly suited for places where there is little head room.

The round type of sectional boiler is made up of cast iron sections piled one on top of another to various heights, according to the capacity required. If the boiler is to be of large capacity extra head room will be required, as each section gives additional height. On account of the limited area of the grate fuel for this form of boiler should be hard coal or coke, or at least a free burning soft coal. It is often the practice where large boiler capacity is wanted for steam or hot water heating to install two or more of the cast iron sectional boilers side by side. The plan supplies a reserve boiler, so that in the event of any trouble the entire supply of heat will not be shut off.

The horizontal tubular boiler is a common type of steel boiler. The construction is simple and it is considered the strongest form of tubular boiler. Ordinarily it has vertical rows of tubes in the lower half, the middle row sometimes being omitted. Some makers "stagger" the rows of flues. Manholes, strongly reinforced, for cleaning, are necessary in such boilers. Domes are considered an element of weakness by boiler designers, yet serve the useful purpose of increasing the storage capacity for steam and as a place from which to draw off the dry steam.

The locomotive type of tubular boiler is so called because that form of construction is much used in locomotives. This has an enclosed fire box and may be used without having a brick setting. The large flat surfaces of these boilers about the fire box render them less strong than the plain tubular type. These surfaces need to be strongly braced. The marine is another type of cylindrical boiler, having a cylindrical fire box, and, while very strong, is more expensive than the others to construct. They are, therefore, but little used in low pressure stationary installations.

Vertical tubular boilers are economical in the use of fuel. The flame strikes the end of the boiler and the heated gases pass through the vertical tubes. The fire box usually is enclosed by a water leg or extension of the boiler below the lower crown sheet, where the deposits of mud gather, convenient for removal. Such boilers require much less head room and are difficult to keep clean. Experience shows the common type to be short-lived, owing to choking with sediment, the opening of joints and leakage around the tubes of the lower crown sheet. New types of vertical boilers have come into use that give much promise. These have closed tubes or loops projecting horizontally from a central upright cylinder, giving large heating surface. They are known as "porcupine" boilers.

The general types of water tube boilers are for the larger installations and scarcely need be considered here. At least one small water tube boiler is made for house installation.

In some small heating plants where hard coal is used a magazine heater is installed, which has the advantage of not requiring re-coaling for many hours.

The effort to make the heating apparatus automatic in its action has resulted in the invention of many devices to control the dampers at the fire box and in the smoke flue. Notable among these is the rubber diaphragm, which is attached to the boiler below the water line, so that it may not come in contact with the steam and suffer the rapid deterioration which would result. The pressure upon the diaphragm sets into action a system of levers and connections with the dampers which closes them and deadens the fire. As the steam goes down the pressure is released and the dampers open again. They are subject to adjustment to the requirements. In another form the pressure is upon a piston head. When the steam pressure overcomes a certain weight, which may be adjusted, the dampers are closed. When the pressure is released they are again opened. Metal diaphragms are also used for the pressure method of damper regulation.

The automatic control of temperature is now accomplished by a number of different systems and is such an important and necessary feature of satisfactory house heating that we treat it separately and exhaustively in Chapter XI.

The covering of steam pipes with non-conducting materials is an important part of the work of installation. Two objects are accomplished by the covering of pipes, the prevention of fire and the conservation of heat for its full use at the radiators. The city ordinances in various municipalities differ somewhat in their provisions for covering steam, hot water and hot air pipes. No uncovered pipes are allowed to be placed within a certain number of inches of combustible materials, a precaution that every architect and builder should insist upon as a matter of safety. The covered pipes also should be kept from actual contact with combustible parts of the walls or floors.

The manufacture of pipe coverings is an industry engaging the attention of many large firms and corporations. The materials most exclusively used for the purpose are asbestos, magnesium and gypsum. The saving of fuel accomplished through having pipes well covered in a steam plant is estimated to be 10 per cent. This covering also prevents the overheating of the cellar, which should be kept at all times as cool as conditions will allow.

The heat generated at the boiler should be delivered at the radiators and not wasted on the way.

The equipment of a house with radiators is the special work of the steam heating engineer. The question of how many radiators there should be and what sizes each room should have is one of scientific knowledge, which has been completely tabulated and is available for those who are particularly interested. In this chapter we shall attempt only to indicate the available forms of radiators and the latest practice in their use. Great advances have been made and the subject is one brimming with interest.

The radiator is the delivery station for the product of the steam boiler. It may be a plain assemblage of radiator sections at one side of a room or it may have a very pretty and attractive design. If other conveniences are not available and necessity demands, the dining room radiator may contain a warming oven with ornate doors. It is scarcely necessary to add that the warming oven should be in the kitchen if possible.

In the halls or in front of windows the radiators may have a height of 15 or 16 inches, with a slab above, to be used as a seat in the summer season. If it is desired to warm a bow window a low circling radiator coming to the sill may be installed. At the side of the stairs in the hall the radiator columns may be of varying heights, corresponding with the heights of the successive steps beside which they stand. In front of a narrow window the central part may be made to correspond with the height of the sill and the sides, the ordinary radiator height of 38 inches.

In the designing of radiators almost every requirement seems now to have been anticipated. It is often desirable that the radiators shall not stand upon the floor. Partly to obviate this an inventive genius has designed a special type of radiator leg or support which hugs the wall and makes the cutting of a carpet unnecessary. It has somewhat the shape of a duck's foot, the leg standing next to the baseboard and a flat extension coming forward on the floor to preserve the equilibrium of the load.

Another type of radiator is extensively manufactured to be supported by substantial brackets on the wall. These are made in convenient sections and are as unobtrusive as any direct-heating apparatus possibly can be. When not required for heating, the wall radiators may be sometimes used as shelves for pictures and other ornaments.

Many tests have been made to determine the efficiency of the various forms of radiators, but results have varied widely, owing to many obvious difficulties. The results generally show that a low radiator yields a greater amount of heat in proportion to its heating surface than the higher forms; that the radiators with widely separated coils or columns are more efficient in proportion to heating surface than those with closely set columns, because the air circulation is better and there is less re-radiation. Rough surfaces yield a much larger percentage of heat units than polished ones. Bronzing the surface of cast iron seems to increase the radiation slightly, while painting with white paint reduces it quite appreciably.

Radiator forms have undergone many changes until now the cast iron sectional type is used almost exclusively in house heating. A comparatively new type is the pressed steel radiator. Claims in its favor are that it is much lighter and therefore much easier to install, and that it has much better conductivity of heat than the thicker metal of the casting. These radiators are also strikingly ornamental.

The old types of radiators include the wrought iron pipe coils, known as the return-bend coils, the branch-tree and the branch-tree mitre coils. The box coil is a compact assemblage of return coils. These forms are still used for shop and factory heating, but are unsightly for direct heating in the house. Vertical pipe radiators were made by screwing short pieces of wrought iron pipe into a hollow cast iron base, the pipes being connected in pairs at the top by return bends. Single short pieces of pipe with closed ends were also used, screwed into a base in the same way. Each pipe contained a diaphragm dividing it into two chambers, connecting at the top, so as to give the same result as two pipes connected by a return bend. Ornamental tops or screens were placed upon these radiators, giving a neat effect. The modern cast iron sectional radiator is produced in such attractive designs that the ornamental top has gone the way of other unnecessary things.

For direct-indirect radiation steam radiators are made so that flues are formed among the several columns, open only at the top and bottom. When connected with a cold air inlet at the bottom they supply a desirable system of combined ventilation and heating.

The valve is perhaps the least ornamental feature of the modern radiator. It has remained practically unchanged for years, and all radiator valves seem to be open to the same criticism. Something in the way of new design to bring it more in harmony with its surroundings and to make it appear more like a part of the radiator would find appreciation among those who aim to harmonize the useful equipment of a home with its ornamental furnishings.

The necessity of protecting delicately tinted walls and draperies from injury to which they are liable by reason of the nearness of radiators has prompted the use of radiator shields. These are made of brass, bronze and other sheet metals, also part glass, in ornamental designs. Some of them are very attractive as well as serviceable. The air currents created by the radiator often are laden with dust particles, which in time streak the walls and soil the draperies. Sometimes the radiators are placed too near a varnished or painted surface and the use of shields becomes desirable, and they are constructed either to separate the surface to be protected from the radiator or to deflect the heat into the room and away from the wall or drapery.

The contriving of ingenious automatic air valves for radiators seems to be the particular sport of inventors. They have produced so many patterns in this necessary appendage that the market is supplied with a number of excellent designs. The valve should be automatic rather than positive in its action or much trouble will result in the wetting of carpets and staining of walls, floors and draperies. Valves should be placed on all radiators for the escape of air, which is certain to collect at high points in the heating system. Where the valve needs to be opened and closed by hand it is very human to open it to allow the air to escape and then go away, forgetting all about it. The ascending steam drives out first the air and then perhaps the water of condensation, if it has not run off when the radiator was cool. This water is usually rusty and sometimes greasy and offensive.

One form of air valve depends upon the heat of the steam to expand a metal strip the ends of which are held securely, causing the middle to bend under the heat, closing the air valve. In another a slender cylinder has a minute air escape in the end. The heat of the steam lengthens the cylinder slightly, forcing the aperture against a pin-plug held between two uprights that are not affected by the heat. Other forms make use of other expansive substances than metal to cause the air-escape to close when the steam heats the valve. To prevent the escape of water if the other part of the valve does not close under heat, some valves are provided with floats which act upon the aperture as soon as water enters the chamber, effectively closing the valve.

Indirect heating by steam presents several advantages over the direct method. The radiators are placed in the basement in an enclosed chamber, from which the heat is conducted to the rooms through pipes in the same manner as from a hot air furnace. A fresh air inlet is necessary, as in the case of the hot air furnace, and the advantage of ventilation is secured, an advantage greatly to be desired for the health and comfort of the family. Special forms of radiators are constructed for indirect steam heating systems. These take the form of the extended surface radiators or radiators with fin-like and pin-like projections, which increase the radiating surface. These may be assembled in stacks in a single chamber or may be installed in separate boxes beneath the floor near where the register is to be placed for the room above. This method of indirect heating saves much space in the rooms for other uses that by the direct method would be occupied by radiators. Although made as attractive in design as possible, the heating apparatus in a room is not desired for other than its utilitarian purpose.

Both the direct and indirect systems may be employed in combination with advantage, the indirect for the lower rooms and for the purpose of ventilation, and the direct for the more remote upper rooms, which are less easily heated by means of hot air pipes of the indirect system.

The registers should be placed in the baseboard rather than in the floor for indirect heating or for ventilation. The floor register becomes a catch-all for sweepings and other litter and, where carpets are used, necessitate cutting around the registers.

Where rugs are used the floor registers often interfere with their arrangement.

An improved system of distribution for warm air in indirect heating systems was described by A. O. Jones in "Domestic Engineering" September 15, 1906. In this system only half the number of pipes lead from the furnace or heating chamber, each pipe having large capacity and designed to furnish warm air for two rooms. The registers for the two rooms, one on the first and the other on the second floor, are placed preferably in the baseboard of each room, one directly over the other, and connected by a wall flue. The current of air from the big pipe is divided at the lower register by a deflecting wing extending into the pipe. This deflecting wing or valve may be adjusted so as to take much or little of the column of air or may deflect the whole column to either room. The advantages of this arrangement are that the warm column has greater height and therefore a more rapid movement, which advantage accrues in part to the lower room; also that the air may be shut off entirely from the upper rooms when not in use, giving the lower rooms the advantage of larger pipes than otherwise they would have. The saving in piping is also a consideration as well as the advantage of being able to secure a better arrangement of pipes at the hood of the furnace or warm air generating chamber.

The filtering of air for the house, desirable both from the practical as well as the esthetic point of view, is easy of accomplishment. The saving of much labor by reason of reducing the amount of dust and soot to enter the house is worth many times the effort. For a house already built cheese-cloth screens may be placed in the cold air inlet. The system, preferably, should have a commodious filtering chamber in the basement, where large surfaces of cloth may be interposed between the outer air and the heating apparatus or house interior. This room may be long and narrow, the frame for the filtering cloths running lengthwise of the room. The frame should fit snugly on all sides and, to prevent the filter cloths from bellying, may be covered with coarse poultry netting. The filter cloth should be made the size of the frame, so that it may be fastened on hooks or pins at all the edges and easily removed to be cleaned. Two or more cloths may be provided, so that fresh ones may be put in place as often as necessary. Two doors should open into the filtering chamber, one in front of the filter and the other behind it. It should be possible also to shut off the air supply from the house while changing the filters, so that any dust falling from the filters may not be carried into the house. The filter cloth should not be so fine as to shut off too completely the supply of air, nor so coarse as to let into the house the sooty particles that float in the atmosphere of most cities and large towns. A closer fabric may be desirable in winter than summer and other variations may be suggested by experience.

Authorities do not encourage any attempt to humidify the air in excess of fifty per cent of saturation. Dry furnace air is no longer considered harmful, for it is known that on the contrary some of the most healthful settlements of the country are those situated in the desert regions, where the percentage of moisture in the air is very slight.

Air washing devices have been long in use, in which the process consists of forcing the air through a sheet or spray of water which combines with the impurities in the air and prevents their passage to the ventilating system. Prof. John R. Allen says that the air-washing system of one large building yields two wagon loads of dirt per week, taken from the air by the spraying device. This method is also used for cooling the atmosphere.

The vacuum steam heating system is considered to be the most signal advance in the science in many years. In an absolute vacuum, 29.92 inches, water will boil at 98 degrees, producing a warm vapor. In a 20-inch vacuum it will boil at 161.2 degrees. The weight of the atmosphere, 14.7 pounds to the square inch, prevents water boiling in the air until a temperature of 212 degrees is reached. In the vacuum system advantage is taken of this law and the radiators are heated to any desired degree through a wide range of temperature.

In installing the vacuum system it is necessary that the fitting be done perfectly to make it absolutely air-tight. The smallest leak in any part of the piping in time breaks the vacuum and impairs the efficiency of the system. Vacuum heating can be applied to old systems of steam heating, greatly increasing their efficiency and working a large saving in the winter coal bills. When steam enters any steam heating system it expels the air through the various valves, and when the steam cools and condenses a vacuum is left in the pipes and radiators. By the use of simple devices this vacuum is preserved so that the temperature of the water in the boiler may be held far below the boiling point and yet maintain in the system the hot vapor which will supply the necessary radiation for warming the apartments.

The radiator and valves are all connected, through very small pipes, with simple devices in the basement, which operate to maintain any particular temperature for which the indicator may be set. By controlling the vacuum the temperature at the radiators may also be controlled perfectly. The saving of fuel is shown to be from one-fifth to one-third of the usual amount consumed in the ordinary steam heating plant, thus securing an advantage in lower cost of fuel and the reduced labor of handling it.

Chapter VIII.

HEATING BY HOT WATER.

Its advantages. Types of house-heating hot water boilers. Draft regulators. Expansion tanks. Heat retainers, generators, and heat economizers. Special circulation fittings. Radiators. Wall and window radiators. Radiator valves. Radiator air valves. Systems of piping.

HOT WATER systems for heating have their earnest advocates in large numbers. Theory and experience have brought into existence many inventions and improvements which, by their practical application, have advanced this method of heating to a high state of perfection. The distinctive advantages claimed for hot water heating are its economy of fuel and the more satisfactory degrees of temperature attainable.

In a general way the hot water system is a duplicate of the steam heating plant, with such variations as are made necessary by the slower movement and greater weight of the water. The hot water system is more expensive to install, requiring larger pipes and more of them, and a far greater area of radiating surface. It is also less responsive than the other systems, requiring a considerably longer time to warm the house, but once in action it maintains a steady heat at a fixed temperature so long as it has reasonable attention. It is probably the least exacting in its demands for attention of all systems, and therein is one of the dangers. We are sometimes apt to expect too much. A radiator in a remote part of the house may be turned off inadvertently and allowed to freeze, bursting a section, a flood following. An air valve may become slightly disarranged and flood an upper room with water. No system is without its defects or its exactions in the matter of attention.

The types of boilers for heating by water are practically identical with the steam boilers, many being made for the double purpose. In the water heater, however, the steam section, dome or header is not necessary. The horizontal cast iron sectional boiler with square fire box is one of the types most used. It requires little head room and is strong and simple of construction. The method of construction is an elastic one, the capacity of the boiler being increased by the addition of sections longitudinally. The round sectional upright may be used where there is plenty of head room. The required capacity is attained, as in the horizontal type, by adding sections. These are of cast iron and are piled one on top of another until their combined capacity equals the necessities of the installation. This type has all the advantages in fuel economy of other vertical boilers. The fire plays directly upon the lower sections and the hot gases pass through the flues to their final escape in the stack.

The aim in boiler construction, to secure the largest results from the combustion of the fuel, is attained in varying degrees and with more or less completeness in boilers of modern design. For small plants the boilers or water heaters are supplied complete and compact, requiring the least possible expense in their installation, and one may scarcely choose amiss among the better known makes.

The qualities to be sought in a water heater or boiler are several. There should be an abundant heating surface in proportion to the area of the grate. A grate with 3 square feet of surface should have heating surface in the boiler of 60 to 90 square feet. There should be plenty of circulating spaces, so that the water may move freely around the heating surfaces to take up the heat transmitted from the hot gases. The better the provisions in these regards the lower will be the temperature at the stack and the smaller the loss from fuel combustion. In economical heaters the temperature at the stack is not over 300 and in no case should exceed 450 degrees. Unless the fire and its gases are well distributed through flues or fire tubes, the desired economy is not accomplished.

For larger installations the various forms of tubular boilers may be considered, but very satisfactory results are accomplished by using two or more of the cast iron heaters side by side and maintaining the necessary number of fires to meet the exigencies of the season. The several forms of tubular boilers have been mentioned in the preceding chapter. To these may be added a small type of water tube boiler intended for house heating plants, for which is claimed an extreme simplicity of construction and quickness of action that gives it an advantage over the more established types. On account of the advanced state of perfection in the established methods of installation, and of systems generally, any novelty or decided variation from present standards is taken up reluctantly. New ideas must prove their right to consideration and force themselves upon the conservative trade and cautious public. The heating plant is such an important part of the expense of a home that the architect and the owner require sure knowledge upon the merits of the system to be adopted.

No system of heating requires such careful and thorough workmanship as that for heating by hot water. Steam has such facility of movement that it glides through the smallest opening with the swiftness of a race horse, while water moves with slow deliberation and must have a clear path with graceful curves around which it may flow with the least opposition, friction or obstruction. All pipe ends should be carefully reamed, whether for steam or water, particularly for water, in order that there shall be no burrs to obstruct the flow. In the best construction the short elbows common for steam installation should be displaced in the hot water system by long-radius ells, long-radius branch ells, long-radius tees and crosses, turned in the direction of flow. Other special fittings, for the one-pipe system, are made to deliver the return water to the cooler layer on the lower side of the main.

The efficiency of a hot water system depends much upon the freedom of flow, and this flow depends upon the difference in weight of the water in the hot and cold legs of the system minus the friction due to turns and other obstructions. The proper pitch upward for all horizontal pipes carrying hot water and the downward pitch of all pipes carrying the cooled water are to be regarded. Larger pipes are necessary than with steam because of the slower movement of water, and the complete circuit is generally preferred because of the freer flow thus allowed. The two-pipe system requires more piping, but this expense is in a measure offset by the saving in the size of the pipes.

Damper regulation is accomplished with hot water heaters in much the same manner as with steam. In the case of the hot water heater a liquid which will vaporize at a lower temperature than water is used to create the pressure by which a diaphragm is made to act upon levers or clockwork and open or close the dampers. The heat of the water heater is communicated by attaching the instrument where it will continually have the heat of the water in contact with the reservoir containing the more sensitive fluid. The thermostat, controlled by the temperature of the heated apartments, is also made to regulate the dampers of the hot water furnace with considerable exactness.

One feature of the hot water system not required with steam is the expansion tank. Water when heated shows a considerable degree of expansion. The difference between the temperature of greatest density, 40 degrees Fahrenheit, and the boiling point, 212 degrees, is the difference between .99989 and 1.04440, or about 5 per cent of the volume of the water. The expansion tank allows for this change of density. It should be situated somewhat above the highest point of radiation in the system, where it will not be in danger of freezing. It should have a closed cover, a glass water gauge, a vent pipe leading upward to the open air, and a waste pipe or overflow. The connection between the heating system and the tank should be such as cannot become clogged, as the expansion to the boiling point is practically irresistible, and serious results might follow the stoppage of the expansion pipe. The size of the tank, based on the law of expansion, should have a capacity somewhat in excess of one-twentieth of the cubical contents of the system. The height of the tank above the boiler will influence the boiling point to the extent of the pressure exerted by the head thus created. Each foot of head is equivalent to 0.435 pounds per square inch. With a 36-foot head the boiling point would thus be raised to a temperature of 250 degrees and a pressure at the boiler of 15 pounds per square inch above the atmosphere.

This additional pressure is of advantage when higher temperatures are desired at the radiators. To provide for certain additional stress upon the system various inventions have been made under the names of heat retainers, heat generators and heat economizers. These take the form of mercury traps interposed at some convenient point between the system and the expansion tank. A body or column of mercury is made to resist the expansive force of the water to create the desired pressure, generally about 10 pounds in excess of the pressure under ordinary conditions. It is seldom desirable to carry over 20 pounds pressure, either in a steam or hot water plant, for the purpose of heating. Where the mercury seal is used greater results are secured from the same area of radiation on account of the higher temperatures throughout the system. A saving of about 10 per cent of radiators and piping is claimed for these devices. The heater must be of full capacity, however, the higher temperature merely accelerating the movement of the water in the system and securing a greater service from the radiators.

The radiators in the hot water service require two connections, one at the top of the columns and the other at the base. The columns themselves must also have top and bottom connections with one another in order that the water may circulate through them. In these respects they differ from the steam radiator. While hot water radiators may be used with success for steam heating, the steam radiator cannot be successfully used in a hot water heating system. The arrangement of the hot water radiators may be planned in the house as for steam heating, except that space must be provided for about one-third greater radiating surface.

Manufacturers provide radiators for hot water, as for steam, to meet every requirement; low radiators to be placed in front of windows, curved radiators for bow windows, and thin ones to be suspended upon wall brackets. Special forms are made for indirect heating, the radiators being installed in chambers beneath the floor, which open into warm air flues that discharge through registers at the baseboard. Fresh air is fed into the chambers from out of doors and the plan serves the needs of ventilation and heating. Flue radiators are used for the direct-indirect system of heating. The columns of the radiators are so made that, when assembled, flues will be formed among the columns, open only at the bottom and top. The radiator is made to sit over the box end of a cold air duct, which admits fresh air from out of doors through the radiator flues, where it is heated and passes into the room. This system affords desirable ventilation.

As a precaution against freezing, the radiator valves of a hot water system are usually so that they may not be entirely closed. A small hole is left in the valve-shield to allow the water to circulate so long as there is heat in the system. There are numerous patterns and it is wise to see that valves of the kind described are used in any new system. Here again may be emphasized the desirability of something more ornate in the exterior design of radiator valves, something not quite so suggestive of the shop from which they came.

Radiators for hot water require air valves, as in the case of steam. These are, or should be, automatic in their operation, closing with a float. A defective air valve upon a hot water radiator may cause a small flood before its defective character is discovered, and for this reason the valve should not only be of good design, but well made. It will be costly economy to use any but the best.

The various systems of piping for hot water heating are governed in their design by the law of flow which manifests itself when the natural equilibrium existing between two connected columns of water is disturbed by the application of heat. In a heating system the pipe or riser, from which the connections are made to the upper parts of the radiators, is taken from the top of the water heater. The return pipes from the bottoms of the radiators are brought to the bottom of the heater. The water is heated and thereby expanded, losing a certain amount of weight in proportion to its bulk. The weight of water at 40 degrees is 62.425 pounds per cubic foot. At 212 degrees it is 59.760 pounds, a difference of more than 2½ pounds per cubic foot. The difference of a few ounces in weight between the ascending and descending columns is sufficient to establish and maintain a steady flow, the law operating to re-establish the equilibrium, but the heat of the fire keeping the two columns out of balance.

In the one-pipe system the riser connects with one or more horizontal mains, which make a circuit of the basement at a pitch downward, coming into the bottom of the boiler. From these mains smaller risers ascend to each radiator, one connecting with the top of the main and the top of the radiator, the other connecting with the bottom of the radiator and with the lower side of the main. The pitch of all pipes must be such that the system may be completely drained when the fire is out.

In the two-pipe system the mains traverse the building so that each radiator conveniently may be connected with the flow and return mains and may be cut out or shut off without interfering with the circulation of the system. This is called by some a compound circuit to distinguish it from a simple circuit where the water flows direct from the heater to a single radiator and is returned to the heater direct.

The open circuit is that in which the main flow is through all the radiators, none of which may be shut off without stopping the flow from all. This may be used with advantage frequently for a part of the heating system of a house, as in contiguous rooms and halls which are in continual use and where there is no occasion to shut off any one radiator.

It is important to maintain the water in the system at a certain head. This is done by means of city water pressure, or, in its absence, a hand force-pump at the boiler, a few strokes from which will restore any loss through evaporation or waste at the expansion tank. A gauge on the boiler shows the pressure and the height of the water in the system at all times. While the expansion tank should have a glass water gauge attached, it is seldom necessary to refer to it except for the purpose of verifying the altitude gauge on the boiler.

SUMMER CARE OF HEATING PLANTS.

Not alone for the purpose of preserving one's property but in order to have the heating plant in proper condition when it is desired to make use of it again in the fall, every owner of a heating system or tenant who has occasion to use one should see that it has proper care. The following directions for caring for steam and hot-water heating plants in summer, so that no deterioration shall take place while they are not in use, were prepared by experts in the business and deserve to be posted in every basement and heeded in every particular by those to whom they apply:

All boilers, cast iron or steel, water or steam, should have the water removed which was in use during the winter season, and the system filled with fresh water up to a point where the mains and lateral branches are full. The pipes above the cellar floor and radiation in the rooms will soon dry in the interior, so there is no necessity of filling them with water, for they will not rust while dry.

In boilers with hand-hole plates, or boilers of which the interiors can be cleaned in any way, it is well to wash them out thoroughly before refilling with cold water.

The deterioration of heating boilers that takes place in the summer months is due, to a large extent, to sulphur contained in the soot, particularly if soft coal has been used as fuel. The water in the atmosphere condenses on the cold plates of the boiler and moistens the soot, forming in combination a substance that attacks the plates and destroys them very rapidly. Therefore great care should be exercised in removing all particles of soot from all parts of the boiler where it has adhered.

Spray all flue surfaces with kerosene oil, or crude oil. This prevents rusting.

Leave the feed, ash, and clean-out doors open.

Take down the smoke pipe, clean it carefully, and leave it down until fall.

Remove all ashes and clinkers from grate bars and ash pit.

Paint outside surfaces with heat proof black enamel, made for the purpose.

Chapter IX.

HEATING BY WARM AIR.

Its advantages. Types of warm air furnaces. Combination warm air and steam and warm air and hot water heaters. Auxiliary heating coils and sections. Draft regulation. Location of furnace. Brick work. Fresh air supply. Warm air in flues. Furnace pipe and fittings. Wall and floor registers.

THE hot-air furnace of today was evolved from the cast-iron stove. It is still a stove, upon a large scale, enclosed in a chamber and by means of pipes made to do duty for several rooms instead of one. It is best suited for small houses, but fails in efficiency very often because of improper installation.

Very often the fault is with the architect because of his imperfect knowledge of the requirements in successful house heating by warm air from the common furnace. Even the best of furnace men cannot be expected to take the complete plans of a house and so dispose the pipes from a furnace as to get adequate results. If the architect is a master of the principles of heating and ventilating he will have provided for the location of the furnace and the course and location of the heating pipes in his plans. If he is not a master of these principles his duty is clear. He should submit tentative plans to a competent furnace man and ascertain what the requirements are that he may incorporate in his plans such provisions as the furnace expert may suggest.

A bumptious architect is certain to suffer loss of reputation, or may fail to win one worth having by a disregard of what many have hitherto considered small details, the details of the furnace system. True the furnace is a simple affair but not too simple to have a mighty influence on the comfort and pleasures of a home. A house may have the most beautiful facade on the avenue, the most pleasant outlook, the costliest wood-work and the finest of architectural detail and yet be about as habitable as a country barn in winter if the heating system is not adequate to the requirements. The purpose of this chapter is to offer such timely suggestions as we have been able to gather from many sources, as to the best practice in hot-air furnace installation.

The market affords many successful types and patterns. The oldest houses in the furnace trade in this country have been in the business over sixty years, so that there is plenty of good advice available and it is in the nature of things that the proportion of successful furnace installations should be much larger than really it is. The fault primarily is with the architect who thinks the furnace man is to blame. But the latter says the tinner may not have gotten the pipes just right. So it is the tinner, who never studied physics in his life and cannot explain the first principles of a furnace, who really is to blame. The owner regrets that he didn't watch the job more closely, but says that he hired the architect for that purpose and supposed he was attending to it. The upshot is that all the bills having been paid and the house occupied, the furnace heats one or two rooms well and all the others indifferently. The family is destined thereafter to hug the grate fire in zero weather and shiver in all the other rooms. The furnace is crowded to the utmost but shows an unmistakable partiality for two or three flues. The discomfort might all have been avoided by the forethought of the architect in properly placing the rooms, the registers, the ventilators, the pipes and the furnace and specifying the capacity of the furnace.

Long practice has shown that the furnace should have a large combustion chamber directly over the firepot where the blaze and the hot gases may have their first full play upon an ample surface which will transmit and radiate the heat rapidly. Sometimes the combustion chamber is crossed by several flues for the more complete radiation of heat. In some types of furnaces this chamber is surrounded by one or more rows of perpendicular flues around which the flames and gases may play, creating currents of air upward through the flues. In other types the combustion chamber is extended around the outside of the central chamber with air space between, thus greatly extending the radiating surface.

The advantage of the hot air furnace is the low cost of installation and the ventilation which the system affords. No other system of heating keeps such a volume of fresh air in motion except the indirect methods of steam and hot water heating.

The cost of original installation as estimated by furnace men is placed at one-half that of steam and one-third that of hot water, for an ordinary dwelling. But after the hot air system is all in place it may prove to be a failure in some parts of the house. No system requires more careful study by a furnace engineer of unquestioned competency. It is within the knowledge of almost every one that many furnaces fail to perform with even fair satisfaction the duties expected of them, a condition due to competition or to the inability of the furnace man to do his work properly.

Other advantages claimed for the hot-air furnace are: that little skill is required in its management and that it needs but little attention; that it is not liable to get out of order and when repairs are needed they are comparatively inexpensive.

Although used comparatively little, one of the most successful systems of heating is that which combines the hot-air furnace with the hot water or steam heat. This provides for the ventilation of the house and insures the proper heating of rooms remote from the furnace. The furnaces constructed with this double purpose in view are made to heat 80 per cent of the house with hot air and 20 per cent with hot water or in any proportion up to 70 per cent hot water and 30 per cent hot air. The water is heated by means of coils or specially cast hollow plates with proper connections suspended in the combustion chamber of the furnace. These coils or plates are so placed as to interfere as little as possible with combustion but at the same time are completely enveloped in the gases from the burning of the fuel.

Some fifteen years ago the combination of hot air and hot water in heating houses was considered one of the most advanced steps made in this important science. But steam heating and hot-water heating became so popular that the combination system, possessing such indisputable merit, was to a considerable degree lost sight of. But shrewd manufacturers, while yielding to the popular demand, did not overlook the value of the combination system and have evolved excellent types of apparatus for this purpose.

Steam is to some extent used instead of hot water in the combination system. When this is done a tubular boiler is suspended in the large combustion chamber of a specially built furnace. The plan leaves large radiating surface for the warm air system of heating and ventilating.

The advantages of the combination plan are that, while having the desirable ventilation of the hot-air system, the radiators for hot water or steam may be placed in the more exposed and remote rooms and perfect heating in those apartments secured. The first floor of the house may be warmed by the hot-air system with the advantage of abundant ventilation, with perhaps a hot water or steam radiator in the hall and the upper rooms also supplied with the radiators. Ventilators should be supplied in all rooms, preferably in the baseboards, for the escape of vitiated air. The fresh air from below will thus find its way to the upper rooms, keeping the air of the whole house in an agreeable condition.

The heat of the furnace is frequently used as an auxiliary source of hot water for the kitchen tank and the bath. This is done by suspending a coil or special hollow casting in the dome of the furnace with proper connections. Unless the demand for hot water is large the amount of pipe-heating surface in the furnace should be very small or the water in the tank will be kept at too high a temperature.

The object of all furnace designs is to secure the highest results from a given amount of coal or other fuel. Each designer or manufacturer is aiming to reach the same goal but by a slightly different route. In selecting a furnace preference should be given to such forms as make best provision for the radiation of the heat and the upward movement of the heated air among the flues. Some furnace designers contend that it is as bad a mistake to get too much radiating surface in proportion to the size of the grate and the fire-pot as too little. Practice has established the rule of providing a maximum of about 70 square feet of radiating surface to each square foot of grate. By the rules ordinarily followed a house containing 16,000 cubic feet of space to be heated would require a furnace having between 4 and 5 square feet of grate and 300 to 350 square feet of radiating surface. The heating capacity of a furnace is often figured too high and liberal allowance should be made. It is better to err on the side of a large furnace than on too small a one. It should never be necessary to crowd a furnace to the extent of having the fire-pot red hot.

So many conditions arise to influence the effectiveness of a furnace that liberal estimates are best. The direction and violence of the wind, the ventilation of the rooms, the disproportionate arrangement of the hot-air flues, the snug or loose construction of the house, all have a bearing upon the behavior of the hot-air furnace. The movement of a current of air whose motion depends upon the buoyancy due to its heat is often upset by a trifling cause.

A well-built house is the best help to a furnace. A house needs to be well sheathed and the sheathing well covered with two or more thicknesses of heavy building paper beneath the siding. A single thickness of building paper is full of air holes. All spaces around the sills need to be well stopped so that no air may get between the walls. The joints around window and door casing and around windows and doors themselves need to be snug, to resist the winter winds. Such precautions make the best start toward having a house properly heated in the coldest weather. Storm windows should be supplied, particularly on the more exposed sides of the house. The best time to have these made is when the house is built, making them a part of the contract.

With a house thus carefully constructed, the heating problem is simplified. Practical furnace men prefer to put in a large furnace with pipes larger than the actual necessities, but the conditions of competitive bidding generally forbid this. As with other systems the radiation and distribution of heat should be such as to heat the house with ease and without forcing in the coldest weather.

An ideal hot-air furnace is one that not only meets requirements in economy of fuel and abundant radiation but which may be cared for easily; one which has an ample ash pit and doors that close tight so that fine ashes may not escape while shaking. It should have tight joints which do not permit the escape of gas or smoke into the air flues. There should be no perpendicular joints which need to be closed with cement because the uncertainty of the cement remaining in them renders them liable to leakage sooner or later. For this reason the castings of the fire-pot and the dome over the fire-pot should be complete as to their circumference. If all cemented joints are horizontal, with flanges well packed with furnace cement, their permanency is assured.

Draft regulation with the hot-air furnace is generally accomplished by means of chains extending to some convenient point on the first floor. The chains connect with the several dampers which may be raised and lowered as desired. The automatic regulation of dampers is very satisfactorily done by means of thermostats and mechanical connections for the purpose. We shall have more to say about these in Chapter XI.

The furnace should have a chimney connection through a seven or eight inch pipe and the chimney flue should be large. Eight by twelve inches is none too large and the flue should have no other openings for grates or stoves. A large flue makes a good draft to carry off the gases when their heat has been extracted by the radiating surfaces. Small chimney flues are continually giving trouble.

The location of the furnace is preferably near the center of the basement where all the lower rooms as well as the upstairs connections may be reached with short pipes of about equal length. Remote rooms should have furnace connections much larger than their cubic contents would require if situated near the furnace, for the obvious reason that there is loss by radiation in going the greater distance and if several turns are required in the pipe the movement of the air column through the pipe is slower.

In a paper read before the American Society of Heating and Ventilating Engineers at its summer meeting in Chicago, published in DOMESTIC ENGINEERING August 11, 1906, Mr. R. S. Thompson described his plan of making all pipe connections with the hood of the furnace at the top of the hood. He requires that the hood be made square instead of beveled and each connection is carried straight up to an elbow which brings the pipe within 3 inches of the ceiling. It is then carried horizontally to the register box or boot for the partition riser. The argument for this plan, which he carries out in all his work, is, that the 3 to 5 feet of perpendicular direction, added to that which the air already has as it leaves the sides and top of the furnace, gives the air an accelerated movement and prevents one pipe from robbing another, as often is the case in the old method of arrangement.

Mr. Thompson also contends that the covering of furnace pipes with asbestos paper is futile in preventing radiation and loss of heat unless it is put on in several layers. He argues that a single layer radiates the heat more rapidly than the bright tin, which is smooth while the paper is rough and has a greater radiating surface. He advises half an inch. Double pipes with air space of three-quarters of an inch would be better. Mr. Thompson's allegation that the asbestos paper draws moisture and rusts the pipes during the part of the year when the furnace is unused is borne out by the experience of others.

Mr. Thompson's ideas and practice are contrary to tradition and the practice of nearly all engineers who aim to take the air from the furnace to the registers by the most direct routes.

Expert advice on furnace setting is now generally against the brick-set furnace. It is a waste of heat to keep a great body of brick warm and impossible to avoid it when furnaces are thus encased, as brick are readily absorbent of heat. The furnace casing preferred is galvanized iron, lined with bright tin. Between the casing and the lining there should be an air space of three-quarters of an inch to an inch, regulated by a series of corrugated strips which will hold the two casings evenly apart.

The properly set brick cased furnace makes a very neat-looking job but is of doubtful economy. It renders the furnace more difficult and expensive to get at when repairs shall be needed and takes up more room than the furnace with galvanized casing. When the brick casing is used there should be two walls, one enclosing the furnace direct, usually circular, surrounded with an air space and then the square wall for the finish. The cold air should be admitted at the top of the outer air-space so that it may take up any radiation from the inner brick wall. It will pass downward, thence through numerous spaces to be left in the bottom tiers of the inner wall, and up between the furnace and its casing to the warm-air flues. This arrangement permits only a minimum of radiation from the outer wall to the basement.

The fresh air supply should be preferably from a cold-air room having two or three inlets from as many directions so as to get the benefit of changing winds. These inlets should take the air from a point well above ground, particularly in low-lying localities, so as to get the best air available. Commonly the cold-air duct is made of wood but galvanized iron is much to be preferred when the duct is above ground. A cold air inlet recommended by many authorities is built below the cellar bottom, consisting of a tile conduit or a brick-lined trench plastered with Portland cement. The opening for such a shaft should be provided for in the construction of the foundation wall. No wood should be used in the construction of such a duct, in order that there may be no decaying substances within it.

Noteworthy improvements have been made in furnace fittings by which much better work than formerly is now secured. Instead of being made by tinners of indifferent skill the numerous fittings are now made with the aid of machinery according to fixed standards. All pipes and flues which pass near woodwork or combustible material of any sort should be double. The square tin flues to go between partition walls are thus made in sections that fit accurately together the air spaces between the two walls of tin being half an inch wide and ventilated so that no heat may be confined in them. These double pipes are to be preferred over the single pipes with wrappings of asbestos paper because they are safer and have less radiation of heat than any other method of construction.

All turns in warm air flues should be as gentle as possible to avoid rebounds of air or eddies in the current through the pipe. Abrupt bends need to be avoided in all fittings for the conveyance of warm air because the flow at best is not a swift one and any interruption of movement reduces the efficiency of the service.

The registers for the final delivery of the heated air are to be had in a great variety of designs and many styles of finish. Nickel, bronze, white and black enamel are the commonest styles of finish. The register faces and borders are usually of cast iron, but for cheap gratings where strength is not a requisite, stampings of sheet metal having the appearance of the cast iron registers are now available.

Modern practice now places the registers for warm air heating preferably in the baseboard. The floor register catches so much of the sweepings and is so continually collecting dirt that its use is discouraged. Wall registers with a narrow foot rest are made to supply one of the chief advantages of the floor register, namely that of conveniently warming the feet. Where carpets are used, particularly on the upper floors it often has been necessary to cut around the registers. This necessity is obviated by placing the registers in the wall.

It is desirable to have provision made for the recirculation of the house air through the furnace, as the supply of fresh air through the ventilating system of the furnace usually is in excess of the needs of the family. A large wall register in the front hall to supply a pipe three-fourths the size of the fresh-air duct will be found valuable in the coldest weather. The fresh air supply may then be cut down and the recirculation pipe opened wide. The plan will save fuel, increase comfort and leave sufficient ventilation to keep the house sweet and agreeable. The construction of this duct should be such as to prevent air from outside flowing into the house through it instead of going through the furnace.

Reference has been made in a former chapter to the plan of warm air distribution advocated by A. O. Jones, in DOMESTIC ENGINEERING, Sept. 15, 1906, which appropriately may be repeated here in brief. Mr. Jones takes from the hood of the furnace only half the number of pipes that there are rooms to be heated, all of the pipes having double capacity, however. The first floor and second floor registers are placed directly over each other or nearly so, and open into the same flue, fed by the one large pipe. The lower register has a deflecting wing which may be made to take all the air from the flue or only a part of it, or may throw it all to the floor above as desired. Apparently the plan has many advantages, placing the product of the furnace under better control than the old plan.

Chapter X.

VENTILATION.

Quality of air. Amount of air required. Preparation of air for breathing. Humidifying air. Drying air. Filtering air. Varied systems of ventilation.

TO impart to the house in the coldest months of the year the delightful and invigorating freshness of a June day is one of the aims if not the actual achievement of good ventilation. If you enter such an atmosphere in midwinter you may suspect that back of it lies the intelligent application of the science of ventilation, together with that of filtering and humidifying the air before it is introduced into the building or apartment in which you become conscious of its presence and sweetness.

Every building breathes more or less through ten thousand crannies. Many building materials are porous and more or less air passes through them. It is alleged that a candle can be blown out by a blast of air through a brick wall. The writer has never attempted to prove that such is the fact. Certain it is that the porosity of building materials and the usual inaccuracies of construction are a protection to the health of those who have never given the subject of ventilation a thought and never intend to do so.

But it is unwise to depend on the self-ventilation of any building. It is best to help nature and to teach our children to be conscious of and to appreciate the pleasure of fresh air in the lungs and sweet odors in the nostrils. It is true that people do live and thrive physically in close, poorly ventilated rooms, but it is also true that tuberculosis and other deadly diseases thrive most generally in such cramped quarters.

The importance of ventilation is proven by the mere fact that we breathe oxygen and discharge carbonic acid from the lungs. The purpose of ventilation is to keep up the abundant supply of oxygen in the atmosphere of the apartments which we occupy. The normal person breathes about one pint of air sixteen times a minute, which would be two gallons of air per minute. One pint of fresh air contains 15.8 ounces of nitrogen, 4.19 ounces of oxygen and .008 ounces of carbonic acid. After breathing, this same volume contains the same proportion of nitrogen as before, but the oxygen has been reduced to 3.26 and the carbonic acid has increased to .94 ounce. Expired air also contains watery vapor with organic matter which we cannot fail to recognize by the odor when we enter a closely packed and poorly ventilated audience room where the meeting has been in session for an hour or so.

From the figures given it will be noted that in order to keep up the proportion of oxygen in the air we breathe and keep down the excess of carbonic acid to a point somewhere near the normal about 100 pints of fresh air should be admitted to the apartment for each breath of each person in the room. The amount would be about 12,000 gallons per hour for each person. This would be equivalent to an inlet the size of a gallon measure in which the air current would move two feet per second, 120 feet per minute, or 7,000 feet per hour. Each gas jet or lamp should count as one person in these calculations, as all exposed lights burn oxygen. Small rooms increase the need of ventilation. Each person should have not less than 1,000 cubic feet of space. The smaller the apartments the more abundant should be the ventilation.

Excessive drowsiness in a closely-shut house on winter evenings is due to the excessive amount of carbonic acid in the atmosphere and the lack of oxygen. Good ventilation in houses where stoves are used would make asphyxiation by coal gas extremely unlikely or impossible. Preachers have despaired of keeping certain members of their congregations awake when the sleepiness was due to lack of ventilation and not to anything soporific in the sermon. Extreme sleepiness in a crowded car is usually from the same cause. Sixty people in a car 8 feet wide, 8 feet high and 50 feet long would have only a little over 50 cubic feet of space for each. The air soon becomes surcharged with carbonic acid unless windows and ventilators admit a constantly fresh supply.

Another consideration urges itself upon us, favorable to ventilation. Investigations to ascertain the number of microbes or living organisms in the air show that fresh air contains often less than one microbe per cubic litre (61 cubic inches). In a well ventilated room they range from 1 to 20 per cubic litre. In close school rooms 600 per cubic litre have been found. In well ventilated school rooms 17 living organisms per cubic litre are found to be about the average.

Not only is it desirable to have fresh air, but it should also have a certain amount of moisture to render it more agreeable. It also should be clean. Reference is made in a preceding chapter to the washing of the air by means of sprays to take out the soot and other floating particles for city buildings. The spray also is used for adding moisture to the air. Nearly all hot air furnaces have basins or reservoirs in which water is to be kept, to be taken up by the warm air as it passes through the heating chamber. Usually this reservoir, to be effective, is in a wrong location. To accomplish the purpose of humidifying the air to an appreciable degree the water should be placed in reservoirs in each hot air flue, so made as to hang below the interior wall of the flue, but with its water surface exposed to the action of the air. Some furnace pipes are constructed thus.

A humidifying device has been produced which consists of a large pan of water in which steam pipes are fitted for the purpose of heating the water to the point of evaporation. The supply of steam to the coils is governed by a delicate instrument of the same order as the thermostat except that it is influenced by humidity instead of temperature.

In measuring the humidity of the atmosphere the complete absence of water from the air is rated as 0, and complete saturation as 100. The point of saturation changes with temperature. The dryest climates known contain about 30 per cent of moisture. The most agreeable condition of the atmosphere is when it contains about 70 per cent of moisture. The content of water in the form of vapor in the air at the freezing point is very slight, only .003 of a pound to one pound of air. At 150 degrees the same amount of air will hold .22 of a pound, its capacity for taking up moisture having increased nearly 70 times above what it was at 32 degrees. Extreme dryness in the air is objected to on account of the discomforts in resulting dryness of the throat and nostrils and a too rapid evaporation from the body. Air passing from a low temperature to a high one will change from a humidity of 70 per cent, outdoor measurement, to 30 per cent, indoor measurement. For the purpose of comfort the indoor humidity should be at least 50 per cent. The air at 65 degrees will then be far more comfortable than 30 per cent moisture and 70 degrees temperature. The provision for humidifying the air must be sufficient to produce a perceptible effect or it is not successful. In the absence of scientific instruments and apparatus to keep the right balance the dryness or comfort of the throat and nostrils may be depended upon to indicate the absence or plenitude of moisture in the air of the house.

When the atmosphere is too damp or humid for comfort a portion of the moisture may be removed by passing the air first through a cooling chamber, where the condensation will take place on the cooling pipes or surfaces, after which the temperature is restored in a warming chamber.

The filtration of the fresh air supply also has been described in a previous chapter. The requirements for a reasonably effective filtration are few and may be applied to the simplest heating and ventilating system. The interposition of cheese-cloth screens in the cold air duct will catch a surprising quantity of floating particles, but for a thorough system of filtration a roomy chamber in the basement should be provided. Here, with plenty of room, screens of finer mesh may be used and may be so arranged as to be cleaned and replaced frequently. The improved cleanliness throughout the house will well repay all efforts to install an effective filtering equipment. It is the ounce of prevention that will save many pounds of hard work, which seems to be the only cure for dirt.

Several systems of fan ventilation have been devised and are operated with varying degrees of success. Such systems of power ventilation are in operation in large office buildings, hospitals, schools, public buildings, factories, theaters, apartment buildings and other edifices in which natural draft ventilation would be ineffective. In the congested parts of a city, where high buildings stand close together, especially is ventilation by powerful fans a necessity.

The system most used is that by which the air is forced into each apartment. This is best known as the plenum system, the definition of the word fully signifying the method of operation. The supply of fresh air is made so abundant that all leakages of air are from the room outward. Outflow conduits are provided, of smaller capacity than the fresh air inlets, the difference supplying the inevitable leakage of the room around doors and windows.

In the exhaust or vacuum system the ventilating apparatus is so placed as to draw the air from the room, being the exact reverse of the plenum system. This is used in large office and other buildings to some extent. The air is drawn out through baseboard registers or ventilating plates, on the theory that the foul air of the room, carrying the carbonic acid from respiration, lies at the floor. The fresh air supply must be so abundant under this system that there may be little inducement for inward leakages of air from other than outdoor sources. It is inevitable, however, that there shall be a considerable inflow of air through other channels than the fresh air duct and in winter this may lead to considerable discomfort to the occupants of the apartment. In the opinion of authorities upon ventilation the exhaust system has no advantages over the plenum or forcing system, but on the contrary has the disadvantages noted.

A third system combines the plenum and the exhaust principles. One set of fans drives the air to the apartments and another set draws it away. This is objected to because of the extra and unnecessary expense. If the air is forced in it will find its way out, and ordinarily it matters not whither it goes.

Authorities, therefore, generally agree that the plenum system of ventilation, under conditions where fans are required, is the most practical and effective. The delivery of fresh air to the apartments is made certain and there is no chance for the admixture of air already vitiated from other sources. Only one fan or one set of fans is required, and the system is as simple as may be made to secure the results demanded.

In winter the ventilation is combined with the heating system. The fresh air is drawn or driven over the heated coils or other heat radiating surfaces and passes into the main conduits for delivery in the remote apartments. Here is where the ventilating engineer is confronted with the most serious problems. The effective distribution of heated air through pressure conduits demands the cleverest of planning. The writer recalls the almost complete failure of a system of heating and ventilation under the plenum system installed as late as 1903 at a cost of many thousands of dollars. The system was designed to heat and ventilate a group of university buildings and the money available was abundant for the purpose. The failure was therefore the more ignominious. Extensive remodeling of the system became immediately necessary.

The fault of the system lay in the fact that the attempt was made to distribute from the main conduit, through valve registers, the amount of air required for each room. The result of this plan was that when the supply registers for the rooms nearest the fan were opened the rooms were immediately flooded with air at a stifling temperature, while the distant rooms intended to be supplied by the same conduit received no warm air at all. The resistance of the conduit and radiation from it had not been calculated. The air was driven into the conduit by a powerful fan and so great was the pressure upon the registers nearest the source of supply that upon the milder days of winter the leakage of the registers when closed was so great that windows had to be opened to reduce the uncomfortable temperature produced by such leakage. The principle was not unlike that of attempting to pump water to a certain altitude through a pipe containing small holes a foot apart. The higher the column of water the swifter the flow from the lower holes, due to the resistance of gravitation. The resistance of distance against the air in the heating and ventilating conduit, and the numerous places of escape throughout its length left but a feeble pressure at the remote apartments which the ventilating engineer had intended should have equal service with all the others.

This failure proved, as others also have forcibly demonstrated, that the currents of air from the fan must be divided near the fan and conducted separately to the rooms to be heated and ventilated. The delivery registers in the different rooms must be equi-distant from the fan if they are to be supplied from the same main conduit, or the branches from the conduit must be of equal length and equal resistance if the rooms are to be evenly heated. This principle applies to all systems of ventilation and of combined heating and ventilation. The columns of air must be apportioned and divided at the point where they receive their positive impulse and after leaving that point, if divided at all, the branches must be of balanced resistance, so that the resistance of one or more branches shall not drive the principal flow into the other or others. The problem requires a nicety of calculation that can be left only to the most skilled to work out. On any installation it perhaps would be wise to construct a model to scale and apply the air, measuring the resistance or force at each opening. A system cannot be regarded a success until adequate pressure is shown at all points of delivery, the requirement of each room being regulated by the size of the pipe or branch.

To overcome the uncertainties and irregularities of the delivery of air from a main conduit a plenum chamber has been used. This should be of such ample proportions that the pressure may adjust itself to all parts of the room. Into this room the air is poured from the fan and from it the pipes lead off to various parts of the building to be ventilated. The size and distance of each room from the plenum chamber will control the sizes of pipes to be used. It is necessary to calculate resistances from a chamber as from a fan.

If it is desired to use the air of ventilation for heating the building the coils may be placed in this chamber. If direct radiation is used the air in the chamber may be tempered so that it may not enter any apartment with chilling effect.

In planning a system of warm air heating and ventilation for a private dwelling, where the movement of the air depends wholly upon the heat of the furnace and the exhaustion of the air in the rooms by the ventilating ducts warmed by partition walls or by an air shaft warmed by the main chimney, it should be borne in mind that resistance, as far as possible, should be elimniated. All flat surfaces presented at opposing angles to the course of the air currents are obstructions to be avoided.

Possible eddies should be guarded against in all construction. From the time the air enters the screen or passes the filtering chamber, if there be one, it should have a smooth course, devoid of obstacles of any sort. Every turn should be an easy one—never abrupt. If it be possible to have each turn the perfect arc of a circle more than twice the diameter of the pipe a distinct advantage will be gained.

When we consider that the movement of the air in such a system at best is but a feeble motion in comparison with what is expected of it, we begin to realize the importance of having these clear passage-ways for its course of travel. In most hot air furnace installations we find the cold air duct a series of right angle turns with pockets and eddies at several points. How much better it would be to have all these square corners, whether interior or exterior angles, so rounded as to shunt the air current gently in the way it should go! It would help the up-draft of air around the furnace very perceptibly. These are minor details, to be sure! But they are all minor details throughout the system, and it is the attention or non-attention to such minor details that spells success or failure in the installation.

Then comes the space around the furnaces within the casing. The radiation from the furnace expands the air with heat, giving it a buoyancy that sends it upward with a rush, only to bump against the bonnet or hood of the furnace. All the force of that splendid up-rush is lost in the rebound against the top of the furnace.

If you have ever seen a pack of hounds in hot pursuit of the quarry come to a stone wall that is too high to scale and there lose the scent of the fox, you have seen a disorganized mass of animals running in all directions trying again to get their bearings.

The volume of hot air in the bonnet of the furnace, as usually made, may be compared to the pack of hounds which has come to a full stop. The air in the furnace now has to take a new start, slowly at first, and it goes on by the routes of least resistance to the places of escape. This may explain to many why it is so difficult to heat distant rooms with a hot air furnace. Clearly the rules of ventilation and of the movement of air currents have not been observed in the work of installation.

There has been suggested a furnace top which may be called the "anti-rebound hood," which takes full advantage of the buoyancy of the air as it passes the furnace. This hood is so constructed that no flat or angular surfaces whatever are presented to the upward moving air. The whole top of the furnace is a mass of assembled flues. The division of the air current is made at the point of its greatest impulse and when each column of rising air is well started in its particular flue it is led off by a gently rounding elbow in a horizontal pipe near the ceiling to the particular register or partition flue for which it may be intended.

Engineers who design apparatus for forced ventilation are careful that no obstacles shall be placed in the way of the current after leaving the fan. All flat surfaces that may retard the air movement are eliminated. How much more important, then, is it to take the same precaution where the source of impulse is the furnace instead of the fan!

The top of the average furnace—indeed, we may say of nearly all furnaces—is a complete though temporary check upon the movement of the air through the furnace chamber. The hood with concave or hanging cone top is a step in the right direction, but not by any means accomplishing all that needs to be accomplished.

In the construction of boots, elbows, off-sets and all fixtures for the conveyance of air currents, the laws to which attention has been called should be observed if the full measure of success is to be attained. The four-piece elbow is to be preferred to the three-piece because it more nearly fulfills the requirements of the natural law of the flow of currents, whether of liquids or gases. The laws are simple enough. It is merely necessary to have them in mind and to comply with them at all stages of construction and installation.

Where it is desirable to have power or fan ventilation in a private dwelling the fan may be introduced either in the cold air duct or in a chamber from which it may draw the hot air from the furnace or from the heated coils or radiators. Preferably the fan should take its air supply from such a chamber, so that the division or apportionment of the air to the several conduits may be made at the fan. This will simplify the problem of successful distribution. The entrances to the several conduits and at all Y's may be equipped with movable partitions, which may be adjusted by test so as to equalize the distribution of the air and thereby correct any miscalculations of original planning.

The delivery of the air into an apartment is usually made at the baseboard or from a floor register. Some theorists have advocated its introduction at the ceiling or at a point about eight feet from the floor. In some cases this has been done. It is very disagreeable to most persons to sit where there is a down-draft of air upon the head. There are always drafts upon the floor and our feet seem to have become inured to them. Besides, there cannot be any valid objection to the introduction of fresh air or heated air at the base-board. When heated, air will rise to the upper part of the room of its own buoyancy and mingle with the air of the room. If the foul air is drawn off through ventilating plates and flues in the base-board on the same side of the room as the fresh air inlet, the air will make a more complete circuit of the room than if admitted at the ceiling. Preferably the fresh air should be admitted to a room from the side opposite the windows. In cold weather this arrangement directs the inflow of warm air toward the windows, which are the coldest exposed surfaces, and the warm air tends to counteract their cooling influence. The down-draft at the windows promotes circulation and the currents of air naturally are directed toward the foul air outlets. No registers should be placed in the floor, on account of their filth-gathering tendencies.

Where direct radiation is used, with steam or hot water radiators, an effective method of ventilation is to use the flue radiators with boxes at the bottom through which fresh air is admitted directly from out of doors to the bottoms of the flues. This necessitates many outdoor openings, which need to be well protected with filtering screens, or much soot and dust will enter the house.

Chapter XI.

TEMPERATURE CONTROL.

Various systems employed. Results to be obtained must provide comfort, safety and fuel economy.

IF there were no other considerations, the economy of fuel alone would justify the expense of installing a system for temperature regulation in the home. It is the experience of nearly all householders who are not living up to their opportunities that the temperature of the house is about as uncertain as the weather. It varies from 40 or 50 to 85 or even 90 degrees. Some people have a faculty of adjusting the dampers and fixing the fire so that the furnace will run at an approximate temperature for several hours, but a sudden change of the outside temperature or a high wind may defeat the plans of the most careful furnace attendant.

But why trust to the human attention at all, other than to put on fuel and remove the ashes? Why not live up to these opportunities which the inventors have laid before us? The complete house must have all these things that save labor and brighten the lives of those who live within its walls. The arguments in favor of temperature control are many besides that always practical one of saving expense. It saves labor, care, time, trouble. It provides real luxury at small cost.

The specific things that a successful system of temperature control accomplishes are: A saving of 15 to 25 per cent in the ordinary fuel expense. Such a saving will soon pay for the system and we may have all the other advantages for nothing. Beyond the removal of ashes and the supplying of fuel at stated periods, the heating plant becomes automatic in its operation. Skill of management no longer is a necessity. Skill has given place to an automaton which acts in accord with physical laws and cannot act otherwise. Its operation becomes as fixed, so far as movements are concerned, as the motion of the stars. The comfort to be derived from a uniform temperature in the house is not to be undervalued. Its influence upon the health of the family cannot be otherwise than favorable to its best preservation. There is comfort of mind, too, in knowing that the furnace is all right and does not need watching. If the heating plant contains a steam boiler or water heater the appliances for automatic temperature control prevent the pressure going beyond desired limits or falling below the necessities of the weather.

The warming of the house in the morning is always a problem necessitating the early rising of someone to open the drafts and warm the rooms for the comfort of others. The instruments for temperature control remain on duty all night, as well as all day, and will have the house at the desired temperature when morning comes. Half the discomforts of the northern climate in winter are due to the poor and unsuccessful systems of heating the houses, an evil which the systems of temperature regulation ultimately in a measure will correct, when their application is better understood.

The first efforts toward producing a system of temperature control were made many years ago. They were crude and inaccurate at first, just as all valuable inventions have been, but practice has perfected them and range in temperature has been narrowed down to a very few degrees. We are assured by some manufacturers of these appliances that by their use the temperature may be kept within a range of 2 or 3 degrees. Such perfection is not a mere approach to the ideal, but a full realization of it. One enthusiast has said that such an achievement is the equivalent of bringing the air of Florida or of California into the house for winter use. It gives the invalid the unchanging temperature that is often sought by days of travel at great expense and numberless discomforts. The temperature regulator also has been likened to the governor of a steam engine. Without the governor the engine would run fast or slow, according to its load, and when all load was removed would perhaps tear itself to pieces by "racing." So the furnace without such control races to one extreme, and when the checks are applied goes to the other extreme.

Several types of appliances for temperature control are now manufactured. These are designed for steam, hot water and warm air heating and to control ventilator inlets. The aim with steam plants is to maintain an exact pressure, this pressure extending to all radiators. The method of control is by means of pressure valves or diaphragms which act upon the dampers that control the fire. An increasing pressure shuts the dampers and a reduction of steam pressure opens them to give the fire a little more oxygen and a little more circulation in the chimney flue.

In some of the instruments a rubber diaphragm is used. This is placed below the water line, where a slight change of pressure acting upon the diaphragm moves a lever or series of levers which act upon a carefully adjusted system of dampers which maintain the fire at the right degree of activity to keep up the pressure. If the weather becomes colder the radiation from the radiators takes place faster and the return flow of water from condensation demands more fire. Other instruments employ the metal diaphragm, which may be attached to the steam chamber or upper part of the boiler. The action is essentially the same as those below the water line using rubber. The principle is the same in all, the value of the different makes depending upon the measure of success in applying the principle.

Where steam or hot water radiators are used the temperature regulator may be installed in a single room to control the temperature of that room alone. It may be applied also to control the inlet of warm air from a furnace whenever there is a likelihood of overheating a single apartment or suite of rooms. When the steam or water for heating is derived from a central heating station the regulator becomes invaluable, restricting the flow to the actual needs of the house or room. Where thus used the mechanism acts upon the valves, regulating the flow either to a single radiator or to a whole system.

In one of the well known thermostats the actuating material is a liquid which boils at 55 degrees. This is confined in a disk-like compartment. With an increase of temperature the pressure of the liquid in the disk increases. At 70 degrees, the temperature best suited for the house, it has quite an appreciable pressure, which is lessened or increased with the falling or rising of the temperature. The very slight movement either way is made to open or close very small air valves, which admit or release air under pressure to a diaphragm motor in the basement. A lever attached to the diaphragm acts upon the nicely balanced dampers of the furnace and air inlets, to open or close them ever so slightly as the sensitive instrument dictates.

Another form uses vulcanized rubber as the thermostatic element. This consists of a tube sufficiently large to contain the mechanism necessary to open and close valves which admit or release air under pressure to a diaphragm motor, the latter acting upon the dampers. The changes of temperature lengthen or shorten the vulcanized rubber tube and this movement, very slight indeed, serves to move the delicate mechanism within the tube.

A third form makes use of the unequal expansive qualities of different metals under changes of temperature. Strips of brass and steel soldered together constitute the usual combination for this purpose. One metal being influenced more than the other by the rise and fall of temperature will cause the combined strips to bend one way or the other as the changes of temperature take place.

Advantage is taken of this slight movement to open and close very small air valves which govern the supply of compressed air to the diaphragm motors employed to operate the dampers of the heating system.

In place of the compressed air a clockwork mechanism, to be wound up once a week, is used in some systems. In other systems the electrical force plays a part in the adjustment of dampers. In others the pressure of water is used. Indeed, a vast amount of study has been expended and much ingenuity developed in devising appliances for the control of temperature in apartments and buildings for all sorts of purposes.

To have successful control of temperature, however, it is needful that the system of heating shall be adequate and well balanced. The appliances for temperature control will not bring order out of chaos when the chaos consists of a badly apportioned distribution of the heat. If one apartment is at 50 when others are at 70 degrees, the disproportion will continue, thermostat or no thermostat. The supply of heat must be adjusted evenly before the best results can be secured. The hot air pipes and radiators must be of correct sizes to meet the approximate requirements of each room. When the heating system is well balanced and efficient then the maintenance of an even temperature throughout the house becomes a comparatively simple problem.

Temperature control is not limited to the atmosphere of the room, but extends to the temperature of the hot water storage tank. It frequently happens that persons are seriously scalded by having the water supply for the bath too hot. It is also disagreeable to have the water turn to vapor on opening the faucet, filling the apartment with a cloud of moisture. The same devices for controlling the temperature are used here as elsewhere, being varied only in their form to adapt them to the particular service required.

Chapter XII.

COLD WATER SUPPLY.

Connections with city main, yard hydrants and street washers. Setting of meters. Stop and waste cocks. Filtering. Storage of water. Water lifts. Cistern water supply. Air compressed water supply. Domestic water works service for detached homes. Rams. Pumps. Windmills and towers. Plumbing brass goods, laundry tray bibbs, kitchen sink bibbs; basin cocks; ball cocks.

IN cities generally the connections with the public water supply for domestic use are regulated by ordinance. The connection is made at the main with a gooseneck of lead pipe, which supplies the needed flexibility at that point. Changes due to contraction, expansion and settling of pipes makes this flexible connection desirable, if not absolutely necessary. It might be accomplished in other ways, as by swing joints, but the lead pipe is the simpler and preferred method employed. On account of the heavy pressure usual in water mains the connection ordinarily is not larger than a half or three-quarter-inch pipe for a house of two or three stories. Larger dwellings, tenements and apartment houses have street service connections from one to two inches.

At the curb line a stop-and-waste cock should be provided. The city ordinance usually requires this in order that the water supply may be completely shut off from any building or grounds. The location of this should not be lost sight of, as an accident at any time may make the immediate shutting off of the water very important. Sometimes the protecting boxes over the valve key become covered up in the work of grading and are not again thought of.

Sometimes outdoor hydrants are necessary. These should, of course, be of the non-freezing type, with provision for quickly wasting the water that is left in the pipe above the shut-off. Such hydrants are available in very ornamental styles, made to be turned with a special wrench, with compression cock or by an attached hand-wheel. Sometimes they are automatic, turning on the water when the pail is hung on the spout.

Street washers at grade have been much used in the past, but some people substitute the sill-cock with stop-and-waste cock in the basement. Where street washers are used they need a protective box and waste opening below frost line. Convenience of location should have attention when placing street washers, hydrants, lawn sprinkler connections and sill-cocks, the aim being to have them so placed that the least amount of hose shall be required to reach the farthest part of the grounds. On large grounds several hose connections may be required, when the same attention to location may save both labor and extra hose.

Where the measurement of water supply is desired the proper location for the meter is within the wall of the cellar or basement inside the basement stop-and-waste cock. It is important that the meter shall be accurate and if any doubt exists it may be tested by running water through it at various speeds, carefully weighing the water and comparing the result with the record shown by the dials of the meter. Any inaccuracy will in this manner be detected. Meters are made in sizes from those using a three-eighths-inch pipe up to six inches. A meter made for a one-inch pipe will deliver approximately sixty gallons of water per minute. The stop-and-waste cock at the meter, as well as those elsewhere, should be strong, preferably with handle attached, and so made that it will not corrode or stick when finally it may be necessary to shut off the water. The practice of sinking the stop-and-waste cock in a small box in the ground below the cellar bottom seems now to be generally abandoned. It is rendered more accessible and is much less likely to get out of order when above ground.

The filtering of the water supply is always desirable if for no other purpose than to have it clean or to have the sense of cleanliness when using it. In many cities and towns the sources of public water supply, even with many precautions on the part of boards of health and boards of inspection, are not above suspicion. If any doubt exists the water for drinking purposes should be boiled. This puts the user on the safe side at least, with very little trouble. Water may be reaerated after boiling by shaking in a large bottle partly filled. This removes the flat taste objected to in cold boiled water. Often the filtering is sufficient.

Many styles of filters are on the market. A filter, to be effective, should be able to take the silt-laden waters of the Mississippi and Missouri or the roiliest flood waters anywhere and deliver them with a crystal clearness. The most effective filtering substance in general use for house filters is tripoli stone. This is made into cylinders with thick walls and the cylinder is so arranged as to receive the water on its outer surface and discharge through the central bore. Even in the small sizes this arrangement gives a filtering wall nearly an inch through. Such a filter ten inches long and three inches in diameter when clean will deliver nearly or quite a gallon of water a minute. It easily meets the needs of an ordinary family unless the service is so muddy as to require all the water for the house to be filtered. In such cases large filters must be installed in the basement.

Tripoli stone filters should be so constructed that the stones may be lifted out frequently to be sponged or brushed free of silt and then rubbed with flour of tripoli, ground very fine. This fills the minute cavities in the outer surface of the cylinder and maintains the free porosity of the filter much longer than if no powder is used. It may sometimes become necessary to scour the filter stone with soft brick or a piece of tripoli to remove any deeply imbedded impurities, but under ordinary conditions a sponging and powdering are sufficient. With such care a filter stone will last several years.

Where cistern water is used for drinking and cooking a partition of brick is made in the cistern. The construction of the wall is such that the water can pass from one chamber to the other only by percolating through the brick. This gives very clear and palatable water of unquestioned purity, provided that the roofs are cared for and flushed before the supply is turned into the cistern. When the water from small streams is used for domestic supply great care should be taken to see that there is no pollution above the diverting channel. This water may be filtered by running it through layers of charcoal, alternating with sand that has been washed clean, to the storage cistern or reservoir. Such filters are used in irrigated regions, where the ditch waters are diverted to underground reservoirs for domestic supply.

A rather more elaborate filter is made by the construction of two water-tight brick chambers side by side with a sloping bottom extending under both chambers, which are connected at the bottom of the dividing wall. A strong mixture of cement should be used in the work to make it permanent. The inlet from the roof spouts or from the diverted stream enters the deeper of the two chambers, which serves the purpose of arresting the silt. The second chamber has a perforated bottom raised above the sloping floor of the chamber. On this false bottom is spread a layer of clean gravel and then the whole is filled with clean sand to the level of the discharge pipe leading to the storage cistern or reservoir. As the filtering gravel and sand receives the water from below, the silt is deposited on the sloping bottom and gathers naturally in the deepest part of the receiving chamber, from which it easily may be removed without in any way disturbing the filter.

Often it is necessary, in parts of the city or town that are higher than the general level, to take advantage of those hours of the day when the water pressure is best to store water for the day's use. When the pressure is such that it cannot be depended on at all times, arrangements should be made for water storage. The capacity of the tank should be sufficient for two days' supply, counting thirty gallons a day for each person in the family. The storage tank should be a few feet above the highest fixture and should have an overflow and ventilating pipe, both carefully screened against the ingress of birds or vermin of any sort. It should be where it will not freeze and where it may be examined and cleaned. Storage tanks for the supply of drinking water must not be lined with lead or sheet zinc.

In some parts of the country the public water supply, either on account of hardness or impurity, is unfit for all domestic uses. An auxiliary supply from a cistern then becomes desirable and automatic water lifts are introduced in the house for the purpose of supplying cistern water under pressure where wanted. The pressure of the public water system is then used to operate the lifts, on the principle of the steam pump. The location of the cistern should be such that it may be guarded against the admission of any contamination to its contents. It should have ventilation and should be accessible for cleaning. It also should be carefully screened at the ventilators. In order that the best water of the cistern always may be available for use a float has been devised, which always suspends the intake pipe a few inches below the surface. By this contrivance the suction of sediment into the pump is rendered impossible, unless the water becomes very low.

The successful and economical supply of water under pressure to detached houses anywhere in the country where wind and water are available, has made possible the introduction of all the conveniences and luxuries of a city home that depends on water supply. The farm house may now have a bath room and syphon water closet with hot and cold water, lavatories, laundry tubs and kitchen sinks with hot and cold water supplies almost as cheaply as the city home. It is no longer necessary to build a wooden or steel tank high in the air and undergo all the troubles and inconveniences resulting from its freezing. A better way has been found in sinking an air-tight steel tank underground and pumping the water into it against the air so that the air pressure will expel it when a faucet is opened anywhere in the system.

The best location for such a tank is where the head may appear in the cellar wall. Here the connections may be made and the glass water gauge may be examined. It is also a cool location, especially desirable in summer, as the water in an exposed tank is apt to become too warm for drinking without ice. The supply to the tank may be pumped in with a windmill or it may be flowed in by gravity through a very small and inexpensive pipe laid below the freezing depth, from great distances. A storage tank greatly reduces the cost of a pipe line where water is brought or pumped great distances, because, with storage, a small pipe having a continuous flow will supply a large amount of water. A three-eights-inch pipe, for example, will discharge under pressure one cubic foot or seven and a half gallons per minute. When small pipes are used particular care should be taken to have all pipe ends reamed before joints are made, and the intake should be carefully screened to prevent any stoppage of flow. A small spring may be made to do excellent service by this plan. Windmill pumps are made to maintain automatically the required air pressure in the storage tank.

Often a stream whose water may be unfit for domestic use may be made to pump water from a well or cistern. This can be done by the use of a water lift, such as used under city pressure to pump cistern water when the city supply is not suitable for all domestic purposes.

Still another plan of supplying water under pressure to an isolated dwelling is to sink an air-tight tank in a well, cistern or lake, with a pipe connection to the house system and an inlet valve. The tank must be sufficiently weighted to hold it firmly in place even when filled with air. From the top of the tank an air pipe should lead to an air pump conveniently placed. The pipe to the house system should connect with the bottom of the tank. By opening an air cock at the air pump the water will flow by gravity through the inlet valve, expelling the air until the tank is filled. Then the air pressure may be applied, by hand or power, creating sufficient pressure to force the water through the house system until the tank is again emptied. There should also be a back stop valve in the house system to prevent the back flow of the water when the tank is empty and the air pressure is off.

When the suburban or rural source of supply is abundant and the altitude is not great enough to deliver the water under pressure to all parts of a dwelling, a water ram may be used. A three-foot fall may be made thus to deliver one-fourteenth of the volume of water to ten times (thirty feet) the height of the fall. If the supply is limited a storage tank may be used in connection with the ram.

In semi-arid regions the windmill and gasoline engine have made water supplies available from great depths. There are few places where water cannot be obtained at some point below the surface. Rams are now made to raise water in quantity for the purposes of irrigation, so that there is practically no limit to the size and power of these appliances.

The construction of windmills by different manufacturers is now along well established lines. Experiments with a cone-shaped wheel seem to have shown such construction to have superior efficiency. The sloping of the paddles or sails from the center toward the periphery, in addition to the usual slope, apparently securing greater results from the force of the wind. The secret apparently is in the reduction of back-pressure, the wheel having a wider scope of discharge. The towers and mills are generally galvanized to prevent rusting and to insure durability. The transmission mechanism should be as simple as possible consistent with efficiency, so as to require the least attention.

When it is necessary to have the windmills situated on distant knolls or exposed places far from the water supply the mill may be used with an air compressor, now available in the market, made for this specific use. Connection is made through a small pipe with a pump operated by air pressure at the most convenient point and the water delivered under pressure to the house system or wherever wanted. In this use the storage tank is particularly desirable in order that water may be available at all times.

The cold-water piping of the house usually consists of three-quarters to one-inch galvanized iron pipes. The water fixtures should be of the best. Nearly all these are of cast brass, nickel-plated. One indication of quality is weight. Brass is a costly metal and if the manufacturer has put in plenty of metal the goods may generally be depended upon as being good in other respects. All valves should be of the compression type, screwing down firmly to the valve-seat. Such valves should govern all lines of supply. The compression bibb or faucet is sometimes used, but the type most favored and therefore most employed in house plumbing is the Fuller bibb, by which the water is shut off by the compression of a rubber ball. These always have a handle and rarely get out of order. They are suited alike for the kitchen, laundry and bathroom. Where the water is measured and it is the desire to have as little consumed as necessity may require, a self-closing cock is used. It is not convenient for general use, as it must be held open all the time that the water is flowing.

WASTING WATER

Where water is sold through a meter, landlords are wise enough to have self-closing faucets on all bathroom fixtures especially. The practice of washing the hands with running water causes a greater waste than if the water was caught in the bowl for use. This is not the case where the hands are only to be rinsed or damped. A faucet may leak slightly but yet waste a large amount in the twenty-four hours. One was leaking at a rate of over sixty drops a minute and it was found to fill a pint measure in ten minutes, or three-fourths gallon per hour, or eighteen gallons a day.

Most important, perhaps, is the quality of the ball-cock, the automatic device which refills the water closet flush tank. Unless this is well made and operates perfectly it may cause much trouble. The weight of the ball at the end of the rod turns on the water when the flush tank is emptied and the buoyancy of the ball, acting as a float, shuts it off when the water reaches a certain height. This may not be examined from one year's end to another and its failure to operate may cause an overflow. A flood is guarded against in well constructed tanks by an overflow device. The continuous running of the water through the flush pipe is a warning that the ball cock needs attention, as it has not shut off the water completely, or that the discharge valve of the tank does not sit squarely in its seat.

Chapter XIII.

HOT WATER SUPPLY.

Heating water and storing it. Range boiler heaters. Automatic water heating systems. Tank heaters. Garbage burners and water heaters combined. Instantaneous water heaters. Hot water temperature control.

THE ordinary requirements of hot water for domestic use are met by the range boiler in the kitchen. This usually is heated by a water front or water back in the fire box of the range and sometimes by a pipe coil similarly placed. There are many variations from this general practice to meet different requirements and different conditions, to which attention will be given.

The range boiler may be of copper, black iron, galvanized iron or steel. A boiler of superior quality is made of heavy gauge tin-lined copper. Copper boilers need to be well braced inside to prevent collapse under the partial vacuum which sometimes occurs in range boilers.

The black iron boiler, when painted to correspond with the walls or woodwork of the kitchen is not an obtrusive object and has the merit of giving good service. The objection is the rusting of the interior and discoloration of the water. The galvanized wrought-iron boiler, which for a number of years has had preference in house equipment, has proved itself to be very durable and has met the requirements completely. Its moderate cost, as well as proven durability, has always been in its favor. For cheap construction a mild steel boiler, galvanized to look like the old favorite, has been for some time on the market. Some of these are made of steel of a cheap quality, which in time becomes pitted and breaks down. So it is not safe to assume that all galvanized boilers belong in the same class. The galvanizing may cover up serious defects.

In the manufacture of galvanized boilers the galvanizing is usually done after the boiler has been put together. It is important that the interior shall be thoroughly galvanized. This insures durability and water free from rust.

The kitchen boiler should stand above the water front, if the best service is to be secured. The standard should hold the bottom of the tank about on a line with the bottom of the water front, so that the connection may be made nearly direct. Often there are many elbows between the boiler and the water front. Every turn retards the flow.

The construction of a water front may be badly done. It is usually a hollow casting, with walls not too thick if the heat is to be absorbed freely. The lower connection should be close to the bottom of the casting to prevent the deposit of a bed of sediment in it. The properly made front contains a diaphragm extending from the connection end three-quarters the length of the front, so that the water, as it is warmed, may pass around the end of the diaphragm, gathering heat as it flows through the upper chamber to the outflow pipe leading to the upper central part of the tank. The water front connections should be 1¼-inch pipe to insure first-class results. The larger the pipe the less the friction of the flow. The careful reaming of the ends of pipes is another essential, as the water moves under the very slight pressure due to heating. The range connections are made often by inexperienced plumbers, who give too little thought to the principles that apply to the work upon which they may be engaged. Freedom from burrs in hot-water pipes is particularly important to make a successful job.

Sometimes an auxiliary heating apparatus for the kitchen boiler is desired, particularly on wash-day. A laundry stove with water front may be put in and connected with the boiler without interfering with the range connections. This will insure an abundant supply at a time when most needed and with slight additional expense.

An arrangement much preferred by some housekeepers is to have an auxiliary gas heater attached to the kitchen boiler. This gives a much broader service, as it may be lighted when there is no fire in the kitchen range or laundry stove. It will also serve as the extra heater in place of the laundry stove on days when extra hot water is in demand. In modern economy hot water is in demand all the time, night and day, and the small tank heaters have found a definite place in household equipment. As now constructed they have high fuel efficiency. The heat from the gas flame is so directed as to make rapid progress in heating a tank full of water. The household invariably finds occasion for the frequent use of such apparatus when once it is installed. There are numerous makes of such auxiliary heaters and their simplicity of operation and moderate cost have made them very popular.

The luxury of hot water at any and all times is provided for by several makes of automatic water heaters. These are usually installed in the basement and are necessarily heated by gas. They are so constructed that upon opening the hot water faucet in any part of the house the gas jets are automatically lighted from a pilot light and continue to burn so long as the faucet remains open.

When the faucet is closed the gas is shut off, with the exception of the pilot light. The heating of the water is accomplished by placing a stack of pipe coils directly over the assemblage of gas burners, the coils having a sufficient number of turns and the jets generating a sufficient number of heat units to heat the water while it passes swiftly through the pipes to the open faucet. These heaters are made to deliver from three to nine gallons a minute at an expenditure of energy of one foot of gas to each gallon of water, according to the guaranty of the makers, starting with water at a temperature of 55 degrees and delivering it at 130 degrees.

In order to meet a demand for hot-water tanks whose contents may be heated from a steam heating plant such tanks are made with pipe coils which may be connected with the steam heating system in the same manner as radiators are connected. These tanks are usually of large size and may be suspended with iron straps from the floor joists in the basement or placed upon substantial supports so as to be above the return mains of the steam system.

The ordinary kitchen tank has a capacity of 30 to 40 gallons. If there is an extra bathroom in the house an additional capacity of 30 gallons should be added.

Advantage is sometimes taken of the extra heat of the kitchen range boiler to warm a room above by flowing the hot water through a radiator. The connection is made from the top of the boiler to the top of the radiator and from the bottom of the radiator to the return flow pipe of the boiler or by an independent connection. This can be done satisfactorily only when the fire in the kitchen range is continuous. The connections should be so made that the radiator may be cut out in summer.

Water heaters that perform the additional function of burning the garbage are now available and help to solve the ever-present problem of garbage disposal. The question may be settled, each householder for himself, by providing for burning all garbage on the premises. It disposes also, in part, of the problem of keeping down the rapid breeding of house flies. We never shall attain the acme of hygienic conditions until a system of inspection and law enforcement abolishes the places where house flies may breed. The burning of garbage in the home, if attended to by all, would remove one of the most disagreeable features of life in the city. A garbage crematory into which all rubbish may be thrown to be destroyed, using the fire to provide the hot water supply, is both economic and hygienic.

Where the amount of garbage is small it is sometimes burned in the small magazine water heater usually installed in the basement or stable. It is thrown into the magazine and a little coal put on top. It dries rapidly and burns quickly when it reaches the fire. A garbage burner when installed in the basement should close tightly to prevent odors from burning bones or meat scraps from permeating the house.

There are several makes of combined garbage burners and water heaters, both portable and brick-set styles. The combustion chamber is enclosed by a water jacket and coils or gratings of water pipes above the fire form a drying rack for the garbage. In some of these a change of dampers sends the blaze up so that it ignites the dried garbage and helps to heat the water. In others the dried material is transferred to the lower grate. In large dwellings, and especially in apartment buildings, the garbage burner has come to be a recognized necessity, to the end that the premises may be kept neat, agreeable and sanitary. Soft coal is preferred for most of the successful garbage burners and heaters. It is not only cheaper but any drippings from the garbage do not affect the fire.

The hot-water connections with the laundry, bathroom and kitchen sink, as well as to lavatories, are usually made with pipes of the same size as those for cold water. A three-quarter-inch pipe is ample for such purposes. The fixtures should be of the best, as inferior bibbs and valves are costly in the long run. Where pipes are carried over rooms containing valuable wall decorations, choice draperies or carpets, possible loss may be prevented by placing beneath the pipes a water-tight trough with suitable discharge. The condensation of moisture on the cold water pipes often amounts to considerably more than will adhere to the pipes and much dripping is the result, which may lead to the loosening of the plastering in time with resultant damage to furnishings or decorations.

A plan of heating water instantaneously, entirely independent of the kitchen boiler, is provided in several small gas heaters suitable for the bathroom, kitchen, laundry or stable. The plan of operation is so simple that there is little excuse for accident; no more, in fact, than with the gas stove. In some makes the water is thrown in a spray so that the minute drops may gather heat from the hot gases of combustion arising from the gas flame. The water comes in direct contact with the gases in the upper part of the combustion chamber and falls on perforated plates, which also are hot, and flows to other plates below till finally discharged through the spout. These heaters are properly constructed entirely of copper and form one of the most valued conveniences of the home. Other types of construction avoid the direct contact of the water with the gases in the combustion chamber, but depend upon a multitude of coils to transmit the heat to the water flowing through them. In practice the consumption of gas is not found to be a serious matter. The gas is burned but a few minutes at a time and the total amount used in a month is insignificant in comparison with the time saved and the convenience afforded by the use of the heater. The temperature of the water flowing from the heater is regulated by the amount allowed to flow into it.

Temperature control, as previously noted, may be applied to the kitchen boiler or other storage tanks to prevent the water from becoming too hot. Such control is desirable, to prevent disagreeable results, when the hot water faucet is opened. Scalding hot water is not required for the ordinary uses to which the tank supply is applied, and a temperature of 130 to 160 degrees is sufficient for the usual purposes. Excessive steaming when the hot water faucet is opened should be prevented because of its danger to the members of the family, and clouds of steam are both disagreeable and destructive. The tank regulator is applied to the kitchen boiler in much the same way that it is applied to the furnace. It is controlled by temperature and sets in operation the necessary force to close or open the dampers.

If gas is used it may be made to turn on the supply or shut it off. If the tank is heated with a steam coil the regulator reduces or shuts off entirely the supply of steam to the coils. The thermostats and pressure devices for temperature control are described in Chapter XI.

In the installation of the kitchen boiler no valve except the usual stop and waste cock should be installed between it and the supply. The expansion of the water produces a back pressure that finds relief against the pressure of the public system, which is usually about 40 pounds. A kitchen boiler should be tested to 150 pounds pressure, and if the water system pressure is excessive the boiler should be extra heavy, capable of withstanding a test of 250 pounds. It is desirable to install a safety valve on each kitchen boiler.

Chapter XIV.

THE KITCHEN.

Proper flooring. Windows. The kitchen sink. Grease traps. The cooking range. Ventilation. Refrigerator room. Pantries. Butler's pantry and its equipment.

IT IS a long step in development but a short one in time from the kitchen with its smudgy fire-place, its crane and brick oven to the modern kitchen with its perfect ranges—wood, coal, gas, electric—and its scientific sanitation. With a kitchen equipped as it may be done in these early years of the twentieth century there appears little to be desired. There is no place in the house where the expenditure of money counts for so much in the saving of labor, time, nervous energy and temper as in the kitchen. It is just as important to have the latest and most perfect tools and equipment for work in the kitchen and to have that equipment installed upon a well-thought-out plan as it is in the machine shop or factory for the production of merchandise.

In a previous chapter attention is called to the possibilities of greatly lightening the labor of housekeeping by having the kitchen well arranged and properly equipped. In this chapter we purpose to elaborate that idea and tell what is available and what may be or should be done to make this department of the house an ideal one.

The kitchen usually and very properly is situated in the back part of the house, on the first floor. It should be as close to the dining room as possible without obtruding its noises or odors upon the dinner party or the family at its meals. Two doors and a short passage-way are sufficient to deaden the sounds and to keep down the more noticeable odors of boiling and roasting. The doors should have glass panels to prevent collisions. They should be of light construction, self-closing and made to swing both ways. This arrangement enables the waitress to pass to and fro with both hands full and to do her work rapidly and noiselessly.

It is not desirable to have an outside door to the kitchen, because it brings in too much litter and in a measure defeats the effort to keep the room clean and wholesome. A blast of cold air from an open door in winter is not conducive to the best results in baking and other kitchen work. A well-lighted entry has many uses. Experience shows that a glazed door between the kitchen and the entry serves a useful purpose. In the entry may be placed a shelf on which the delivery clerks may deposit their bundles without coming into the house and engaging in unnecessary conversation. In the entry may be kept the brooms and mops (a good self-wringing mop is now available), each assigned to its particular rack or closet. A broom closet with places for dustpans and receptacles for sweepings should have a place on every floor. It is no economy to have less than three sweeping outfits in any house, each set having a place where it may be conveniently at hand whenever wanted. Dusting cloths and wall-wipers may be kept in the same closets. The broom and dustpan have been looking for abiding places for generations and many modern architects still overlook making provision for them.

In the entry may be kept the baskets that are to be returned to the grocer. The milkman may deliver his bottles in this place. The ice cream man may put his pail of ice with its brick of dessert in here, where it will be safe from molestation. It is a good place for the children's sleds in winter. If it can communicate through a back hall to other parts of the house it will save much traffic through the kitchen. In planning the entry its variety of uses should be kept in mind lest it be made too small, for it can be useful only in proportion to its capacity.

The flooring for the kitchen is commonly of hard maple cut in narrow strips and closely matched. The light color of the wood shows spots distinctly and on account of its absorbent character requires a deal of scrubbing to keep it clean and white. There are better things that the housewife will appreciate. One of these is a rubber lock-tile specially designed for kitchen, bathroom and laundry floors. Other tile may be used, but care should be taken to avoid a slippery quality. The hard glazed tile or the hard marble or slate tiles are not pleasant to stand on while at work and are treacherous when wet. The rubber tiles, in a variety of colors, make a beautiful floor and fulfill a demand that has long been known to exist. Linoleums have been much used, but their joints and edges have a faculty of gathering dirt, and it cannot be washed down as successfully as can the new tile, which are impervious.

The walls of the kitchen should not be papered and there should be as little woodwork as possible. Walls that can be washed with soap and water meet the sanitary requirements best. A smoothly plastered wall may be painted two or three coats with oil paint of an attractive shade, which may be renewed with a single coat from time to time. This may be stippled to reduce the glossy effect. A sanitary wall covering is now made to meet the desire for decorative effects. It consists of a dull-finish oilcloth in almost as great a variety of suitable patterns as may be found in kitchen wallpapers.

This oilcloth may be washed with soap and water and is very beautiful not only for the kitchen but for all rooms. It comes in rolls equal to about four rolls of wallpaper and costs about two dollars per roll. It is put on the walls with paste in the same manner as paper, but stays best if the walls are carefully sized before it is applied. As it is calculated to be a permanent covering, it should be put on with care and precision.

A tiled wainscoting makes a clean and pretty effect. Sometimes in the newer houses the entire interior of the kitchen, except the floor, is lined with metal tile, at a cost of $200 to $300, making a room that is the nearest possible approach to an absolutely sanitary covering. By the use of colors in limited degree a surprisingly ornamental interior may be produced. The floor of rubber tiling completes the room so that none but impervious surfaces are presented.

The windows of the kitchen should be large enough and of sufficient number to give good light. It should be one of the brightest rooms in the house. It is one of the most used rooms and good light will help in its sanitary care. A cheerful kitchen helps to make a cheerful housekeeper and a more contented servant. There should be no dark corners in a kitchen. They are always to be regarded with more or less suspicion. In the use of gas it is necessary to guard against draughts. It sometimes happens that the range is so placed that an open window will blow out the gas and make it impossible to use the range without closing the window. The height of the window sill might be raised above the point where it will strike the gas direct, for in summer it is necessary, for comfort, to have the windows open. The windows should be such as may be pulled down from the top easily for extra ventilation when wanted.

When buildings stand close together the kitchen may have too little light. This often may be remedied by the arrangement of prismatic windows and reflectors. If the white light of the sky can be caught by the prisms they may be made to direct it from angle to angle till the darkest corners are made light. By making the upper parts of partitions of prismatic glass light may be carried through a light room to a darker one to advantage. The prismatic glass may now be bought in sheets and installed at much less cost than formerly. An experienced glazier must be employed to put it in, because the prisms must be arranged in a certain way to secure the results desired.

The kitchen sink has been a problem from the time of the origin of the art and later the science of plumbing. It used to be of wood, stoutly put together and caulked with white lead or tow and linseed oil in the manner of wooden ships. And there are wooden sinks still, even though sanitary science condemns them.

But there shall be no wooden sink in this modern home, for it is not handsome; the wood is absorbent of every liquid and oily substance that gets into it and it is very difficult to keep clean. Then beneath the wooden sink there are so many crannies that rarely are looked into. Think of the labor that is saved when you throw away the wooden sink!

If the sink is made of plain cast iron it should be painted inside and out and repainted as often as cleanliness demands. There should be no woodwork whatever around it, for reasons already noted. Iron sinks are often galvanized. If this is well done it makes a very good looking and sanitary sink. The next upward step brings us to the cast iron, porcelain enameled sink, with roll rim and high back, all in one piece. This fixture is handsome enough for any house and has the quality of durability that makes it desirable from an economic point of view. Pressed steel sinks, enameled, are considerably used, and give excellent service. Soapstone has also been much used for kitchen sinks.

Sometimes the sink is made of copper or of German silver, but these metals are not commonly employed for this purpose. They are to be seen rather for the sink in the butler's pantry, which serves for the more delicate operations in connection with the culinary work of the house. Slate and soapstone slabs cemented together have been used for sinks, but iron is stronger and seems destined to supplant all other materials either in its galvanized or porcelain enameled form.

The most beautiful sink is the solid porcelain. For this purpose the fine china clay is ground and mixed with the greatest care and the mold allows for a thick and heavy fixture not likely to be broken and as near ideally sanitary as such a fixture can be made. The back is high and the bibbs project but slightly, so that they are out of the way.

The modern pattern of kitchen sink has the drain board as an integral part of it, making a complete and attractive fixture. Where the sink is of cast iron or porcelain, rubber draining mats are used for dishes to reduce the liability of breaking them. A useful pattern has a drain board at each end. This arrangement is appreciated when washing dishes, the dishes being taken from one board, washed and placed on the opposite board to drain. A special vegetable washing sink is also made. The combination of laundry tray and kitchen sink in one fixture has been mentioned in Chapter VI, on the laundry. In this case the drain board forms a removable cover to the laundry tray. This arrangement is suited only to the very small house or flat.

The location of the sink is preferably near the pantries under a window, where plenty of light is thrown upon the work. Theoretically the plumbing of the house should be upon the inside walls to remove any liability of freezing. A permissible violation of that rule is in the placing of the sink and its fixtures. Too often the sink is placed in a narrow space between two doors, where the worker stands in her own light, where a narrow sized sink is bought and a very short drain board put in to fit the space. This, of course, insures a perpetual inconvenience to the housekeeper. In planning the kitchen aim to have plenty of room and have it in the right place. Avoid the necessity of putting in makeshifts immediately on occupying the house. A marble shelf over the sink, which may be kept clean easily, is a convenience in the right place. Another convenience for the sink itself is a removable lattice rack for the bottom of the sink for use when it is desired to keep the dishes off the bottom. A drain basket for the corner of the sink is a convenience in separating the coarser material from the liquid.

The sink should be supplied with the best faucets, such as will shut off completely and will not be constantly dripping. The self-closing faucet is not usable here. The cold water supply should have a hose bibb end, as it is sometimes desirable to attach the hose in the kitchen with which to flush some fixture elsewhere in the house. The faucets should be compact, close to the back, and high up out of the way so that dishes may not be broken by striking against them. Sometimes a strong wire basket may be used in the sink for the dishes to rest in for rinsing instead of being placed on the drain board. If the wall back of the sink may be tiled to a suitable height it gives a clean and pleasing effect and the tiles may be easily wiped free of spatterings.

The grease trap is not regarded as a necessity in the ordinary dwelling. The amount of hot water passing through the drain pipe of the sink is usually sufficient to carry the grease to the sewer. A frequent flushing with hot water from the hot water faucet is desirable. The flow may be regulated so as to continue for a long time, gradually melting any accumulation of grease throughout the length of the drain. Sudden and short dashings of hot water are not sufficient to be effective.

Grease traps are merely for the purpose of arresting the flow of grease and accumulating it in one place, where it may be taken out in quantity from time to time. Unless the trap is cooled sufficiently to coagulate the grease it will be carried on through the drain to collect on the sides beyond or go on to the sewer. The grease trap violates the theory that all refuse should be made to pass as quickly as possible from the drainage system of the house, and unless it is cared for frequently it becomes objectionable. The need of a grease trap arises only when so much hot fat passes through the waste as to clog the trap by its sudden cooling and checking the flow. If the hot water faucet is allowed to run freely whenever greasy waste is poured into the sink there is little danger of clogging from this cause.

The waste pipe from a sink is frequently larger than necessary. A pipe that will run full is less likely to become foul than one which is so large as to lose the scouring effect of a full flow. An inch waste pipe is better than two inches for the ordinary kitchen sink. The strainer usually is without any provision for closing, though such a convenience often is desirable. Strainers are made with double perforated disks, so that by turning the pivoted disk the holes are closed or opened. Others have a standing overflow plug accurately fitted. A piece of sheet rubber may be used to lay over the strainer, when no other device has been provided, to retain water in the sink.

A salesman whose business it is to give expert advice on gas ranges says the selection of a range is a delicate matter to be left entirely to the woman who is most concerned. He shows to the customer all the good points, and objectionable ones also, and that ends his story. He stops short of the decision. Some women will leave the choice to the husband, while others exclude him from the transaction.

The gas range is most generally used in the big cities, where dollar gas in available, and in the natural gas regions. But gas for cooking, at any price, is far preferable to coal or wood. The saving of time and labor is such as to make it the ideal fuel for the kitchen. The temperature is always under control for the oven or for the pans and kettles on top of the stove. The common type of gas stove has four burners on top, an oven below and a broiler still farther down. It is a compact piece of furniture, the objection to it being that the oven blaze is not in view without stooping and the broiler is so low as to be inconvenient.

A new type of gas range has a high oven in the middle, with warming oven above and broiler below. The burners, four in number, are placed two on each side of the oven, so that it is not necessary to reach over a blaze to get to the back burner or to the oven. The objection to high ovens back of the burners is that it is necessary to reach over the burners. Any stove which compels the user to reach over the front burners may be classed as objectionable, if not dangerous. A combination gas and coal range for use where the demands are heavy is one of the novelties.

Another new gas range has a vegetable oven or an enclosed burner, where such vegetables as cabbage and onions may be cooked without any of the odors escaping even to the kitchen. The oven is entirely of copper, or with copper heating plates and nickeled brass shell, and form one of the most valued stovepipe, through which all the odors pass up the chimney.

Another variation has the broiling oven at the side with a long griddle above it. The arrangement of the burners so that a removable galvanized iron pan may be placed below them to catch the burnt matches and scraps of food that are dropped during the process of preparation is a distinct advance, making it possible to keep the stove clean and attractive. A removable tin oven may be used with a very small gas burner or may serve to give additional oven capacity on a large range. Sometimes the gas cocks in gas stoves are cheap and of poor quality, when they should be the best, free from liability to get out of order.

The coal and wood ranges show a marked advance over what was available a few years ago. The modern ranges of the best type have a double grate which may be partially revolved to remove clinkers and clear out the ashes for a hot fire. It has a feed spout in front so that it is not necessary to remove a lid or kettle when putting on coal. The arrangement also prevents the escape of gas or smoke into the room. There is also a door at the end so that the fire may be stirred from below. The top of the stove over the fire box is hinged so that it may be lifted a few inches permitting the broiling of steaks or the toasting of bread over the coals. The top serves as a hood to prevent the escape of smoke or soot into the room. The oven is provided with a thermometer by which the right degree of heat may be gauged for the considerable variations of temperature desired in baking and roasting. The cast iron or riveted steel stove having the features mentioned is quite certain to be superior in its other qualities. Cooking ranges need to be kept clear of ashes to give best results and the cleanouts should be opened frequently and examined. Electric ranges and cooking devices are treated in Chapter XVIII.

The kitchen should have good ventilation. A chimney flue of ample size with large grating near the ceiling should, if possible, be devoted exclusively to the function of drawing off the upper strata of the kitchen atmosphere. Sometimes a large sheet-iron hood is placed above the range, adjustable to any height. Such equipment is certain to catch a great deal of dust and it encumbers the kitchen so much that it is of questionable value. The provision of specially ventilated broiling and vegetable ovens tends to remove the need of a ventilating hood. The location of the range should be with full regard for the light. There cannot be too much light upon the work of preparing the food for the family table. It should not be too close to the sink, especially if it be a coal or wood range, as it would compel anyone at work at the sink to stand uncomfortably near the fire.

If the refrigerator may be placed by itself in a small room contiguous to the pantries and opening into the kitchen it will have a most convenient location. The room should have an opening through the outside wall of the house to a piazza from which the iceman may fill the ice chamber without entering the house. The drain should be accessible and large enough to admit the end of the garden hose for the purpose of flushing. The drain should not connect directly with the sewer but should drip over an area or basement drain or sink. Good construction requires a trap in the refrigerator drain pipe near the refrigerator. This trap should have an accessible screw cleanout and the discharge should be situated where it may be seen frequently. All parts of the pipe should be exposed, as such a drain pipe is subject to clogging with fungus growths, bits of straw and sawdust.

The refrigerator itself has developed into an article of high sanitary efficiency. Galvanized iron and zinc have given place in the better makes to porcelain enamel linings which may be kept clean easily and offer the least inducement for the lodgment of particles of food or foreign materials. A screen window in the refrigerator room for winter use obviates the necessity for ice during cold months for the preservation of food.

The situation of the pantries is preferably along the passageway leading to the dining room. The china closet should be nearest the dining room and the butler's pantry next. The kitchen pantry proper needs to open only into the kitchen, although a light door opening to the butler's pantry will be found useful on many occasions. Light sliding doors should close the butler's pantry and the china room effectually from the passageway. The pantries may be lighted by narrow windows which require as little of the wall space as possible.

The butler's pantry should be equipped with a small sink having above it high goose-neck hot and cold water faucets made specially for such use. The butler's sink usually is made of copper or german silver. White enameled cast iron or pressed steel, or solid porcelain may be substituted.

Heat should be supplied to the kitchen pantry to prevent the freezing of food in winter and to provide comfort for the workers in that apartment. The kitchen pantry is most serviceable if it is roomy, affording space for a molding board with flour bin close at hand and storage for all the articles and materials used in making bread, cakes and pastry. It is desirable to avoid taking all this work into the kitchen and much labor will be saved by the suggested arrangement. Here, too, should be a strong shelf to which may be attached a meat and vegetable grinder, to remain in place. This is a desirable machine in household economy, but is little used if it is always necessary to get it out, fasten it to the shelf and put it together before using. The chopping bowl appears then to be an easier alternative. One side of the pantry should have shelves with glass doors where food may be kept.

The walls back of all the pantry shelves should be of some material that will not disintegrate from shock or other cause and fall down. On this account a plastered wall is objectionable unless covered with an impervious oil-cloth. A closely ceiled or tiled wall makes a neat and clean finish.

A lavatory installed in the entry or in a convenient place in the kitchen will remove the necessity for using the sink for such a purpose. A well appointed kitchen is not complete without its separate lavatory.

Chapter XV.

THE BATH ROOM.

In proportion to its use the most sumptuous room in the house. Light and air. The baths, shower, tub, sitz and foot. The lavatory. The water closet, washout, washdown, syphon jet, or flushing valve; the plumbing woodwork; high tanks and low tanks. Traps. Bath-room accessories. Out of door water closet, anti-freezing and frost proof.

THE modern bathroom is the most sumptuous room in the house in proportion to its size. Infinite study has been expended upon the devising of bath room fittings until they seem now to approach the ideal of luxury and perfect sanitation. The evolution has been rapid and the signal advantage of the new things over those that were accepted only a few years ago is apparent to every observer.

Our ideas have changed too as to the number of bath rooms a house should contain. Even now we consider the influence of bath-room luxury upon character and habits of personal cleanliness, not only for the family but for the employees of the house and the premises. Cleanliness and perfect sanitation in one place suggest the enforcement of similar conditions in all places. The idea is catching.

Even the smaller dwellings should have two bath rooms. The idea that the servant's closet should be in the basement has become obsolete. There should be a well equipped bath room adjacent to the servants' rooms. Its effect is excellent and the investment will be returned several fold in better service and more cleanly habits on the part of the domestic help. It is in the nature of things that such results should follow these provisions for their health and comfort. The arrangement has a time-saving value also.

In the better houses a bath room situated off the family room or suite and a general bath room off the hall are provided. The extra room is sometimes adjacent to the guest room for the exclusive use of the guest. Toilet rooms for the children, with small fixtures, are very desirable in homes where there are children. In the construction of a house the children are entitled to consideration and nothing will minister more to their comfort than to have such a convenience exclusively for them.

The notable improvements which have been made in plumbing and fixtures have not been attended with greater costliness, but rather the reduction of cost has made the superior articles more generally available. Where one bathroom was considered a luxury a few years ago two or more bath rooms are now regarded as necessities. Reduction in price, the standardizing of fixtures, the ability of the plumber to figure accurately and give a price for the fixtures installed in place, ready for use, have simplified the business from the viewpoint of the purchaser. He does not feel that he is plunging into an extravagance of unknown extent, because there need be nothing indefinite in the contract.

Again, people are better traveled and more widely experienced. The higher way of living appeals to them and the luxury of a complete home is marked "number one" in the list of things embraced in their aspirations. No part of the house is more expressive of the refinement of the family than the bath room. The little ideas that are wrought into its making and the marks of its proper use are ineradicable to the observant eye. The modern bath room is truly a show room. The housekeeper, in showing her friends through her new home, takes no less pride in directing attention to the neatly or beautifully equipped bath room than in displaying the furnishings of other rooms, for no room more than this bespeaks luxury, if made according to the latest ideas of what is best in the art and science of good plumbing.

The bath room need not be large for the ordinary equipment of bath tubs, lavatory and water closet. The addition of shower bath, foot or sitz bath tubs will require additional space. Usually six by eight or ten feet are sufficient dimensions, while eight or ten by ten afford exceptional luxury. One small, stout chair and a small table are desirable where room for them can be given. The apartment should have abundant light. Rarely does it have more than one exposed side. A good arrangement is to have two windows with sills waist high or higher with sufficient space between for a plate glass mirror. The man of the house will appreciate this as an ideal provision for the morning shave. Gas jets on each side of the glass or suspended from above it complete the arrangement. The windows should be as wide as the space will permit and should open easily to provide good circulation in summer and additional ventilation when wanted at other seasons. A ventilator with a good draft is particularly desirable for the bath room, in order that there may be a constant inflow of air from other rooms rather than any outflow whatever to other apartments. To this end a ventilating register near the ceiling, in addition to the one in the baseboard, will not be superfluous. In many situations the omission of the threshold or the cutting of half an inch from the bottom of the door will greatly facilitate the change of air. If the bath room may have direct sunlight during some part of the day so much the better. The purifying effect of the sunlight should make it a welcome visitor to every room.

The walls of the bath room need to be impervious to vapor. In no place may fancy tiling be used more appropriately than here. Frequently the entire interior of the bathroom is lined with art tile of costly and elaborate workmanship. The mosaic patterns are especially beautiful. Recently there has come into quite general use enameled sheet metal which so closely imitates tile that one does not casually observe that it is not glazed ceramic tiling. The entire interior of the bath room may be lined with this material, as suggested for the kitchen, giving a very clean and sanitary effect. The walls may then be spattered freely without harm and the sense of cleanliness which such walls impart makes them very desirable.

Bath room floors are best when made of impervious material. Mosaics are much used. The one-inch hexagon, the three-quarter-inch squares and the thirteen-sixteenths-inch round mosaic tiles may be laid in patterns innumerable. A greater variety of color is available in the mosaic tiles than in any other suitable material for the bath room floor. A pattern border with solid center over which rugs may be laid gives a pleasing result. The interlocking rubber tiling has an advantage to which the attention of those not familiar with it should be called, namely, that it does not become slippery. The amount of rubber in its composition is comparatively slight, but sufficient to give it elasticity and adhesiveness which make it safer perhaps than any other available floor covering. It is also noiseless and when once in place the joints close so snugly that it is as impervious as if it were one solid piece.

The simpler and cheaper forms of bath room floors are oil-finished wood, mosaic wood carpet or parquetry, linoleums and cement with an admixture of hardwood sawdust which gives a slightly flexible and warm floor. The wood floor with inlaid patterns cannot be classed among the cheaper floors as they are often elaborate and handsomely artistic.

Too often the bath room is not well heated, making it necessary in very cold weather to bring in a portable stove to warm the room sufficiently for bathing. If ample provision is not made for heating the bath room, especially when a hot-air furnace is used, it will be found difficult and costly to remedy the defect when finally it is discovered.

When the bath room is situated in a part of the house remote from the furnace it will require a much larger heating flue than if situated in the central part of the house where the course of the flue may be more direct. It is not difficult to guard against such an error in the heating plan. A little forethought will save much trouble. Attention is called to it on account of the frequency of the error.

The bath tub has undergone such a marvelous evolution that it is worth while to revert to some of the earlier types. The best remembered by the present generation is the old wooden form, lined with tin, zinc or copper. The copper-lined tub has shown such lasting qualities that it is in use today in many of the old houses. It is all boxed in, with unknown dark and often dank recesses, where the water has been splashed for decades. The fiber tub was a short-lived affair. It was made of indurated fiber such as seen today in the so-called paper pails and tubs. It was found to be objectionable because the white enamel turned yellow and cracked and the material was of an inflammable character. Such tubs are no longer manufactured.

The cast-iron tub is not new but has developed through many years to its present state of enameled perfection. Cast iron and sheet steel or iron tubs have been variously made. Tinned copper has been used as a lining, with a layer of putty between the copper and iron and with a wooden rail around the top. The effect was one of solidity but the copper was always liable to puncture and the wooden rail was objectionable. Enamel paint, baked on, in the same manner as bicycle frames are enameled, was one of the developments. This paint is still used for the outside of enameled tubs. The ordinary cast-iron tub was also painted inside and out and gave a very satisfactory bath that was, however, somewhat difficult to keep clean and the paint wore off after a little use.

The cast-iron tub with porcelain enamel finish and roll rim is the best known development of the iron bath. This, too, has been through a process of evolution. It was first made with provision for a wooden rail around the top. This was fastened on by means of screws through holes in a flange for the purpose or through ears left on the casting through which screw holes were drilled. The enamel is not sufficiently hard to resist the effect of gritty scouring materials such as are often used in keeping bath tubs clean. If the enamel is to be preserved in its original freshness of gloss no abrasive materials should be used in cleaning it. A little gasoline on a cloth is an effective cleansing material, but dangerous to use on account of liability of ignition.

The price of these tubs, not so very long ago, was almost prohibitive for general use. Improved processes of manufacture and their production by a large number of factories have made them available for the ordinary dwelling. What was considered a high degree of luxury not many years ago is now one of the common possessions of families of modest means.

A sheet steel tub pressed into shape so as to be entirely seamless promises to contest the market with the cast-iron tub. It is claimed for the seamless sheet steel tub that it weighs only half as much as the cast-iron tub and that steel will hold the porcelain enamel better. Being only one-eighth of an inch thick it also takes less heat from the water and does not impart the cold feeling that is noticeable in cast-iron tubs. It is said of the new tub that it weighs only about 150 pounds as compared with 300 pounds in the cast tub. It is therefore possible that we are upon the eve of another revolution in bathroom fixtures, the pressed steel having many possibilities if the tendency to wrinkle in pressing may be successfully overcome. It is asserted that this has been accomplished.

The solid porcelain tub, molded and glazed with the same care that is given to the best quality of tableware, is regarded as the ideal in bath-tub manufacture. Its elegance is undisputed. It has the unmistakable color and solidity that suggests the height of refinement in these fixtures. The china tubs are made in heavy and light grades, these terms being merely comparative. Both grades are heavy and require substantial bases for their installation. Art has found its opportunity in designing graceful outlines and very handsome decorations give a luxurious touch to these superb fixtures.

Two standard shapes are in general use, the French and Roman. The French style slopes at one end only and is the commonest type, while the Roman shape slopes at both ends with faucets back of the tub. The best fittings admit the water noiselessly from the side or bottom or very close to the edge at the top. Good practice aims to do away with all noisy fixtures. When it is necessary to place the bath tub in a recess or corner it is well to get one that will fit the place exactly. Such a tub is made with a square corner or corners so that it may be fitted perfectly to the wall tiling or marble slab without leaving any opening for the accumulation of filth or litter behind or under it. The back and ends are effectually shut in so that no water may drip through to the enclosed space.

The ordinary bath tub is not usually placed sufficiently far away from the wall to permit sweeping behind it. When conditions permit the plumber should so "rough in" his work as to permit a space of six or eight inches between the wall and the back of the tub.

Art has given many variations of the two standard shapes in the arrangement of the legs or base and in the pattern lines. Color is used to some extent but more generally the pure white tub is preferred. Elaborate decoration seems out of place in bath-room fixtures. Strong colors are especially to be avoided. A base which completely encloses the space beneath the tub, making the tub appear to sit immediately upon the floor, has the advantage of doing away with a place where ordinarily much dust and litter will accumulate unless given frequent attention. Such a base adds considerably to the cost of the tub but makes a substantial and handsome installation.

The manufacture of bath tubs, particularly the solid porcelain or china baths, is attended with a certain amount of uncertainty in the quality of the product. Cracks, warps and blisters may appear in the process of firing, resulting in a grading that gives three classifications, usually designated as *a*, *b* and *c*. The grade *a* implies a perfect article; *b* a very slightly defective one, and *c* any other that is fit for use. A considerable difference in price is made on account of even slight defects. Bath tubs are made from four and a half to six feet in length in the Roman and French styles, a short deep tub being preferable to a long and shallow one, a short tub giving greater depth of water for the number of gallons used.

A foot bath tub is a very desirable fixture in the bath room. The restful and tonic effect of a foot bath may be had with greater convenience by using a tub made specially for the purpose. The ordinary tub is not suited to bathing the feet alone and the attempt to use it for that purpose by sitting on the edge is attended with no little risk. The footh bath is made of enameled cast iron with roll rim, and also of solid china. The tub is usually about 26 inches long, 21 inches wide and 15 inches high.

The sitz or seat bath tub is usually about 30 inches long, 27 inches wide, 21 inches high at the back and 13 inches at the front. The ideal material is solid porcelain or, next in favor, cast iron, with roll rim and porcelain enamel finish. Besides having the distinctive use for women the seat bath is especially convenient for bathing little children. It is also a good substitute for the foot bath tub. The seat bath is frequently provided at the back with a liver spray treatment with which is sometimes recommended by physicians on account of the resulting local tonic effect.

A pretty arrangement for the nursery bath is a tub on a pedestal standing about the height of a table, 31 inches.

The shower bath and its variations of needle and rain baths is variously provided for in modern installation. The receptor style has a round or square shallow tub with open drain, above which are suspended the spraying devices surrounded by a waterproof curtain sliding on a circular bar with rings. Receptors are made also to fit in a corner of the bath room. Again the fixtures may be placed in an alcove or stall with tiled or marble sides and a dished impermeable floor with drain, a waterproof curtain taking the place of a door.

The rain bath differs from the shower bath in having the water fall in large drops at low velocity, while in the shower bath the water is delivered in small drops or jets at high velocity. The needle bath delivers the water in fine jets at high velocity from several rows of pipe around the body as well as from above. Portable shower baths are also made and the ordinary bath tub may be used as a receptor for the shower bath. The fixtures may be arranged above the tub and the waterproof curtain may be thrown back so as to be out of the way when not in use. In the installation of the shower bath with special receptor or stall opportunity is given for pretty effects in art tile and mosaic work.

The fittings for the bath tub and for the shower bath should in all cases be of the best quality. Overflows in the bath room are usually more serious than in any other part of the house, often damaging the ceilings and discoloring the walls. No effort should be spared to make the bath room secure against such accidents, both in its fixtures and plan of drainage. The simplest method of bringing the hot and cold water to the tub is through separate faucets. A combination faucet is more often used in good construction but if there be a mixing chamber a distinct advantage will be thereby secured. This chamber, if provided with a thermometer with bulb placed within it, will be found most useful in securing definite temperatures. Especially is the mixing chamber necessary for the spray baths. If properly constructed, it delivers the hot and cold water through rows of small holes from pipes within the chamber from which it flows, thoroughly mixed, to the bath tub bibb or spraying nozzles. A rubber pipe with a rose spray, attached to the combination faucet of a bath tub, is the usual substitute for more elaborate shower-bath fixtures.

The supply pipes for the bath tub should be of ample size to fill the tub rapidly. Economy of time demands such a provision and where several persons may wish to bathe there will be less waiting. The waste pipe also should be large, that the tub may as quickly be emptied, the water serving the useful purpose of flushing the drain.

The bidet is installed only in the more expensive bath rooms. It is usually of solid porcelain and is not ordinarily deemed a necessity when the room is provided with a seat bath. The urinal is also considered a superfluous fixture in bath room installations in the home. Unless regularly attended to and supplied with deodorizers a urinal is apt to become offensive. The construction is such as to require liberal flushing and frequent cleansing by more effective methods.

Sunken baths are not often installed unless a large pool is wanted. For the mere purpose of bathing they have no advantages over the commoner method of bath-room arrangement, while being considerably more expensive. Where a pool of considerable dimensions is wanted it may be constructed of wood, or reinforced concrete, with a lining of glazed tile, sheet lead or copper. Great care is necessary to make such a pool water tight. The basement is the better place for a swimming pool.

In the installation of bath tubs, especially where the floors are of wood, a marble or slate slab has often been placed upon or in the floor. This is countersunk to catch any water from leakage. On account of better construction both in fixtures and installation such safes are not now considered necessary. The amount of water likely to get upon the floor is too inconsequential to be considered.

The lavatory shows the most pronounced improvement of any plumbing fixtures. In a short time radical changes have taken place in favor of the solid earthenware and the enameled iron and the plain and decorated basins. The marble slab and earthenware decorated bowl, with marble wall-pieces were only a short time ago considered the finest type of lavatory construction. The business of manufacturing these fixtures has vanished. It would be difficult to find a plumber now installing such a fixture except perhaps to use up old stock on some customer who is seeking a bargain.

The integral lavatory, with slab, bowl and back all in one piece, combines all the requirements of a sanitary fixture except as to its overflow duct and the short piece of pipe from the waste plug to the trap. Latest types of the integral lavatories have the waste at the back with a vertical overflow duct which may be reached throughout its length for cleansing. A removable screen in the waste opening makes the waste pipe equally accessible. This has been objected to because of the liability of losing the screen or of allowing the waste pipe to become clogged while the screen is out. Practice does not prove the objections to be well founded, while good design and good sanitation seem to require such a provision to keep the fixture in a wholesome condition. The standing overflow plug is regarded with favor if the basin is recessed at the back to allow its use. This must have a carefully ground seat or rubber washer and should be cleaned frequently. The greatest simplicity is to be sought in the devices to control the waste outlets of lavatories. Intricate mechanism is likely to have too much fouling surface to warrant its use. In erecting all fixtures we are careful to have impassable barriers placed between the air of the soil pipe and that of the house. To be entirely consistent we must see to it that the lavatory waste pipe and overflow are of sufficient size to be easily cleaned and to that end they must be readily accessible. In choosing the lavatory fixtures these points deserve to be kept in mind.

The best basin cock is the combination which may be supplied from both the hot and cold water system. Only one bibb is thus presented to interfere with the use of the basin. This should be of a design that projects but slightly over the edge of the bowl. The tall, slender ones which throw the water to the center of the bowl are considered less desirable in modern practice.

In the new types of lavatories many very pleasing designs have been produced. On account of the great weight of the solid porcelain fixture various pedestal designs have been brought out. The effect is graceful and natural. Massive fixtures on slender brackets, however strong, do not quite satisfy the demands of the eye for supports of a volume proportionate with the load. The pedestal lavatories, as well as those designed to be supported on wall brackets are made to meet all sorts of conditions, while a studied grace of outline is apparent in all of them. In the pedestal type there may be one or more basins on the same support. The wall basins are also made single and double, and for public use are constructed in ranges of any number desired. In shape the new lavatories are made to fit corners and recesses and to stand in the open. The less work required for their installation is one of the important savings brought about by the new integral types. There is no fitting of slabs to wall spaces and no adjusting and cementing of the bowl to the marble slab, as formerly. The cost of repairs is reduced to the minimum. The new order of things is welcomed alike by plumber and customer. The former profits by the wider use of such conveniences and the customer becomes a more willing purchaser of goods that are practically indestructible and still within his means.

In this evolution of a few years we have seen the water-closet pass through quite as many changes as the other fixtures. We are surprised, as we look back, that the pan closet was ever tolerated. It was unsanitary and extremely offensive, one object of its construction being to use as little water as possible. We had not then risen to the free use of water to which almost every one is now accustomed. Indeed, how the views of the world have broadened in this regard! In most cities we are using gallons where formerly we used pints.

From the pan closet we progressed to the plunger type. This consisted of a bowl whose outlet was stopped by a big valve or plunger situated in a side chamber which shut down over the sewer connection. The bowl was emptied by lifting the plunger and holding it up until the contents had flowed out. A chain or lever operated a slow-closing valve on the water pipe or in a flushing tank which released enough water partially to refill the bowl. It was a great improvement over the pan closet, but there was a large fouling surface in the side chamber of the bowl around the plunger that was difficult to reach. These types were condemned twenty years ago and their installation is prohibited by ordinance in many cities.

The aim of invention has been to get away from any form of mechanism in the closet bowl itself. The plain hopper closet was the first success in this direction but the amount of fouling surface was still too great to make it a satisfactory type. Although nearly or quite as old as the pan and the plunger closets, it is still in use, particularly for exposed places. The long hopper closet is the most simple device available for installation in situations where there is danger of freezing, but should never be used in a warm place, where a better type is safe. The hopper connection, for this purpose, is made to extend to a trap below the frost line and the water connection is provided with valve and waste situated also beyond the reach of frost. The connection between the hopper and trap should be direct so that any obstruction may be removed. Such an installation is to be avoided in a confined space on account of the long fouling surface inevitable in a non-freezing closet. An abundant water supply is desirable in order that the hopper and its trap connection may be well flushed before and after using.

The short hopper closet was the forerunner of the syphon jet closet, which at the present time is considered the best. The defect of the short hopper closet is that it requires a large supply of water from the flushing tank to get the water in the hopper into motion. Frequently a second flushing is necessary to clear the hopper satisfactorily.

The washout closets are made with several variations in outline, according to the ideas of the designer. In these the water in the bowl is at a different level from the water in the trap. In operation the water simply washes the waste matter from the bowl over a shelf or weir where it passes through a trap, if the water is abundant. If not, it may stop on the near side of the the ordinary short hopper form. This style of closet has been and is destined to be extensively used in ordinary work. The objection to it is that it has a considerable fouling surface not easily reached. While having the appearance of being sanitary it falls considerably short of that ideal. The space between the bowl and the trap is certain to become foul and offensive.

The washdown is a better type of closet, having its weir or dam hidden behind the wall of the bowl and protected by a good water seal. The noisy operation of the washdown and washout closets is one of the objections to these types.

The syphon closet differs from the short hopper style in having a deeper seal. With a sufficient flow of water from the flushing tank the bowl fills until the abundant overflow in the long leg of the syphon sets up syphonic action, drawing out all the contents of the bowl until the inrush of air breaks the syphonage.

The syphon jet is the standard of the present time in closet construction. When properly made it has the long-sought ideal of a limited fouling area, a deep seal against gases from the sewer or soil pipe trap, with no hiding places for filth. With little attention it may be kept practically odorless. The only fouling surface is that between the flushing rim and the surface of the water seal. This is always in sight. It is an improvement upon the syphon closet. The shapes are nearly the same but it has the additional feature of introducing a jet of water at the bottom of the trap. This jet, when the flushing lever is operated, quickly starts the water in the trap in the direction of the overflow and aided by the flow from the flushing rim the hopper is effectually emptied of its contents and refilled with fresh water. The jet prevents the return flow of any of the fouled contents of the bowl. The action of the closet is as nearly noiseless as the flow of water may be made. The syphon jet closet is the most expensive style to manufacture, requiring expert skill in molding the parts and putting them together so that an even shrinkage will take place in the firing. It is important that they be made of the best materials in order that they may not fracture easily, as the cheap ones are pretty certain to do sooner or later from slight shock. The purest white china of best quality should be insisted upon for any installation.

Closet seats and covers of every conceivable shape and of several kinds of wood are obtainable. The best varieties are oak, cherry, mahogany and walnut. Cross strips, dowels or bolted sections are usually necessary to prevent splitting from shrinkage and shock. The seat metal work is not always made with proper care. It should be of heavy brass, nickeled. The strain of constant use will result in the fracture of light fittings, especially the hinges. If a part is broken it may become necessary to buy an entire new set because of the difficulty in matching a particular pattern. It is desirable to have the closet woodwork in harmony with that of the bath room where possible. Usually the casing about the flushing tank and the seat have the same finish.

The local ventilation of water closets is not generally practiced. These vents are merely for the purpose of immediately removing odors from the bowl and they require a positive draft outward continually, to be of avail. Prompt flushing sometimes answers the same purpose. Local vents complicate the construction of the bowl, add fouling surfaces and make it necessary to have an additional connection with a ventilating flue. In case of the fracture of a bowl it is necessary to secure an exact duplicate or rearrange the connections. Notwithstanding these objections the local vent is a desirable feature and should be secured if possible.

Floor slabs for closet bowls are less used than formerly, but they are desirable. While a water closet bowl may be set directly upon the trap or Y leading to the soil pipe, greater rigidity is secured by interposing a floor slab. When floor slabs are used they are made of marble, slate or soapstone. Slate or soapstone is preferable to the permeable marble. The dark color of the slate is an objection not present in the soapstone, which on account of its grayish color is less noticeable when in place.

Flushing tanks or cisterns were for many years placed about five feet above the point of discharge in the flushing rim of the closet bowl. Manufacturers then found that an enlargement of the water-supply flushing pipe, permitting a larger volume of water to be fed to the bowl, did away with the necessity of so much head, and the "low down tank" came into being and finally into general use. It was also found that it would be far more convenient to have the tank down where it could be looked into easily, while it might be made narrow and higher to give it equal capacity with the high tank, so as not to encroach seriously upon the limited space of the bathroom.

The low tank is therefore sometimes preferred in new installations. Sooner or later the best of tanks must be repaired and one needs to be familiar with its operation or be compelled to call a plumber when it fails to act correctly. The convenience of the low tank at such a time is immediately apparent. One recommendation is its almost noiseless operation. A large amount of plated piping is eliminated, which reduces expense both for labor and material.

All plumbing fixtures must be separately and effectually trapped. The trap should be as near the fixture as possible so that there may be little fouling surface between the fixture and its trap. The trap should have a good depth of seal and the flow of water through it should have a scouring effect to keep it cleansed. If the trap is very deep this is not accomplished. The back venting of all traps is expected to remove any likelihood of trap syphonage by reason of air compression or rarefaction. Syphonage from evaporation or the capillarity of threads or ravelings lodged in the traps is not likely where the plumbing is used frequently, but needs to be guarded against in fixtures that are little used, such as stationary lavatories in unused rooms.

A lavatory and closet are now often provided on the first floor of the ordinary dwelling. This arrangement is found to be very desirable, saving many steps and much stair-climbing for members of the household. It is especially convenient for the use of guests who are in the house for a short time only. If placed near a small cloak and hat room or opening from such a room it will be the better secluded. The space under a stairway is often thus used, but unwisely so, because of the probable lack of light and ventilation.

A toilet room for children has been suggested. Toilet fixtures for the little folks are extensively manufactured for primary schools and kindergartens and the equipment of such a room is a simple matter at moderate expense.

A slop sink should be provided on the second floor rather than use the bath-room fixtures as a place to empty slops. The slop sink may be installed in the room or closet where the sweeping and dusting materials are kept. Various styles are available. Some are made to fit in corners; others are hopper-shaped to be placed near the floor, while a third is provided with a pedestal with trap integral with the sink. They are made of solid porcelain, cast iron and pressed steel coated with white porcelain enamel. Such sinks should have hot and cold water bibbs high enough to permit the use of pails in the sink.

Several bath-room accessories may be mentioned, all of them desirable and most of them quite necessary. The medicine cabinet is often placed in the bath room, either built in or attached to the wall. The portable style may be had at various prices up to $25. The best ones have shelves of thick glass with a plate glass mirror on the door. There should be room in the cabinet for soaps and toilet supplies of all sorts. For such purposes the cabinet needs to be of good size. It should be remembered, however, that such cabinets afford a fine chance for dirt to collect, and a miscellaneous assortment of left-over and unused medicines is a mournful sight.

Towel rails and hooks cannot be too plentiful in the bath room. Rails of glass in nickeled supports are among the favored fixtures. A stout nickeled rail along the back of the bath tub which may serve the double purpose of a hand rail and towel holder is a useful fixture. The fatal accident to Mrs. Henry Tilford, of Louisville, Ky., while visiting the family of Mayor Tom L. Johnson, of Cleveland in September, 1906, is an emphatic reminder that danger lurks in the modern bath. Mrs. Tilford slipped and fell in a bath tub, fracturing her skull against the tub. To prevent such accidents rubber mats for the bottom of the tub are provided and every tub should have one. Mats are also made to fit the roll rims of tubs.

Much comfort is to be had also from bath tub seats. Of these there are two types, one a stool with rubber-tipped feet to stand in the tub, the other an adjustable seat suspended from the sides of the tub. A style of tub is made with the seat in it at one end, integral with the tub. It is really a terrace in the tub, on which the bather may sit. Its popularity is yet to be demonstrated.

Ingenuity has devised many forms of soap cups, sponge cups, drinking glass holders and tooth brush racks, all of which are needed in the complete equipment of the bathroom. In no place is a good mirror more serviceable and several of them are not out of place in the decoration of the room.

Chapter XVI.

LIGHTING THE HOME.

Gas as an illuminant. Individual gas plants. Proper distribution of gas. Clever and useful gas appliances. Acetylene lighting plants. Lighting by electricity. Economical devices in electric lamps. Individual electric plants.

THE art of illumination has long since grown to such dignity that men have given it scholarly attention and a new profession, that of illuminating engineer, has arisen. This engineer finds his most profitable field of labor in the artificial lighting of public buildings, public streets and places; churches, clubs, schools, libraries, steamships and the palatial homes of very wealthy citizens. He has at his command newly discovered and wonderful forces, the fruits of exhaustive scientific research and experiment and the valuable products of patient invention. Out of the vast store of devices for illumination and the several practicable illuminants it is his office to choose those best adapted to his purposes. He must determine the conditions, estimate the power of his light units and so dispose them that they shall yield the required amount of light with as little waste of illuminating values as his experience will enable him to do.

The ordinary dwelling does not come in for much scientific study in matters of artificial illumination. The architects generally suggest the theory that the artificial lights should illuminate the room from the same direction as the mediums of natural light, the windows. The arrangement of furnishings in a room usually has some relation to the windows and the light therefrom. It has been suggested therefore that the daylight harmony of light and shadows should be preserved by the artificial lighting. The discussion usually ends by hanging the chandeliers in the center of the room where a single light will give the greatest service.

The human eye is most at ease in a diffused light. Artists select for their studios rooms having north windows, finding that the north light is most favorable for determining fine differences in color and the light is more even throughout the day. The eye during the countless ages of its development has become accustomed to receive the light from above and any reversal of that plan is attended with painful effects. Snow blindness, sand blindness and water blindness are examples of injury from light entering the eye from below. The Indians of Alaska are credited with making a kind of leather goggles with a flap which prevents the reflected light of the sun on the snow from entering the eye. These are said to be a complete protection against such injury. In the grape growing region of New York state the pruning of the vines is often carried on in winter when the snow is on the ground. Cases of severe injury to the eyes from sunlight reflected from the snow are quite common, due to ignorance of the fact that the eye must be protected against a strong light entering from below. The eye can bear the strongest sunlight at midday, yet it strives to avoid the direct rays of the sun as it approaches the horizon with less than a hundredth part of its midday brilliancy.

These observations are intended to emphasize the importance of having the lights in the house so elevated that they may not shine directly in the eyes, particularly if such a white light as the Welsbach, the Nernst glower or the acetylene flame is used. Practice favors the center of the principal rooms as the best location for the chandelier. Where many incandescent electric lights are available they are very pretty and effective when placed along the frieze of a coved ceiling. The central chandelier may be supplemented by wall brackets placed where extra light is wanted. In the chambers wall brackets are generally preferred. The error is often made of placing them too low and using intense lights not sufficiently covered with diffusing opalescent globes.

Lighting fixtures are available in such infinite variety that no attempt can be made to describe them. The general style is changing continually so that an experienced person may almost tell in what year a house was built by observing its lighting fixtures. The tendency is toward better quality, the dealer taking pains to discourage the use of those that will not give good service. One may spend a large sum in buying his lighting appliances or for a moderate sum may secure a better equipment than ever before was available.

Gas made from coal, enriched by the addition of various other materials, is the most common illuminant. It is only a little more than a hundred years since illuminating gas was first used and less than a century since it first was applied to public illumination in London. It is less than fifty years since the present economical methods of manufacture were invented. Improvements from time to time have reduced the cost until now in many large cities the price is less than one dollar per thousand feet. The public gets the gas at about the cost of manufacture and the companies depend upon the by-products for their profits. It may be said that in none of the public utilities does the public get such a large value for its money, yet few corporations that deal so intimately with the public come in for such a large share of abuse.

In piping the house for gas one needs to look well ahead for possible requirements. In addition to the openings for chandeliers and brackets in places designated by the architect, it is pretty certain that extra gas connections will be required in the kitchen for a gas range and range boiler heater. and in the laundry for heating water or flat irons, if the ironing is to be done in the laundry. In some of the rooms there may be artificial logs in the grates or asbestos fronts to be supplied with gas for heating on cool days or for supplementing the furnace or radiators during extreme weather. If these are provided when the house is in the rough, before lathing, plastering or floor laying has been done, the extra cost is trifling.

Gas is served to the consumer under very slight pressure—only a few ounces per square inch. But even under such pressure there is often leakage of pipes with frightful accidents sometimes occurring as a result of careless piping. The escape of gas in a confined place soon causes trouble and often much expense. The careful gas-fitter makes sure that his pipes are free from obstructions by looking through them or blowing through them at the time of putting them in place. He sees that the threads on the ends of the pipes are well painted with red lead before screwing them into the couplings or other fittings and he caps all openings immediately to prevent anything from getting into them. When he has all the piping in place he puts on a pressure of four pounds to the square inch with an air pump made for the purpose. This is supplied with a gauge which will indicate any leakage. The pressure is left on for 24 or 48 hours and if no leak is shown he calls the owner and architect together and asks for a certificate that the pipes have been tested and the system proven to be perfect. This protects him against responsibility for any future accidents due to work around the pipes by carpenters or other workmen.

Recently there have come into limited use gas burners in which the gas is heated before reaching the tip. A nearly white light is the result. In some of these the burner is inverted so that no shadows are caused by fixtures below the light.

The setting of the meter is left to the gas company, the street service pipe having been put in at the time of digging the cellar. The service pipe should have a sufficient grade to cause the water of condensation to flow back into the main. If it is necessary to have the connection lower than the main, a waste cock must be provided where the water may be drawn from the pipes from time to time when the lights flicker. The whole piping system should be so constructed that any water gathering in the pipes may be drained.

The meter may be put in near the cellar wall or it may be connected at some more convenient point by extending the service pipe. Where the slot meters are used they should be placed in an easily accessible place with good light on the dials for the reader's convenience. Thorough instruction to the consumer as to the use and operation of the slot meters is one of the essentials in placing such gas measuring devices. The gas company here again comes in for a great deal of harsh talk on the part of the user who imagines that the meter has measured more gas than he has consumed. He doesn't understand the meter. In the ordinary gas meter the gas is measured by the action of diaphragms which are actuated by the gas pressure. The movement of the diaphragms back and forth causes the hands on the indicator dials to revolve. Any leak in the diaphragm or any inaccuracies in the valves that connect the chambers behind the diaphragms will allow gas to pass to the burner without registering. But the dials will not register unless the full amount of gas passes through, plus the leaks which are always in the consumer's favor. A correct knowledge of the operation of a gas meter tends to preserve the peace of mind of the householder who might otherwise imagine that he was suffering loss through the unwarranted activity of the meter.

When the development of electric lighting threatened the illuminating gas industry the Welsbach burner was placed on the market, greatly broadening the use of gas for illumination. The fact that gas may be used for light and heat and for the kitchen range has established it more firmly in popular favor. Many improvements have been made from time to time extending the usefulness of the Welsbach burner until now it is the simplest and most effective gaseous illuminant available in the chief cities.

The electric incandescent lamp has one marked advantage over the gas lamp in that it does not consume oxygen or vitiate the atmosphere of the house in any degree. It is deficient in lighting power in comparison with the Welsbach burner, with cost apparently considerably in the favor of the latter. It lends itself more readily than any other form of light to decorative purposes and is safer than any other illuminant in the great variety of its uses in artistic work. The fact that any number of lights may be turned on by throwing a single switch gives it wide usefulness. In many small towns incandescent lights are extensively used for domestic illumination. The over-capitalization of electric companies in the larger cities and the necessity for earning dividends on such excessive capital stock apparently has restricted the operations of such companies to the more profitable field of arc lighting and where conditions imperatively require the incandescent light at the higher price, regardless of the competition of gas.

The relatively high price for incandescent lights in the larger cities has resulted in the general installation of independent plants for office buildings, stores and industrial concerns. Requirements in such places have far outgrown the limitations of gas which must needs remain the illuminant for small establishments and the city home where circuit lighting is not necessary.

Countless novelties are to be had in electric lamps and fixtures. One of the most useful is one which permits the lamp to be operated at various degrees of brightness, saving the current and avoiding a bright light where it is not wanted.

The amount of illumination required for any apartment cannot be determined in advance of its completion and furnishing. Walls and ceiling of a light color will reflect the rays while dark colors absorb it. Light shades are always to be preferred in the ceiling and upper walls of rooms where good illuminating effects are wanted.

Where electricity is to be used for lighting, the conduits for wires should all be put in place before the lath and plaster are put on. Wire for the incandescent system is not expensive and conduits should be extended to all places where light is likely to be required, with extensions to switchboards in the most convenient places. Arc lights are entirely unsuited to small interiors. A particular advantage of the incandescent light is that it may be turned on in any part of the house in advance of entering the apartment.

The Nernst lamp is the latest claimant for public favor in the electrical field of illumination. Two small tubes are heated to incandescence by the electric current, the steady glow giving a strong light. It is especially valuable for lighting large interiors and for street illumination. Economy of current is one of the advantages claimed for it. The light is so intense that it is always covered with a white globe for its effective diffusion. It is used on a 225-volt current and the smallest of the lights is 50 candle power or twice the strength of the usual acetylene flame. The small Nernst lamps are adapted to house illumination, the globes being placed rather higher than the ordinary chandelier.

It is quite as easy a matter to equip the isolated home in the suburbs or far out in the country with an up-to-date lighting system as it is with a system of water supply. Two means for such lighting are available, gasoline and acetylene. The gasoline is placed in an underground tank situated at a safe distance from the house and other buildings. Air pressure is maintained by a hand pump placed in the basement where a gauge also should be installed. The house is piped as for ordinary gas and the Welsbach burner is used. The gasoline flame may be used also for baking and cooking in stoves made for the purpose.

Cheap acetylene is one of the most recent gifts of science to the practical world. The gas itself has long been known to chemistry but it was in the early '90s that a practical method of generating it was discovered. The gas is the product of carbide of calcium when combining with water. The carbide consists of finely ground coke and quicklime combined under a heat of 4,000 degrees in an electric arc. The proportions are 40 per cent coke to 60 per cent lime. The resulting combination is a hard mass of a brownish gray substance which, when removed from the furnace, is crushed and packed in air-tight cans, being then ready for the consumer. The acetylene burner in common use burns half a cubic foot per hour, giving far better illumination than a 6-foot gas burner, as shown by photometric and other tests. The price of carbide at this writing, November, 1906, is 5 cents per pound in 100-pound lots and 3½ cents by the ton. One pound produces about 5 cubic feet of gas so that the cost of illumination is about half a cent per hour per burner, with carbide at 5 cents. The one-half foot burners are rated at 25-candle power, being considerably greater than the common fish-tail gas flame. It possesses more nearly the properties of sunlight than any other illuminant.

Many forms of generators have been invented for the production of acetylene gas from the carbide. The conditions required in a good generator are that gas shall be produced in very small quantity under automatic control, whether supplying one burner or several; that the generation of gas shall be attended with as little heat as possible; and that the charging of the generator with carbide and the removal of the residuum may be easily done. Two applications are used, namely, water to carbide, also called the drip principle, and carbide to water. The latter seems generally to be preferred except that difficulty is found in producing a mechanism that will deliver the carbide to the water as wanted. On account of the considerable heat attending the chemical changes due to the contact of water with the carbide it is desirable that a liberal amount of water be used. A temperature in excess of 140 degrees reduces the efficiency of the gas.

The safety of acetylene has often been questioned. It is difficult to make any gas-generating system fool-proof but the best generators are nearly so. By observing the rule that no lights are to be taken near the generator when charging or removing the waste no danger can result. The work around the generator should be done during the day when no artificial light is needed. The air becomes explosive when mixed with 12.5 per cent of acetylene, the same as it does with common illuminating gas. Common gas escaping from a 6-foot burner in a room might become explosive in a few hours, while acetylene would require twelve times as long, as the largest acetylene burner uses but half a foot per hour. Acetylene is not a poisonous gas and if allowed to escape in a room will awaken the sleeper by irritating the throat. The flame has the least effect on the air of any of the illuminants except electricity, producing only a minute quantity of carbon dioxide and consuming but a small amount of oxygen.

When acetylene is substituted for ordinary gas the piping of the house may be the same, except that special tips are required, costing about 25 cents each. One hundred dollars will buy one of the best generators. The whole process is exceedingly simple and when the premises are equipped with such a system a city home can rarely boast of having a better means of illumination.

Chapter XVII.

THE STABLE.

Stable heating and plumbing. Water supply. Special stable drainage. Sanitary care of manure. Carriage washers. Stable fittings.

THE private stable may be a modest affair or a costly structure, but there are certain essentials to be considered for the sake of economy and convenience and no effort should be spared to make it inoffensive. There is such a thing as a practically odorless stable, but it must be something more than a shed and stalls. It must have good equipment and fixtures and the laws of sanitation must be observed to the letter.

The stable with four or six stalls is of good size. Two of them should be for stalls, or spaces convertible into box-stalls. If we are to keep down the odors, the floor, walls and ceiling should be of impervious materials. A waiscoting six feet high of glazed brick, with plaster above, makes a good wall. The ceiling may be plastered and paneled with cross beams. A concrete floor with a finishing coat of rich cement slightly roughened with a broom when still soft makes an impervious surface that may be washed down with the hose, yet not slippery. Before the concrete is laid where the stalls are to be, the stall drains should be put in so that the iron plates over the drains will come flush with the floor when finished.

The floor of the stalls may be sloped and grooved so that the fluids may be removed quickly by gravity to a drain just behind the animals or an additional drain may be put in running crosswise of the stalls just in front of the hind feet, connecting at the end of the range of stalls with the main drain. Another form of drain is a branch from about the center of the stall to the main drain at the rear of the animal. This compels the animal to stand on the iron cover of the drain much of the time. The stable drains should be accessible throughout their length so that they may be flushed frequently. The removable covers have perforations sufficient to allow the entrance of fluid and by the free use of water all waste may be driven to the sewer or drain outside the building. Such drains and gratings are purchasable from various concerns engaged in supplying stable fittings. The main purpose to be kept in mind is so to construct the floor and its system of drainage as to prevent the contact of the fluids with absorbent materials. For this reason common brick do not seem to be a suitable material for stable floors. Good cement is cheaper and more easily laid and offers the advantage of a continuous and impermeable surface.

The prevention of the breeding of flies in the manure and waste is one of the objects of good stable construction and so is the prompt and proper care of the fluids and droppings. The stable should be well screened with brass wire-cloth screens. The ammonia arising from stable waste will cause iron wire-cloth to rust rapidly. The manure heaps that are not effectively covered and screened and the open garbage cans and heaps are the principal sources of those summer pests, the house and stable fly. The presence of flies in annoying numbers is due to carelessness and neglect. It ought not to be necessary to have special ordinances compelling stable owners to screen all manure pits and to drain their stables and keep them well ventilated and in a fresh and sweet condition. But we shall not be even partially rid of the fly nuisance without stringent laws rigidly enforced.

While the manure pit should be of ample dimensions, securely covered and ventilated through brass wire-cloth screens, the manure, especially in summer, should be removed frequently. The pit should be large enough for a man to work in handily when removing the contents. If the floor of the pit may be as high as the top of a wagon box, or even higher, it will facilitate the removal of the manure. Such an arrangement may be planned easily when the stable is built on sloping ground. Again, the stable drain may discharge into the manure pit if it is desired to save all stable refuse for fertilizing purposes. In such case, and preferably in all cases, the floor of the manure pit should be water-tight so that the fluids may be soaked up by the drier contents of the pit.

In good construction the mangers and water pots as well as the hay racks are of metal. They may be kept cleaner than wood and are practically indestructible. They are far less likely to communicate disease than the wood mangers, if it happens that other animals are temporarily placed in the stalls. For farm purposes the use of metal feed troughs and mangers is becoming common, perhaps on account of economy as much as because of sanitary consideration.

In the city stable, with its few animals and abundant help, the question of convenient location for the provender room is not considered. Hay is bought in the form of bales and the oats a small quantity at a time. Where there are many animals and few hands must do much work it is desirable to have an alley from which all mangers and hay racks are accessible. The feed may then be distributed rapidly. Where the hay and grain bins are on the second floor a chute to each manger is found convenient, and one from each grain bin to the first floor makes the grain supply always convenient. It scarcely need be said that the grain bins should be of metal or lined with tin or sheet iron to keep out the mice, which are an inevitable pest always to be provided against.

One may go as elaborately into stable equipment as his means will allow, or he may plan a simple and comparatively inexpensive stable, yet free from the usual objections if the essentials already noted are provided.

The stalls may be divided by handsome partitions of varnished wood in natural colors with wrought iron or cast iron grill above. Iron terminal posts at the ends of the stall partitions may be had in various ornamental styles or plain patterns. A particularly fine stall has a solid porcelain manger worth $20 to $30. Others are lined with white enamel. Wrought iron and cast iron hay racks made to fit a corner or the flat wall are so constructed as to prevent waste of hay. Box stalls may be fitted with sliding or swing doors with fancy hardware trimmings. Watering troughs are made of solid porcelain, iron with vitreous enamel and galvanized iron. Sinks for washing harness are made of the same materials. Watering troughs are fitted with protected ball cocks so that they may refill as fast as the water is used.

The harness room should be of ample size. Something more than a mere closet is desired, where all the harness may be kept and the room separately locked. A special table or "horse" is manufactured for use in cleaning harness. The place for this is in the harness room. Various devices are also made which may be suspended from the ceiling to facilitate cleaning. The room may contain also a cabinet for the various medicines, soaps and small supplies of the stable. The room should have proper hooks and racks upon which appliances may be kept without losing shape. These may be had in the exact forms wanted. Covers should be provided for the best harness and there should be plenty of rails on which the folded blankets and robes may be kept.

An orderly stable even if not an expensive one is desirable, yet the tendency generally is toward disorder and carelessness in respect of things about this part of the premises. If a place is provided for the necessary things there will be a better regard for tidiness and the better care of the horse furnishings as well as of the animals themselves. Brooms, shovels, forks, whips, saddles, girths, yokes, poles and shafts all should have their proper hooks, racks or other supports. Pails should have a special bench and grain measures and baskets may be placed in wall holders near the chutes. Wheeled racks are very convenient to receive the harness from the horses, thence to be rolled to the harness room. It is a simple contrivance, saves walking and also saves the harness. Other conveniences are sponge racks, soap boxes, chamois boxes, brush boxes, salt boxes, manure cans of galvanized iron, doing away with the necessity for a manure pit. A metal feed car on two wheels to take the feed from the provender room to the stalls is another labor-saving device.

Carriage jacks are quite a necessity and they are made in dozens of styles. Where a special wash-room is provided for carriages a jack which lifts the entire vehicle off the floor at once is not only convenient but saves much time. Another feature of the washing-room is a hose swinging from a pivot in the ceiling. This arrangement requires only a short length of hose which may be swung quickly to any point around the vehicle. It is quite desirable to have the water tempered at times in the stable. This result may be secured by having the carriage washing-room warmed by a coal-burning water-heater attached to a range boiler of large capacity. Unless other means of heating are provided it will be necessary to keep a continuous fire in the heater during the cold weather.

It is not desirable to have many doors to a stable on account of drafts. A low temperature is best for all animals, but while at rest they need to be protected from direct drafts. On the other hand the stable should have good ventilation both summer and winter. Fresh, clean air is quite as necessary to the well-being of domestic animals as for the human family. Two or three ventilator shafts taking the air from the upper part of the stable-room will be most effective. If a warm chimney flue connection can be made the ventilation outlets may be placed near the floor, the warmth of the chimney keeping the air in motion.

Fixtures are available for use in grain chutes, such as the cut-off and measuring devices. Others contain a device for cleaning the oats as they fall from the bin. Where a chute is used the bottom of the bin should be hopper-shaped so that old stock may not lie too long in the corners.

A very strong wooden tub for washing and soaking the feet of horses is another one of the stable necessities. These tubs are made preferably with brass or bronze hoops and handles, and though rather more expensive, they have lasting qualities that compensate for the extra cost.

The carriage door casings and exposed corners of buildings always should be protected by wheel guards. These guards may consist of curved rods placed obliquely against the building or casing and imbedded in the ground or may be solid castings in plain or ornamental designs.

Where hot water or steam heat is used in the house, the stable often may be heated from that source, having pipe and radiator connections the same as for the house. Usually the location of the stable is beyond the effective range of the house hot-air furnace and such a connection would in any event be undesirable, owing to the likelihood frequently of a back-draft from stable to house. A small, independent hot-air furnace may be installed in the stable basement or upon the main floor for the protection of the plumbing to heat the few rooms in the stable occupied by employees.

The plumbing of the stable needs to be done with the same care as that in the house. All fixtures should be of the best character installed according to latest practice. All connections need to be safely trapped and ventilated. The stable drain when connected with the sewer should lead first to an open receiving basin with proper screen and trap where straw and other coarse particles may be arrested and removed. This permits the flushing of open drains and the basin and the prevention of accumulations of filth at any point.

Where a coachman is employed there should be no lack of provision for his comfort and convenience. If a single man, he may be accommodated in a suite of rooms on the second floor of the stable over the harness or carriage room. Here should be a small sitting room, bedroom, bathroom and a commodious closet for his livery and other belongings.

If the man to be employed as coachman is a married man, the quarters should include the usual accommodations of a small and complete cottage with three or four rooms on the ground floor. The forerunner of good service is ample provision for the coachman's well-being in all particulars. He may then respond to his duties with facility, correct in his dress and immaculate in his neatness. A slovenly coachman is not wanted by anyone, but often it is not entirely the coachman's fault if his equipment is rusty and his appearance against him.

Before the plans for a stable are made it will save much time if the catalogues of various firms which supply stable fittings are consulted. New ideas are constantly being evolved and they come to the attention of the public through the advertising of the houses producing them. This advertising literature is of the greatest value, showing what is the best practice and having many suggestions that can be secured in no other way. The inventions and appliances that have stood the test of years are spread before the eye in these catalogue pages and in a few moments the interested person may sweep through the stages of progress in stable construction and equipment and take his pick among the things that today are considered best.

A special line of hardware for the stable is now manufactured, in response to a demand that could not be ignored. Correct knowledge of what is available will bring the most satisfactory result in the finished stable.

Chapter XVIII.

ELECTRICITY IN THE MODERN HOME.

Reasonable cost. Kitchen and dining room appliances. Sewing room motors. Electricity in the sleeping room. Electrically heated coverlets, carpets, rugs, and lounging robes.

THE modern home is not complete unless it is wired throughout for electric current, as there are no labor saving devices of greater importance than those of the home which are now available operated by electric current. Provision should be made for electric lights with convenient receptacles for heating devices and electric motors to be used on the electric lighting circuits. The price of electric current in the home is being reduced by electric companies throughout the United States. At Schenectady electric current is sold for cooking, baking and ironing at the rate of 5 cents per kilowat. At Buffalo the current for lighting has been reduced to 9 cents at a maximum and this price will undoubtedly be lowered in the near future by popular demand and a 4 or 5 cents rate made for electric cooking and heating devices as well as for the operation of motors during the day time. While these places have hydro-electric power, Schenectady from the Spiers Falls water power plant and Buffalo from the Niagara power house, and the prices of current have been somewhat reduced, still lower rates are looked for and will be demanded by the public, and wherever current can be obtained at low prices during the daytime for heating and power load electric current can be utilized in the homes to special advantage. In these and other cities it will be found that fewer residences are lighted by electricity than in many country towns, and the contractors, builders, house owners, and electric companies should awaken to the fact that the people are demanding greater conveniences in their homes and it is time to meet these demands obtaining profit thereby.

In the dining room electric outlets are provided for using the electric chafing dish, the coffee percolator and the water heater, and in the kitchen electric cooking apparatus, electric knife sharpeners and coffee grinders can be employed to advantage. In the laundry the electric flat iron is available and electric washing machine motor does its work with rapidity and satisfaction. These electric labor saving devices greatly lighten the work of the housewife and the domestics. In the den and on the piazza outlets are provided for electric cigar lighters and in the bath room electric water heaters are possible as well as the heating bath, the massage motor, and the electric shaving cup.

In the sewing room the electric sewing machine motor furnishes the necessary power, and for pressing the newly made garments a small electric flat iron is to be had.

In the bed chambers electric outlets are provided for electric heating bath, electric curling iron and milk warmers, while throughout the entire home electric lights are well arranged and electric heating devices, electric radiators of various types and electric fans are employed, the radiators being of the luminous type.

Many modern conveniences are now made for the home provided with cheap electric current such as the immersion heater and electric wash boiler in the laundry, electric ovens, pancake griddles and broilers in the kitchen.

It is well known that electricity, the transmitting agent of power and light, is also an excellent conductor of heat. By causing a certain density of current to pass through a conductor of determined resistance the energy contained in the electric current can be almost completely transformed into heat.

It will be noted that this action is of immediate effect from the beginning to the end; further it produces neither smoke nor combustion, consequently there is no disengagement of gaseous products, either injurious or troublesome. Finally by observing very simple rules regulating the value of the current to be employed, the regulation of the disengagement of heat can be effected with astonishing facility without risk of bringing about the incandescence of the conductor or any danger of fire.

These special properties have been utilized for electric heating for a long time, but it has not yet been applied largely to domestic uses in the most practical and economical way.

Metallic webs forming rheostats have been manufactured and asbestos fabrics used for heating; but such fabrics were intended particularly for high temperatures by radiation and their employment was necessarily limited; first they were not very well constructed and were wanting in flexibility. Such heating could admit only of certain applications but could not be introduced into modern houses in a practical manner.

The French thermopile fabrics, it is maintained, are constructed with special processes of manufacture and very simple precautions are taken to avoid a too great heating of the conducting wires and to avoid running risk of deteriorating such fabrics intended for warming at mild temperatures and particularly by contact.

In order to succeed in giving these fabrics great flexibility and suppleness it was necessary in the first instance to have a textile and conducting thread which was suitable for all fabrics and for all weaving looms.

It is claimed that this French electro-thermic thread is a filament built up in such a manner that its textile part alone serves for traction when stretched, and that its conducting part is subject to no tension and presents a large heating surface in proportion to its small section. This thread is very supple, does not buckle in weaving and can be made in all sizes and with all textile materials according to the use for which it is designed in all kinds of fabrics of hemp, cotton, wool, silk; heavy fabrics and light fabrics.

It is held that such thermopile fabrics also preserve first their ordinary manufacture and then all their appearance and all their usual suppleness; lastly they can be applied to all the uses of all similar fabrics but have the additional property of heating.

The French thermopile fabrics are electrically auto-resistant exactly like an incandescent lamp; consequently, as they are employed under a determined electric tension, they can, when entirely spread out, only give the uniform temperature for which they have been made and that without any abnormal heating or dangerous electric current.

The woven electro-thermic threads are, it is stated, sufficiently fine to become their own cut outs in case of manifest imprudence, and the thermopile fabrics are regulated to avoid any short circuiting in their use.

The great number of electric thermic wefts composing in circuit permits of having between two neighboring wefts a difference of potential of only from half a volt to one volt at the most. Further, in the case of multiple circuits, their various units receive the current by collector wires specially insulated and placed with a single pole in each selvage of the fabric. Finally the various circuits of the same fabric are branched in weaving in such a manner that the difference in potential is nil between the neighboring wefts of two successive circuits. There is therefore every security against short circuits and to such a point that these fabrics may be wetted and then caused to dry by the current itself, thereby permitting all humid applications.

All danger is therefore absolutely removed, and there only remains possible the stoppage of the current, of which the causes of breakage have been reduced to a minimum. First, the electro-thermic wires are perfectly buried and almost invisible in a thermopile fabric; they are so completely imprisoned in it that they remain intact in spite of the manipulations to which it is subjected, then these special wires never reach quite to the edges of the fabric; they stop short at a suitable distance and they are absolutely protected so that they cannot be affected by wear.

It is claimed that in this way the electro-thermic threads leave the space for the insulated collector wires of the various circuits and also permit the invisible and easy mending of a weft accidentally broken. It can be readily found and the circuit can be very rapidly closed again.

At the selvage the collector wires can be provided with or without an external rheostat in order to couple at will multiple circuits for the purpose of obtaining various desired temperatures; in any case these thermopile fabrics demand in their management only the most simple and elementary precautions.

The hygienic applications include electric carpets, coverings, coverlets, and knitted fabrics.

It will be noted that the heating furnished by the electric thermopile realizes a considerable progress over all systems of heating heretofore used. Such heating can be obtained wherever the electric current is already used for lighting, by means of carpets, coverings, coverlets, and lace fabrics which by their suppleness, elegance, comfort, are adapted to all the exigencies of the most luxurious modern installations.

In the house it is the least cumbersome, as a supple wire, an electric coupling, with suitable switches, and fusible plug, are sufficient to convey, with security, the current to the thermopile.

In the bed room it is the cleanest method of heating, in fact, it creates neither dust, nor odor, requires neither reservoir nor fuel. The carpet is a necessary element in the most simple furnishing and it harmonizes with the business office as also with the elegance of the most luxurious saloon.

In the dining room or parlor it is least dangerous; it presents no danger of fire or of accident when the fitting, which is very simple, is undertaken by a competent person; it cannot give a greater heat than that for which it has been arranged, provided that when in use it is completely spread out in the free air and is working at the tension arranged.

As a covering it is claimed also to be most hygienic, it disengages neither smoke nor gas and borrows no element from the atmosphere more than does an incandescent lamp; it produces no electric action. It warms persons and even the air by contact. The thermopile carpet creates the real heat-syphon of the atmosphere, it warms the body, giving a mild and absolutely uniform temperature and finally realizes in the purest air a cool head and warm feet, the acme of hygiene.

As to the cost of operation it is most economic if it is duly considered that it affords heat over large surfaces and that it instantaneously transforms into heat all the electricity it receives; so soon as it is placed in circuit at the exact moment of its use and all is finished as soon as the current is broken. It therefore does not give rise to any lost heat.

It is held that the electric thermopile by all its advantages of comfort and hygiene offers the ideal of domestic warming in its numerous applications of soft carpets of all dimensions, as foot warmers and oriental carpets. The Oriental Gobelin is woven with electro thermic threads and most beautiful colorings. It offers supple and light coverings for lounging chairs, instantaneous bed warmers, elegant counterpanes of great luxury, in which warmth is obtained at will and very simply.

It is stated that all kinds of material can be employed in the manufacture and covering of thermopile fabrics, in order to permit of the most perfect applications in our most modern residences.

The electric thermopile is made generally so as to give 85° to 95° F. for carpets, and 70° to 80° F. for coverlets in ordinary temperatures. It can be made for all temperatures, but those mentioned are the most agreeable in order to avoid being inconvenienced by too great a heat; if these temperatures appear low at first and particularly to the simple touch, their use for some minutes is sufficient to fully demonstrate that these temperatures are satisfactory and comfortable.

For medical purposes the backs of chairs or shawls of knitted electric thermic threads are very practical for warming the arms, back and loins of rheumatic subjects.

The mean consumption of electricity by the thermopile is as follows, degrees Fahrenheit above the surrounding temperature being given in dry, calm air and by square meter of thermopile:

Oriental Gobelin moquette carpets in offices and private rooms give 45° F. per hectowatt or 4 hectowatts for 85° to 95° F. The double thick fabrics such as carpets, incubators and filters give heat of 50° F. per hectowatt or 3 hectowatts for 75° to 85° when bare, and when covered 60° F. per hectowatt or 2 hectowatts for 75° to 85°. The simple light fabrics such as coverlets, compresses when bare, give heat 50° F. per hectowatt or 2 hectowatts for 65° to 75° F. and when covered 70° F. per hectowatt or 1 hectowatt for 65° to 75°.