THE HOUSE OWNER'S BOOK

CHURCHILL
—
WICKENDEN


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THE HOUSE-OWNER'S BOOK

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A MANUAL FOR THE HELPFUL GUIDANCE OF THOSE WHO ARE INTERESTED IN THE BUILDING OR CONDUCT OF HOMES

ILLUSTRATED WITH CUTS AND DIAGRAMS

BY

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INTRODUCTION

"The Owned Home," say the real estate advertisements, "is the Happy Home"; so that, in view of the recent remarkable increase in the number of home-owners, this country should be a happier place than it was ten years ago, assuming, of course, that the real estate advertisement is true. And it should be true. To own a home should be a joyous thing. A home should be something more than a shelter on which one pays taxes instead of rent. It should be a pride, a consolation and, above all, a hobby.

But before a man can have any pride in his house, he must know that there is some real basis for his pride, and if pride is missing, how can there be consolation? To make your home your hobby, you must live not only in it, but with it. You must know its weaknesses as well as its strength, you must familiarize yourself with its secret and inmost parts, you must know the why and the wherefore of its little idiosyncrasies and love it the better for knowing them.

How many house-owners really know their own homes? How many can tell of what wood it is built, whether the water pipes are of galvanized iron, black iron or brass, how much load it is safe to put on any particular electric circuit, how much paint will be required to cover the outside trim? How many bought the house because they knew it was well built of good materials, and how many because they liked the location; or because the big closets pleased their wives; or (alas! in how many cases, in these days) because it was the only one available at a possible price, and a man must have somewhere to live?

This book aims to help you, whether you are building or buying, to do so intelligently and with knowledge of what you are doing; or, having built or bought, to show you how to keep your house in repair; to make it as comfortable and convenient as conditions will permit, and perhaps, above all, to familiarize you with its many details. "To know all is to forgive all," says the old French proverb, and while the jerry-builder or the unscrupulous plumber do not deserve to be forgiven, it will help you to overlook some of the shortcomings of your home if you understand the limitations within which the builder had to do his job.

The writers of the *House-Owner's Book* are not architects, builders, carpenters, plumbers, or practitioners of any of the other honorable trades and professions related to the building and equipment of houses. They are house-owners. The book which they have written is intended for fellow house-owners. In it are embodied the joint results of their experiences of years in the business, science, or art of house-owning. An architect, a builder, a carpenter, a plumber might have (and perhaps has) written a wiser or more profound book, but the writers like to believe that their book will be more useful to the house-owner than works written by experts in these trades and professions.

For it can not be disputed that it is difficult for the expert to write for the layman. The expert takes for granted many things which the layman perhaps ought to, but does not, know. It is difficult for him to get down to the level of the ignorance, or (as he might put it) the stupidity, of the man who has not acquired the fundamentals of his profession or trade. The writers, being as ignorant (or as stupid) as any, when they started their business of house-owning, have learned some things, and these are the facts which the *House-Owner's Book* tries to tell in a plain and practical way.

The writers are not owners of estates or "places." They are owners of houses, and while there is much information of value to the owner of the estate or "place" in these pages, they are written chiefly for the house-owner who, from necessity or choice, prefers to run his own house, to tinker about, to make minor repairs; in short, to be a real house-owner.

There is no intention of driving the builder, carpenter, plumber or painter out of .business. The house-owner will learn quickly the limit of his capacity and will not undertake, for a second time at least, jobs which cal' for expert skill and judgment.

Not all the information contained in the *House-Owner's Book* is the result of experience. Much has been taken from authorities on the subjects treated, from government publications, and, in the case of new devices and appliances, from the catalogs of manufacturers. No possible source has been neglected, and whatever shortcomings it may have, it may claim to be accurate and trustworthy where these qualities are essential.

Those departments of household equipment and management which are essentially feminine are not dealt with in the *House-Owner's Book*. Thus the broad fields of kitchen economics and interior decoration are left to others, partly because the writers lack both qualification and presumption, and partly for the reason that the ground is already more than amply covered.

The *House-Owner's Book* is, so far as careful search has disclosed, the only recent volume which attempts to include about everything that the average house-owner would want to know. It has been the aim of the writers to give the information plainly and yet concisely, and to make the book of the greatest possible practical value. The measure of their success will be the extent to which this purpose has been accomplished.

ACKNOWLEDGMENTS

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and to the Cement Products Co. for an illustration of a patent septic tank.

The drawing of the well on page 227 is adapted from a report of the Chelmsford (Eng.) Rural District Council, and reproduced in *The Examination of Water and Water Supplies* by J. C. Thresh.

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ON OWNING A HOME

The desire to have a home of one's own sooner or later probably comes to every normal man or woman. For the home is the foundation of family life and traditions. With many, however, the aspiration remains only an ideal. In some cases this is the fault of circumstances which can not be overcome, but in many other cases it is the result of a mistaken idea that the building of a home is beyond the possibilities of the average salary or wage earner.

A Financial Asset. The practical advantages of owning one's home have become sharply apparent as a result of the housing crisis which resulted from and followed conditions arising from the World War. It has long been a mooted question whether or not it was more profitable to own or to rent houses. Much time and calculation have been given to prove that in the long run it is cheaper to rent than to buy or build. When rents began to go skyward, following the war, this question ceased to be academic, and there were few among those to whom the ever-increasing rents became a nightmare who would not agree that it is not only more profitable but more comfortable to own one's home.

It is true, of course, that building costs went up proportionately with rent charges. But even taking this into consideration, the carrying charges for a house of one's own are likely to be less than charges for rent, while they have the advantage of stability. No one is gifted with sufficient imagination to know what his rent will be the next year, but the charges for interest on mortgages, taxes, insurance and the like will deviate little, if at all, from year to year.

Aside from the practical value of having one's home, there are sentimental values which are not less important. It makes better men and women and better citizens. The home feeling is an asset of the highest possible value. It results in a sense of self-respect, of more responsible citizenship and of moral poise as a member of a community. The man who owns a home becomes a member of a neighborhood or community, and is regarded with more respect than is the so-called "floater."

Altho the man of practical vision will hope and expect that his house will remain a financial asset, it should be regarded not so much in terms of possible profit or loss. There are on the practical side, however, striking advantages to the house-owner. When one pays rent one pays for that in which he has no ownership. He is entirely dependent upon the landlord for necessary changes or additions. While the landlord may be reasonable, again he may not. In either case, it is he and not the tenant who decides on what shall be done in the way of living comfort, convenience, and the welfare of the tenant and his family.

If the money paid out for rent were applied to paying for a home, one becomes his own landlord and acquires property rights of which he can not be dispossessed. Whatever changes or additions are necessary can be made in accordance with the house-owner's own decision or wishes. If the necessity arises, the house becomes an asset on which money can be obtained.

The "Own Your Own Home" campaigns, inaugurated by the Government and encouraged by various organizations throughout the country, have, in the years following the World War, greatly stimulated home building. Many persons, who otherwise had not considered the possibility of owning a home, have had their attention directed to ways and means of bringing this about and have discovered that it is far less difficult or mysterious than they had thought.

Problems of Financing. Of course, the problems of financing the building or buying of a house are not acute if one is fortunate enough to have sufficient capital with which to carry on and complete the operation. Most of us, unfortunately, are not thus situated, and it is for such to consider methods by which a house may be purchased or built with the least possible expenditure of our own money.

There are at present two general methods by which money can be obtained for financing the building of a home. It can be borrowed from institutions or individuals who deal in mortgages, or obtained by becoming a member of a building and loan association. In many cities "Own Your Own Home" associations have been organized by real estate operators, material builders, and others interested in stimulating the development of the community. These associations usually offer very liberal terms to builders. The basis on which loans are made by these agencies is the value of the lot on which the house is to be built, plus the cost of the house. The specific methods employed, the interest rates, and the laws governing such loans vary in different communities, but the general principles are the same everywhere. Usually, it is possible to borrow from these associations from 60 to 80 per cent of the value of the house and lot combined.

What is the best method in individual cases depends entirely on circumstances. If the prospective builder has funds available which are equivalent to one-half the cost of the lot and buildings, he can usually obtain the remainder from a bank, a title, trust, or mortgage company, or from an individual who invests in mortgages. The security given will be a first mortgage on his property. It is always well to consider that mortgages must be renewed from time to time, and it is, therefore, advisable to know in advance what the lender's attitude is toward a renewal. First mortgages are sometimes made on an annual basis, but more often on a three-year basis, that is, at the expiration of one year or three the payment of the full sum is due, and it must either be paid or arrangements made for its renewal. There is no fixed rule as to the time in which the mortgage must be redeemed, but it is usually stipulated by the lender that at least one-fourth of the loan must be repaid within five years. In case the prospective builder's funds do not amount to half his building investment, it is often possible to secure, in addition to the first mortgage covering half the value of the property, a second mortgage loan for the difference. Banks and other financial institutions which deal in first mortgages customarily do not handle second mortgages, but in nearly every community there will be found reliable institutions and individuals who do this, and in many cases contractors who build houses will take a second mortgage in part payment for their services.

In most cases second mortgages run for a shorter time than first mortgages and usually require monthly payments both on principal and interest.

Building and Loan Associations. If the prospective builder is not so fortunate as to have accumulated capital, the building and loan association offers the quickest and safest plan. In order to participate in the benefits of these associations, one must become a member, as they are operated by and for members only. Membership consists in purchasing shares in the association, as many or as few as are desired, which may be paid for in monthly instalments of 50 cents or more per share. These payments participate in the profit of the association, which are compounded quarterly. When sufficient stock has been paid up by the accumulation of payments and accrued profits, the member may obtain a loan by assigning the paid-up stock to the association, and by giving to it a first mortgage for the difference between the value of his paid-up stock and the total sum of which he is in need. The amount required to be paid up varies in different States from 20 per cent to 35 per cent of the total value of the house and lot. Having reached this stage, the borrower is required to pay: first, monthly instalments to complete the payment for the remaining shares for which he has subscribed; second, monthly interest instalments on his loan; and third, monthly instalments on his loan equal to his interest payments. When the payments on his shares, plus their interest earnings and on his loan equal the amount of the loan, the borrower surrenders his share to the association and all indebtedness against him is canceled. Under this plan, the monthly instalments extend over a period of from ten to twenty years and it is claimed that the borrower actually obtains the money for his building at about 4½ per cent interest. In most cities where "Own Your Own Home" campaigns have been financed by real estate builders or others, the home-builder is required to have in cash 20 per cent of the amount needed. A mortgage is taken for the remaining 80 per cent and this is paid off in regular monthly instalments of principal and interest. The total monthly payment is usually 1 per cent of the total investment. Thus, on a house costing $5,000, a monthly payment of $50 would be required.

Precautions. It is a safe plan to follow that one should not pay out money, or enter into a contract, for the purchase of property or the building of a home without proper legal advice. This advice should be secured at the beginning and not after one has been committed by contract or otherwise. The contract with the builder should be carefully scrutinized by a lawyer, in order to avoid misunderstanding and difficulties and to make sure that one's rights and interests are fully protected. Proper care taken in these measures, before one has committed oneself to any obligation, may be the means of saving substantial expense or a large loss at a later date. If every purchaser and builder of a home would proceed with ordinary care and with regard to these various considerations, there would be very much less misunderstanding, loss, and legal controversy, and all parties concerned, including the purchaser, the seller, the lender and the contractor, would experience less difficulty and be better satisfied.

CHAPTER II

MATERIALS

Wood

It is an unfortunate fact that wood, which always has been, and probably always will be, the most commonly used structural material, is the one regarding which exact knowledge is the most difficult to obtain. In fact, the many authorities on the subject are, as a rule, so discouraging, and their treatises are so voluminous and complicated, that the ordinary man who wishes to learn something of the subject, but is not prepared to make the study a life-work, is apt to abandon his investigation in despair almost before it has begun. In these pages an attempt will be made to select such information as the house-owner most desires, and to present that information in such a manner that, without making him a timber expert, it will enable him to discuss the choice of lumber with his builder or carpenter, or to select the right type of wood for any minor construction work which he may, himself, wish to undertake.

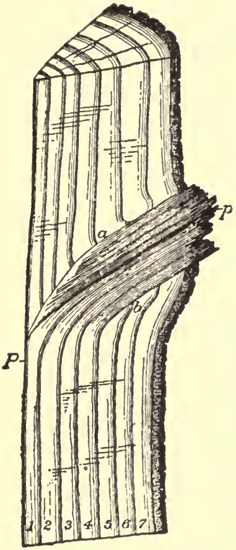
First, let us courageously face the difficulties underlying the subject. The fundamental trouble is that wood is a natural product, and the efficiency experts have not yet succeeded in persuading Nature to turn out her products according to specifications. In other words, no two trees are identical, even when they belong to the same species. This renders it impossible to say that always, under all circumstances, one kind of wood will be superior to another for any particular purpose. It may well happen that a good sample of an inferior species will be greatly preferable to a poor sample of a superior species. You will find, therefore, that when you begin to question an expert lumberman as to the best species to use for this or that purpose, he will promptly (and quite rightly) begin to "hedge," and the greater his knowledge the more he will hedge.

For the second great difficulty, Nature is once again responsible. She has lavished too many varieties of trees on this favored land! In Europe, the varieties of wood used in building are comparatively few and their identification is proportionately easy. But in America, the different kinds of wood are so numerous that their exact identification becomes almost impossible, even to the man who is handling lumber every day of his life. There are, for instance, eight or more varieties of pine, and as many different kinds of oak and hickory. All these differ in their properties, yet to distinguish one from another is often difficult for the expert and utterly impossible for the amateur.

The responsibility for the third great difficulty rests equally upon man and Nature. All those who handle lumber, whether it be for building purposes, for paper manufacture, or for any other use, divide wood into two great classes: hardwoods and softwoods. (Outside these two classes are the yuccas and palms, which are of minor importance.) Unfortunately these terms are misleading, for the simple reason that some softwoods are harder than some hardwoods, and some hardwoods are as soft as the softest softwoods. Because of this anomaly, it has been suggested that the so-called "hardwoods" should be renamed "deciduous woods" (that is, wood from trees which shed their leaves in winter) and the softwoods "evergreen woods." But here Nature steps in, and once again confuses what is already confused enough. A tree which is deciduous in the region, let us say, of New York, becomes evergreen in a warmer climate, and, moreover, some softwoods are not evergreen! A third suggestion, that the hardwoods and softwoods should be classed as "broad-leaved" and coniferous," is, perhaps, a little better, but even this will not quite do, for there are "conifers" which are broad-leaved and bear no cones!

It is at this point that the enquiring house-owner begins to feel that there are subjects which the ordinary man, who wishes to retain his sanity, had better leave alone. It is time, therefore, to state that all these difficulties can, to a great extent, be ignored. It is true that wood of the same species differs greatly in character, but it is also true that there are certain good and bad features common to all varieties, and the recognition of these features is easily learned by any man sufficiently interested to make the slight effort required. Similarly, the exact identification of every variety of wood may be a practical impossibility, but any man, who so wishes, can learn to distinguish many of the commoner woods, and can familiarize himself with the special properties of the types of lumber used in the construction and furnishing of his house. And, finally, altho it is dangerous to place too literal an interpretation on the terms "hardwood" and "softwood," yet it is pretty generally understood that by "softwoods" are meant the pines, firs, cedars and trees of that character, while "hardwoods" include oak, cherry, gum, ash, walnut, and the broad-leaved trees generally. The classification will cause no confusion if it is remembered that the names refer to two classes of trees having different habits of growth, rather than to two classes of wood possessing different degrees of hardness.

Having cleared the ground by cutting away



Section of wood showing position of the grain at base of a limb. *P*, pith of both stem and limb; 1-7, seven yearly layers of wood; *a. b*, knot or basal part of a limb which lived four years, then died and broke off near the stem, leaving the part to the left of *a. b*, a "sound" knot, the part to the right a "dead" knot, which would soon be entirely covered by the growing stem.

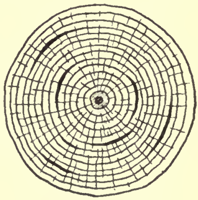
the superfluous, let us first consider what the user of lumber should look for in purchasing his supplies. The simplest and most logical way of dealing with this question will be to describe the chief defects likely to occur in wood. In purchasing lumber, look for these defects. If you find them present to any marked degree, you will be well advised not to buy at any price.

Common Defects in Lumber. Lumber, like men, is subject both to diseases and to malformation. The diseases may have been present in the tree or may have developed in the wood after it was cut. Serious malformations originate in the tree, altho minor malformations may develop through improper handling of the wood. The commonest defects which affect the strength and durability of lumber are the following:

(1) *Knots.* Knots are found where branches join the main trunk of the tree. It sometimes

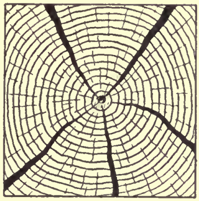
happens that a branch will be broken off when the tree is still young, and the stub, left on the tree, will die. As the tree continues its growth, this dead stub becomes covered with new wood, and a "dead" or "loose" knot is produced. These knots have no connection with the sound wood by which they are surrounded, and frequently, when the log is sawed, they fall out, leaving a hole. By some carpenters, the term "knot" is restricted to these dead knots, while others include sound knots as well. Both sound and dead knots lessen the strength of a beam, but dead knots are a worse defect than sound knots. Where one side of a beam is more knotted than another, the knotty side should be placed uppermost, as the weakening effect is more marked when the beam is under tension than when it is under compression.


Heartshake


Windshake

(2) *Shakes.* Shakes are of three kinds: heartshake, windshake and starshake. *Heartshake* is caused by the rotting of the heart of the tree, thus producing a cavity which spreads outward in the form of radial cracks to the bark of the tree. *Windshakes,* sometimes known as *cupshakes,* are believed to be caused by the bending to which the

tree is subjected by strong winds, altho this theory is questioned by some. In this case, cavities are not radial, but follow the lines of the annual rings. *Starshake* is similar to heartshake, but there is no rotting of the heart. It is usually possible to discard that part of the tree affected by shakes, and from the rest of it to cut perfectly sound lumber. Shakes seldom appear, therefore, in finished lumber.


Starshake

(3) *Checks* are formed during the drying or seasoning of lumber, and are due to unequal shrinking of the cells of which the wood is composed. This unequal shrinkage causes the wood to split and checks appear in lumber as cracks along the face of the wood. They seriously affect the strength of lumber.

(4) *Warping.* Warping is also caused by unequal shrinking, or sometimes by the swelling of one side of a board, due to the absorption of moisture. It is scarcely necessary to issue a warning against the purchase of lumber having such an obvious and familiar defect, but there is danger that a board may appear perfectly straight and flat when purchased, but may warp after it is in place. Such warping is generally an indication of improper drying or seasoning, but before blaming the lumberman it is well to ascertain that the board is

not subject to unusually moist or unusually dry conditions. Wood used in interior work in dwellings, particularly in regions where steam or hot-water systems are used for heating, should always be properly kiln dried. Even then, it will not be absolutely bone-dry, but will contain from five to eight per cent of moisture. This is the ideal figure for water content. If the wood is dryer it will absorb moisture, and swell; if it is moister it will dry out and shrink. The percentage of moisture may be easily determined by cutting off a few pieces, weighing them carefully and then drying in an oven heated to about the boiling point of water. After drying for six hours the pieces should be weighed again, and the loss in weight will represent the amount of water which they originally held.

(5) *Rot.* Rot is of two kinds: wet rot and dry rot. Both are caused by fungi, and may be looked upon as diseases. The fungus begins its attack on the outside of the wood, and then spreads inward into the cells of which the wood is composed, throwing out a network of fine threads in every direction which convert the woody substance into soft food upon which they depend for growth. Wet rot attacks the living tree, and, therefore, need not concern us here, but dry rot attacks lumber and is the chief cause of the decay of all wooden structures. Altho it is known as "dry" rot, the fungus depends upon moisture for its growth, and an absolutely

dry piece of wood will never develop rot. The best condition for the production of dry rot is a warm moist atmosphere with no circulation of air. Temperatures over 150° F. kill the fungus, and properly seasoned lumber is far less liable to develop dry rot than green lumber. It is especially dangerous to paint imperfectly seasoned wood, because it contains amply sufficient moisture to promote fungus growth and the paint protects the fungus, rather than the wood, by preventing access of air and by retaining the moisture. Certain preservatives poison the fungus and prevent its growth, the most satisfactory being bichlorid of zinc or of mercury, and creosote. To avoid dry rot, therefore, the following precautions should be taken:

(1) Use only well-seasoned, preferably kiln-dried lumber;

(2) Prevent access of moisture by covering the wood, when dry, with paint, tar, varnish or other coatings;

(3) Where conditions are favorable to fungus growth, as, for instance, where wood is in contact with the ground, or with damp brick in concrete, preservatives should always be used.

Identification of Lumber. Enough has already been said to make it clear that the exact identification of different kinds of wood is no easy matter. But to familiarize oneself with the common woods used in building is by no means a formidable undertaking. There must be few men (or, for that matter, few women) who can not distinguish oak from white pine, and white pine from mahogany; and the recognition of gum, cedar, redwood, cypress, cherry, and birdseye maple is just as easy for those whose natural curiosity is sufficiently developed to give them a desire to investigate. By far the best method is to visit a friendly dealer in lumber and obtain from him small pieces of the various woods which he handles. Mark them clearly and compare them from time to time. Note their relative weight, their color, their odor, their texture, their hardness. If you accumulate your collection by degrees, so much the better. You will have time to become thoroughly familiar with your early specimens, and will more readily notice the special characteristics of the later ones.

You will possibly protest, with some justification, that the writer is trying to place the burden of your education upon yourself; or, in the vulgar, but perhaps, more expressive tongue, is "passing the buck." In order to do his share, therefore, he adds the following tables, with the warning that it is almost as easy to diagnose a disease with the help of "Every Man His Own Doctor," as it is to identify wood by means of a written description. The tables, however, may supplement your own discoveries in the same way that a medical text-book assists the budding doctor in his study of diseases.

TABLE 1

HARDWOODS

	Color	*Texture*	*Weight*	*Special Comments*
Ash	Yellowish to grayish brown	Coarse	Very heavy	Resembles oak in appearance, but is coarser. Used as a finishing wood when oak is too expensive
Basswood	White	Fine	Light	Soft. Similar to poplar
Beech	White or light brown	Coarse	Heavy or very heavy	Seldom used in building
Birch	Brown or red	Fine to medium	Medium to heavy	The sapwood is almost white. A handsome wood used for inside finish and as a substitute for cherry and mahogany
Cherry	Reddish brown or yellowish	Fine	Heavy	Chiefly used for finishing. Heartwood is reddish and sapwood yellowish
Chestnut	Dark brown	Coarse	Light	Grain somewhat resembles oak. Wood is much softer, lighter, and coarser in texture
Elm	Brown or reddish brown	Coarse to fine	Heavy	Seldom used in building. Very tough. Used for furniture
Gum	Reddish brown	Fine	Heavy	Lighter in color than cherry. Often has blackish streaks. Used for furniture and interior finish
Locust	Reddish brown	Medium	Very heavy	Hard and durable. Close grained
Maple	White to pale brown	Fine	Heavy	Used for floors and other interior finish
Oak	Straw to reddish	Coarse Uneven	Very heavy	Oaks are of two kinds—white and red. White oaks are more durable, but red are equally strong
Poplar, Yellow	White or yellowish white	Fine	Light or very light	Frequently has a satiny luster. Soft, used for shelving, doors, etc.
Sycamore	White	Coarse	Medium to heavy	Used for finishing. Frequently cross-grained
Walnut, Black	Rich dark brown	Coarse	Heavy	Seldom used nowadays. Occasionally used for furniture and cabinet work

Table 2

SOFTWOODS

	Color	*Texture*	*Weight*	*Special Comments*
Cedar	Grayish or reddish brown	Fine	Light to very light	White cedar is grayish brown, red cedar reddish brown. Spicy odor
Cypress	Grayish brown	Fine	Light	Resembles white cedar in appearance, but has no spicy odor
Fir	Yellowish white to pale brown	Medium	Very light	Resembles spruce, but is not as strong
Hemlock	Pale reddish brown	Medium to coarse	Light	Used for cheap framing and rough boarding
Larch (Tamarack)	Russet brown	Medium	Medium	Hard and strong
Pine, White	Yellowish	Medium	Very light	A very popular building wood. Straight grained. Soft
Pine, Yellow	Yellow	Medium	Medium to light	Many varieties. Harder, stronger and more resinous than white pine
Redwood	Dark reddish brown	Medium	Light	Resembles red cedar, but has no cedar odor or taste
Spruce	Yellowish white	Medium	Light to very light	Soft, moderately strong, compact in structure

In classifying the woods in the above tables with regard to their weight, the standards adopted have been those established by the United States Department of Agriculture: very heavy woods are those weighing from 42 to 48 pounds per cubic foot, heavy woods weigh from 36 to 42 pounds, woods of medium weight from 30 to 36 pounds, light woods from 24 to 30 pounds, and very light woods from 18 to 24 pounds.

The Kind of Wood to Use. Below is given a list of the principal uses to which wood is put in the construction and furnishing of the home, with the names of a few suitable woods for each particular purpose. These are offered as suggestions. It must not be thought that no other woods can be substituted for them. If, however, lumber of good quality, belonging to the species named, can be obtained, it will be found to give satisfactory service.

Light Framing. Spruce, white pine, yellow pine.

Beams and Girders. Yellow pine, oak, chestnut, cypress.

Siding and Exterior Finish. White pine, cypress, yellow pine, redwood.

Roof Boards and Sub-floors. The cheaper softwoods.

Shingles. Cedar, redwood, cypress.

Flooring. Oak, maple, yellow pine, fir and birch.

Doors. White pine, yellow pine, yellow poplar, cypress.

Window Frames. Cypress, fir, hemlock, white and yellow pine.

Interior Finish. Oak, maple, mahogany, redwood, gum, white pine, cherry, ash, birch, sycamore and others.

Cupboards. White and yellow pine, elm, hemlock, cypress, gum, and others.

Draining Boards. Elm and cypress.

Shelves. White and yellow pine, cypress, hemlock, gum, and others.

As a further guide to the choice of lumber, it may be stated that hardwoods are more liable to warp than softwoods, and it is well for this reason to avoid using them for doors, sash, window frames, and kitchen tables and utensils. For outside use, especially where the wood comes in contact with the ground, the more durable woods should, obviously, be selected, and in this connection, the following tables will be found helpful. They are taken from Circular No. 70 of the Bureau of Standards. They were prepared by Mr. Arthur Koehler, an expert in the Forest Service of the U. S. Department of Agriculture. Mr. Koehler offers the tables as an aid to the builder in selecting the more durable species for posts, sills, sidewalks and other structures subject to decay, but he is careful to add a word of warning. "It must be remembered," he writes, "that woods vary in dura-

Relative Durability of Common Woods

SOFTWOODS

Very Durable	Durable	Intermediate	Nondurable
Cedar, northern white Cedar, western red Cypress Redwood	Fir, Douglas Tamarack Larch, western Pine, longleaf Pine, eastern, white	Hemlock, eastern Hemlock, western Pine, loblolly Pine, Norway Pine, shortleaf Pine, sugar Pine, western white Pine, western yellow	Firs, true Spruces

HARDWOODS

Very Durable	Durable	Intermediate	Nondurable
Chestnut Walnut, black Locust, black	Cherry, black Oaks, white	Ash, white Butternut Gum, red Poplar, yellow Oaks, red	Basswood Beech Birch Buckeye Cottonwood Elm, white Maple, hard Maple, Oreg. Maple, soft Sycamore Cotton gum

bility as they do in other properties, and exceptions may be found which apparently are not consistent with this classification." In other words, the tables are intended only as a guide, and in choosing your lumber you must take into consideration the condition of the actual wood which you are offered.

Sawing and Quartering. The manner in which the stick is sawed from the tree has a remarkable influence upon its qualities and behavior, and it should, therefore, either be specially sawed or selected with a view to its character and to the purpose for which it is to be used. This is a matter fully appreciated among only a few wood-users, like the wheelwrights, piano makers, etc., but it needs to be observed much more than it is, even in building. Quarter or rift sawing, i.e., cutting sticks or boards out of the log in such a manner that the annual rings are cut through as nearly as possible radially, has lately been practised largely for the sake of the beauty of the even grain thus obtained, and also for flooring on account of the better wear which the even exposure of the grain (hard bands of summer wood on edge) secures; but it should be much more widely applied to secure greater strength and more uniform seasoning and thus to reduce to some extent the one drawback to wood as a material of construction, that is, its liability to "working" (shrinking and swelling).

Brick

You have noticed, no doubt, that there are bricks *and* bricks. There are perfectly shaped, smooth-faced bricks, and rough, porous bricks. There are red bricks, yellow bricks, gray bricks, cream-colored bricks and purple bricks. It will be no surprize, therefore, to learn that all bricks are not made in the same way. There are, in fact, three methods commonly in use by which bricks are manufactured. By the first method, soft clay is pressed into molds either by hand or by machinery. The clay contains a large amount of water, and the resulting brick is very porous and has a rough surface. In the second method, known as the stiff-clay process, clay or shale is mixed into a stiff mud with water, and then forced, by machinery, through a die, in such a manner as to form a long, rectangular mud "sausage," the area of the cross-section of this sausage being equal to the area of the face of a brick. The sausage is carried by a belt to a table, where it is cut into bricks by means of wires stretched on a frame. The bricks made in this manner have a peculiar texture, and appear on the market under various trade names, such as "rug," "tapestry," or "Devonshire" bricks. The third method is known as the dry-press process. The raw materials are ground to a moist granular powder, and then forced, under great pressure, into molds. This method produces well-finished, uniform, dense bricks. In all three processes, the bricks, as they come from the machines, are allowed to dry for a few days, and are then burnt in kilns at a temperature varying from 1500° to 2200° F.

The color of the finished brick depends upon the composition of the clay and the temperature to which it is heated in the kiln. By mixing different clays, or by adding to the clay small quantities of mineral ores, a great variety of tints can be obtained. The American manufacturer has specialized in the production of these colors, and nowhere else in the world has the home builder such a wide range to choose from.

From the point of view of the home-owner, none of the processes above described can be considered better than the other two; good bricks and bad bricks can be produced by all three. It is true that the dry-press bricks are less porous, but as far as durability goes, it is only necessary to remember that there are many structures built in the middle ages, of hand-molded bricks, which are still in an excellent state of preservation. The choice of bricks will depend, very largely, on the nature of the architecture. It is certainly true that more beautiful and pleasing effects can be obtained with the soft-clay and stiff-clay bricks than with the dry-press bricks, and their increasing popularity in recent years is undoubtedly due to that fact.

How to Test the Quality of a Brick. A good brick is one which will resist the disintegrating effects of weather—particularly, of frost. The first essential is that it should be well burned. The simplest method of testing a brick is to strike it with a hammer. If it gives a clear, ringing sound, it is well burned. If the sound is deadened, or dull, the brick is soft-burned, or contains cracks. Another test, a little more complicated, but still simple enough, is to find out how much water the brick will absorb. Dry the brick in the oven, weigh it carefully, then place it in boiling water for about five hours, leave it in the water until the latter has cooled, then remove the brick and weigh it again. The weight of the dry brick, subtracted from that of the wet brick, will give the weight of water absorbed. For stiff-clay, or dry-press bricks, this should not exceed one-eighth of the weight of the dry brick; for soft-clay bricks, it should not exceed one-sixth.

If you are still in doubt as to the quality of your bricks, here is a still more scientific test, but one that any man with the necessary patience and enterprise can easily make. Buy five pounds of sulfate of soda (Glauber's salts) and mix this in two gallons of water. Allow to stand for two or three hours, stirring vigorously from time to time. You will notice that most of the salts will dissolve, but there will be a little undissolved solid at the bottom of the pail. You will know from this that you have what the chemist calls a "saturated solution," which means that the water has taken up all the salt it can hold in solution. Pick out a few representative bricks and break them in two. Dry one-half of each brick in a moderately hot oven for several hours, and when cool drop them into your solution of salts. Let them stay there for twelve hours. Dry them in the oven again, and then return to the solution. If your brick will stand five successive treatments of this kind and still show no cracks, you may feel confident that it will withstand the vagaries of the American climate for many years longer than you will yourself. If it crumbles to pieces after the second drying, it is a weak brick and you should hesitate to use it. In this connection, it is necessary to point out that backing-up bricks do not need to be of such good quality as facing bricks, and when testing a brick by any of the methods described, this fact should be borne in mind.

"Whitewash" is the name given to a white deposit which sometimes forms on the surface of bricks after a building is completed. It consists of sulfate of lime, and is due to the fact that either the brick or the mortar contains soluble salts. To ascertain whether your bricks are likely to develop this undesirable discoloration, place a few of them on edge in a pan containing a little pure *rain* water. (Ordinary water, especially hard water, must not be used.)

The depth of the water should be about one inch. Let the bricks stand in it for several days, and if, at the end of that time, there is no deposit on the top surface, you may feel confident that your bricks will not be responsible for trouble from this cause, and, if it should develop, the blame must be placed on the mortar. In most cases it will disappear in time, and it can be removed temporarily by washing first with rain water containing a little muriatic acid, and then again with pure rain water.

Brick Bonds. Should you be building, or about to build, a house of brick, it is probable that at some time your architect or your builder will begin to talk impressively of "English bond," or "Flemish bond," of "stretchers," and "headers," and "bats." There is no reason at all why you should not surprize them and gain their increased respect by letting them know that *you* know exactly what they are talking about.

When a brick is laid lengthwise of the wall with its long narrow face outwards, it is called a "stretcher." When it is laid crosswise, with its short face outwards, it is a "header." When a piece is broken from a brick to fit into some place too small to accommodate a whole brick, the piece is known as a "bat."

Running or *Stretcher Bond* consists of layers or "courses" of bricks placed lengthwise, one above the other, in such a manner, that the vertical joints in any layer occur in the center of the bricks in the layer above or below them.

Common or *American Bond* consists of stretcher bond with a course of headers about every sixth course.

English Bond consists of alternate courses of headers and stretchers.

Dutch Bond is very similar, but whereas in English bond the vertical joints in the stretcher courses are strictly below one another, in Dutch bond the vertical joints in one stretcher course come directly over the center of the bricks in the next stretcher course. A glance at the illustration will make this clear.

In *Flemish Bond,* headers and stretchers alternate in every course, the header in one course being placed in the center of the stretcher immediately below it. There are modifications of these bonds, but if you familiarize yourself with these five you will appear at least intelligent to your builder.

Cost of Brick. Brick has a reputation for being expensive. The comparative cost of wood and brick will vary somewhat in different parts of the country, but it may be said that the difference between them is far less than is generally believed. According to figures compiled by the American Face Brick Association, it costs from five to ten per cent more to build a brick house than a frame house. They estimate that a $7,000 frame house would cost from $7,350 to

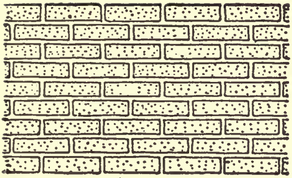


Fig 1. Running or Stretcher.

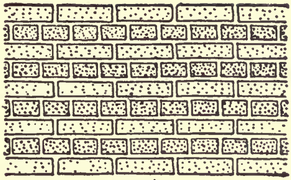


Fig 2. English.

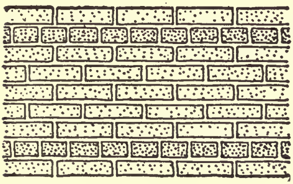


Fig 3. Common.

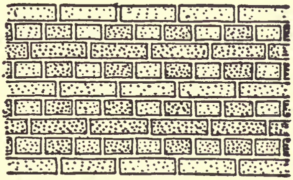


Fig 4. English Cross or Dutch.

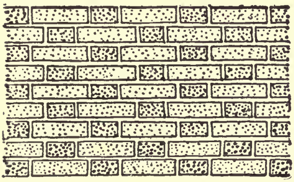


Fig 5. Flemish.

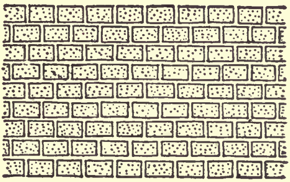


Fig 6. Header.

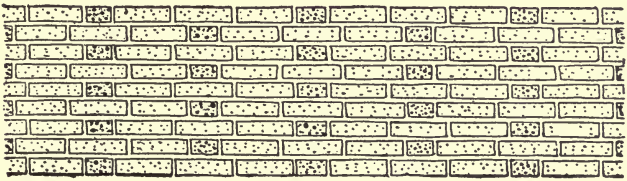


Fig 7. Garden Wall.

Brick Bonds Face

$7,700 if built of brick. A frame and stucco house would cost from $7,050 to $7,250, while a frame with brick veneer would come somewhere between the two. Of recent years the cost of lumber has increased more rapidly than that of brick, and it seems probable that brick houses will be far more common in the near future than they are at present. Other arguments in favor of the brick house are low cost of maintenance, small depreciation, low fire insurance rates, and greater warmth.

Hollow Tile

The advantages of hollow tiles for building purposes are so obvious that their growing popularity is in no way surprizing. The air spaces in the tiles form a protection against damp, and against heat in summer and cold in winter; while the durability, low cost of maintenance, and fire-proof qualities already mentioned in connection with bricks, are possessed to an equal degree by hollow tile. Perhaps the ideal combination is that of a hollow-tile building with a brick facing. This gives the desirable insulation against dampness and extremes of temperature possessed by hollow tile, together with the architectural effects of brick. It is, also, possible to obtain a special type of hollow tile having a face similar in character to the ordinary brick, and, with this type, effects very similar to those obtained with face brick can be produced. The commonest finish for a hollow-tile house is, however, stucco.

Much of what has already been said regarding the quality of bricks applies equally to hollow tiles. They should be free from cracks and well burned, especially when used for outside walls. An absorption test carried out as described under *Brick* should show a moisture absorption of not more than ten per cent. The relative size of voids and shells is also of some importance. The void should not measure more than four inches in width and the thickness of the webs and shells should be not less than fifteen per cent of the width of the void. Where hollow tile is used for inside partitions, it is not necessary to be quite so particular regarding quality.

As regards the cost of hollow tile, the general public, as in the case of brick, has an exaggerated idea of the expense involved. Moreover, the slight extra cost over frame construction is usually more than offset by the saving in repairs, painting, insurance and in fuel.

Stucco

Stucco is a cement plaster, consisting of cement and sand, or cement, sand and lime, mixed in varying proportions and applied to the outside of a building either for decoration, or protection, or both. On houses built of brick, hollow tile or concrete block, the main function of stucco is that of decoration. On the frame house, however, stucco, if properly applied, gives a more durable structure, and one costing less for maintenance, while at the same time it affords considerable protection against fire from outside sources. The cost of a frame and stucco building is very little greater than of the same type of building covered with clapboards, the cost of a $10,000 house being from $200 to $500 more.

Methods of Building Frame and Stucco House. There are various methods of building the frame and stucco house, but there are two which may be said to typify all of them. In the first, the outside of the frame is sheathed with boards, fixed diagonally, sheathing paper or tarred felt is then applied, and, on top of this, metal lath is fastened, this lath forming the support for the stucco. In the other method the metal lath is fixed to the studs, and cement mortar applied to both sides of the lath. Both methods, when carefully and properly carried out, are satisfactory, the second having the advantage that the metal lath is completely covered and so protected from rusting.

Stucco on Wood Lath. The practise of applying stucco to wood lath is not uncommon, but there is greater danger of serious cracking than when metal lath is used. The wood may shrink or warp, sometimes causing such damage to the stucco that large sections have to be removed and replaced. There are now on the market several kinds of woven wire mesh, or metal lath, specially designed for use as a support for stucco, and altho the cost is slightly greater than for wooden lath, it is usually true economy to make use of them.

Proportions for Stucco. No two authorities agree as to the mixture which gives the best results for stucco. Some claim that sand and cement only should be used. Others advocate a mixture richer in lime than in cement. Probably the truth is that the best possible mixture has not yet been determined, because stucco has not yet been in use for a sufficient length of time for the point to be finally settled. It is also true that the skill and care with which the mortar is applied is of greater importance than its composition. There seems to be general agreement that the addition of lime gives a more easily worked mixture, and there is no indication that such an addition in small quantities is in any way harmful, while the advocates of the mixtures rich in lime actually claim for them greater strength and durability. An average mixture which is certain to give good results consists of two parts sand, one part cement, and an amount of *hydrated* lime equal to one-tenth the weight of cement. In other words, for every bag of cement used, add about 9½ pounds dry hydrated lime. Care must be taken to avoid the use of quicklime, or disastrous results may follow. The quicklime will absorb water and swell, and the stucco will become pitted or completely disintegrate.

The mixture given above will cover approximately fifty square feet, with a coating half an inch thick for every bag of cement used.

Methods of Applying. Stucco is applied in three, or sometimes two, coats. The first forms a protective covering for the metal or wooden lath, and if the latter is used it must be made thoroughly damp before the stucco is applied. If the stucco is applied to the dry wooden lath the latter will absorb moisture from the plaster, thereby tending to spoil the stucco and at the same time to warp. If, on the other hand, the lath is too wet, it will shrink as the plaster dries, and may separate from the stucco. It will be seen that the use of stucco on wooden lath is attended with considerable risk.

The best time to apply the second coat is after the first coat has hardened, but before it has become dry. In any case, the first coat should be soaked with water and painted with a mixture of cement and water before applying the second, and if it is also scratched, so as to produce a rough surface, a better bond between the two coats will be obtained. The same reasoning applies to the third coat, which should be applied as soon as the second has hardened. In each case, care must be taken to apply the coat before the cement paint has hardened.

The method of applying the third coat depends upon the character or finish desired. A smooth finish is produced by using a wooden float or trowel. This finish is not popular, however, as it is, to most people, less attractive than the rough types of finish. It also has the disadvantage of rendering cracks and imperfections more prominent. A brushed surface is obtained by scratching the partially hardened surface with a wire brush. Perhaps the most attractive finish, however, is the pebble-dash or rough-cast. This is produced by throwing the final coat against the wall, usually with the end of a small whisk brush or a bundle of twigs. Frequently, a mixture of cement, sand, and small pebbles is used for the finish.

After the coating is complete, it must be protected from sun or wind with canvas or burlap, which should be kept damp for some days. After this protective covering is removed, the stucco should be sprayed with water at intervals for about a week, so that there may be sufficient moisture present to insure a proper hardening.

Repair of Stucco. Stucco, if properly applied, should require very little in the way of repairs for many years. All stucco will develop small cracks to a greater or less degree, but these are seldom sufficiently serious to cause damage, and in most cases are best left alone. Where a crack develops, of such serious proportions as to admit moisture to the interior wall, it may be filled with a cement-sand mixture by much the same method as that described under *Concrete* for repairing a crack in a leaky cellar. In this case, however, it is advisable to chip away as little as possible, or preferably none at all, as the patched crack is certain to show, in any case, and the wider it is the more conspicuous it will be. Defective spots must be chipped out and patched, every effort being made to use a mixture so similar in make-up to that originally employed that the patch will not be too noticeable. Care must be taken to wet the adjacent stucco very thoroughly and to keep the patches, or filled-in cracks, damp for several days after the work is complete.

In those cases where the repair work is very conspicuous and unsightly, the entire wall may be painted over with a thin wash of cement and water. There are, also, on the market, special water-proof preparations for painting stucco, and these give good results in many cases.

Cement and Concrete

Portland Cement. Portland cement is made by heating a mixture of limestone and clay (or similar materials) in a kiln to such a temperature that fusion takes place and clinkers are produced. These clinkers are ground to a fine powder, and are usually mixed with about three per cent of gypsum. The resulting powder consists chiefly of calcium and aluminum silicates.

On mixing with water, these compounds combine with it, chemically, forming hydrated silicates of calcium and aluminum.

Lest it should be thought that an unnecessary incursion is being made into pure chemistry, it may be said that a thorough understanding of the statements contained above would enable the amateur to avoid more than half the failures which follow his attempts at concrete construction. If you contemplate working with Portland cement, even if only to the extent of closing a crack in your cellar floor, grasp the fundamental fact: the setting of concrete is *not* a process of "drying out"; it is the exact opposite—a process of hydration. Unless sufficient water is present concrete will never, *can* never, set really hard and solid. Moreover, the setting is, in reality, a very slow process, and concrete seldom reaches its maximum hardness in less than a year. It is, however, during the first few days that a sufficiency of moisture is so important, and after the concrete is mixed and poured into the forms steps must be taken to keep it damp. It should be protected with canvas, wet sand, or some other simple covering, and both concrete and covering should be sprinkled with water sufficiently often to keep the whole mass thoroughly damp for some days.

Proper Proportions in Mixing Portland Cement. As regards the amount of water to be used in making up the mixture, this will vary considerably according to the condition of the sand and stone mixed with the cement. Where the sand is very dry, more water will be needed than when it is wet. The exact amount of water required, therefore, is seldom given, and it is almost entirely a matter of personal judgment. This frequently presents difficulties to the amateur, and he nearly always errs on the side of insufficiency. He finds it difficult to believe that the sloppy mixture which he has prepared will ever set to the hard, stonelike mass which he aims to produce, and he adds a little more cement to "stiffen it up." This is often a fatal mistake and results in a soft concrete. The consistency which gives the best results is that of a jelly. The mixture is sometimes described as "quaky," which means that it will "shiver," just as a jelly does when it is jarred. It should be neither thin and watery, nor yet so stiff that it will not flow.

Concrete. Concrete is a mixture of cement, sand, pebbles, or small stones, and water. All four constituents may be considered equally important. Cement is manufactured under strict chemical control, and if you buy any of the well-known brands you may have absolute confidence in its quality. The important part played by water in concrete construction has already been indicated, and on that point little more need be said, except as to the quality of the water. One authority on concrete has made the statement that water that is good enough for concrete is good enough to be drunk. This may be carrying things a little too far, but it is necessary that the water should be clean and free from suspended matter.

The importance of having good quality sand and stone is apparent. Concrete may be looked upon as a mixture of these two materials bound together by cement. It follows, therefore, that if the sand and stones are soft and weak, the whole mixture will be soft and weak. Do not use sand that powders easily when rubbed, or that contains appreciable amounts of clay or other impurities, and choose pebbles that are hard, clean and smooth, or broken stone from granite, trap-rock, or other hard rocks. If sand or stones of this description are not available, make the best of poor material by washing it thoroughly before use, so as to remove the clay and other foreign matter.

Quantity of Sand and Stone to Use. The proportions of sand, stone, and cement recommended vary considerably according to the work to be done. An average mixture which will be found suitable for most work around the home consists of one part of cement, two of sand, and four of gravel or stone. This is known as a 1 : 2 : 4 mixture, and the proportions are given according to volume—not weight. For foundations a 1 : 2½ : 5 mixture is frequently used, and in the construction of roadways a

1 : 1½ : 3 or even 1 : 1 : 1½ mixture is preferred. The general rule, in this connection, is that the greater the proportion of cement the more water-proof and dense is the concrete, and, up to a certain limit, the greater the proportion of sand and stone, the stronger is the concrete. There must be sufficient cement to produce a thorough coating of the sand and stone, as there will not be otherwise a perfect bond between the different particles constituting the mixture. For the same reason, the concrete must be very thoroughly mixed before use. For facing walls, filling cracks and making repairs, generally, a mixture of cement and sand, only, is used, usually in the proportion of 1 : 2.

How to Estimate Quantities. In order to determine how much cement, sand, and stone will be required for any particular job, it is first necessary to calculate the number of cubic feet which the finished work will occupy. Then for a 1 : 2 : 4 mixture, order a volume of gravel equal to the volume of the finished work, half as much sand and one quarter as much cement. A bag of cement contains about 1 cubic foot.

Some Simple Jobs. (1) *To Stop a Crack.* Suppose your cellar is leaky, due to cracks in the floor or the walls, it is usually possible to make it perfectly water-tight by the following procedure:

First, with a hammer and cold-chisel, chip away the concrete on each side of the crack to a width and depth of about half an inch. Sweep out the loose pieces and then soak the crack with water. Do not be afraid of using too much water. The concrete on each side of the crack must be thoroughly wet or you will never get a good joint between the old work and the new. Now make up a thin paint of cement and water and brush it on to the sides of the crack which you have made. Next make a 1 : 2 mixture with water, and fill the crack with it. If the repair is on a wall, the mortar must obviously be stiff enough to stand up in the crack, but if it is the floor that is being repaired, the mixture may be a little thinner. In a few hours, the mortar will have set, and all that remains to be done is to keep the repair damp for about a week. *Do not neglect this.* (See above.) Cover with canvas, burlap or wet sand or earth, or sprinkle frequently with water. But do not let it dry out. If the work is carefully done, the joint should be absolutely water-tight. There are many so-called water-proofing compounds for concrete, but these are unnecessary and very often worthless.

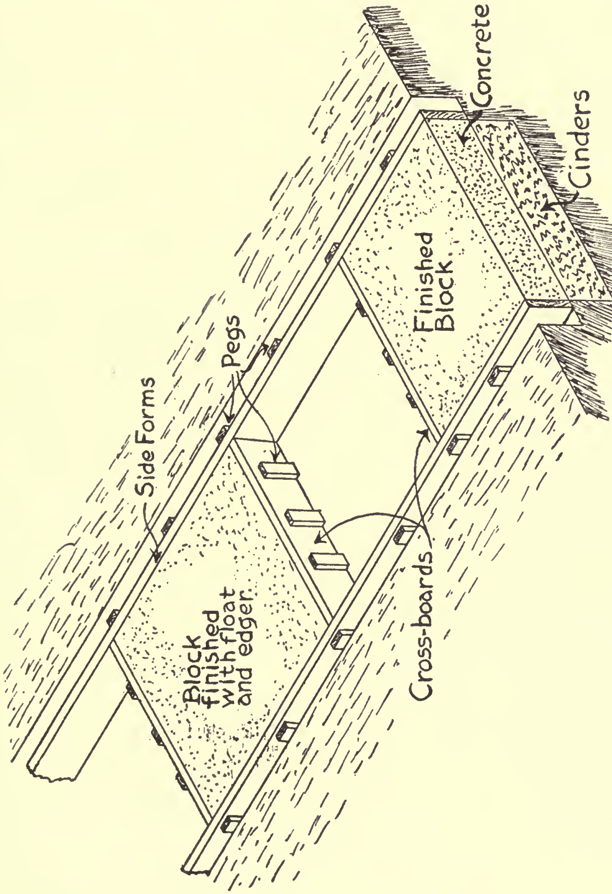
(2) *To Plug an Opening.* It is sometimes desired to stop a small opening between floors, or between the cellar ceiling and the ground floor, in order, for instance, to prevent rats or mice

from gaining access to the upper part of the house. This may readily be done by using a piece of expanded metal or stout wire netting, and covering this with the 1 : 2 cement mortar. Where the hole is very small, nails can frequently be driven across it in order to form a support or "reinforcement" for the concrete.

(3) *Concrete Foundation Piers.* This is one of the easiest jobs in concrete construction, and a good one for the amateur to gain some knowledge regarding the behavior and characteristics of the material. Let us suppose that you wish to make some piers for a small shed or chicken house. You will proceed as follows:

Having marked out the size of your building, you will dig six holes, one at each corner and one in the middle of each long side. (The number will, of course, vary with the size of your building.) Make the holes about ten inches square and twelve to fifteen inches deep. Next make six wooden boxes, having neither tops nor bottoms, and measuring nine inches square inside and fifteen inches long. Set the boxes in the holes in such a manner that they project about nine inches from the ground, make sure that the tops are exactly level, and also that each box is fixed firmly in its hole. Then remove all loose earth from the bottom of the holes.

Now mix your concrete. This is a process which requires a little care, and you will be well



Method of Laying Concrete Path

repaid for any extra trouble you take with it. The job in hand being a small one, a good sized box will do for your mixer. Place your sand in the box and pour the dry cement on the top of it. Mix the dry materials thoroughly with a hoe. Then add enough water to make a fairly thick mortar after which you can work in the stones or pebbles. Now soak the wooden forms with mortar and pour the concrete into them, filling each one to capacity. Give the concrete at least twenty-four hours to set. When it is quite hard, the forms can be taken apart and removed, if it is so wished. If it is desired to fix the wooden sills of the shed to the piers, bolts should be placed, heads downward, in the concrete, before it sets, in such a manner that the threaded ends will project above the piers to a sufficient length to pass through holes drilled in the beams forming the sills. By means of washers and nuts, the sills can then be fixed firmly to the piers.

(4) *Laying a Concrete Path.* This is a more ambitious undertaking, but it should present no great difficulties to any man possessing a little mechanical skill.

First prepare your foundations. If your path is to be made on solid, well-drained ground, this is a simple matter, and merely consists in digging out the soil to the required depth and smoothing and tamping it down so as to secure a solid bottom. If the ground is newly made or naturally soft, special foundations will be necessary. In this case, dig out the soil to a depth of at least ten inches, tamp the earth solid, as described above, and then fill in to a depth of six inches with clean cinders, gravel or broken stone. Whether or not you have prepared special foundations, the actual laying of the path is carried out as follows:

Make the trench, which is to be filled with concrete, from four to six inches deep, and about four inches wider than the finished walk. On each side of the trench place boards, four to six inches in width (according to the depth of your trench) and one inch thick. These will be held firm by wooden pegs, 3″ x 1″, on the *outside,* and by 4″ to 6″ cross boards on the *inside.* These cross boards should be placed at regular intervals as they form the sections into which the path will be divided.

As soon as your "forms" are ready and all loose earth removed from the trench, you can mix your concrete. The box used for the concrete piers will obviously be inadequate for this job, and you will need a larger box, measuring about three feet wide and six feet long, and about eight inches deep. Then proceed as follows:

Measure out eight buckets of gravel or stone and spread this out at one end of the box. Pour on top of it four buckets of sand, and then two buckets of cement. Mix all three dry as thoroughly as possible. This can best be done by shoveling the whole pile up to the other end of the board, and then shoveling it back again. Now add water—preferably by means of a hose—and mix once again, very thoroughly. Now begin to fill in the sections, *alternately*; that is to say, fill the first section, leave the next empty, fill the third, leave the fourth, fill the fifth and so on. As each section is filled, remove any excess concrete by placing a straight-edge on the edges of the forms and moving it backward and forward. After about an hour smooth the surface with a wooden float, and round off the edges of the block with a small trowel. If possible, permit the blocks now in position to set for about a week before proceeding to fill in the remaining blocks. Then remove the cross-boards, fill in with concrete, level and finish exactly as before. Your path is now completed and all that remains to be done is to keep it moist for at least a week. Cover it with canvas, empty cement bags, earth or sand, and keep everything wet.

The four jobs described above are fairly representative of the concrete work which the house-owner will undertake. By studying what has been said regarding them he should be able to carry out successfully any simple concrete construction. The following summary, with some few additional hints, may be found of value:

(1) Mix your concrete thoroughly—first dry, then wet.

(2) Do not pour your concrete from too great a height. If you do the stones will separate from the finer constituents, and you will have an uneven, weak concrete.

(3) Do not mix, at one time, more concrete than you can handle in half an hour. Concrete that has begun to set before it is placed will never be strong.

(4) Use neither too much nor too little water. Your mixture should be a quaky jelly—neither a thin liquid nor a stiff mortar. Let your water be clean.

(5) To prevent concrete from sticking to the forms, wet the wood thoroughly just before pouring. Or still better, soak the forms in crude oil.

(6) After your concrete has set, keep it moist for several days.

(7) In mixtures containing both sand and pebbles, always use more pebbles than sand—usually two parts of pebbles to one of sand.

(8) Do not use dirty sand or stones.

Mortar

Mortar may be either a lime mortar or a cement mortar. The former is a mixture of slaked lime and sand; the latter of cement and sand with more or less lime added in order to improve the working qualities of the mixture.

The usual proportions for a lime mortar are one part, by weight, of slaked lime to three parts of sand; for a cement mortar, opinions vary, but a satisfactory mixture consists of two parts of sand to one of cement with about one-tenth the weight of hydrated lime. Frequently, however, much more sand and lime are used, one recommended mixture consisting of equal volumes of cement and hydrated lime and six volumes of sand. Generally speaking, it may be said that the addition of lime to the mixture reduces the strength but improves the working qualities. For ordinary purposes, a lime mortar, altho not as strong as a cement mortar, will give perfectly satisfactory results.

To repair the joints in old masonry, it is advisable to chip out the old mortar to a depth of about half an inch, spray water over the entire surface until it is quite damp, and then fill in the joints with a mixture of slaked lime and sand, care being taken to make the mixture rich in sand. If the mixture contains an insufficient amount of sand, it is liable to shrink and fall out.

Plaster

The composition of plaster varies somewhat according to the uses to which it is to be put. It is usually applied in three coats, known respectively as the scratch coat, brown coat and finish coat, and they are seldom of the same composition. The scratch coat is applied directly to the wood or metal laths, or to the concrete, brick or hollow tile, as the case may be. The brown coat forms the body of the plaster while the finish coat gives a smooth and even surface and may be tinted to any desired color.

The scratch coat generally consists of a mixture of hydrated lime, sand and hair or of calcined gypsum, sand, and hair. A representative mixture contains one hundred parts of gypsum to two hundred and seventy parts of sand and one part of hair. If hydrated lime is used, there will be about three hundred parts of sand to one hundred parts of lime. Both wooden laths and all kinds of masonry should be thoroughly wet before the plaster is applied. All crevices in the masonry are filled with it, or it is pushed between the laths. The surface is scratched before it is dry in order to give a stronger hold for the second coat.

The brown coat is similar in composition to the scratch coat, but contains more sand. It forms about three-quarters of the total thickness of the plaster. The mixtures generally recommended are

Sand: 800 parts
Hydrated lime: 200 parts
Hair: 1 part

or

Sand: 300 parts
Calcined gypsum: 100 parts.

The composition of the finish coat depends upon whether a perfectly smooth, or a so-called "sand float," finish is desired. In the former case, one part of calcined gypsum to three of lime will give good results and in the latter one of calcined gypsum, two of lime, and three of sand.

The first two coats should, in each case, be allowed to set and dry, and then be wet again, before applying the next. Any cracks which develop in the brown coat should be filled in before the finish coat is applied.

To cover a wall 10 feet by 10 feet (100 square feet in all) with all three coats will require about 200 pounds of calcined gypsum, five cubic feet of sand, and 50 pounds of hydrated lime; or, if hydrated lime is used instead of gypsum, the amount required will be about 150 pounds hydrated lime, together with 1 to 1½ pounds of hair.

Cracks in plaster are usually caused by the settling of foundations, but in some cases they are due to the brown coat containing too small an amount of sand. On the other hand, a plaster which crumbles easily and lacks strength contains too much sand in the brown coat. Where the different coats separate easily from one another, or where the finish coat can be rubbed off with the hand, or peels off in flakes, too little water was used in wetting the brown coat before applying the finish coat.

Roofing

For the construction of the roof of his house, the home-builder has a wide choice of materials. The character of the architecture, to some extent, determines his choice, but, leaving this on one side, he demands a roof which will be waterproof, cool in summer, warm in winter, durable, and pleasing to the eye. In thickly populated districts, the question of fire protection assumes an important aspect, and his thoughts turn to slate, tile and the various artificial shingles made of asbestos and other fireproof materials, but in outlying districts the wooden shingle retains its popularity. There is of course no roofing material which is from every point of view perfect, but there is no difficulty nowadays in obtaining a roof which will give more than reasonable satisfaction, the only difficulty being to know which kind to choose.

The principal roofing materials now on the market are:

(1) Wooden shingles
(2) Asphalt shingles
(3) Asbestos shingles
(4) So-called "rubber-type" roofings
(5) Asbestos roll roofings
(6) Metal roofings
(7) Slate
(8) Tile

Wooden Shingles. At the present time wooden shingles are, undoubtedly, the most popular roofing material for the ordinary American house. This popularity is largely due to the fact that a shingle roof is pleasing to the eye and blends well with many different types of architecture.

It is obvious that the woods used for making shingles must be very durable. Those most commonly employed are cedar, cypress and redwood, altho pine, larch, hemlock and chestnut are sometimes used. Even the most durable wood is benefited by treatment with preservative, and it is the common practise to stain the shingles with a mixture consisting of color ground in linseed oil and thinned with creosote oil. There are two methods of applying this preservative: by painting after the shingles are in position, or by dipping before the roof is begun. The advantages of the latter method are obvious. Every part of the shingle becomes impregnated with the liquid, greatly adding to its life and to the durability of the color. It is possible to purchase shingles which have been already dipped, and these are supplied in a great variety of colors, all shades of green, red, brown, and gray being obtainable. By a special system of laying the shingles, a "thatched roof effect" can be produced, the results, with certain types of buildings, being decidedly pleasing. If you decide to roof with wooden shingles, it is well worth while to obtain some of the advertising literature on the subject. You will be agreeably surprized at the choice of materials offered you.

Asphalt Shingles. The deserved popularity of the wooden shingle has led to many attempts to imitate its natural charm, and at the same time to improve upon it by manufacturing a shingle which is more durable and more fire-resistant. In many cities, wooden shingles are prohibited within certain zones, and the artificial shingle becomes a valuable substitute. The asphalt shingle consists of felt, soaked in a tarry liquor, and coated, top and bottom, with an asphalt compound. The felt consists of a mixture of wool, cotton, and burlap, together with varying proportions of paper, straw, and wood. It will be seen, therefore, that the asphalt shingle is by no means unburnable, but the outer surface is commonly coated with crushed slate, gravel or shells, which renders it fire-resistant. Due to this outer coating, the shingles can be supplied in a pleasing variety of shades of green, red, and gray. They form a fairly durable and satisfactory roof. These shingles are also made in strips of four or more, the shingles being joined together at the upper part of the strip. In other words, they consist of strips of material with slots cut in them which give the effect of shingles, while they can be laid in less time and with less labor. Care

ASPHALT SHINGLE ROOFING

this fact should be reassuring, for while much might be said for rubber as a roofing material, if it could be renewed every few months, its propensity to "perish" when exposed to the weather is sufficiently marked to make it quite impossible for a roof which is expected to last for thirty years or more. The name arose from the rubber-like appearance which these materials possess, but their composition is similar to that of the asphalt shingles already described; namely, a mixture of felt and bituminous matter, such as coal-tar, pitch or asphalt. They are supplied in roll form and are fixed on the roof in somewhat the same manner as linoleum is laid on the floor. Some brands have a coating of ground slate, shells, or pebbles. These roll roofings form the cheapest roofing material available, and find their widest application on barns, garages, and outhouses generally, altho of recent years they have been used to an increasing extent on the smaller types of dwellings.

Asbestos Roll Roofings. Akin to the rubber-type roofing, but superior to it as regards durability and fire-resistance, are the asbestos roll or "ready-to-lay" roofings. They consist of asbestos felts impregnated with asphalt or similar water-proofing materials, and cemented together with hot asphalt. They are supplied in roll form, similar to rubber-type roofings, and are also laid in much the same manner. Their first cost is somewhat higher than the rubber-type roofings, but owing to their greater durability and lower depreciation they are probably more economical in the long run.

An objection to any type of roll roofing is the difficulty of laying it absolutely flat and the practical impossibility of preventing wrinkles. This not only spoils the appearance, but introduces an obvious weakness in the roof.

Metal Roofing. Practically the only metals now used for roofing purposes are "terne-plate," sometimes known as tin-plate and copper. Terne-plate consists of soft steel, or wrought iron, coated with an alloy of lead and tin. Tin is not easy to apply and it needs constantly repainting in order to prevent the development of leaks due to rusting. Copper has the great advantage of being practically everlasting. It is now obtainable in small pieces, similar to shingles, and comes in a variety of colors ranging from green to rich brown. These copper "shingles" can be used for a new roof or can be laid over an old roof of wooden shingles.

Slate. In certain districts, where slate is plentiful and easily obtained, there is much to be said for this material as roofing. It can be obtained in a variety of shades of green, purple, blue, and gray, and soft and pleasing effects can be produced with it. It is durable, and fire-resistant, and while hot in summer, during the daytime, it readily gives up its heat after sundown.

Tiles. Much that has been said regarding bricks applies also to roofing tiles. They should withstand the Glauber's Salts test, and be well baked and sound. When tested for water absorption, as described under *Brick,* they should not absorb more than ten per cent of their weight. They should also be free from the tendency to "whitewash," a test for which is described under the same heading.

In certain types of architecture, effects of real beauty can be obtained with tile. If of good quality, they are very durable, the depreciation is small, and they are highly fire-resistant. In laying both slate and tile, care should be exercised in nailing. If the nails are driven up tight, without any "play" being given, there will be danger of breakage.

Comparative Costs. You will find that quotations on roofing are usually given at "so much a square." A square of roofing is one hundred square feet. The most expensive roofings are tile and high-grade asbestos shingles, and the cheapest the roll roofings. Wooden shingles are about midway between the two, while asphalt shingles are a little cheaper. Slate varies in cost in different localities, and may be cheaper than wooden shingles or about as expensive as tiles. Copper roofing, including labor, costs approximately $26 per square.

Metals

The chief metals used in the construction and fittings of a house are iron, copper, brass, bronze, nickel, zinc and coated metals, such as plated goods and galvanized iron.

Iron. Iron may be subdivided into cast iron, wrought iron, and steel, but these subdivisions merge into one another, and it is impossible to draw any hard and fast distinction between them.

Cast iron is made from "pig" iron, the ingots produced when the molten metal from a blast furnace is run into molds and allowed to cool. The pig iron is remelted in a cupola furnace and then poured into molds of the desired pattern. Cast iron varies greatly in its characteristics according to the impurities which it contains. Gray iron, which contains uncombined carbon in the form of graphite, is tough and can be worked in a machine. White iron also contains carbon, but in this case it is chemically combined with the iron, which is very hard and brittle. Phosphorus causes the metal to flow more easily when it is melted, and is, therefore, valuable when small castings of intricate design are being manufactured.

Cast iron occurs in stoves of all kinds, radia-

THATCH ROOFING

tors, hot-air registers, furnace shakers, and many other utensils. Cheap tools are frequently made from cast iron, and owing to their brittleness are very unreliable.

Malleable cast iron is prepared by annealing at a high temperature after casting. This treatment renders the metal softer, less brittle, and more easily worked. It is, therefore, much more resistant to shock than ordinary cast iron. It occurs very commonly in the household as pipe fittings, which are nearly always made of this material. Cheap hammers and other tools are also made from it.

Steel is also made from pig iron, by refining by the open-hearth method or in a Bessemer furnace. Hard steels contain up to one per cent of carbon. When such steel is heated and then plunged into water, it is rendered hard and brittle and can then be used for razor blades, knives, and sharp tools. Soft steel is very little affected by such treatment, but more closely resembles wrought iron. Between the two extremes a great variety of steels can be manufactured. Structural steel usually contains about 0.3 per cent of carbon and is known as a medium carbon steel.

The exact control of conditions when manufacturing and tempering different grades of steel is a delicate matter, and it is not surprizing that the ultimate user finds considerable variation in the quality of his goods. When a razor blade soon gets dull it is a sign that the steel from which it is manufactured is too soft. When a knife or a chisel nicks easily, or even snaps under slight strain, it is obviously too hard and brittle. These faults are due either to improper composition of the steel or to lack of control when tempering.

Wrought iron is made by melting a mixture of pig iron and scrap iron, with a flux, in a puddling furnace. The impurities are removed in the form of slag, and the residual iron is then worked into a ball. It is then removed from the furnace, squeezed and rolled. The iron is then reheated and again rolled or forged.

Wrought iron is much softer and less brittle than cast iron. It resembles soft steel, and as the latter product can be manufactured more cheaply, wrought iron has, to a very large extent, been replaced by it.

Galvanized iron consists of iron or steel coated with zinc. There are three processes by which the zinc is applied—the "hot dip," the "electrolytic" and the "Sherardizing." The hot-dip process, as the name implies, consists of passing the metal, previously cleaned with acid, through a bath of molten zinc. The zinc forms an alloy with the iron, and a coating of pure zinc outside this alloy. In the electrolytic process the coating is formed by depositing zinc on the iron by mean of an electric current, along the lines of the well-known "plating process." In the Sherardizing process the zinc is volatilized by heating and deposited on the iron, just as water vapor is deposited on cold objects introduced into a warm, moist atmosphere. The process is carried out by heating the metal in an iron drum in the presence of powdered zinc.

Large objects, sheet metal, and piping are usually "galvanized" by the hot-dip process. Good quality galvanized iron should be covered with an adherent coating of zinc, free from pinholes and other surface imperfections. The coating should be sufficiently thick to afford ample protection, and yet thin enough to permit some bending without cracking. In applying the bending test, some discretion is necessary before condemning material as of unsatisfactory quality. Galvanized iron which will stand a sharp, complete bend, is unknown, but it should be possible to bend it to some extent without any immediate evidence of peeling.

Brass and Bronze. Brass is an alloy of copper and zinc; bronze an alloy of copper and tin. They form probably the best materials known for door knobs, hinges, window-catches, and plumbing, gas and electric light fixtures. Many of the so-called brass or bronze fittings on the market, however, are nothing more than cast iron or steel, covered with a thin coating of the more valuable metal. By careful inspection it is usually possible to distinguish between the sham and the real, and if there is any doubt on the point, scraping with a knife will soon reveal the cheaper metal if the article is merely coated.

In many cases, of course, economy will prevent the use of solid brass or bronze fittings. The coated products cost from one-third to one-fourth the price of the solid, and if of good quality are sufficiently durable for ordinary purposes. It should be remembered, however, that the iron beneath the coating will quickly rust should it become exposed, and the coating must be sufficiently thick to afford real protection. Lighting fixtures are subject to very little wear, and coated iron or steel gives general satisfaction for these fittings. Door-knobs, on the other hand, are subject to a great deal of wear, and a coated article will inevitably show signs of rust sooner or later. When this occurs, the rust should be removed with fine emery paper and the knob given a coating of bronze paint.

Plumbing fixtures are usually of solid brass, or of brass plated with nickel. In the latter case, the thickness of the nickel coat is a matter of importance. Constant use will soon wear through a thin nickel coating, showing the brass underneath, and thereby spoiling the appearance of the fixture.

Brass piping is occasionally used for water. It is very durable, and once installed should give no trouble. With very soft water its use is sometimes inadvisable owing to the solvent action of the water. (See chapter on *Water Supply.*) Its first cost is, of course, very high.

Copper and Zinc. These two metals are used to only a limited extent in the average household. For roof gutters, copper is almost ideal, owing to its great durability. Its first cost is high, but considering the very short life of a galvanized iron trough, the use of copper is an economy in the long run.

The same is true of zinc. A zinc gutter will outlast a galvanized iron gutter many times over, and zinc is in common use for this and similar purposes in Europe. In this country it is very little used along these lines at the present time, largely due to the fact that zinc was formerly looked upon as a brittle metal, very difficult to work. Of recent years, however, improvements in the process of manufacture have indicated that the alleged brittleness of zinc was due to the presence of impurities, and the production of zinc of a high degree of purity has shown it to be as soft and ductile as copper. Under ordinary weather conditions it is not subject to corrosion, and unpainted zinc roofs have remained in good condition for fifty years and more. It seems certain, therefore, that zinc for gutters, leaders, and other architectural accessories will find an increasing use. It is now largely a question of overcoming the natural conservatism of the average tinsmith, who shows the reluctance, common to all mankind, of handling the unfamiliar.

CHAPTER III

CARPENTRY

Speaking the Carpenter's Language

When your carpenter talks lightly of sills and joists and studs, does he produce in your mind a clear picture of what he is talking about, or do you feel about as definite as the fair applicant for an automobile driver's license, who, when asked what the universal joint was, replied that it was "something connected with something that did something that made the car go"? Below is given a glossary of the principal terms used by the carpenter. The list is not a very long one, and it is believed that it will make clear what, to many, has been more or less obscure.

Sill. A sill is a horizontal piece of timber forming the lowest member of a frame or structure. It is most familiar as the door-sill or window-sill, but unless it is clear, from the context, that he is referring to one of these, when the carpenter speaks of the "sill," he probably refers to the heavy timbers forming the foundation framework of the house. They rest upon the underpinning and usually consist of beams of spruce or pine, measuring 6″ x 6″ or 6″ x 8″.

Girder. A girder is a main horizontal beam supporting other and smaller beams (see *joists*) which in turn support the floor.

Joist. A joist is a horizontal piece of timber on to which the floor boards or ceiling strips are nailed.

Corner Post. A corner post is exactly what its name implies: the timber placed at each corner of the house. It may be a piece of 4″ x 8″, or be compounded of two 4″ x 4″, or of one 4″ x 4″ and two 2″ x 4″'s.

Girt. (Sometimes *Girth.*) A horizontal beam built into the frame of a house to support the upper floors.

Ledger-board. Similar to a girt but used only in balloon framing (see below). Whereas the girt will be a heavy beam, probably a 4″ x 8″, the ledger-board will be a plank, about an inch wide and 6 inches or more deep. Like the girt, it supports the floor joists.

Plate. The plate, or "roof-plate," is the horizontal beam forming the top member of the frame and supporting the lower ends of the rafters.

Stud. The studs are the small uprights which fill in the framing of the house, and to which the laths are nailed.

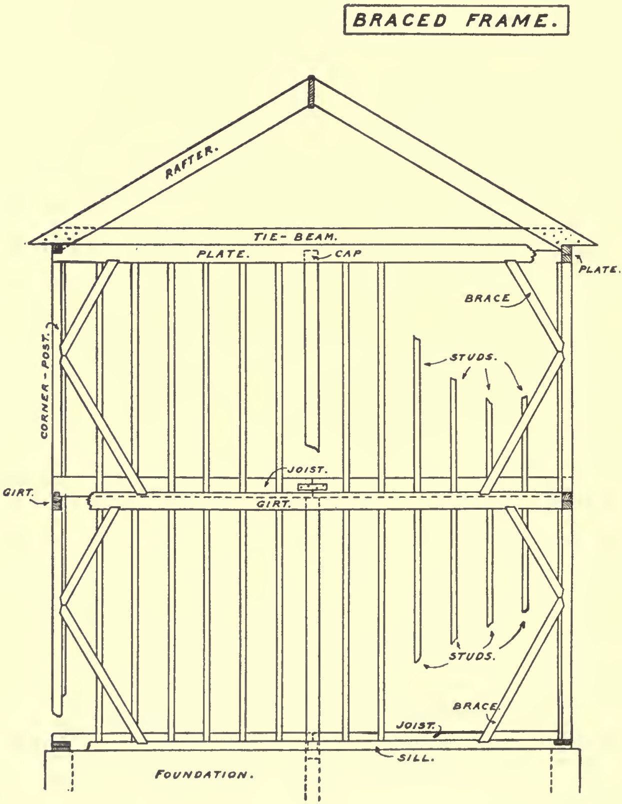
Bridging. If you will go into your cellar and look up at the joists supporting the floor above you, you will notice at certain intervals short pieces of wood fixed across the joists, usually diagonally. Their purpose is to stiffen and strengthen the framework and they are also placed between the upright studs—either horizontally or diagonally. These short pieces are known as "bridging."

Brace. A brace is a small piece of timber fixed across the corner of a framework in order to stiffen the frame and to prevent distortion.

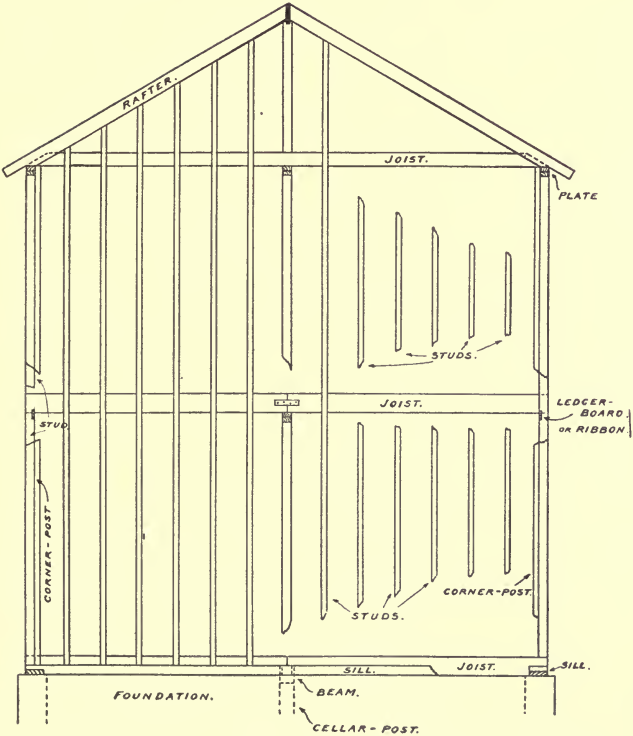
Cap and Sole. The boards forming, respectively, the top and bottom finish of the partition walls.

Braced Frame and Balloon Frame. These are the two types of frame in common use. The braced frame is the stronger, the balloon frame the more economical. In the braced frame, each wall consists of the sill, at the bottom, the plate at the top, two corner posts, one or more girts supporting the upper floors, diagonal braces at each corner, and studs running from sill to girt. In balloon framing, the studs run from sill to plate, and there are no braces and no girts. A horizontal piece, called a ledger-board, or sometimes a "ribbon," is set into the studs at each story, to support the floor joists. Balloon framing is comparatively modern, and is looked upon with disfavor by many.

Splices and Joints. The methods by which two pieces of wood can be joined together are many and various. Many of the joints used are


BRACED FRAME.
RAFTER.
TIE- BEAM.
PLATE.
CAP
PLATE.
BRACE
CORNER - POST.
STUDS.
JOIST.
GIRT.
GIRT.
STUDS.
BRACE.
JOIST.
SILL.
FOUNDATION.

BALLOON-FRAME.



wonderfully ingenious and not a little complicated. Some of them have been in use for centuries, and the names of the original inventors are lost in obscurity. To become familiar with all of them is scarcely necessary for any one but a skilled carpenter, but it is worth while to be able to distinguish some of the principal joints, especially as the more complicated joints are mostly developments from them.

A *splice* is a connection between two pieces of wood in the same straight line. A *joint* is a connection between two pieces meeting at an angle.

Joints. The principal *joints* are:

Butt Joint. In its simplest form, a butt joint is formed when two pieces of wood meet at right angles and are nailed together, as, for instance, in rough boxes and packing-cases. If the pieces meet at an angle it is frequently necessary or advisable to saw the end of one piece obliquely, so that two flat surfaces may come together. Another special form of butt joint is shown where two pieces come together at an angle, and a slot is cut in one to accommodate the end of the other.

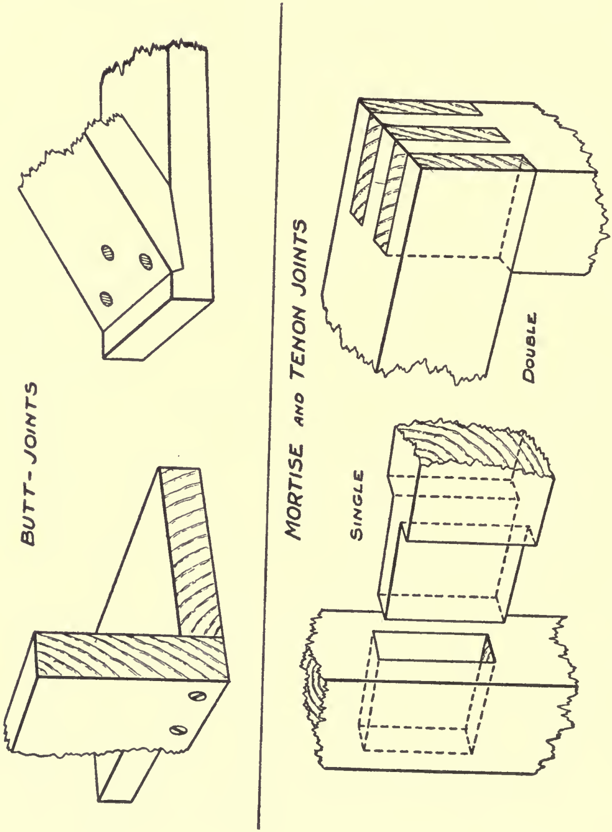
Mortise and Tenon. A mortise is a hole, or slot, cut in a piece of wood, and a tenon is the projection from another piece of wood, so cut and shaped as to fit exactly into the mortise. A *double tenon is* frequently used, the joint, as the name implies, consisting of two tenons fitting into two mortises.

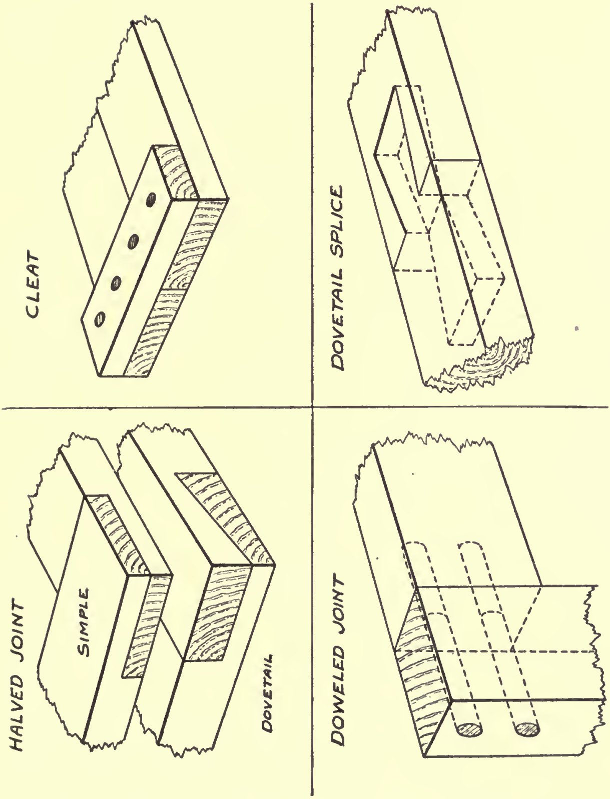
Halved Joint. This joint is commonly used in many forms. When two pieces of wood cross, or meet, at right angles, a slot is cut in each equal in depth to half the thickness of the wood. The pieces then make a perfectly flat joint. The joint may be *dovetailed*—that is, cut wider on one side than the other—or may be cut in other special forms.

Cleat. A cleat is a strip of wood placed over the adjacent edges of two boards, and screwed, or otherwise fastened, to both, so as to produce a joint between them.

Doweled Joint. A dowel is a round stick of wood used in place of nails or screws. Holes are drilled in the pieces of wood which are required to be joined together, a little glue is brushed around one hole, and one end of the dowel is dipped into the glue and driven into the hole. The glue is then allowed to dry, when the process is repeated with the other end of the dowel, the flat surfaces of the wood being also glued before they are brought together.

Splicing. The simplest form of splicing is to place the two boards, which are to be joined, end to end, and then nail, above and below them, strips of wood of the same width as the boards. Other forms of splicing are similar to the joints described above.


BUTT-JOINTS
MORTISE AND TENON JOINTS
SINGLE
DOUBLE


CLEAT
DOVETAIL SPLICE
HALVED JOINT
SIMPLE
DOVETAIL
DOWELED JOINT

The Home Carpenter

No attempt will be made in this chapter to make you into an expert carpenter, first, because expert carpenters can only be produced by much practise combined with natural skill, and secondly, because it is by no means necessary to be a skilled carpenter in order to do the many odd jobs which the average house-owner is frequently called upon (usually by his wife) to perform sooner or later. If the writer can assist you in impressing the uncritical lady just mentioned, and at the same time make your odd jobs a little easier, a little more interesting, and a little more satisfactory, his object will be attained. The man who already possesses more than a passing knowledge of carpentry will probably learn very little from the next few pages, but it is hoped that even he may find a few hints of value.

The Care of Tools. There is an old saying that it is the bad workman who complains of his tools. This may be true, but it is certainly equally true that the best of workmen would have just cause to complain of the tools with which the majority of amateur carpenters try to work. Some of the finest tools in the world are manufactured in this country, and the difference in price between the first-rate and the second-rate is usually so trifling that there is little excuse for using the latter. Buy good tools, and having bought them, keep them in good condition. You must not let your wife read this, but it may even be advisable to keep them under lock and key. It is not given to the female of the species to distinguish between a screw-driver and a chisel; to them, these tools are alike in character and interchangeable in their functions, and it is discouraging to the ambitious amateur to try to use, for legitimate purposes, a chisel which has already seen service as an ice-pick, or in dragging tacks out of the kitchen linoleum. To the man who loves his tools, moreover, it is a cause of real anguish to see his screw-driver, grasped by the blade, being used as a hammer. For reasons such as these, therefore, there would possibly be fewer unhappy marriages if husband and wife shared a check account, but had separate sets of tools. Buy good tools, guard them from sacrilegious hands, and keep them sharp and free from rust. How many a man will proclaim the impossibility of shaving unless he strops his razor daily and yet will use the same saw, unsharpened and unset, through the period of his married life! Keep your planes, chisels and saws as sharp as when you bought them, or sharper. Buy an oilstone and learn how to use it. If you can not sharpen your saw, at least take it periodically to a carpenter and let him do it for you.

Necessary Tools. What tools are absolutely necessary? That, of course, depends. There are households which get along for years with a hammer and a screw-driver as their sole outfit. But it is logical to assume that your ambitions soar somewhat beyond this, or you would never have troubled to read this chapter. To meet all ordinary emergencies, therefore, we suggest the following as being the minimum requirement:

1 Two-foot or three-foot rule,
1 Try-square,
2 Chisels—¼″ and ⅞″,
1 Hatchet,
1 Smoothing-plane,
1 Panel saw,
1 Rip-saw,
2 or 3 Gimlets,
2 Screw-drivers—one large, one small,
1 Hammer,
1 Pair pliers,
1 Oilstone,
1 Glue pot.

If you expect to attempt anything but the simplest odd jobs, the following additions to the above list will be found almost equally necessary:

1 Steel framing square,
1 Jack-plane,
1 Keyhole saw,
1 Brace with several bits,
A few files,

1 Mallet,
1 Pair of pincers,
1 Spirit level.

You may prefer to buy a complete outfit to start with, or you may choose to buy the tools one by one as you need them. For those who can afford them, there are, on the market, excellent tool chests containing complete sets—and fitted with locks!

How to Use Your Tools. Having bought your tools, you will want to get the best out of them by using them correctly. If you are lucky, you will have learned how to do this in your boyhood. If you are wise and humble, you will admit your ignorance to some learned friend, and seek his advice. But if, like most men, you are foolish and proud, you will prefer to stumble along in your own way, even at the cost of efficiency. It is for such as you that the following hints are offered. For the sake of convenience the tools are named in alphabetical order.

Brace and Bit. There are several varieties of bits, but for all ordinary work around the house the auger bit and the twist drill will be found sufficient. An expansion bit, which is adjustable so that it can be used for boring holes of various sizes, is a useful tool.

The use of the brace and bit is a simple matter, but there are a few points connected with it that are worthy of attention. When boring a hole through a board, clamp a small piece of waste wood on the side furthest from you; or, failing this, bore the hole until the spur of the bit can be felt coming through, and then turn the board round and bore from the other side. Failure to observe one or other of these precautions will result in splintering the board.

In drilling into the end of a board in the same direction as the grain of the wood, you may experience some difficulty in getting the tool to "bite." You should withdraw the bit very frequently when drilling in this direction, and carefully remove all chips. This will overcome the trouble. The same precaution should be taken when drilling very small holes in any direction.

When removing the bit from the hole, do not "unscrew" it by reversing the direction of rotation, or you will leave the hole full of chips. Instead, pull the bit outwards, turning it in the *same* direction as that used when boring.

Chisel. The two types of chisel most commonly used in amateur carpentry are the *firmer* and the *framing.* The former is intended for light work, the latter for heavy. The handle of the framing chisel is frequently metal-bound in order to enable it to withstand the blows of the mallet. The firmer chisel should be used for hand work only. Keep your chisels *sharp.*

Files. Files are flat, round, triangular or half-round.

Single-cut files have teeth in one direction only; *double-cut* files have two sets of teeth crossing one another obliquely. Files for metal have finer, narrower teeth than those used for wood.

When filing, use *both* hands, one to hold the handle of the tool, the other to hold the end. Press downwards on the forward stroke only.

If the teeth become clogged with wood, brush with a stiff brush. Special wire-cleaners are made for the purpose. If this fails to remove the dust, soak the file in hot water and try again.

Hammers. Hammers are made in many forms, sizes, and weights, but the common carpenter's hammer is the most generally useful. Hammering is the most elementary operation in carpentry, yet it is the one which betrays the incompetent amateur quicker than any other. Watch a woman or young boy hammering a nail. They will grasp the hammer somewhere near the head, or at the best, half-way down the handle, and attack the head of the nail with a series of shoves rather than blows. This no doubt is partly due to a weakness of the wrist, but there are boys who seem never to grow out of the bad habit, even in the full strength of manhood. Yet, it is a hundred times as difficult to drive a nail straight when the hammer handle is held in the middle as it is when it is grasped at the end.

Here, then, is the right way to use the hammer. Grasp the handle near the end, swing the hammer from the wrist—don't push it from the elbow or hurl it from the shoulder. The head of the hammer should move in the arc of a circle, and the center of the circle (your wrist) should be about on a level with the head of the nail. If your wrist is too low, you will bend the nail away from you; if too high, toward you. Try it out and prove it to your own satisfaction. In hammering, as in most other things, the right way, once you get the knack, is far easier, as well as far more efficient, than the wrong way.

Oilstone. Before buying your oilstone, decide just what kind you need. They vary all the way from the hard, fine-grained stones to soft, coarse-grained. The former produce the keenest edge, but require much patience, as they grind slowly. You will find a moderately coarse stone will give you the most satisfaction. Some stones do not require oil, water being used instead. If you use oil, avoid linseed and similar drying oils, as these will quickly gum up the stone and spoil it. A light lubricating oil, or kerosene, gives good results.

Sharpening a tool on an oilstone is largely a matter of common sense, but there are one or two points which are worthy of notice. The keenness of an edge depends upon the acuteness of its angle; the acuter the angle the sharper the edge. But there is a practical limit to the possible acuteness, because the acuter the angle the weaker is the edge, and the more quickly is it spoiled. For the same reason, when working on very hard woods it is advisable to reduce the acuteness of the angle. The flat side of a chisel or plane should *never* be ground, but to correct any "overlap" that may have been produced on the flat side by grinding the beveled side, the tool should be placed almost flat and drawn over the stone once or twice—no more.

Do not attempt to sharpen the tool on the stone to the full extent of the bevel. You will probably notice a second narrow bevel, near the edge of the tool, and this is the one which should be sharpened. Move the tool steadily backwards and forwards, carefully avoiding any rocking motion.

Grind a little, frequently, rather than a great deal at long intervals.

Plane. A few years ago planes were made with wooden stocks, and such planes are still used to some extent, but iron planes are now much more popular. The two planes which are most important to the amateur carpenter are the *jack-plane* and the *smoothing-plane.* The jack-plane is used for a preliminary smoothing of a rough surface. A convenient length is about fifteen inches. It is probable that most of your lumber will have received a preliminary smoothing before you receive it, so that a jack-plane is one of the least necessary tools. The *smoothing-plane* should be about seven or eight inches long, and, as its name implies, is used for smoothing or finishing a surface which has already been given a rough planing.

In the jack-plane, the edge of the front iron may be as much as one-eighth of an inch from the cutting edge, but in the smoothing-plane it must be quite close to the cutting edge.

The chief difficulty encountered by the amateur in using the plane is to keep it level. There is a natural tendency to press down on the back of the plane at the beginning of the stroke and on the front of the plane at the end of the stroke, so that the surface under treatment becomes more or less curved. A little practise will soon overcome this fault.

Saws. The *rip-saw* is used for cutting with the grain, the *cross-cut* or *panel saw* for cutting across the grain. The two saws have differently shaped teeth and one can not satisfactorily be used in place of the other. The cross-cut saw usually has from eight to ten teeth to the inch; the rip-saw from five to eight. The teeth on the rip-saw are usually larger than those on the cross-cut saw, and are ground on a different principle. They really consist of a series of small chisels which chip off the ends of the fibers as they are pushed against them. It follows that the rip-saw cuts only on the forward stroke. The teeth on the cross-cut saw consist of small knives, each tooth having two sharp edges as well as a sharp point. The saw cuts the fibers on both forward and backward stroke. Of the two saws, you will find much more use for the cross-cut than for the rip-saw, as most of your splitting will be done before the lumber reaches you.

There are several other kinds of saws, but the only other for which you will be likely to find much use will be the *keyhole saw.* The best kind to buy is one with removable blades, so that one handle can be used for several blades of different sizes. The keyhole saw is used for cutting curves of all sizes, altho the saw used for larger curves is frequently known as the *compass* saw.

Supplies. *Glue.* What was said about buying tools applies equally well to supplies, and especially to glue: *buy the best.* Good glue, when soaked, will absorb much more water than poor glue, without dissolving.

The best way to prepare glue is to soak it in cold water overnight, then heat it, in a double glue-pot, by boiling water in the outer pot. Add enough water to make the glue fairly thin, so that it will flow easily. Every time glue is re-melted it loses a little of its strength, so it is not worth while to use the same glue more than three times. Use the glue as hot as possible, brush it well into the wood, press the two surfaces to be joined tightly together, so as to squeeze out all superfluous glue, clamp your pieces together whenever possible, give the glue plenty of time to set, and you should have a joint which is stronger than the wood itself.

Ready-made liquid glue can be obtained, and if of good quality will give satisfactory results.

Nails. Nails are of many kinds, but the only kind you will ever need to use will be, in all probability, the wire nail. These are made in a variety of lengths and weights, and can be obtained with flat heads or with small heads very little larger in diameter than the nail itself. Do not let your nails get rusty, and if they do get rusty, do not waste time trying to use them.

Putty. Putty is a mixture of whiting and linseed oil, occasionally containing a proportion of white lead. To prevent putty from hardening before it can be used, remove it from the wrapping paper and keep it under water. The wrapping paper absorbs the oil from the putty, and should not be left in contact with it longer than necessary, while, by placing the putty under water, air will be kept from it, and so hardening will be prevented.

Sandpaper. Sandpaper can usually be obtained in eight grades of coarseness, designated by numbers, 00 being the finest and 3 the coarsest. When sandpapering flat surfaces, use a small block of wood as a support for the paper, folding the paper over the wood.

Screws. Screws can be obtained in all lengths and in various degrees of stoutness, with flat heads or round heads, and made of steel or brass.

Use bright screws, and to make the work easier, use a touch of grease or oil on the point. If the greasy spot which may be produced is objectionable use common soap instead.

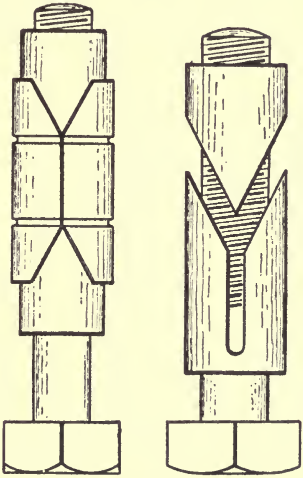
When screwing together two pieces of wood bore a hole in the outer piece sufficiently large to let the screw slip through easily. The size and depth of hole to be bored in the inner piece, must be left to your judgment. It should be sufficiently large to prevent the wood from splitting and to permit the screw to be screwed home without too much effort. With brass screws, unless the hole is large enough there is a danger that the head of the screw may be twisted right off. If, on the other hand, the hole is made too large, the screw will not bite and a poor joint will result. Personal judgment based on experience is the only guide.

For any but fine work, it is permissible to drive the screw in part of the way with the hammer. This will save time and labor, and will result in very little loss of strength.

Some Simple Jobs. No attempt will be made in this volume to give instruction in the manufacture of cupboards, coal-boxes, soap-trays, stools, and the hundred and one small articles with which it is commonly considered the duty of the amateur carpenter to fill his home. Text-books, devoted entirely to carpentry, abound, and in them full details may be found regarding such work. This chapter is intended to help the man who temporarily turns carpenter because he must, rather than because he wants to, and who aims to follow the trade for as short a time as possible rather than to prolong it for the sheer joy of work. There are three jobs which sooner or later face every home-owner—the task of fixing a shelf, or a towel-rail or some other article to a wall; the replacing of a window-cord; and the repair of a lock. We will consider each in turn.

Fixing Things to a Wall. The difficulty of this task depends upon the wall. Where it is of brick the task is simple but laborious. By means of a star-drill (which is a special form of cold chisel) and a hammer, a round hole is cut in the wall which is then plugged with wood, the article being then screwed or nailed to the plug. An alternative scheme is to use an expansion bolt—a screw which fits into an expanding sleeve. The sleeve is let into the hole and as the screw is turned home the sleeve expands more and more, until it grips the sides of the hole, and can not be pulled out.

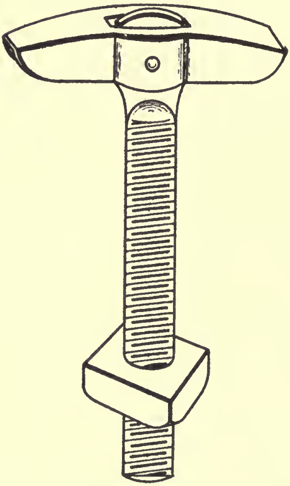
For a hollow-tile wall, the best fastening to use is the toggle bolt. This is a threaded bolt with a hinged cross-piece at one end. A small hole is drilled in the face of the hollow tile, the bolt is introduced into the hole with the hinged piece lying flat on the bolt, which is then turned and pulled outwards, when the hinged piece opens and thus prevents the bolt from being pulled out of the hole.



EXPANSION BOLTS

It is the lath-and-plaster wall, however, which presents the greatest problem. It has been said that there is no best way to fasten anything to a lath-and-plaster wall because all ways are equally bad. This, however, is not quite true. A perfectly satisfactory job can be done provided one drives the screw, or nail, into a stud behind the laths. As in the well-known case of the preparation of jugged hare, however, it is a question of first catching your stud. There are those who profess to be able to discover the location of a hidden stud by gently tapping a wall with a hammer, just as there are those who profess to be able to find hidden waters with the aid of a hazel twig.

There are good reasons for believing that both miracles have been performed, but it is improbable that the average man will have much success at either, and failure to discover the stud is attended with such disastrous consequences to the wall that the method is altogether too risky to experiment with.



TOGGLE BOLT

If you happen to have the plans of your house, and if the carpenter who built it was a man of conscience and skill, and exactly followed the plans, you can, by a few careful measurements, discover at least the spot where a stud ought to be. But even then there is a horrible element of doubt. There is, however, one clue which is usually infallible. Get down on your knees (no, not to pray) and examine the skirting board. The skirting board was fixed before the plaster was applied, and it had to be nailed to something. The carpenter nailed it to the studs, because he could see them. The nail-holes were carefully puttied, and the painter came along later and covered the putty with paint. But the nail-holes can be found—nearly always—and when you have found them you will know that running perpendicularly from the nail-holes to the ceiling there is a stud.

In the case of towel-rails, it will seldom happen that they are of such a width as to fit exactly between two studs, and you will find it easiest and best to fasten a strip of wood to your wall and then fix your towel-rails to the strip of wood.

Replacing a Broken Sash-cord. This is a job which requires patience and care rather than any particular skill. It is necessary to remove the sash which is affected, and if it happens to be the outer sash, both will have to be removed because the outer sash can not be taken out without disturbing the inner.

The first step is to remove the vertical beading on each side of the window. This is best done by prying it out in the middle of the window and removing the nails, when the whole strip can be pulled out. Do not be in a hurry over this job or you will damage the beading. If the cord attached to the inner sash is broken, the sash can now be lifted from the frame. If not, one cord must be detached from the frame, which can then be lifted out.

To get at the outer frame the beading between the two sashes must be pulled out. This is not, or should not be, nailed, so that it is very easy to remove. The outer sash can then be lifted out as far as the unbroken cord will permit.

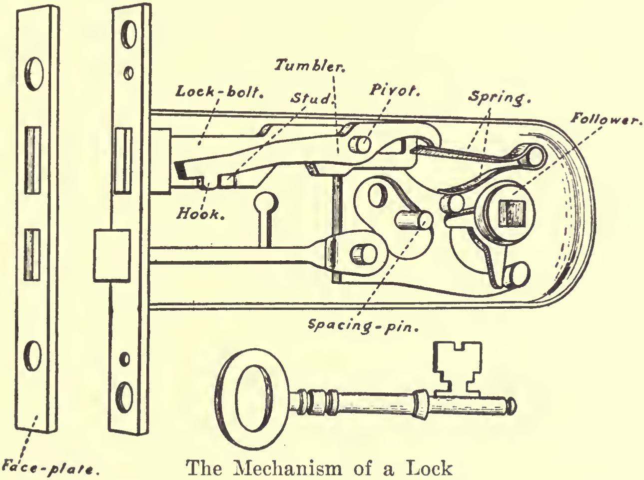
Most windows are built with a movable piece of wood in the frame which can be prized out with a chisel. Remove this piece of wood and you will be able to get at the weight.

Now introduce your new cord into the frame. If any difficulty is experienced in persuading it to pass over the pulley into the sash, a small lead weight should be attached to a piece of string, while the other end of the string is fastened to the cord. The weight is then pushed over the pulley into the frame dragging after it the string, which, in turn, drags the cord.

Sash weights are of various types and you will do well to note the method previously used to attach the cord to the weight. Attach the new cord in the same way, put the weight in position, replace the piece of wood, beading and sash, and then pull the weight up as far as it will come and fasten it by driving a wedge above the pulley, or in any other convenient manner.

Now place your sash in its lowest position, and cut your cord so that it will be taut when fixed to the frame. Attach it carefully, release the weight, and run the sash up and down to make sure that the cord is the right length and that everything is secure. Replace the beading, and the job is complete.

Repairing a Broken Lock. Locks are of infinite variety. The more elaborate are usually best left alone by the amateur, and as they are more substantially made than the cheaper locks, it will seldom happen that they need any repair. The lock referred to here is the ordinary inside door lock, consisting of a beveled bolt, forming the latch, and operated by the door handle, and a rectangular bolt operated by a key.



The Mechanism of a Lock

In locks of this kind, there are usually two, or sometimes three, springs, and the most common trouble in connection with them is due to the breakage of one of these springs. It may also happen that one of the parts will become displaced, causing the mechanism to jam. In either case, the cause of the trouble can be readily discovered by removing the lock.

To Remove a Lock. First, take out the key, and then remove one of the set-screws which fix the two handles to the spindle which passes through the door. This will permit one of the handles to be taken off, and the other handle, still connected to the spindle, can then be withdrawn. Now take out the two screws which fix the cover plate to the face of the edge of the door. This cover plate may be fastened to the lock or may be entirely separate from it. In either case, prize it out with a thin screw-driver. If it forms no part of the lock there will be a second plate beneath it, also attached to the door by two screws. In this case, after removing the screws, prize the plate outwards, as before, and the entire lock can then be withdrawn.

To get at the inner mechanism, place the lock on its side, and remove the screw or screws which hold it together. Remove one of the side plates very carefully, so as not to disturb the parts of the lock. Then examine the lock and familiarize yourself with the position of each piece.

The cause of the trouble will probably now be apparent. If a spring is broken, or weak, remove it and replace it by a new one—which can always be bought at any good hardware store. If a part has become displaced, fix it in position. A broken part will probably mean buying a new lock, but it is worth while to attempt to replace it as spare parts are frequently carried by hardware stores. In any case, before screwing the lock together, remove any dirt from the mechanism and oil the moving parts.

The method of replacing the lock in the door is too obvious to need any description.

CHAPTER IV

HEATING AND VENTILATION

Heat, when it is needed, is the life-blood of the house. And it is needed in most houses from five to eight months in the year. To those fortunate persons who have their abiding places in the semitropical climates, not heat but coolness is the problem. Nine-tenths of the house-owners, however, must have their houses heated in the late fall, winter and early spring.

Insufficient or imperfectly distributed heat destroys the comfort of the home and the happiness of the dwellers therein. One of the first essentials, then, of a comfortable and happy household is correct heating. Fortunately, with a little forethought, this, in most cases, can be accomplished. No phase of house equipment has been more carefully and skilfully studied than the problem of proper and adequate heating, and in none have the results been more satisfactory.

Heat is as old as life itself. Heating the place of abode probably followed close upon the discovery that fire can be produced by artificial means. We can readily picture our remote ancestors of the Stone Age jubilant over the discovery that the fire which cooked their raw meat also gave warmth to their bodies. From this it was but a step to lighting and maintaining fires in the caves and other places in which they lived, for the purpose not only of cooking food but of creating warmth.

The fact that heated air rises and cold air drops was probably discovered by one of the more meditative of our remote ancestors, who had noted the fact that the smoke from the fire in the center of his cave rose and passed through an aperture in the roof, and that a considerable amount of the heat produced by the fire also disappeared through this hole. We can picture him attempting to reduce the size of the opening so that the smoke only would escape. It would not take him long to find that this produced an uncomfortable situation and his next step would only be to provide an artificial passage for the escape of the smoke, in the way of a rude chimney. He would not be long in finding that heat radiated from the walls of this flue itself. This would furnish him with the idea that heat could be produced and retained in a receptacle and made to minister to his comfort.

This great discovery was the basis of our modern methods of heating. In its primitive form, it is exemplified in the old-fashioned "drum" with which many of us were familiar in our childhood, and which is still in use in the more remote parts of the country. The drum was a barrel-shaped enlargement of the stove-pipe from a stove or range, and was usually placed in the second story over the stove below. Excavations in Pompeii have revealed that this principle was employed in the Roman systems of heating. It was likewise used in ancient Greece, where steam or water arising from furnaces below in hollow walls produced heated chambers, or warmed the water in the public and private baths.

By degrees the smoke passage was extended and brought nearer to the fire. The hearthstone was next moved from the center of the room to the side and partly inclosed in the wall until it came to resemble the modern fireplace, and at the same time formed the beginnings of the stove.

The stove and the fireplace were for many centuries the only methods of heating apartments. The Romans employed portable stoves which had no regular exit for the smoke and fumes. Travelers in Spain and Italy will recall with a shudder the braziers of charcoal, which are still the chief means of heating living-rooms in the houses of these countries.

The early fireplaces had no chimneys, and the flues extended only a few feet into the thickness of the wall. There were apparently no chimneys earlier than the twelfth century. The fireplace is the oldest of modern methods of heating, and it became, in northern Europe and other cold climates, an important feature of the development of architecture. It was transferred to America by the earliest settlers, and no one who has visited the old colonial houses in New England needs to be told of the important place which the fireplace played in the life of the people of those times.

It is said that stoves were first used in Alsace in 1490, but not for 300 years did they come into general use as a means of heating. Benjamin Franklin in 1744 invented a cast iron open heater which projected out from the chimney and thus gave out heat from the back and sides, as well as from the front. This stove, with improvements and modifications, is still known as the Franklin Stove and is still widely used. The box stove made of cast iron was invented in 1752, and early in the nineteenth century, round sheet iron stoves were first made. The first base-burner was made in America about 1830, and from that time the different types of stoves were developed.

It is probable that Franklin, in addition to inventing the stove which bears his name, was the first also to construct the hot-air furnace. The first furnace of this type used in New England is said to have been built in Worcester, Mass., in 1835. Heating by hot water dates back to antiquity. Seneca, the Roman philosopher, tells us that the Roman baths were warmed by water running through brass pipes, which were heated by a fire located at one point. After the fall of Rome this method of heating was neglected, until early in the eighteenth century, when it was used in Paris for heating the hothouses in Jardin des Plantes, in Paris. This method was introduced in New England in 1816, and it was used in Canada for some time before it became popular in the United States, where it was not in general use until the last quarter of the nineteenth century.

The possibility of heating by steam was discovered in the middle of the eighteenth century in England, and was not introduced into the United States for a hundred years after. The first building in this country to be warmed by steam heat was the Eastern Hotel of Boston.

Modern Methods of Heating. With this brief historical retrospect into the evolution of heating, let us turn to the more practical question of how we shall best heat our houses and with the most satisfactory results.

The methods of heating fall into two great classes, those of direct and indirect radiation. In direct radiation, the air itself is warmed, as in the case of open fireplaces, stoves and furnaces. In indirect radiation, the air is warmed by passage over some centrally heated surface, usually a furnace, but sometimes a coil of steam or hot-water pipes. Thus direct radiation heats the air already in the room, while indirect radiation brings in the heated air. Indirect radiation is, therefore, also a means of ventilation.

The hot air, steam, and hot water systems are the chief methods for the heating of modern houses, and we will discuss their relative merits under these three headings.

Hot-Air Heating

Heating by hot air still remains, for small houses, the system of widest use. For this there are two reasons. First, it is the cheapest to install, and second, as noted above, it brings fresh air directly into the house, and if the system is working properly, it thus acts not only as heater but as ventilator. By hot-air heating, cold, fresh air is taken from outside the building, drawn through a conduit which ends in an air chamber beneath the heater, and is then drawn up around the fire pot, heated, and distributed through tin pipes through registers located in the floor or in walls above the floor in the rooms to be heated.

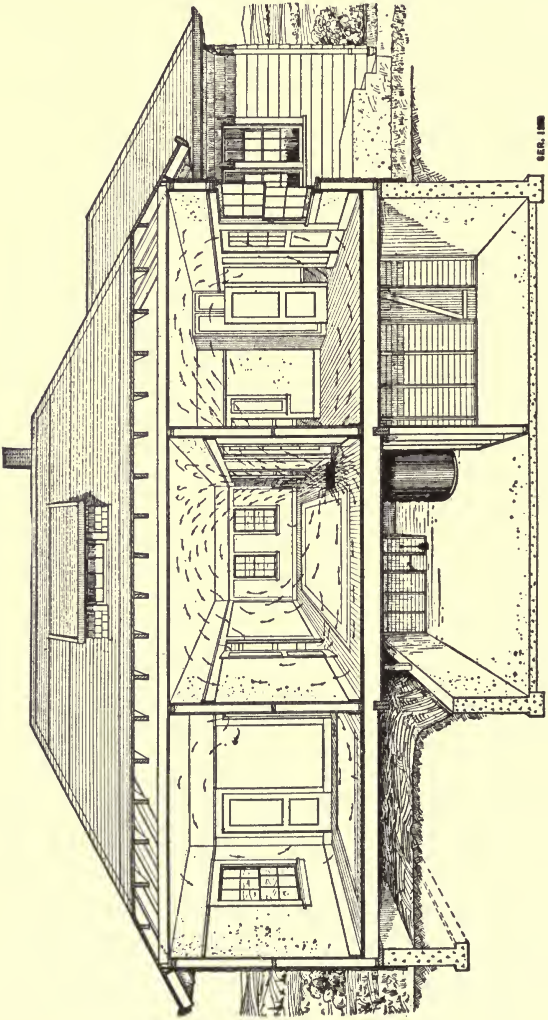
In ordinary hot-air furnaces, fire is burned in a small compartment inside a case, and the air is warmed by its circulation between the inner and the outer cases. Each room to be heated should have a separate pipe line, provided with a damper at the furnace, and each register should be equipped with valves so that the heat may be regulated in the rooms.

It has been found that the small openings in the registers should have an aggregate area at least 25 per cent greater than the area of a cross section of the heat pipe. The supply of fresh air from the outside of the house should be ample. If it is not, the air circulation will be irregular and the rooms will not heat uniformly. The fresh-air box should be made as nearly air-tight as possible, and both the box and the inlet should be kept away from any possible source of contamination. The furnace should be large enough to serve its purpose without being forced, since forced heat is wasteful of fuel and results in overheating the air supply of the rooms.

As the usual thing, the hot-air systems can not be used with advantage in a house of long and narrow proportions, as it is difficult to force the air into the rooms in the direction from which the coldest winds come. For a small square house, however, hot air probably makes the cheapest and most economical system.

The system of hot-air heating has been greatly improved in recent years. Means have been devised for enlarging the surface heated by the fire, so that an additional amount of air can be brought in contact with the hot iron and thus a greater amount carried to the register, without admitting air which has escaped actual contact with the heating surface, and is therefore cold. Provision has also been made for the control of furnace fires by contriving slides in the upper and lower doors, and by a "check-draft" inserted either in the "indirect draft pipe" or in the main smoke-pipe. In most cases, this check-draft acts by admitting more or less cold air to the smoke-pipe or chimney flue, but it is sometimes fitted with a damper, so that when the current is checked by admitting cold air, the smoke-pipe is at the same time partially closed. This produces a double effect.

The Pipeless Furnace. A development in hot-air heating which has come into wide use in the last few years is the so-called one register furnace, known also as the single pipe or pipeless furnace, and sometimes by the name of the device itself, or by that of the manufacturer. The pipeless furnace consists essentially of a heater with a single register, which is located directly above it. This register has two parts, a central portion, through which the warm air passes upward, and the outer portion, which carries the cooler air downward between the outer and the inner casing to the base of the furnace. From there it is circulated upward around the heating surface of the furnace, and out again through the hot air part of the register. The heated air, as it leaves the center of the register, rises straight to the ceiling and "mushrooms" out to the various parts of the



Currents of Hot Air in Pipeless Furnace

house. Thus it is essential that the heated air should have free passage through open doorways in order that the heat may be circulated throughout the house. In this system there is no cold-air box which brings air from the outside. The heat must be supplied to a central room or hallway, from which it passes to the surrounding rooms. The system offers the advantages of economy in installation and in the cheapness of operation. It will be noted, however, that its use is limited to houses in which the rooms to be heated must not be shut off from the others. One of the essential requirements of this system is to install the furnace approximately under the center of the first floor.

The cost of operating this system is in nearly all cases less than that of a warm-air pipe furnace. Economy is effected, as noted above, in the installation, in the saving of pipes and registers to the different individual rooms, and by reheating and using over again the air inside the house instead of continually drawing the air from outside, which requires a greater amount of heat to warm it sufficiently to heat the house.

There are other modifications of the hot-air system to adapt it to meet special conditions. In a house of unusual size, two furnaces, one large and one small, can be installed in a common hot-air chamber. Thus, one furnace can be used in the milder weather and both in the middle of the winter. The fire-pit may be surrounded by a water jacket, in which a certain amount of water can be heated and then circulated through hot-water coils or radiators in the bathrooms or to the most exposed apartments, in which the hot air itself can not be uniformly circulated. In other types of hot-air furnace, the hot-air chamber is divided in the top of the heater into separate sections and each section is connected with a room register, so that each room may receive its intended supply of hot air without regard to the direction of the wind or other conditions.

Operation of Hot-Air System. It is essential for the proper operation of the hot-air system that the flue should be properly constructed and that the smoke-pipe should be as short and direct as possible, the latter, in order to avoid the cooling of the hot smoke and gases and consequent loss of draft. The smoke-pipe should also rise continuously from the furnace to the connection with the chimney. It may, however, be assumed that the contractor who is installing the heating apparatus will do it correctly. Suggestions as to the successful operation of the hot-air furnace will be given in the later section on the operation of furnaces and boilers.

The difficulty of forcing the hot air into rooms so remote that they are not readily reached by the supply from the hot-air furnace, may be overcome by the use of the so-called "hot-water attachment." This is a receptacle of cast iron, or sometimes a coil of pipe which is inclosed in the drum of the furnace, and is kept filled with water. These attachments are connected with pipes which carry the heat to radiators in the rooms to be heated. The attachment adds somewhat to the cost of heating, because it requires a considerably larger amount of coal. This is especially true if the pipes which lead to the radiators come in contact with cold air.

Position of Pipes. It is the first essential for the success of the hot-air system that the pipes which carry the air from the furnace to the rooms are properly placed and of the correct dimension. It is inevitable that a considerable amount of heat should be lost during the journey from the furnace to the register. This is especially true if this heat passes through a long pipe or through cold rooms. In cases where there is unusual exposure, the pipes should either be made double or should be wrapped with asbestos.

In spite of all precautions, it will be found difficult to keep all the rooms of the house at an equal temperature under all weather conditions. Winds easily affect the distribution of heat. The natural tendency of the air toward the lee side during the prevalence of a high wind takes with it the warm currents, through the register, which are distributed freely in the rooms on the side of the house, away from the wind, but do not reach the rooms on the windward side. This result may be remedied to a certain extent by opening the cold-air box, by which the fresh air is taken from the outside, toward the north or west, in order that the coldest winds may blow into it, and thus increase the force of the current through all the registers.

It is sometimes advisable to check the air supply somewhat until the fire is properly started, because a feeble fire may be checked by the circulation of a strong current of cold air through the air chamber. As soon as the fire is well under way, however, the full supply should be restored. Unless this is done, air will be drawn through cracks in the cold-air box, to the cellar, or else some of the registers will lack heat, as in few cases are the cold-air boxes of sufficient size to supply all the registers without the addition of wind blowing into them or from additional air from the cellar.

The area of the cold-air box should equal the sectional areas of all the hot-air pipes, less one-sixth. The fraction represents the expansion of the cold air by the process of heating. If the air-box is smaller than this, a part of the supply of the air to some of the registers should be cut off in mild weather. Unless this is done, some of the registers will draw air down through others less well situated, in order to make up for the lack of fresh air from the outside. This process, however, need be resorted to only in calm weather.

It is a common experience with hot-air heating, that registers in certain rooms, more commonly in the entrance halls, have an insufficient supply of hot air, and, indeed, are sometimes cold. It will be often found by testing that instead of an ascending, there is a descending current of air. This situation is the result of an inadequate supply of air in the furnace or of an incorrect manipulation of the dampers. A little experimenting should result in the improvement of these conditions, if it can not be altogether remedied. The greatest difficulty is usually found with hall registers. In this case, the current of air from the frequently opened doors and from the stairways presses down on the hot air descending from the register and prevents its escape. For this reason, the hall register should be placed under the staircase, when possible, or in some other sheltered position. Where registers have already been placed in an exposed position, a table or other article of furniture placed over them will shelter them from the cold currents and thus increase the supply of warm air.

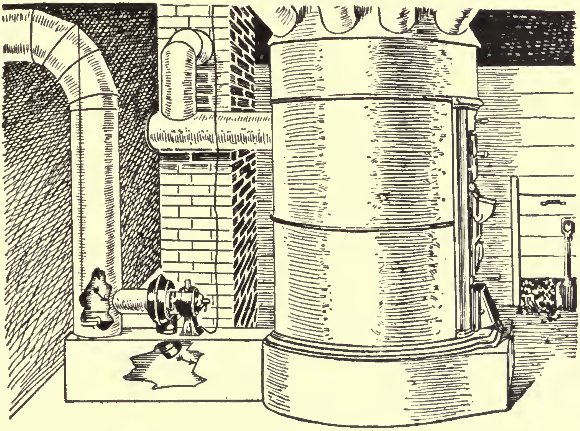
It may be taken as a general rule, that registers located in rooms at a distance from the furnace should be on the side nearest the furnace.

It is a fact to be noted, not only in connection with hot-air heating, but also in indirect steam or hot-water systems, that heated air will not freely enter a room which has no outlet, either in the way of a fireplace or other opening. In modern houses, however, which are, as regards the lower floor at least, practically open, this difficulty is not serious. In upper rooms which are shut off, some method of escape for the air should be contrived, either by the use of a transom sash in the window or by a hole leading into a hall or another room.

An Improved Hot-Air System. A very effective variation of the hot-air furnace has been effected by the use of cast-iron corrugated heat tubes which surround the fire.

The principle of this system is to warm great volumes of air by bringing it into actual contact with very extensive and properly heated surfaces, by dividing the air into as many currents as there are heating tubes. It is more thoroughly and evenly heated than by simply passing a body of air over or next to a hot surface.

There are from 8 to 16 tubes in each generator, according to its size and capacity, and these are placed upright on end in the generator around and on the lower deck and just above the grade surface. The tubes are wider at the back than at the front, forming, when in position, a fire cylinder and combustion chamber, and doing away with the old style fire-pot. The face or straight lower parts of the tubes forming the fire cylinder are 4½ inches wide, 12 inches long, and 1⅛ inches thick. The zig-zag corrugations increase the heating surface and the rays of heat impinge upon them much more readily and



Apparatus for Ventilating Cellar

effectively than they would on a simple surface, or one with perpendicular corrugations.

These corrugations are on the inside of the tubes as well as the outside, and cause the air in passing through to deflect from a straight course, and to become more thoroughly mixed, thereby bringing more of the air particles into contact with the heated surfaces than would be possible with any other construction.

These furnaces are made in different styles, for burning wood, anthracite, and bituminous coal. It is possible by this system to control the currents of warm air, forcing them in any direction by the employment of different dampers. This system is also provided with a ventilating device whereby by a so-called gravity system the fresh air is taken directly from the outside and is passed to the heater through a galvanized iron duct, and connected with the back of the heater. Air passes up through the heat tubes, and being warmed in these separate currents, causes a rapid flow of air through the heat conducting pipes and registers into the rooms.

Steam and Hot-Water Heating

In both steam and hot-water systems, the theory of operation is the same in general principles. In both cases the heat is distributed through iron pipes and radiators which are located in the different rooms, while the unused and cooled steam or water is returned to the heater through a smaller iron pipe, thus maintaining a continuous circulation of hot air or hot water.

The steam system, and especially the "low pressure system," is more economical to install than the hot-water, and, in most cases, is more economical to run. It has, also, an advantage in that the pipes and radiators employed are smaller than those necessary in the hot-water system.

Briefly, in the steam system, a portion of the boiler is filled with water, which is heated to a point when it is turned into steam, which rises into the dome of the boiler, from which pipes carry it to the radiators in different parts of the house. In the hot-water system the boiler is filled with hot water. When subjected to heat, the hotter water rises to the top and circulates to the pipes and radiators, coming back, as in the case of the steam system, to the boiler through the return pipes.

It is generally believed that the hot-water system is more economical because the radiators, even with a low fire, give out a certain amount of heat. As a matter of fact, however, the heat thus produced is so slight in amount that it is useful only in the mildest weather. In colder weather, the slight value of this heat is at once lost by contact with the cold air surrounding the radiator.

Both steam and hot-water systems are made in two varieties, the direct and the indirect. In the former the heat comes from a radiator placed in the room which is to be warmed. In the latter the radiators are in the basement, where they heat a current of fresh air brought in from the outside, which, after warming, is carried to the room to be heated. It is plain that the latter method is the more healthful, as it supplies a continuous current of fresh air. By the direct system, the air already in the room is heated and reheated. Not uncommonly, the two systems are combined. In such cases, the main or lower rooms of the house are heated by indirect radiators in the basement, while the more distant apartments are warmed by radiators placed in them.

There is, also, the so-called direct-indirect system, in which fresh air is supplied to the radiators placed in the rooms, through openings in the wall, or through pipes brought through the floors.

The indirect system is more expensive to install and requires a considerably larger amount of fuel to run. Its great advantage is the constant supply of fresh air. It is, also, less likely to be injured by freezing or by leaking valves than the direct system. The direct system, however, in addition to economy of installation, is easier to manage, as the mechanism is much less complicated.

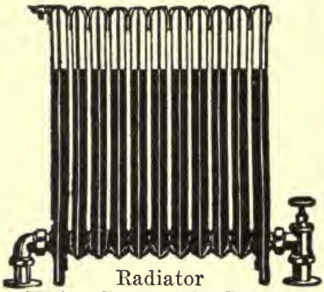
Both steam and hot-water systems are more expensive to install than the hot-air furnace. Assuming that a house could be equally well heated by all three, the steam-heating system would cost from 80 to 90 per cent more than hot air, while the hot-water would be from 100 to 125 per cent more costly. In a large house, however, either system is cheaper to run than hot air, especially if the house is in an exposed position. If the latter is true, steam is probably the least expensive system.

The steam radiators in the larger systems are supplied with two pipes, one of which supplies it with steam, and the other drains off the condensed water and returns it to the boiler. The pipe which carries the water to the boiler is usually smaller than that which carries the steam.

In the case of private dwellings, however, the one pipe system is the more common. In this the steam enters the radiator through the same pipe which carries the condensed water away. Where the pipes in this system are not large enough, the steam rising to the radiators has not room enough to pass easily by the condensed water which is flowing in the opposite direction. The water is thus held or forced back, until a sufficient amount is accumulated to fill the pipe. This cuts off the passage of the steam, which, not able to pass, forces the condensed water before it, until it is propelled against the inside of the radiator, or against a bend in the pipe. This results in the hammering common in steam heating systems. Pressure at times becomes so violent that the radiators or fittings burst. Hammering sometimes occurs also in the two-pipe system, from the collision of the steam with the water which is condensed in the steam-pipes themselves.

It is possible to do away with this hammering of radiators, but it is often an expensive and difficult process and calls for the services of a plumber.

Radiators and Valves. The value of steam as a heating agent is due, first, to its expansion (its volume being increased to 1700 times the volume of the water from which it emanates), second, to its velocity (it quickly flows from the boiler and along the pipes which distribute to the most remote parts of the building which it heats), and third, to its flexibility, the heat and quickness with which the heat may be generated or controlled. Another property of steam which must be understood is that any time that it touches a surface cooler than 212 degrees, it immediately condenses, or turns into water. In condensing, a pound of steam gives up 966 heat units. A heat unit is the amount of heat required to raise the temperature of one pound of water, one degree Fahrenheit. As the surface of the radiator is always cooler, the steam coming in contact with it is always condensing and giving off its heat, and at the same

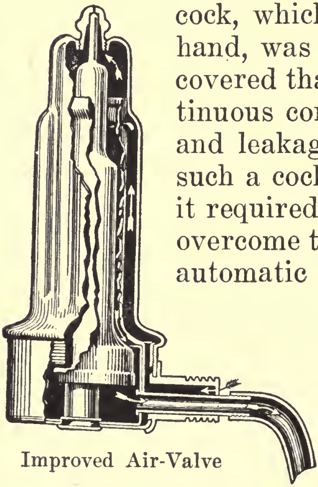


Radiator
White Parts Air Bound;
Means Loss of Heat

time releasing small quantities of air which are entrained with the steam.

When the steam system is started, all the space above the water line, including the radiators and pipes, is entirely filled with air. After the fire is lighted, steam is generated, and because of its expansive property, this steam flows out of the boiler through the pipes, pushing this cold air before it. With the slight increase in pressure, the steam forces the air into the radiators and tends to compress it. It is essential that the steam should enter and heat the radiator which is already filled with cold air, therefore the air must be forced out of the radiator before the steam can enter, and when the air is entirely eliminated the radiator must be at once closed again in order that steam may not escape. Again, when the steam strikes the cold air of the room, it will immediately condense and water will drop on the floors, and if it is allowed to escape in sufficient quantity, will soak through and ruin the ceilings and furnishings of the rooms below. Thus, the problem of steam-heating is, first, to secure and maintain steam in the radiators; second, to get the air originally in the radiators, and that formed by condensation out of it; and third, to prevent the escape of the water formed by condensation or that forced into the radiator because of faulty piping.

To solve these problems is the purpose of the air-valve, the bright nickel valve on the radiator itself. On the operation of this air-valve depends whether or not heat is obtained in sufficient quantities and coal is.burned economically. If the radiator valves leak or hiss, and if the radiators are only half warmed, heat is being wasted. Early in the history of steam-heating it was found necessary to provide some suitable exit for the air, and a small pet-cock, which opened and closed by hand, was used. It was soon discovered that on account of the continuous condensation of the steam and leakage of air in the system, such a cock was unsatisfactory, as it required constant attention. To overcome this condition, a so-called automatic air-valve was designed. That is, a valve that would not only automatically relieve the radiator of air, but would automatically stop the passing of the steam and water.



Improved Air-Valve

Most of these valves are constructed with an expansive member, which elongates upon contact with steam, thus closing the vent port. Because of the fact that there is no uniformity of expansion, it was necessary to provide for an adjustment by hand after installation. In almost all of these automatic valves, a hard rubber valve or tube is used as an expansive measure. On account of the fact that it is almost impossible to control the fire in the steam-heating apparatus so as to maintain a constant steam pressure, it is difficult to regulate this automatic valve properly, and readjustment is sometimes necessary if the full value of the steam is to be received and waste avoided.

There has been perfected a type of siphon air-valve which is automatic and non-adjustable, and which completes its function without steam or water leakage. These valves close up at once as soon as water surges into the radiators or steam reaches the valve. The valve permits the free discharge of air or condensation from the radiator, but closes off the vent-port immediately upon steam contact. It is also claimed that they eliminate hammering and other noises in pipes because the valves are wide open as long as there is air in the radiator. These valves are adjusted when they are manufactured and need no further attention, and they can be placed on any radiator in which the customary valve has been used.

Vapor and Vapor-Vacuum Systems

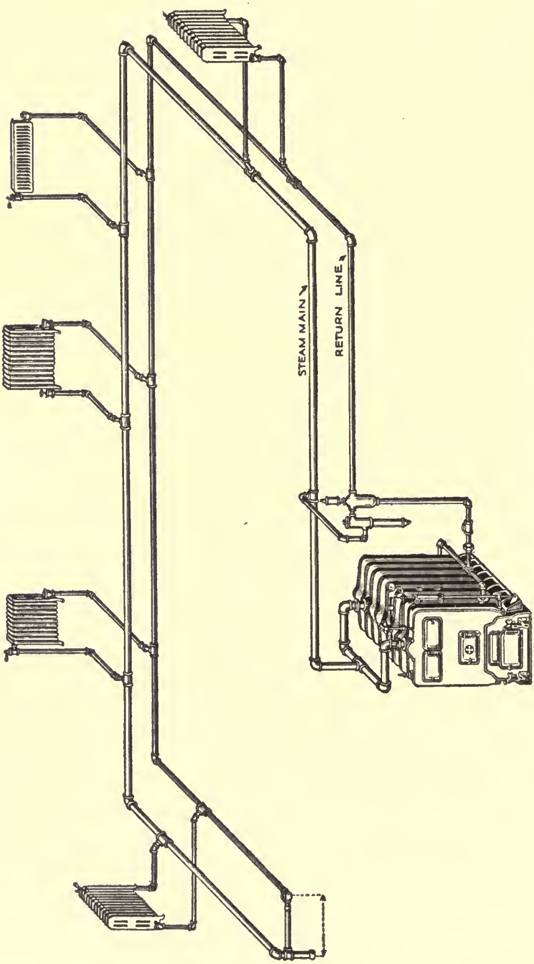
Vapor systems are so called because steam or vapor is generated in well-designed systems under very low pressures. The usual pressure is just sufficient to overcome the frictional resistance in the pipe-lines, and is measured in ounces, while in one-pipe systems pressure is always referred to in pounds.

In all steam systems, the venting of air from the radiators is the pressure-controlling factor in addition to the size of pipe-lines. In ordinary one-pipe systems air must be released through the small vent-ports of the radiator air-valve, and to do this considerable pressure is required because of the high frictional resistance to flow through the small orifice. It will, therefore, be seen why in one-pipe gravity systems pressures of from one-half to two pounds are usually carried.

In Vapor Systems air is released from the radiators through a return-line valve- or radiator-trap into the return main, and then conducted to a point near the boiler where the air is released through a large capacity venting-valve which offers little resistance to flow of air into the atmosphere.

The valve at the end of the radiator, which controls the release of air, likewise permits the condensed steam to flow into the same line as the air, but as soon as the radiator is filled with steam and the thermostatic member of this return-line valve comes in contact with the steam, the vent port is automatically closed and held so until such time as a small quantity of water collects in the valve and cools the thermostat slightly, which then causes the vent-port to open and release the condensation without steam loss. As soon as the condensation is discharged from the valve, contact with steam again takes place, and the thermostat is closed until a repetition is necessary. In most systems, the condensation is delivered to the valve at a temperature which is low enough to cause a slight opening of the vent-port, and a continuous discharge of water takes place as long as there is no steam contact.

On the inlet side of the radiator various types of valves may be used, but the latest, the most satisfactory type, is known as an adjustable modulating valve. In a valve of this type it is possible to so adjust the valve externally when installation is made, that a sufficient quantity of steam is admitted to the radiator to fill it entirely when a certain predetermined pressure is maintained at the boiler by means of a sensitive damper regulator. With proper adjustment, the user can then control, by means of a lever and graduated dial, the exact amount of steam which is admitted to the radiator. For example, if the lever is set so that "½" is indicated on the dial, the radiator will be half filled with steam, or on extremely warm days by turning to "¼" a small amount of steam is admitted to the radiator, and only one quarter of the surface heated. Through this method of adjustment various amounts of radiating surface can be



Vapor-Vacuum System of Heating

heated from a closed valve to a wide open one which will give full heating capacity.

The advantages of a system of this sort, in addition to the possibility of modulating at the will of the user, are the facts that air is not vented into the room, and the coal economy which results from generation of steam under pressures only slightly above atmospheric.

Vapor-Vacuum Systems are similar in appearance to the vapor systems with one exception, that is, the type of vent used on the return main. In vapor systems this vent is normally open while in vapor-vacuum systems the vent-port is maintained closed except when a certain pressure is generated in the return main when air is released. In a closed system the air throughout the system is first compressed to a pressure of 4 to 6 ounces, which is sufficient to open the vent-port on the return main valve, and flow of steam then takes place to the radiators, and upon closing off the ports in the thermostatic return-line valve, through steam contact, the return main pressure will go down below 4 ounces, and the vent-port of the valve will automatically close because of lack of pressure. If generation of steam is stopped due to the banking of the fire, with a closed vent-port on the return main, a vacuum will form in the system which will cause vapor to be generated under pressures below 212 degrees upon the next firing. For example, if there is a 10″ vacuum on the system, vapor will be generated at a temperature of approximately 194 degrees, while if a 15″ vacuum is maintained, the vaporizing temperature will be 176 degrees. From this it will be seen that if the air is once vented, generation of vapor will take place under lower temperatures, and, consequently, the efficiency of the system will be increased to a large extent. Of course the important factor in Vapor-Vacuum systems is the tightness at all joints. In a well-installed system, there is no necessity for generating a pressure above atmospheric for 3 or 4 days at a time in cold weather, altho if there are excessive air leaks it may be necessary to generate a pressure of from 4 to 6 ounces every morning and the remainder of the day operate under vacuum conditions. If daily venting is a necessity, the economies which are obtained make systems of this sort well worth installing.

Hot-Water Systems

Boilers for both steam and hot-water systems are made of cast iron. They are sometimes manufactured in sections, so that the power of the boiler can be adapted to the necessary amount of heat required. The same type of boiler is used for hot water as for steam, except that the safety-valve and other accessories made necessary by the use of steam are omitted. Hot-water heating has an advantage over the steam in that while the latter requires a temperature of at least 212 degrees before steam can be formed, with hot water, as the water itself furnishes the heat, it can be produced much more quickly. It is, also, possible to vary the heat by the hot-water system to adapt it to the condition of outside temperature. This is difficult in the case of steam. The temperature of a steam radiator can be varied only within narrow limits, for if it heats the room on a cold day in winter, it will give out too much heat for the same room in milder weather. There is no way to produce less heat, and the only alternatives are to shut off the heat altogether, or to open the windows, both of which are often inconvenient. There are, to be sure, devices, such as double radiators, in which only one half may be used at night, but these are expensive to install and greatly increase the cost of operation.

While the hot-water system, perhaps, is less oppressive than steam heat, owing to the lower temperature of the heating surface, it affords no means of ventilation. In order to remedy this, indirect radiators are sometimes placed in the basement and the fresh-air current is passed through them.

As the hot-water radiators give out less heat than the steam radiators, they must be proportionately larger in order to obtain sufficient power for the coldest weather. This makes the system more expensive to install, and more bulky, but the system on the whole, when properly adjusted, gives excellent results with comparatively small expenditure of fuel.

The heated water from the boiler in the hot-water system usually ascends to a tank at the top of the house. From this the pipes descend supplying the radiators. Thus, the force gained by the elevation of the tank above the system is sufficient to force the water through the pipes. Theoretically, the force of the water falling from the tank is sufficient to propel the water past doors or under floors; or the radiators are sometimes fed from the upward current. In either case, the whole system should be so arranged that any air bubbles in the pipe will rise to the expansion tank and escape. When the systems are imperfectly installed, traps often occur in which these air-bubbles lodge. In such cases air-valves must be used to release them in order to prevent the circulation from being stopped and the radiators or pipes from becoming chilled. Failure of a radiator to heat is usually caused by a stoppage in the flow of water from a bend in the pipe or from an accumulation of air-bubbles.

In the two-pipe system, care should be taken to have both pipes either open or closed at the same time. If the return-pipe is left open while the steam-pipe is closed, water will be drawn from the boiler into the radiator, as the result of the vacuum left in the radiator by the condensation of the steam remaining in it.

There is always danger of freezing in the hot-water system, as the radiators can not be entirely emptied of water. A small fire in the boiler, however, will be sufficient to keep the water in them warm. In order to prevent freezing in a hot-water radiator, care should be taken in cold weather to be certain that none of the radiators are shut off, by closing the valve which leaves the radiator full of water.

Safety Devices on Steam Boilers. All steam boilers are equipped with three safety devices, a pressure gage, a safety valve, and a water gage, for it is necessary, first, that the operator shall be able to see at once what pressure the boiler is carrying; second, that under no condition shall the steam pressure become greater than that which the boiler is intended to carry; and third, that the water in the boiler never gets below a certain level.

The Pressure Gage. The purpose of the pressure gage is to indicate the steam pressure on each square inch of the boiler. Its essential parts are: A curved, somewhat flexible, metallic tube, this tube connected by a small pipe to the boiler; hinged to the free end of the curved tube is a short connecting rod, the other end of the rod hinged to one end of the lever, the opposite end of the lever carrying a circular set of cogs; these cogs on the end of the lever mesh into the cogs on the cog-wheel, which carries the pointer or index.

As the steam pressure rises within the boiler, the pressure tends to cause the curved tube to straighten out. The tube then pulls up on the rod. The rod lifts the right-hand end of the lever. The cogs at the other end of the lever cause the cog-wheel to rotate clockwise. The index points to a scale printed on the face of the gage. There is always one atmosphere of pressure on the exterior of the boiler. Now the pressure gage indicates the excess of pressure, i.e., the pressure over and above one atmosphere, on the inside of the boiler.

The Safety Valve. Safety valves are of two types: The Ball and Lever type and the Pop-Valve type. In the ball and lever type, the valve is held down by the weight of the ball upon the lever. The pressure is increased by slipping the ball farther out on the lever.

The valve in this case is held down by a spiral spring. The top of the spring rests against a metal washer. This plate may be forced farther down by turning down the screw. The spring then holds the valve down against a greater pressure. In each type, the valve opens and allows some steam to escape as soon as the pressure within the boiler exceeds the amount for which the valve is set.

The Water-Gage. The purpose of the water-gage is to enable the operator or engineer to see exactly how high the water stands in the boiler. The gage is merely a strong glass tube mounted on the side of the boiler at the height at which the water should stand. This glass tube is so connected at both its top and its bottom that the water stands within it at the same height as it stands within the boiler. This gage is of the greatest importance, for the person in charge must never permit the water within the boiler to get lower than the bottom of the gage. The danger from an explosion is very great if the water is permitted to get too low in the boiler.

Water in the Boiler. It is commonly thought that the water in a steam or hot-water boiler should be drawn out at least once a year, and the boiler refilled. This is true where the water is likely to be impregnated with oil or other extraneous matter, but where this is not the case, change of water is not necessary. The addition of fresh water adds to the rusting of the pipes. When the water has once been heated and the gases which occur in fresh water have been driven out, it will not cause rust.

Thus, when the boiler has been filled with water which has been heated, no fresh rusting will take place for years, so long as it remains filled with the same water. Losses of water will occur in the hot-water system from evaporation from the expansion tank, and in the steam system, from leakage, and the water thus lost should be replenished from time to time. Where the water contains a considerable degree of sediment, this should be drawn off at the lowest part of the system to prevent clogging.

In houses of ordinary size a round fire-pot or boiler is more economical of fuel and easier to run. In larger houses, it is necessary to have a size of heater so large that the circular fire pot is not available.

Other Developments in Heating Systems. A comparatively new type of steam and hot-water heater is called by its manufacturers the Heat Machine. While its general principles are similar to those of the regular boiler, an effort has been made to improve the type, both in appearance and in heating efficiency. This apparatus has a revertible flue which enables the maximum of heat to be extracted from the hot flue gases with a minimum of resistance. It has also an exceptionally thick metallic jacket with asbestos lining, which insulates the boiler against loss of heat due to radiation and prevents the waste of heat in the cellar. The machine is provided with automatic regulation. The chief merit of this system is that the boilers are attractive in shape and design, and can be fitted to any sized house and can be placed in a basement too shallow for the ordinary boiler. The boiler is composed of a number of cast iron sections. Each section is provided on both sides with latterly extending peripheral ribs, and internal fins which register accurately with the corresponding ribs and fins of the abutting sections and form the outgoing and the downcoming gas flues. The joints are made tight and there is a single base joint, which does away with all possibility of leakage of air. All surfaces subjected to the action of hot gases are vertical, and consequently offer no support for the accumulation of ashes, soot, etc. This apparatus requires a comparatively small space and may be installed not only in the basement but in other parts of the house. It is claimed by its manufacturers that this type of boiler represents a considerable saving in fuel.

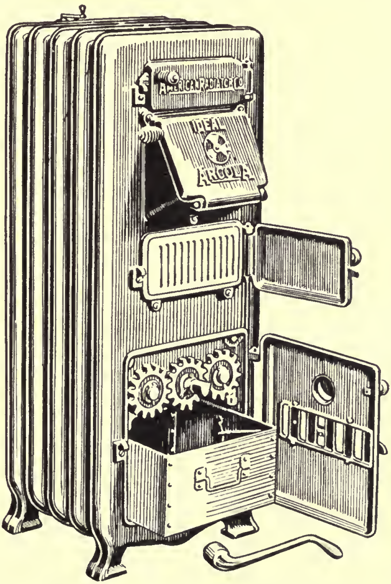
Considerable attention has been given recently to methods of so-called floor heating, and it is not uncommonly employed in churches and other large buildings. It may also be applied to houses, altho it is expensive to install. Through this system the heating pipes run under the floors. Both hot-air and steam may be used.

Gas-Steam Heating

Another valuable development is the so-called "gas-steam" radiator. This is, in effect, an individual radiator producing steam-heat by the use of gas, which may be supplied from ordinary gas jets or from special jets placed conveniently for the purpose. The radiator is provided with a receptacle for holding water, which is heated to the boiling point by the lighted gas, which is distributed through a tube. One of these radiators is sufficient to heat thoroughly one or more rooms. Systems have been installed successfully in large buildings. The advantages of the system are apparent. It does away with the use of coal and its attendant discomforts, and the radiators may be moved from room to room, heating only such as are desired. Whether its operation is cheaper than that of the ordinary heating system, depends entirely on the amount of gas used and the price paid for it. The manufacturers claim, however, that the operating cost is decidedly less than that of steam, hot-air, or hot-water heating.

Combination Boiler-Radiator

Still another development of value is the combination boiler and radiator. In this system the boiler, which resembles a radiator in many respects, may be placed in any room in the house which has a chimney flue. The boiler-radiator has all the essentials of a hot-water boiler. In its general purpose it is like a stove, in that it heats the room in which it is placed. It is unlike the stove, however, in that the spaces between its hollow or double walls are filled with water which expands as it is heated and circulates through connecting pipes to hot-water radiators in adjoining rooms. The water rises as it is heated, and as it cools in the radiators, the cooler, and therefore heavier, water returns to the boiler to be reheated over and over again.



Combination Boiler and Radiator

It is possible to operate this system by connection with outside water supply, or the outfit may be filled with a bucket at the expansion tank which is provided. This system is particularly applicable to small houses and cellarless bungalows. The radiators are made in sections, or units, so that if buildings or rooms are altered in size, or extra rooms are added, extra sections may be added at any time to suit the new heating requirements. Its manufacturers claim that a large saving of coal, a very valuable feature to the average house-owner, is possible in operating this outfit. By attaching a boiler to it, a very satisfactory hot-water supply is constantly available.

Heating by Gas. Heating by gas has been developed in recent years, but its use is practically limited to portable heaters and to fireplaces. The heating of residences exclusively by gas by means of a heater located in the basement is, at current prices for gas, rendered impracticable by the high cost, as compared with heating by coal or oil. The fireplace heaters have been perfected so that they not only give out a considerable amount of heat but are attractive in appearance. Wall-pocket heaters are one of the latest developments of the gas-heating system. This heater is designed for use in bedrooms and bathrooms where the floor space is limited. It can be placed in any wall which has a depth of four inches or more. There are many varieties of portable gas-heaters, and in houses which require little heating, they may be effectively used.

There are other refinements and developments in the science of heating which the prospective house-owner should investigate before deciding upon the method or system used in his house. In any event, no system should be adopted without consultation with an impartial expert as to the best method suited to the size and construction of the house.

The Use of Oil as Fuel. The high price of coal, following and continuing after 1917 and 1918, drew renewed attention to the possibility of using oil as a fuel in furnaces. Several very satisfactory systems were evolved, and these may be employed with any heating system. A typical system of this sort includes: 1, a thermostat; 2, an electrical control box attached to the blower and electrically connected to the thermostat; 3, a blower or atomizer; 4, a combustion chamber housing an ever-burning pilot light; and 5, an oil tank. Thermostatic action causes the blower to act, drawing up the oil before a fan, which blows it into a cool spray within the combustion chamber where the pilot light ignites it.

The requisites for employing this system are a good heating plant; a direct electric current, as electricity is required to operate the blower; and a small supply of artificial or natural gas to supply the pilot light in the combustion chamber. The oil system replaces the coal fire with a smokeless flame of oil, which burns in a square combustion chamber. To install the system it is merely necessary to remove the fire grates and ash door of the furnace, insert the combustion chamber through this door, and let it rest where the fire-grates were. Whatever air space remains open in the neighborhood of the ash door should be closed partially with bricks, concrete, or hard clay. Kerosene is the best oil for use in this burner. Crude oil or coal-tar can not be used. The claim is made that the use of this oil-heating system results in a considerable saving of fuel expense. It has also the advantage of cleanliness and ease of operation.

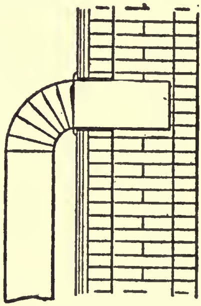
Operating the Heating System

Assuming now that the house-owner has installed the system of heating desired, it will be necessary for him to find, by experiment, how it can be operated most efficiently and economically. There will be times when a furnace will seem to be as temperamental as a prima donna, and this usually when it is most desirable that it should operate effectively. In most cases, however, it will be found that failure to operate properly is due to the fact that the fire-box needs a thorough cleaning out, or that there is a stoppage somewhere in the flue.

The Flue. It is very essential that the chimney flue should be properly constructed, if the boiler is to have the proper draft. The flue should be not less than 9″ or 10″ round if it is circular, or 8 x 12 if it is rectangular. For a very small heating boiler or tank heater, an 8″ round, or 8 x 8 square flue will be sufficient if it is high enough. The flue should have a little more area than that of the smoke-pipe leading from the boiler. The value of a chimney flue depends on the volume of the passage due to its area and the velocity due to its height. Velocity alone is not proof of good draft. There must also be sufficient area. The chimney top should run above the highest part of the roof, and should be so located with reference to higher buildings nearby that the prevailing wind will not form eddies which force air down the flue. Often the shifting cowl, which will always turn the chimney outlet away from the source of adverse currents, will promote a better draft.

The flue should run as nearly straight up from the base to the top outlet as possible. It should have no openings in it except the boiler smoke-pipe. Sharp bends and offsets in the flue will often reduce the area and choke the draft. The flue must be free of any feature which prevents a free area for the passage of smoke. The outlet must not be capped with any device which makes the area of the outlet less than the area of the flue. The best form for a flue is a round tile. There is less friction than in the rectangular form, and the spiral ascent of the draft moves in a most natural manner. A flue of round tile joints must be tightly cemented, or all spaces between the tile and brick work filled in tightly. There must be no open crevices where the sections lap, otherwise the draft is checked.

A flue made of brick only should be in a stack of at least two 4″ courses in thickness to insure safety. If there is a soot pocket in the flue below the smoke pipe opening, the clean-out door should always be closed. If this soot pocket has other openings in it (from the fireplaces or other connections), they check the draft and prevent the best action in the boiler. There should be no leaks around the smoke-pipe where it joins the smoke-hood of the boiler or where the pipe enters the chimney. The joints should be made tight with boiler putty or asbestos cement. The inside of the fire should be "pointed" and smooth. A new chimney may not draw well, but as soon as the mortar dries, better results will follow. The boiler must have a proper inlet draft.



Pipe Too Far in Flue; Cuts Off Draft

Fuel. A satisfactory fire can not be maintained unless the fuel used is of a sort adapted to the furnace, and is up to the proper standard of quality. While it is common knowledge that there are standards of measurements, weight, capacity, etc., it is less widely known that there is a standard of heat called a "thermal unit." This unit, which is technically known as the "British thermal unit," is the quantity of heat necessary to raise one pound of water 1° F. In other words, to raise 100 pounds of water 1° F. requires 100 British thermal units of heat. If it is desired to raise 100 pounds of water 12° F., then 1,200 British thermal units will be expended. One pound of coal, if it contains no incombustible matter, has an equivalent of, approximately, 14,500 British thermal units. Government tests have shown that well known veins of coal in the United States contain about 12,000 British thermal units per pound. It is generally agreed that in order to induce the best draft in the chimney, that is, to supply air for the proper combustion of the fuel, requires about 25 per cent of the fuel or about 3,000 British thermal units a pound of coal. Thus in the average quality of coal, there is available for heat distribution to the rooms to be warmed, the net amount of 9,000 British thermal units per pound of coal. For house-heating use, coal should be selected which is known to have a capacity for about 12,000 British thermal units per pound.

Unfortunately, however, coal is not customarily purchased in accordance with its heating value. The United States Government, to be sure, purchases coal on this principle, but the ordinary user has no method of determining the heat value of the coal which he is purchasing. He will learn by experience that if the coal which he is using seems to be inferior to that used previously, it contains slate, ash, and moisture, which, of course, will not burn. A common indication of a poor quality of coal is clinkers. The time may come when a law similar to the Pure Food Law will be passed, which will insist that coal-dealers supply coal containing the proper burning values.

Anthracite coal is commonly used where it is available. For the average draft, the so-called "stove size" proves most satisfactory for round or square heating boilers and furnaces. If the draft is unusually strong, better results may be secured by mixing in a proportion of a smaller size such as "chestnut" or "pea" with the stove coal. This mixture packs the coal more closely in the fire-pot and prevents too rapid combustion. If the draft is weak, larger sizes than the "stove" may be mixed in and thus provide more liberal passage of air in the fire-pot, producing more active combustion.

Soft coals have widely varying heat-making qualities. Such brands should be selected as have a reputation for good heat-making results. Two types of soft coal are used in heating boilers and furnaces: the "free burning" coal, which breaks apart when burning, allowing the bases to burn freely, and "caking" soft coal, which fuses into a solid burning mass with a hard crust on top, coking slowly as it burns. The "caking" coal is more valuable for house-heating use because the gases are more thoroughly consumed. The gases from soft coal should pass off slowly. The air inlet on the feed door of the furnace or boiler should be left open while the gases are passing off. If possible, uniform sizes of soft coal should be used, and coal having too much dust should be avoided. While the so-called "run of the mine" coal may be less expensive, its heat-making value is much lower. In feeding "free burning" coal on an old fire, the coked fuel or live fire should be raked to the back of the fire-pot. The front part of the pot should then be filled with fresh coal. "Caking" soft coal should be broken up by the poker before more is added. Then the fire-pot should be filled, leaving some of the live coals uncovered, if possible. This exposed fire should be in the rear, so that the fresh coal gases will pass over the hot coal and burn, thus extracting a larger amount of the heat value of soft coal, and with less smoke. When soft coal is used, the boiler flue should be cleaned daily with a wire brush and scraper.

Cleaning the Furnace. Every furnace contains certain openings for the purpose of cleaning the heating surface. These openings vary in position in accordance with the design and construction of the furnace. The openings are usually supplied with small iron doors which are made as nearly air tight as possible, and, if they are properly adjusted, will not materially affect the drafts. The clean-out doors will be found usually at the back and the side of the furnace. These doors should be removed and the accumulated ashes and dust taken out before the furnace or boiler is started each year. In steam and hot-water boilers, the space between the inner boiler and the outer casing frequently becomes completely filled with ashes or dust. This interferes with the proper radiation of heat, and, if it is found that this accumulation goes on rapidly, the clean-out door should be opened at intervals and the matter removed. There will be found in most types of boilers and furnaces a so-called "clinker door" just over the door from which ashes are removed. This usually is a long narrow opening through which a poker may be thrust underneath the fire. Its purpose is to allow the clinkers or lumps of melted ashes, which are likely to collect above the grate, to be pulled out or broken up with a poker with a hook at the end, which is provided for this purpose.

If "dirty" coal is used, clinkers will be a great bugbear. Clinkers are nothing more than melted ashes or other unburnable matter. They come not only from impure coal, but often from wrong methods of running the fire. Too much draft from below and too little from above, in the case of a hot fire, will melt the ashes and cause them to form into a solid mass of clinkers. It is a common custom to open the lower drafts of the furnace in the early morning without having shaken down the fire, and to remove the ashes. This method will produce clinkers very expeditiously.

Another cause of clinkers is the burning of cinders or half-burned coal. These produce a very hot fire, and the result is likely to be the coalescence of the material in the fire into one immense lump of clinkers, sometimes so large that it cannot be removed through the furnace door. And when it is thus removed, the fire is removed along with it.

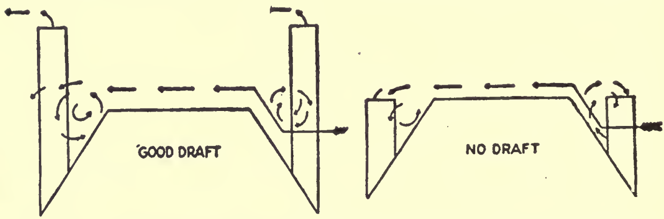
It is a common belief that ashes should be carefully sifted and the solid matter remaining should be burned again. As a matter of fact, coal of proper quality burns up so thoroughly that nothing is left which can be burned. If a large proportion of unburned coal is left in the ashes, either the furnace is not working properly or the coal is of an inferior quality. The remedy is an adjustment of the furnace, or a better grade of coal. The only practical method of obtaining material that will burn properly, from ashes taken from the furnace, is to pick out with the fingers such pieces of coal as plainly have not been burned. This process will be a trial of patience, and it will usually be the decision after one or two experiments that the results obtained are not worth the effort.

It should not be necessary to shake a fire more than once or at most twice a day, in the morning only, or in the morning and night. Most beginners have a passion for violently shaking the fire in order to "wake it up." A more likely result will be its failure to revive, or endure under these manipulations. The fire should be shaken gently until bright coals appear on the grate. The ashes should be removed before they accumulate under the grate. If the ashes partially or wholly fill the space under the grate, they interfere with the draft and, also, under some conditions, will burn out the grate. Boiler surfaces and flues should be kept clean at all times. Accumulation of ashes or soot causes the boiler to require much more fuel than when the surfaces are cleaned. If as a result of burning inferior coal the grate becomes covered with clinkers, a most satisfactory method to obtain an active fire is to dump the grate and build the fire anew. If a hard clinker lodges between the grate bars, do not attempt to take it out by violently shaking the bar. The mass should be dislodged with a poker or slicing bar. The grate will then operate without breaking. Do not clean the fire from the top or attempt to remove the clinkers through the feed door. Do all the cleaning through the clinker door, or by shaking and dumping the grate.

Feeding the Fire. To produce the most satisfactory results the fire-pot should be kept full. The coal should come up to the feed door, and a trifle higher as it slopes back. It is a temptation, after the fire has been well started, to feed it by driblets of coal, just sufficient to keep it burning brightly. This is an excellent method of wasting coal without obtaining the proper amount of heat. When a fire has once thoroughly started, it should not be poked or shaken during the day. The feeding and shaking should be done at regular intervals. In severe weather the boiler should be given careful attention late at night, when the grate should be cleared until it is bright underneath and the pot filled full of coal. In mild weather, the fire should not be overshaken or poked. It should be shaken enough only to make a place for a little more fuel. A hard-coal fire should never be poked from above. Much fuel may be wasted in mild weather by feeding the fire-pot and shaking the grate as in zero weather.

The following directions for running the steam outfit are supplied by one of the largest manufacturers of steam-heating apparatus. Much of it applies equally to the running of hot-air and hot-water systems.

The Necessity of a Good Draft. The draft to the boiler, that is, the air supply to the grate and the chimney flue, must be thoroughly correct to obtain good results. The boiler, under a sluggish and timid draft, burns more coal than a boiler under a good draft. The gases rising from the coal as it takes fire must mix with the proper amount of air to burn them, otherwise



these rich gases pass off unburned, and fuel is wasted. The prodding usually given a boiler under poor draft increases the fuel waste. A boiler under a strong draft keeps up an intense fire and burns the gases as fast as released from the coal. Thus, instead of losing the heat-making gases up the chimney, the heat is employed in its proper function of supplying warmth to the house.

Free Air Supply. The boiler should be set in a room or cellar which permits the circulation to supply all the air needed to the grate and fire-chamber. If a boiler is placed in a small room or tightly closed cellar, the fire is smothered, and heat making is hindered. A lack of heat is often corrected by opening a door or window leading into the boiler-room, thus giving the boiler an ample supply of air to make the heat.

General Rules for Steam and Hot-Water Systems. Do not build a fire until the water supplied to the boiler stands about half-way up the gage-glass. Add enough water occasionally to keep it at that point. Never feed water into the boiler when it is empty with the boiler hot. To fill the boiler, open the heat-cock when the heater is connected with an outside water supply. If not, fill through a funnel. Let the water run until the gage-glass shows about one-half full of water. After the system is in working order, the boiler should be "blown off" under pressure, in order to remove the oil and sediment. This had best be done by the steam-fitter who is installing the system.

The water-glass should be examined occasionally to see that the water is at the proper height. If lower than normal, the supply pipe should be opened until the water stands about half-way in the gage-glass. When no water shows in the glass, or at the bottom tri-cock, the grate should be dumped quickly, and water should not be put into the boiler until it has cooled.

When coal is fed to the boiler, the choke damper, which is inside the smoke-hood or smoke-pipe should be opened, while the check-draft damper, which is usually on top of a round boiler and in the rear of a square boiler, should be closed. It is sometimes necessary to change the position of the regulator-bar which operates the automatic draft in order to do this. This should be replaced after feeding. The opening of the choke-damper and the closing of the check-draft damper makes a draft through the feed-doorway, and prevents the escape of dust and gas to the cellar when the feed-door is opened.

Steam-boilers are provided with a pressure regulator which automatically controls the draft. A little experience will determine the proper adjustment of this regulator. To increase or lessen the pressure of a steam-boiler, change the weight of the regulator-bar, steadying the hold at a point where it will control the tilting draft-door to hold steadily the pressure desired. After the regulator has once been set, the draft-door should be left alone. The chains running from the bar of the automatic damper regulator should be fixed so that the tilting draft-door on the ash-pit is closed before the check-draft chamber begins to open. The chain between the regulator-bar and the check-draft damper should be a little slack when the tilting draft-door is opened a little and the check-draft chamber is shut. The choke-damper in the smoke-hood or smoke-pipe should remain open as much as the draft permits.

In order to obtain steady heating and economy, the chains on the regulator should never be unhooked from the bar: any adjustment of the damper should be made by setting the weight on the bar so that the regulator will control the damper to produce the steam pressure needed. The weight should be so set that the tilting draft-door is opened just enough to produce the pressure desired.

In order to obtain economy in fuel and the best heating results, the air admitted for draft should all pass through the tilting damper-door on the ash-pit. All joints below the bottom of the grate should be thoroughly cemented to prevent extra uncontrolled draft. If the fire burns out too quickly, it may be that these joints are not tight. The slide in the feed-door should be opened just enough to supply sufficient air over the fire to mix with the coal gases and burn them. The amount of air depends on the draft and the care of the fuel used.

The rules for operating the steam-heating system apply in general to the hot-water system also. A few general directions in regard to the operation of the latter system may be given. In filling the hot-water outfit, see that all the air-cocks on the radiators are closed. Then turn on the water, if it is obtained from an outside source, or if not, fill at the funnel. Beginning with the lower floor, the air-cocks on the radiators should be opened one at a time until each radiator is filled. The air-cocks should then be closed and the radiators on the next floor treated in the same way. This should be continued until all are filled. When the water shows half-way in the gage-glass of the expansion tank, it should be shut off, and, after the water is heated and in circulation, the radiators should be vented by opening the air-valves as before. Water should then be added until it rises half-way in the tank gage-glass.

The outfit should always be kept full of water unless the building is vacant during the winter months. In that case the water should be drawn off to prevent freezing. Never draw off the water while there is fire in the heater. To draw off the water, open the draw-off cock at the lowest point in the room. Then beginning with the highest radiators, open the air-cocks on all radiators as fast as the water lowers.

At the close of the heating season, the grate and all the flue surfaces of the boiler should be cleaned out. The smoke-pipe should be taken out, cleaned, and put into a dry place until fall. If this is not done, the acids formed in combustion will soon eat through the tin, which will become as easily punctured as parchment. The hinges of the boiler doors should be oiled and the doors left open during the summer. The boiler should be allowed to remain full of water, and, as noted above, it is not necessary to refill it from year to year.

It is unfortunate that in both steam-heating and hot-water systems it is necessary to use pipes and radiators, which, at the best, are bound to be unsightly. Occasionally, upright pipes are placed inside the partitions. This, while eliminating them from view, is apt to result in complications if, for any reason, there is a leak or freezing of the system.

There has, in recent years, been much improvement in the design of radiators, and they may be obtained in various sizes and shapes, to harmonize with the proportions of the various rooms. Radiators may, of course, be painted or stained to harmonize with the wall decoration or woodwork. Ordinary paint, however, deteriorates rapidly under the extremes of heat and cold to which it is thus subjected. The best coloring for radiators is restricted to the several shades of gold, bronze, and silver powdered paints, which may be easily and cheaply obtained. This material apparently covers the iron so thinly as not to reduce its radiating value, while the various shades of tints available permit the matching of the color of the wall or woodwork.

A method of concealing radiators, especially if they are placed under windows, is to inclose them in cases of wood designed to harmonize with the style of the room. If this is done, care must be taken to provide ample areas of openings in the grills to permit the air in the room to circulate freely through the case and around the radiator. Special care should be taken to allow a space at the bottom for the air to draw in and be carried up and out at the top, front, or sides of the inclosing case. When this method of concealment is adopted, provision must be made for a certain excess of radiating value, to counteract the inclosing of the radiator. This excess varies from 10 to 20 per cent, depending upon the design and arrangement of the grill and case. (See Chapter on *Special Appliances.*)

The automatic valves on steam-radiators sometimes become clogged with dirt, scale, or grease from the system, especially when the outfit is new. This clogging prevents the free escape of the air. In order to clean these valves, the valve in the supply-pipe should be tightly closed. The air-valve from the radiator should then be removed, and soaked in a solution made of ordinary washing-soda dissolved in warm water. When the grease and dirt inside are loose, the air-valve should be thoroughly rinsed in running water to clear it of any remaining dirt. The valves should then be screwed tightly on the radiator, and should then work freely. Often defective air-valves will not permit the escape of the cold air in the radiators, and it is frequently the case that heat will not enter the radiator until the valve has been removed. In such a case, a new valve should be obtained at once.

Heat Regulators. One of the most useful and convenient developments in the field of heating has been the heat regulator, which, when it works properly, saves much trouble and preserves an even heat. The most complete of these regulators consists of a thermostat, a motor, and the necessary fittings. The thermostat is a simple mechanical contrivance so constructed that when the temperature in a room reaches a certain degree, the thermostat arm expands, and closes an electrical circuit. This releases the motor in the basement, the crank shaft makes a half revolution, and closes the drafts.

If the house should cool below a certain degree, the thermostat arm contracts in the opposite direction, closes another circuit, and the motor again makes a half turn, opening the drafts and increasing the fires. If it is desired to have the house cooler at night than during the day, the thermostat may be set to maintain a lower degree of heat by simply turning the index on the thermostat to the desired degree. The temperature will then not fall below this point.

The time attachment consists of a reliable clock mechanism which is attached to the thermostat. The clock will move from the point of temperature control to the normal day temperature an hour before the household is up in the morning, and the house is thereby warmed.

There are many simpler devices for controlling furnace heating. In some cases an ordinary alarm-clock connected with the automatic draft on the furnace works efficiently.

Fireplaces

Houses are seldom built nowadays without provision being made for one or more fireplaces. It is common to have a fireplace in each of the main rooms. Fireplaces have not only artistic and social value, but serve admirably as ventilators. The late Harry F. C. Mennecke thus describes in *House and Garden* the construction of a practical fireplace:

The first essential of a fireplace is that the smoke shall go up the chimney, and not into the rooms. There must be sufficient draft to accomplish this and also to produce a certain amount of heat. The architectural design of a fireplace should be considered in relation to the room in which it is placed.

If possible, an ash-dump door should be constructed on the hearth to be connected with the flue to the ash-pit in the basement, where a door is provided two inches above the floor. Such a device will save much dusting and cleaning in the room, as cleaning out the fireplace inevitably spreads ashes about the surrounding surfaces. The opening for the fireplace is usually made before the flue is built. In all cases the fireplace, the opening, and the flue should correspond in proportion. The opening is governed largely by the kind of fuel to be burned, and by the size of the room. In order to bring about perfect draft, the height, width, and depth of the fireplace should be in certain proportion to each other, as well as to the lines and throat and area of the flue. In a room of modern size, the width of the fireplace is usually from 30 to 36 inches, and the height usually 30 inches. While these dimensions vary, the rule should be followed that the height of the opening shall be two-thirds to three-fourths of the width. The lower the opening the better the draft, as a higher opening permits too much cold air in the winter, and thus prevents a satisfactory draft. If an error has been made in the construction of the fireplace, a sheet metal shield or hood may be carried across the top of the opening.

The depth of the fireplace should never be less than one-half the height. It should be at least 16 inches for a coal fire, or 18 inches for a wood fire. For the latter 20 inches is even better, and for a large wood fire it should be 24 inches. If it is more than this the heat will not radiate properly into the room.

The sides and the interior of the fireplace should be run back straight about 4 inches, and then splayed 2 inches to 5 inches per foot in depth, so that the opening into the room is wider in front than behind. The back should run upward with a forward slant or curve, beginning at a point above the hearth. This will tend to contract the fireplace toward the top and make sure that the air at this point is thoroughly heated. This greatly improves the draft, and causes the heat to be drawn forward and out rather than upward. It also forms the smoke or back-draft shelf without which no fireplace should be built. This prevents and deflects all downward drafts which cause smoke and ashes to be blown into the room.

The throat of the fireplace should be built well to the front, and its area should be one-half that of the flue, which should never be less than 3 inches wide, or more than 4½ inches, and its length should equal the entire width of the fireplace opening. The throat should begin 6 inches above the bottom of the arch at the top of the opening, and should never be more than 3 or 4 inches wide, as the greater width tends to deflect smoke into the room. The smoke-chamber, beginning at the top of the throat or damper, should slant about 60° on both sides, until the flue side has been reached. The bricks which form the slant of the chamber should be chipped or laid so as to present a smooth surface that will not retard the draft. No mortar or plaster-

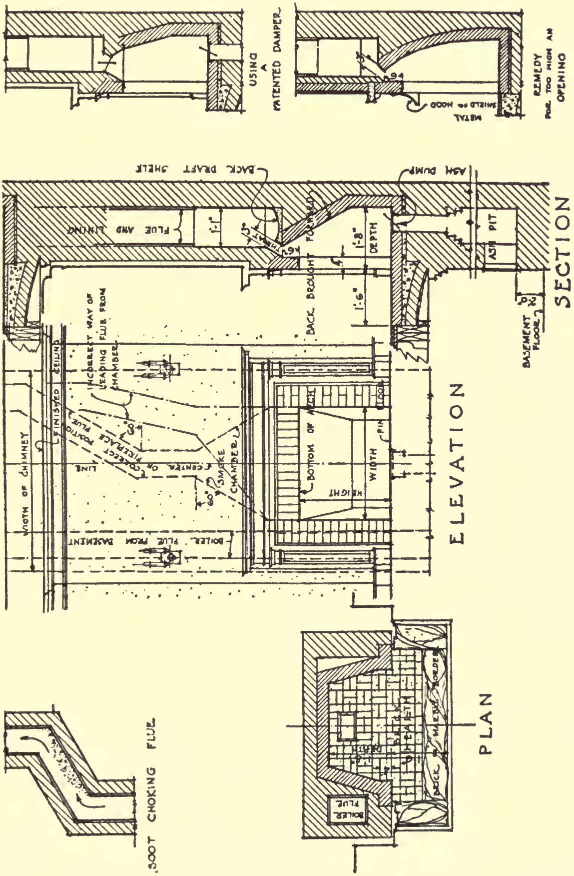


Diagram of Fireplace

ing should be permitted in the smoke-chamber. Forms of metal or terra cotta may be built in to insure this smoothness. The flue should rise directly above the center of the smoke-chamber, otherwise the draft will be strongest on the side nearest the flue, and the fire will probably smoke on the other side. The vertical direction of the flue up through the building should be at an angle of about 60°, and never less than 45°. The steeper the angle the less possibility for soot and ashes to form a deposit and clog the flue. While the chimney is being built, holes should be left in the masonry at the points of changes in direction and at the bottom of the flue, in order that mortar which is left during the building can be cleaned out before it becomes set. After the holes have been cleaned out, they should be closed with masonry. All flues should be cleaned out from top to bottom each year. Each fireplace should have its separate flue, and no more than two flues should be permitted in the same chimney space. If there are more than two flues each third flue should be separated by a fourth division wall.

The failure of the fireplace to draw well and admit smoke is due to a number of causes: if all doors and windows in the room are closed, no leakage of air is permitted in the room to supply a draft of air to the fire; the fire may be too shallow; there may be a lack of wind or back-draft shaft at the throat to prevent downward draft; the flue may be undersized, and the proportion of the various parts of the fireplace incorrect; often faulty construction of the flue, especially at the points of the changes of direction, causes a choking of the draft.

Experiment will usually show just where the fault lies, but it sometimes requires more skill than the house-owner himself possesses to correct deficiencies in the fireplace. In such a case an expert should be consulted.

Ventilation

Fresh air is the cheapest, and, at the same time, the most beneficial of all elements. It can be had for the asking, and in any desired quantity. If heat is necessary to insure comfort in the cold weather, fresh air is no less essential. Its practical value is recognized by builders of factories, office buildings, and other large structures. Employers of labor have been convinced, through repeated experiments, that efficiency to no inconsiderable degree depends upon an abundance of fresh air.

Its necessity in the home is no less. The fatigue and lassitude, often attributed to overexertion, or lack of exercise, are often the result of a lack of fresh air in the house.

It is not necessary to keep the rooms cool. The proper temperature at which the house is kept will probably be the result of compromise. Ordinarily, 65° F. is sufficiently warm for the normal person. If the temperature comes up to 70°, drowsiness is likely to result. There are those to whom 55° is more comfortable than 65°, but the latter figure may be taken as a safe average mean.

We have seen in the chapters on heating that the hot-air system, when the air is brought in from outside, provides a thoroughly efficient system of ventilation, if the system is working properly, and a sufficient amount of air is admitted through the registers. On the other hand, steam and hot-water systems not only provide no fresh air, but heat the air already in the room, and extract the moisture from it. Where these systems are in use, it is extremely essential, therefore, to have some method of supplying the moisture which is thus lost. There are patent devices for this, but an efficient and practical method is to keep water standing on the radiator. The evaporation will provide the moisture absorbed by the heating surface. Attractive vessels made for this purpose can be obtained. (See Chapter on *Special Appliances.*)

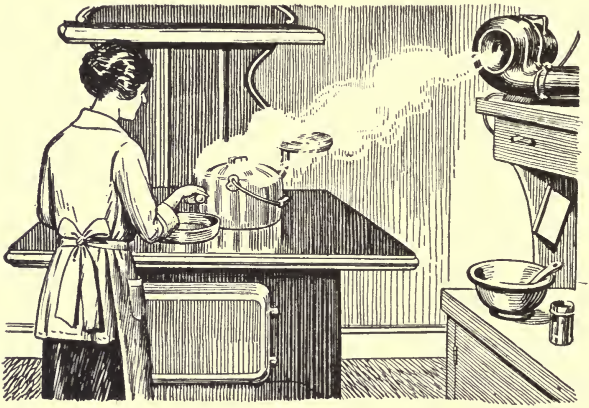
It is not enough that the air in the room should be relatively pure. It must also be in ceaseless motion and must be renewed constantly and evenly. It has been proved by experiment that warm air, even when it is not pure, ceases to produce the effects of bad ventilation when it is set and kept in motion. Moving air does not necessarily mean a draft. Electric fans properly distributed form an excellent means for keeping the air in motion.

In a house which has been constructed with a view to proper ventilation, the doors and windows are so placed that the warm air goes out from the top of the room and the cold air comes in from the lower parts, such as lower windows and well placed intakes for the air. Thus the air is kept moving without draft. In the average room the air change is one to two times per hour. In a house in which special pains have been taken to insure ventilation, the change takes place from two to three times per hour. This is due to fireplaces, properly placed windows, doors, etc.

The requisites for good ventilation are: 1st, a temperature of from 60 to 65° F., and a relative humidity of moisture of 45 to 60°; 2nd, pure air, which is free from dust, insects, oily vapors, soot, etc.; 3rd, odorless air, which is free from gases and vapors; 4th, the constant motion of the air.

While it is important that the living room should be well ventilated, proper ventilation is more necessary in the kitchen than anywhere else. This usually affords difficulties. If the kitchen is kept cool it often means a draft. It not only means possible cold, but interference with the processes of the kitchen. In the kitchen, also, odors arise, and unless the door is kept closed, which is often inconvenient, these are spread through the house.

The cellar should also be well ventilated and provided with windows and doors to insure a current of air.



Ventilating the Kitchen

Without special apparatus for ventilation, the ordinary air in the room cools, and cooling, falls. As it falls, it is heated and rises again, thus keeping up a rotary circulation. Knowledge of this fact may be utilized in the employment of several simple devices for ventilation. Thus, the windows may be opened top and bottom, so that the warm air will pass out at the top and cold air come in at the bottom. This starts the circulation of air. If it does not result in too strong a draft, a door should be opened opposite the windows, or a board may be placed on the window sill to curb the draft. Cool, moist air may be obtained by hanging a damp sheet or cloth in the room, and rewetting it as it dries. Fireplaces act as ventilators and with small or large fires in them, produce air currents. Effective and comparatively inexpensive devices for ventilating have been effected. These consist of blowers and fans. The apparatus is attached to an ordinary electric socket and placed in effective places. The motors are encased and are noiseless in action. Some of them are self cooled. The electric fan, which is used in hot weather for rotating the air, is equally useful in ventilating the house during the winter.

CHAPTER V

PAINTS AND PAINTING

PAINT is to the house what clothes are to the man, and like clothing, paint is both protective and decorative. Painting is one of the easiest things to do about a house, or perhaps, it may be better said, it is one of the easiest things to begin. The mere process of putting on paint is not difficult. To put it on properly calls for pains and experience.

It is not suggested that every man should become his own painter. The job of painting a house is one for an expert and, unless one has special qualifications or experience in the painting line, he ought not to undertake so ambitious a project as to cover the entire area of the house.

There is, however, much in the painting line which the house-owner can do quite as satisfactorily as a professional painter. One who has never before handled a paint-brush will be surprized at the results of which he is capable after a course of experimental attempts. This is, of course, suspectible of a double meaning. Every spring there will be plenty of odd jobs to do with the paint-brush. The house-owner should be able, for example, to paint the porch floor and steps. It might be wiser for him to begin with the back porch before attempting work which will be more openly exposed to the public gaze. There are also many places in the inside of the house which do not require a greater amount of skill than is possessed by the ordinary house-owner.

If the painting is to be done on a small scale, it is quite as economical and much easier to obtain the paint in prepared form. Care should be taken, however, that the paint is of a well-known brand, for nothing is more abominable than poor paint.

If the house-owner is ambitious enough to undertake painting on a large scale which will require paint in large quantities, he will find it more economical to mix the paint himself. There are no mysteries about this operation, and a little experience will determine the proper proportions of the various ingredients to be used.

Paint is a mixture of solid particles called the pigment, and a liquid called the vehicle, which, when spread out in thin layers upon a surface, dries solid and protects the surface to which it clings. The best and standard liquid for a vehicle is linseed oil. Other vegetable, animal, and mineral oils are used but none is so good as linseed oil. The quality which makes linseed oil the best vehicle for painting is the fact that when it is exposed to the air it gradually becomes hard, or "dries up." In doing this it extracts from the atmosphere a large proportion of oxygen, which forms a new compound of a resinous character. This quality of combining with oxygen distinguishes linseed oil from other oils, which have little or no power of combining with oxygen. The second essential for paint is pigment, which is the solid part. For this, white lead or oxid of zinc, or a combination of the two is used. Care should be taken in using white lead that it shall be pure. There are many brands of so-called white lead which contain very little of that substance. The mixture of linseed oil and white lead or zinc combined to the proper consistency forms white paint. Colors are produced by introducing metallic oxids of various tints.

When the paint is made from a proper combination of zinc and lead, many troubles which are experienced, when either lead or zinc oxids are used singly, are avoided. The proper combination of zinc and lead in paints leads to durability, and gives a good, smooth surface. Such paints also retain their colors.

The coloring of any desired shade may be obtained from the dealer in paints. The desired color can be found only by experimentation with different quantities of pigments. Paint should also contain a small amount of so-called dryer, which can also be obtained at the paint store.

Only the best liquid dryers of some well-known manufacturer should be used. For outside work as little dryer or turpentine should be used as possible. If it is found necessary to thin the paint, an additional amount of linseed oil should be added to it. When paints are not to be used immediately, caution should be taken to keep them air-tight to prevent the oxidation of the linseed oil.

Finishes. The principal finishes given to interior paints are as follows: flat finish, oil finish, and enamel finish. A combination of 70 per cent or more of lithopone with zinc oxid, and a small quantity of some inert substance, such as asbestos, silica, china clay, whiting, or barytes, worked up with a good varnish, and a minimum of oil, to the proper painting consistency with a volatile thinner, will yield a flat finish.

Oil finish is obtained by employing a well-made mixed paint in which the blending of the pigments and vehicles has been properly attended to.

Enamel finish is distinguished by its high gloss. It is obtained by employing the best grades of enamels. Some of the better kinds of zinc oxid paints make excellent enamel finishes for interior work.

In painting new surfaces, the priming coat is of the utmost importance. The object of the priming coat is to fill up the pores in the wood and to form a firm basis for the paint proper.

There is sometimes a strong temptation to use inferior material for this coat on the theory that as it is to be covered by a second or third coat and will not, therefore, be exposed to wear and to the eye, the quality is not essential. The fact, however, is that it is the most important coat of the three. If you are under the necessity of using an inferior paint anywhere, it should be applied to the last coat and not to the first.

When old work is to be repainted, it is advisable to remove all loose paint by scraping, sandpapering, etc. After finishing over with sandpaper, the surface should be touched up with a coat of priming paint. Two coats of the selected paint should then be applied to the surface. In repainting iron, steel, and other metal surfaces, all loose scale, rust, and other adhering matter should be removed by hammering, scraping, or scrubbing with wire brushes, and oils and grease should be washed off with benzin or other solvent. It is usually advisable to apply three coats of paint to such surfaces.

How to Paint. The priming coat must be entirely different from other coats in consistency. What this consistency shall be depends upon the kind of surface to be covered and the conditions at the time. It may be said, however, that the primer will require more oil than subsequent coats, for the porous surface will absorb more of the priming coat than any other and will also extract some oil from the pigment.

Thus, enough oil should be used to satisfy the surface, and still leave the mixture of pigment and oil in correct proportions to give a well-dried painting surface.

New wood in average condition will require 6 to 7 gallons of raw linseed oil to 100 pounds of white lead for the priming coat, whereas the following coats will need only 3½ to 4½ gallons to the same quantity of white lead or zinc oxid.

In applying the paint, it should be brushed well in the pores, and should not be allowed to simply "flow on" as is frequently done. Paint should never be applied while the surface is wet or while rain or snow is falling, or immediately after a frost, however light. The pores in wet wood are already filled with moisture and the paint film on that account does not obtain the hold in them which is necessary to make it stick.

For filling nail holes, cracks, etc., nothing should be used but putty made of equal parts of linseed oil and white lead and whiting. Much of the putty now sold is made of other oils than linseed combined with ground limestone or inferior whiting. They give the appearance of yellow nail holes and cracks, which are often seen on painted surfaces.

In painting jobs of any considerable magnitude, it is usual for the contractor to furnish all materials, labor, transportation, scaffolding, utensils, etc. Before the paint is applied the surface should be thoroughly cleaned, sandpapered, and dusted, and all surfaces should be thoroughly dry before applying paint. The painting should be done only in dry weather, and never when the temperature is below 40° F. All knots and resinous and sappy portions should be treated by first burning until the surface is slightly charred. This operation, however, should not be carried far enough to cause shrinkage of the knot. The charred surface should then be scraped and thoroughly washed with turpentine or benzin, one half-hour before painting. Each coat of paint should be thoroughly dry before the next is applied.

Exterior Work. Different woods require somewhat differing treatment in the application of paint. If the wood to be painted is cypress, the priming coat should contain, in addition to the other thinners used, one pint of solvent naptha to a gallon of paint. If the wood is yellow pine, the priming coat should contain 1½ pints of turpentine to the gallon, in addition to the other thinners used. Not less than three full days should be allowed for the drying of each coat before the following coat is applied. The rules above apply to new work. In repainting old work, all loose or adhering paints should be removed by scraping or sandpapering. When it is necessary, the old paint should be removed by burning or scraping or with a paint and varnish remover. All portions from which the old paint has been removed should be sandpapered and touched up with the regular priming coat of paint. Two coats of the color selected should then be applied.

In painting new plaster, cement, or concrete, all cracks and other surface imperfections should be closed with plaster or cement. After this is dry, a solution of zinc sulfate dissolved in water, 4 pounds of zinc sulfate crystals to the gallon of water, should be applied. This should be allowed 36 hours for drying. Four coats of paint should then be applied in the same proportions and manner as in other outside work. In repainting old plaster, cement, or concrete, the same rules are to be followed, except that there will be no necessity for applying the solution of zinc sulfate. Usually not more than two coats of paint are necessary if it is old work.

When galvanized or zinc-coated iron is painted, the entire surface should be treated with a solution of copper acetate in water, six ounces to the gallon. This should be allowed to dry, when the excess dust should be brushed off. In the case of copper, the surface should be sponged thoroughly with 160° solvent naptha. Zinc need not be painted for protection. If it is desirable to paint for decorative purposes, the same method should be followed as for copper.

In painting tin roofs, all rosin and oil should be removed by scraping. The surface should then be rubbed with waste, saturated with either turpentine or benzin. The priming coat should then be applied, which should be followed by a second coat of the same or other paint.

Interior Work. The same general rules apply to interior as to exterior work, except that certain modifications are necessary in the painting of plaster and cement surfaces. If such surfaces have stood less than a year without paint, they should be treated before painting with a solution of zinc phosphate, 4 pounds zinc phosphate crystals to the gallon of water. The surface should then be thoroughly coated with this solution, applied with a broad soft brush, and allowed to stand not less than 48 hours before painting. On such surfaces the priming coat, except where an oil finish is desired, should be made from a flat wall paint or wall finish. To each gallon of this paint, one quart of pure raw linseed oil should be added. If the finishing desired is to be washable and flat, the last coats should be of the same paint as the priming coat, except that no linseed oil should be added.

If an oil finish is desired, a pure oil, ready mixed, paint may be used. In such a case, about one-fifth of the thinner portion of the paint should be poured off before stirring, and turpentine substituted. If an exceptionally brilliant gloss finish is required, a finishing coat of varnish can be applied to the final coat of paint.

When interior cement or concrete floors are painted, the same rules may be followed as in exterior work, except that there should be added for the first coat, after the priming coat, one-half pint of floor or spar varnish to the gallon of paint, while one pint of varnish should be added to the finishing coat.

For an enamel finish, plaster or cement, the preliminary treatment and the priming coat should be the same as in the case of flat finish. For the priming coat, and one or two following coats, flat wall paint may be used. Over the priming coat not less than two additional coats should be applied. If only two coats in addition to the flat coat are necessary, the first should be an enamel of standard quality. After this has dried, and has been lightly sandpapered, a finishing coat composed of similar enamel should be applied. If more than two coats are desired in addition to the flat coats, the first and second should be as indicated above, while the third coat should consist of a proper quality of varnish. After drying, each enamel coat should be slightly sandpapered before applying a succeeding coat. For enamel finish on woodwork, the same rules as for work on plaster should be followed, with the exception that 50 per cent of linseed oil and 50 per cent of turpentine should be used for a vehicle.

In painting or repainting the woodwork of a small house, it will usually be found quite as satisfactory and more convenient to use the standard prepared paints instead of mixing paints in the required proportions and quality.

Wall Paints. The custom of using paint on interior walls has become common in recent years. It is especially useful where, as is usual, the paint can be washed. These paints usually contain about 65 per cent of pigment, which is general lithopone, and about 20 per cent of turpentine substitute, or light mineral oil, to which is added about 15 per cent of non-volatile vehicle. It is important to have the paint contain enough thinner to allow some addition of oil for the first coats and still be of the proper consistency for the brush. The non-volatile vehicle commonly used in such paints is a rosin chinawood oil varnish.

Shingle Stains. The stains used for shingles are similar to paints, but as they are designed as a preservative as well as a coloring, they are much thinner and usually contain coal-tar creosote as a part of the vehicle. The pigment used should be of the best quality, having the maximum color strength, and should be ground very finely in oil. The amount of pigment should not exceed from 1½ to 2 pounds to the gallon of stain. The vehicle generally used is about 40 per cent creosote oil, 40 per cent heavy benzin, and 20 per cent benzin Japan dryer. The best method of application is to dip the shingles in the stain before putting them on the roof or sides of the house. Shingle stains, however, are frequently applied with a brush. While these stains are intended primarily to preserve the wood, the shingles should be uniformly colored; thus, the pigment used should have great color strength and be very opaque.

Wood Stains. Wood stains, like shingle stains, are exceedingly thick paints, but they differ from shingle stains in several important respects. They are not intended for protection, and are generally used in connection with other methods of treating wood. Thus creosote oil is not a part of the vehicle. As wood stains are not intended to completely hide the original color of the wood, and only to modify it and bring out the grain, the pigment used should not be too opaque. Suitable pigments are finely ground siennas, umbers, and ochers. From 1 to 2½ pounds of suitable pigment are used to the gallon, in a vehicle composed of about 70 per cent linseed oil, 20 per cent turpentine, and 10 per cent dryer in the case of so-called oil stains, while the varnish stains have a vehicle of thin varnish. Sometimes anilin dyes are used instead of the pigments mentioned. Brilliant effects can be produced by their use, but stains made with them are likely to fade.

Water Paints. These include whitewash and calcimine. Whitewash is the cheapest of all the paints and is very useful for many purposes. Lime, which is its basis, is sanitary, and whitewash is therefore useful for the interior of stables and other outbuildings and cellars. Ordinary whitewash, made by slaking quicklime and adding water to produce a mixture of proper consistency, is often quite satisfactory, but this does not adhere to the surface so well as whitewash to which certain additions have been made. These additions include salt, flour paste, milk, glue, cement, alum, etc. The following recipe is a standard one for use on wood, brick and stone:

> Slake half a bushel of unslaked lime with boiling water, keeping it covered during the process. Strain it and add a peck of salt dissolved in warm water; 3 pounds of ground rice put in boiling water and boiled to a thin paste; half a pound of powdered Spanish whiting and a pound of clear glue, dissolved in warm water; mix these well together and let the mixture stand for several days. Keep the wash thus prepared in a kettle or portable furnace, and when used put it on as hot as possible, with painters' or whitewash brushes.

Whitewash may be tinted by the addition of colors, but care should be taken not to use colors which are affected by lime. Colors which are not affected include yellow, ochers, siennas, umbers, iron-oxid red, ultra-marine blue, bone black, etc.

Calcimines have as their basis whiting, clay, silicates, etc., instead of lime, as in the case of whitewash. As these materials do not adhere, it is necessary to use a binder of some kind, generally of blue or casein. The following recipe for calcimine is taken from "White Paints and Painting Materials," by Scott:

> Ordinary white stock (calcimine).—(a) 16 pounds of whiting mixed until free of lumps with 1 gallon of boiling water; (b) ½ pound of white sizing glue; soak 4 hours in ⅛ gallon of cold water. Dissolve on a water bath and pour into 16 pounds of whiting mixed until free of lumps with 1 gallon of boiling water. This will make about 2 gallons, weighing 12¾ pounds per gallon. It is of proper brush consistency and may be used at once but is better after standing a half hour. This material will cover per gallon about 270 square feet on plaster, 180 square feet on brick, or 225 square feet on wood.

Removing Paint and Varnish. Burning off with a painter's torch is the most effective method of removing old paint and varnish. The film is softened by the heat and can be scraped off. This method should be used only by expert painters, and can be applied only on flat surfaces, and where slight scorching of the wood is not objectionable. A solution of hot caustic soda or concentrated lye is an excellent paint remover. The quantity used is 1 pound to the gallon. This should be applied with a fiber brush until the paint becomes soft. Care should be taken not to get this mixture on the hands, and surfaces treated with it should be thoroughly washed with water and allowed to dry before repainting. They should also be thoroughly sandpapered. Prepared paint and varnish removers can be purchased. Most of these consist of mixtures of benzol, acetone, and methyl alcohol.

Care of Brushes. As good paint brushes are expensive, they should be carefully treated. Too often they are allowed to dry with the paint still adhering to them, and become hard and sometimes useless. Brushes should be well cleaned after using. If they are to be kept only over night, however, it is usually sufficient to wrap them in several thicknesses of paper. Some painters simply place their brushes in water over night. If the brushes are not to be used for several days, however, the paint should be washed out of them. Turpentine is a satisfactory material for this washing, but it is expensive and kerosene is usually quite as good. After washing off the paint with kerosene, the brush should be rinsed with gasoline or benzin, and after a thorough shaking should be well washed with soap and warm water. After this it should be shaken thoroughly again so as to be as dry as possible and then hung up with the bristles down. When it is thoroughly dry, the brush should be protected from dust. If the brush is to be used again within a comparatively short time, it is less trouble to keep it in turpentine or kerosene. For this purpose hooks should be fastened on the inside of the pail, with a close fitting cover, and the brushes hung either by holes in the handles or by loops of string, so that they are suspended in the kerosene or turpentine in the bottom of the pail. The bristles should not touch the bottom. Brushes which are used for whitewash or calcimine should simply be washed and not placed in the same liquids in which the brushes for oil paints are kept. If a brush has been used for shellac varnish, it should be kept in alcohol, or in the varnish itself. Generally, a varnish brush may be kept in the varnish in which it is used.

Quantity of Paint to Cover Given Areas. To find out the quantity of paint needed, measure the length, width and height of the building to be finished. It may be measured at one corner in securing the height, as it is not necessary to measure at the highest point of the gable. Add the total number of feet of the two sides and two ends of the building—this gives the total length of the surface to be painted; then multiply this by the height of the building in feet, which gives the number of square feet of surface to be covered. Divide the number of square feet obtained by 250, and this gives the number of gallons required. For example:

Length of front.............	30 feet
Length of rear..............	30 feet
Length of one side...........	20 feet
Length of other side........	20 feet
Total	100 feet
Multiply by the height..	20 feet
Total	2000 sq. ft.

Dividing by 250 gives 8 gallons, and this quantity covers 2000 square feet, two coats. Allow about one-fifth to one-fourth extra for trimming.

General Observations on Paints and Painting. Paints containing compounds of lead should not be used about stables or outbuildings where the fumes from decaying organic matter occur, for these gases are likely to darken the lead paints. Pigments which may liberate compounds of sulfur should not be used with lead compounds. Thus, ultra-marine blue, which contains sulfur, may be used with zinc white but should not be used with white lead, or any other lead pigments. Prussian blue, however, does not contain sulfur, and may be used with lead pigments.

Turpentine and benzin are extremely inflammable and care should be taken not to bring paint containing these substances near any light or open fire.

Some pigments are poisonous, and care should be taken to remove all paint stains from the skin and not to allow any paint to get into the mouth. It is not best to use turpentine or benzin in removing paint stains from the hands. Linseed oil, or any fatty oil, followed by a thorough washing with soap, is much better, providing the paint has not been allowed to dry too thoroughly on the hands.

Choosing the Color Scheme. It has been proved by experiment that paints of warm tint will wear longer than those of the cold or neutral tints. Browns, olive greens, reds, etc., are the most durable, while harsh greens, yellows, and cold colors in general do not wear so well.

Nothing is more attractive than a house freshly painted white. This is especially true if the house is placed against a green background, or among green surroundings. Unfortunately, however, white paint soon becomes soiled, and it should not be used, therefore, where smoke or dust from roadways or other sources are likely to blow against it. A very light gray or pearl gray may be more durable than pure white, and yet give a nearly white effect.

A house which is placed closely among trees or other verdure should not be painted green or olive, altho these colors may be used in the trimming. Colors which contrast with the surroundings are better for the body of the house.

If the structure is low, a dark color should not be used. A light paint gives the effect of height.

Houses with shingle upper stories should, as a rule, be painted on the lower story with a lighter color. Both parts of the house should be made to harmonize, as light or dark olive with Indian red, cream with brown, gray with dark gray or dull red, etc.

All colors or tints of paints are not equally durable. Grass greens, blues, and the cooler shades of yellow produce a deterioration of the paint film, due to the fact that they do not reflect or turn back the heat rays of the sun, but permit them to penetrate the film.

Tints which are based on the reds, browns, and blacks are as a rule the most durable. Thus, the grays, the slates, the browns, and the richer yellows are not only superior for wear, but at the same time give most pleasing and artistic results.

CHAPTER VI

TREATMENT OF FLOORS AND WOODWORK

While floors and woodwork, perhaps, form different departments in the household economy, their care and treatment have so many essential similarities that they may be treated for practical purposes in the same chapter.

The floor is, perhaps, the most conspicuous part of the interior of the house. It is always "under foot" and not less certainly under the eye. To keep the floors in good condition, if they have not been originally laid and cared for properly, is one of the chief tasks and often the chief despair of the housewife, and it frequently happens that the patience and physical energy of the house-owner himself are often called into play.

If the right floor is laid when the house is built and there has been no abuse of it, the problem is greatly simplified, and with very little care the floors may be kept in a condition that will satisfactorily endure any inspection.

Floors may be laid with either soft- or hardwood. As to their respective merits there is no question. Hardwood is always the best. It is, however, more expensive, and the purse may dictate when the cheaper material must be used. When carpets were the prevailing mode in floor covering, softwood floors were as good as hard. Nowadays, however, carpets which entirely cover the floor are rarely used, and the exposed flooring must be of a sort that can either be polished or painted.

Softwood Floors. If softwood floors must be used, pine and spruce are the most suitable. Clear pine in these days is rather expensive, but in certain parts of the country second quality pine can be obtained which is suitable for this use. This wood is soft and easily holds the tacks that are driven into the carpet, for it is assumed that pine floors will be almost entirely covered with carpeting. Pine is not suitable for staining or varnishing as the wood is so soft that stain soon wears through. It also contains many knots which show through even under a dark stain.

Spruce is a much better softwood than pine. It is much freer from knots and when fresh has an agreeable appearance. Floor boards made of spruce, however, are apt to curl up at the edges. They also splinter easily. The best spruce flooring is obtained from trees of young growth, the wood of which is less likely to splinter than that from older trees.

It is, of course, not absolutely essential that the carpet should be used over a softwood floor.

The floors may be stained all over, or a space may be left in the middle to be covered by a rug. Artistic and daring experimenters may find much latitude for their talents in devising the proper color scheme. Visitors to the older houses in Greenwich Village, New York, which have, for the most part, softwood floors, have often been startled by the bizarre and diverse effects obtained by the use of different colored stains on the floors. Stains of any color or combination can be obtained ready mixed. These are chiefly oil stains. Better results can be obtained by using water stains, which can also be bought ready for use. These absorb much more satisfactorily into the grain of the wood and give a clearer color. Water stains, however, must be varnished after they are thoroughly dry. Two coats at least should be given, and only the best quality varnish should be used. Varnish adds greatly also to the durability and appearance of oil stains.

Floors which are stained should be carefully watched for signs of wear and varnish should be applied to worn spots before the stain is worn through. It is difficult to patch such places so as to avoid spots after the varnish has penetrated. If the floor is very old and has been worn before an application of varnish or stain has been applied, it may be planed down so that a fresh surface is exposed. Where the floor is so badly worn and splintered in the middle but is in better condition around the edges, the border only may be stained while the middle may be covered by a large rug or carpet. A border of 20 inches for the exposed part of the stain is usually found the most satisfactory, whether the room is large or small. Where there are bay windows or similar recesses, the whole surface within them may be stained. If a stain cannot be found which matches the rugs or furniture, or where the floor is already stained and is too shabby to be stained again, paint in any color may be used. This should be mixed thoroughly with plenty of dryer or boiled oil, so that it will harden quickly. Any number of coats may be applied to produce the desired results. A coat of varnish may be applied to this paint with good results.

Hardwood Floors. However well stained or attractive softwood floors may be made, hardwood is much better under any conditions. There are intermediate woods, which, tho classified as softwoods, are hard enough to produce a satisfactory surface. Of this the cheapest is North Carolina pine, which ordinarily costs but little more than spruce. This wood, however, should be carefully selected. Floors of this material can be polished with wax with excellent results. Better than North Carolina pine is Georgia pine. It is more expensive but harder in surface. It is susceptible of a good polish. This wood, too, should be carefully selected with reference to the proper grain and hardness.

The strictly hardwoods used for flooring include maple, ash, birch, and oak. Other "fancy" woods such as cherry, mahogany, and black walnut are less frequently used. Maple is the cheapest of the hardwoods. It makes a very durable floor, but the boards in process of seasoning are likely to acquire a bluish tinge at the ends, and for this reason maple is seldom used for entire floors in private houses. With all hardwoods, including maple, the boards must be narrow. The common width is about 2½ inches, and 2 inches is even better. Maple is much used in parquet or inlaid floors, on account of its whiteness. Ash costs but little more than maple, but it is not suited to a floor which is to receive severe wear. It is subject to slivering. Ash is often used for stairs and floors which are not exposed too much to hard use. Birch, altho hardwood, is not often used. Oak is best of all woods for ordinary flooring. It is hard, has an attractive grain, and does not sliver. It is, however, likely to have knots and streaks of white sap, so that the wood must be carefully selected. Whatever wood is used, the boards should be at least ⅞ inches thick.

The Treatment of Hardwood Floors. Hardwood floors, after they are laid, should be carefully scraped in order to insure a perfectly even and polished surface. This scraping may be done with power- or hand-scraping machines which are in common use by carpenters and contractors. Floors should always be scraped lengthwise of the wood, never across the grain. After the scraping, the floor should be gone over with No. $1\frac{1}{2}$ sandpaper to insure the best results in finishing. Following this, the floors should be thoroughly swept and any dust removed with a soft cloth.

After the floor is perfectly clean, it should be treated with one of the standard brands of paste fillers. The color of this filler depends upon the tone desired in the finished floor. A liquid filler should never be used. The paste filler may be thinned by the addition of turpentine, benzin, wood alcohol or gasoline. The highest grade of oak flooring should have a natural oak filler which does not alter the original color of the wood. After the filling has been well applied, the floor should be gone over with a little burnt umber mixed with turpentine, in order to darken any light streaks that may appear.

After the filler has been well applied and the gloss has been removed from it, the surplus should be rubbed off with excelsior or cloth, rubbing across the grain of the wood. This will make a perfectly smooth and even surface which will keep out dirt and provide a good foundation for varnish and wax dressings. The filler should be allowed 12 hours in which to set. After this, two coats of white shellac should be applied, giving ample time for drying between coats.

For some reason, nearly all painters wish to varnish hardwood floors. This should not be permitted. The immediate effect will be attractive but the varnished surface will become spotted and worn in time and no amount of patching or staining will be able to restore the original perfection of the surface.

The floor is now ready to receive the wax finish. Any standard floor wax is good, but it is very simple to make a wax by using the following ingredients:

Turpentine	1 pint
Beeswax	4 ounces
Aqua Ammonia	3 ounces
Water	about 1 pint

The beeswax and turpentine should be mixed and heated by placing the vessel containing them in hot water until the beeswax dissolves. They should then be removed from the source of heat and the ammonia and water added. The mixture should be stirred vigorously until the mass is creamy. In mixing this wax care should be taken to heat only by setting in hot water. There should be no flames in the room, as turpentine is very inflammable. The best method of applying the wax is to use a cheese-cloth folded into double thickness into the form of a bag. In this should be placed a handful of the wax. As the floor is gone over this wax will work through the meshes of the cheese-cloth so as to give an even distribution without waste. After the floor has been gone over with the wax and allowed to dry for twenty minutes, it is ready for polishing. It should be rubbed to a gloss with a clean soft cloth or with a weighted floor-brush, first across the grain of the wood and then with it. If a brush is used a piece of wool, felt, or carpet should be placed under it to give the finishing gloss. After about an hour a second coat of wax should be applied and rubbed to a polish in the same manner. This process should result in a perfectly waxed floor.

Care of Hardwood Floors. In cleaning hardwood floors, the waxed surface may be gone over with a cloth dampened in tepid water to remove the dust and dirt, but the dampness should be taken off immediately with a dry cloth. An excellent mixture for keeping a hardwood floor in perfect condition is made of equal parts of sweet oil, turpentine and vinegar, well mixed, and rubbed on the floor with waste or a cotton or wool rag. The vinegar will cut the grime worked into the finish, the sweet oil produces a luster, and the turpentine dries the mixture. This mixture thoroughly rubbed in will speedily renew the finish of a waxed floor. It will not be necessary to use it more than once a month. The occasional use of a weighted floor-brush, with a piece of carpet or other cloth beneath it, will help to keep the finish of the floor in the best condition. Once a year the floor should be given a dressing of wax, well rubbed. The floor should not be left until the finish is worn down to the wood.

The Kitchen Floor. Contractors or carpenters sometimes will attempt to save in the construction of the house by using a softer or cheaper wood on the kitchen floor. This is a great mistake. The kitchen floor is in many respects the most important in the house. It should be attractive, easy to keep clean, noiseless, odorless, vermin and dust proof, and comfortable to the feet and back. Wood, of course, is most commonly used in kitchen as in other floors, and would be in any case the foundation for the floor. Over this can be placed linoleum, cork, concrete, or a tile floor. If a wooden floor is laid, it is bound in course of time to need attention. It will eventually splinter and show marks of the heavy usage which it receives. Altho it may be scraped down and refinished, the wooden floor is less useful in the kitchen than in any other room in the house. If possible, the kitchen floor should be of hardwood, of oak, maple, or Georgia pine. The floor should be carefully and closely laid to prevent the cracks becoming traps for germs and dust.

Linoleum makes an excellent covering for the kitchen and bathroom floors. If it is used, care should be taken to employ only the best. Material is often sold as linoleum which in reality is not linoleum at all. The test is to look at the wrong side and if it has burlap on the back and is difficult to tear, it is an indication of the genuine article. Good linoleum always carries the name of the maker. If the linoleum is laid over wood, the nails should be hammered in below the surface. The wood should be well seasoned to avoid dampness and cracking. It is rather difficult to lay linoleum, and nearly all large dealers will send a man to put it down. This is in most cases the most economical method. If linoleum is laid over concrete it should be placed over felt in order to insure wear to the linoleum and comfort to the feet. In cleaning linoleum only mild soap should be used. After the washing it should be rinsed with clear water and dried at once. Strong soap will eat the pattern. It may be waxed occasionally with good results.

Excellent floors for the kitchen are made by the use of cork compositions. These are made of clean cork shavings, pressed together, from which all moisture has been driven out by high pressure. The cork tile is made in various shades of brown and some compounds come in many designs and colors. A cork floor which is well made will last indefinitely. It is easily kept clean, is not slippery, and is comfortable to walk upon. Cork, if laid over concrete, should, like linoleum, be placed on a felt surface.

Tiled kitchen floors are not uncommon.

These are attractive but are not as comfortable as other floors and should be covered with mats.

Many floorings of compositions of cements and mineral mixtures are available. Most of these are excellent. These compositions are warmer than tile and a little less expensive. They are fireproof and are easily kept clean. These floors, of course, should be laid only by an expert.

Standing Finish. The interior woodwork of a house, exclusive of the floors, is known as standing finish. This may be either varnished or painted, or it may be treated with wax in precisely the same manner as the floor. If varnish is used only the best quality should be employed. This treatment applies only to wood finished in the so-called natural colors. Where the interior is painted, instead of being finished in the natural color, there is great latitude for taste and method of treatment. Nothing is more attractive than the white surface, which may be either in flat white or enamel. The flat white is very attractive when first put on but is easily soiled. The enamel finish gives a glossy surface which is easily kept clean. White woodwork is likely to turn yellow with time. This is due to pitch in the wood or to defects in the paint. Paint made of white lead has the property of turning yellow in a dark room. Zinc white paint is not subject to this and is, therefore, preferable for inside work.

Nothing is more effective or economical than a black finish for woodwork. A simple mixture is turpentine and lampblack, which can be applied with an ordinary brush. Before this is dry, it should be gone over lightly with a cloth in order to develop the grain. After this finish is thoroughly dry, a slight surface of flooring wax should be applied and polished. This finish requires the least possible attention.

Treatment of Walls. Within the last few years the use for interior walls of paint which can be washed has become very general, and paints which answer very well for such use on plastered walls are easily obtainable. In applying these paints, which come in all shades, it is important to have the mixture contain enough thinner to allow some addition of oil for first coats and still be of proper consistency for the brush without any danger of drying with a gloss.

If for any reason it is not desirable to use paint for the wall treatment, there are available several standard compositions which resemble paint but which are more inexpensive and more easily applied. Some of these substances are in the form of calcimine, and before they are applied the walls must be treated with a "sizing" of glue or other material. Some of these substances, otherwise attractive and practical, have the disadvantage that they can not be washed and they are affected by steam and easily become discolored. There are many excellent and well advertised methods of covering walls, but this whole subject comes more properly in the domain of interior decoration, which, however interesting to the house-owner, comes more properly in the department of feminine elements of the household and, therefore, need not be treated at length in this book.

Varnish and Varnishing. Varnish may be applied with excellent and satisfactory results to woodwork, floors, or furniture. Its effect is to bring out the grain of the wood. In order to produce the best results, the surface to be varnished must be free from all impurities. The brush must be of the right sort, and the temperature of the room should be between 70 and 75 degrees. In the case of an old surface that has already been varnished, a thorough cleaning should be given with ammonia water, in the proportion of one tablespoonful of ammonia to a quart of water.

If varnish is to be employed on woodwork, an interior varnish must be used. If on floors, a varnish which will sustain hard wear and will not crack should be used. The dealer in paints will be able to tell you the proper varnish to use for any purpose and also recommend the correct brush. Varnish before it is applied does not need to be shaken or stirred. It should be applied with a well-filled brush and the surface should be given a uniform coating. The application should not be too thin or too thick. The varnish does not need to be brushed into the surface like paint and will dry smoothly without leaving brush-marks. As soon as the entire surface has been covered, the room should be closed and the varnish allowed to dry. This requires at least three hours. Care should be taken to keep the room dry during this time. To produce the best results several successive coats of varnish should be applied. When the first coat is thoroughly dry, it should be sandpapered lightly and another coat put on. At least 48 hours should elapse between the two coats. After sandpaper has been used, the dust resulting from it should be carefully wiped off. The second coat should then be applied in the same manner as the first. When this has in turn become dry, it may be either left in its natural gloss or rubbed with rotten stone and water. For a so-called satin finish, the varnished surface should be rubbed with pumice-stone and water.

Where new wood is to be varnished for the first time, it should be rubbed carefully with sandpaper. If the wood is to be colored, an oil stain is to be used first, followed by the varnish. After the first coat has been put on and dried, it should be gone over with sandpaper and thoroughly smoothed. After this, a second coat should be put on without being thinned. In the case of oak and other close-grained woods, a wood filler must be used before the varnish is applied. This will require 24 hours for drying. It should then be treated with sandpaper so that all rough surfaces may be removed. The varnish should then be applied in accordance with the method described for wood that has been previously finished.

As noted above, hardwood floors should not be varnished. Varnish can, however, be applied with excellent and beautiful results to the standing finish of the walls and other woodwork.

CHAPTER VII

LIGHTING THE HOUSE

The problem of proper lighting systems for the house has been considered very diligently by architects in recent years. The consequence of this study is that great improvements have been introduced which have added materially to the comfort and convenience of house dwellers.

In the days of our fathers the chief need was to get a practical amount of light in any available way. For hundreds of years candles were the only method of obtaining light, and their use still survives, but ordinarily they are used only for decorative purposes.

Candles were succeeded by various oils and the discovery of petroleum in large quantities, followed by the manufacture of kerosene, made the kerosene oil lamp for many years the chief illuminant. In many remote communities kerosene oil is still the most general method of lighting.

In settled communities, houses are now lighted either by gas or electricity and in many cases by both.

Too often the question of proper lighting is treated as incidental and is not considered until the house is practically finished. The house-owner will save himself much trouble and vexation if he will consider the lighting-system an essential part of the house from its first planning. Lighting nowadays means more than enough illumination for practical use. Experts have studied the effects of methods of lighting not only on the eyes, but on the general health. It has been discovered that a raw and glaring light is very injurious. It reacts readily upon the physical condition. The tendency nowadays is to make the lighting of the house as unobtrusive as possible. The so-called indirect system by which the rays of light are subdued by the use of opaque glass, or by placing shaded lights in the side instead of in the center of the rooms, has produced a much more comfortable and satisfactory light than resulted from the old method of obtaining all the light from one central source suspended in the center of the room.

In most new houses where electricity is available this is the simplest and most effective method of lighting. Even where electricity has not developed and gas is used, the house-owner will be wise if he has his house wired for electricity at the same time that the gas appliances are put in. It may be assumed that in time he will be able to employ the electric system, and to install this after the house is completed is an expensive and bothersome process. It would add comparatively little to the expense to have the wiring put in before the house is finished. It will make for economy and comfort, too, if a generous supply of "plugs" are inserted in various parts of the rooms. These plugs are merely holes in the baseboard through which wires are run and the proper fixtures applied. From these wires may be extended to connect with table or floor lamps.

As noted above, the chief methods of lighting are by kerosene oil, electricity, and gas of various kinds. These include natural gas, ordinary manufactured or "city" gas, acetylene, gasoline or "air" gas, and some compressed gases, as Blau or Pintsch gas.

Lighting by Kerosene Oil. Kerosene oil is still very generally used as an illuminant. Its use is comparatively cheap. The different sizes of kerosene lamps do not differ greatly in efficiency. The large brown-wick lamps give more light than the smaller flat-wick lamps, but burn correspondingly more oil. Kerosene lamps used with incandescent mantles have been devised. These give three or four times more light for a given consumption of oil than an ordinary lamp, but their construction is usually rather complicated and their operation not always satisfactory. Before spending money for an oil-burning mantle lamp, one should insist on a thorough trial of the lamp in actual use.

Lighting by Gas. Ordinary gas is commonly used in open flame burners but this is very wasteful except in cases where a small amount of light is sufficient and mantles are likely to be broken. With the use of mantles, a very effective and comparatively cheap light can be obtained from the use of gas. If mantle lamps are used the efficiency depends on the care taken to keep them in condition, but with the use of a good mantle, a lamp should give four or five times more light than the open flame, which greatly reduces the cost of the gas. To balance this saving, however, there is the cost of the lamp and of the mantles. Usually a mantle lamp substituted for an open flame gives more light and uses less gas, and if a year's use of a lamp is considered it will generally be found that the saving in the running expense is more than sufficient to pay for the lamp, while a great deal more light has been furnished. In addition to saving in gas, mantle burners furnish a much steadier light. In some cases also there is a reduction of the risk of fire since the mantle burners are protected by chimneys and inflammable objects are less likely to be exposed to the flame.

In order to obtain the best results from the use of mantles, it is necessary for the houseowner to know something about the adjustment of the lamp. The proper operation of the burners depends upon securing the correct mixture of the air with the gas. The air is drawn into the mixing tube through holes located near the base of the lamp and in most lamps these holes are provided with sliding covers which can be turned so as to close off the air more or less completely. In most cases the air-holes should be opened as wide as possible. The first step in adjusting a lamp, therefore, is to find these holes and see if they are open. In some of the more modern lamps covers for the air-holes are omitted so that they are bound to be open.

The lamp also has a screen or valve for controlling the amount of gas admitted. This has no connection, of course, with the cock by means of which the gas is regularly turned on and off. This regulating valve should first be turned so as to reduce the amount of gas until one can see plainly that the mantle is not as bright as it should be. Starting from this point, the valve should be opened until the mantle is made as bright as possible. It should then be closed enough to make a perceptible but very slight decrease in the brightness. This method will usually give an adjustment at which the lamp operates satisfactorily. If the lamp fires back, that is, if the gas ignites in the mixing tube, the gas first must be turned off entirely. The air-holes should then be partly closed and the process of adjustment described above tried again. In many cities the gas companies employ men for the special work of correcting faults in gas appliances, and assistance will in these cases be freely furnished in case the house-owner has difficulty in getting the proper adjustment of lamps or other appliances.

Acetylene Gas. The use of acetylene gas for illuminating purposes is useful for small installations such as country homes or hotels, or in small towns which have not a general gas system. The calcium carbid which produces the gas can be handled and stored easily. There are to be had many reliable generators of acetylene gas which require very little attention for their operation. Open flame burners are used because no mantle burner has been devised to give reliable operation with this rich gas. The cost of acetylene gas is about the same as for ordinary gas, for while acetylene gives as much as ten times more light per cubic foot it also costs about ten times as much to operate.

Natural Gas. In communities where natural gas is available, it should always be used with a mantle, for natural gas gives very little light in an open flame. With a mantle, however, it gives a larger output of light for a given volume of gas, because of its high heating value.

Electric Lighting. There are three kinds of electric lamps common in household use. These are ordinary carbon lamps, metallized carbon or "Gem" lamps, and the tungsten lamp. Nearly all the latter kind are sold with the trade name "Mazda." The tungsten lamps are so much superior that the other kinds are rapidly disappearing from use. About 80 per cent of the incandescent electric lamps made in this country are tungsten.

All the three kinds of lamps are commonly marked with the number of watts or power which they take when used at the number of volts or electrical pressure also marked on the lamp. When electricity is paid for at a certain rate per kilowatt-hour, the cost of current for any lamp is easily calculated. The kilowatt-hour is 1000 watt-hours, and the number of watt-hours used by an electrical device is simply the watts multiplied by the number of hours burned. For example, a 50 watt lamp at 20 hours uses 1000 watt-hours, or 1 kilowatt-hour. At ten cents for a kilowatt-hour, current for such a lamp costs one-half cent per hour. This is true of any 50-watt lamp, without regard for the kind of filament used. The amount of light produced by different kinds of filament is, however, decidedly different. In round numbers, the tungsten gives three times as much light as the other lamps for a given power consumption.

It is common to substitute for the old carbon lamps new tungsten lamps with practically the same number of watts. While this gives much more light it makes no saving in the lighting bills. In some cases it would be better to use lamps of lower wattage, thus reducing the cost and at the same time increasing the amount of light. The cost of the lamps is small compared with the cost of the power used, and one can well afford to throw away the old lamps and buy new.

There are various devices for regulating electric lights. By the use of these the light may be dimmed as much as is desired.

In communities where electricity can not be derived from a general power plant, there are many systems of storage batteries by which individual lighting plants can be maintained.

CHAPTER VIII

ELECTRICITY

In the average modern household, there are usually three distinct uses of electrical power. Firstly, there is the lighting system, secondly, the telephone, and thirdly, a more or less elaborate system of electric bells and buzzers. The telephone need not concern us here. The repair department of the company is usually ready to correct any trouble at short notice, and for this reason the telephone is best left alone by the amateur. The lighting system should be treated with caution. In the little wires carrying the current there is sufficient voltage to cause a severe shock, and in certain circumstances, death. Before tampering in any way with the lighting system, therefore, the amateur should be quite certain that he knows what he is doing. The electric bell, supplied from one or more dry batteries, is perfectly safe, however, and its repair or installation comes legitimately within the range of the house-owner's duties.

Electrical Terms. Electricity is a mystery. Let that be admitted. Nobody can tell us what electricity is, nobody can explain why certain mechanical or chemical action should produce it. But there is no need to make it more of a mystery than it is. The attitude of many otherwise intelligent persons toward everything electrical is one of helpless bewilderment. Tell a man that water is running through a pipe at the rate of ten gallons a minute and at a pressure of five pounds per square inch, and he will understand fairly well what you are saying. Tell him that an electric current of five amperes is flowing through a wire at a voltage of one hundred and ten, and he will probably nod with what he thinks is an assumption of understanding and be just as wise as he was before you spoke to him.

Now a volt is no more mysterious than a pound, and an ampere is just as simple as a gallon, and a watt is as easy to understand as either. Before attempting to undertake any electrical work, let us first know the meaning of the chief units of measurement.

Rate of flow is measured in *amperes*, just as the flow of water is measured in gallons per second. The force with which a current flows, or, as some prefer to put it, the pressure of the current, is measured in *volts*. In all parts of a simple electric circuit, the amount of current flowing will be the same, but the force of the current will vary at different points. This is easy to understand if we take the analogy of a river. Suppose at some point in its course the river widens out and then becomes narrow again. The amount of water flowing past the banks where the river is broad is the same as where it is narrow, but in the broad part of the river we say the current is "sluggish," its force is small. At the narrows, however, the water rushes by with tremendously greater force. The "voltage" at the wide part is low; at the narrow part it is high, while the "amperes" remain the same at each point. At the narrows the resistance to the passage of the water rises. In electricity, resistance to the passage of a current is measured in *ohms*. A *volt* is the pressure produced when one *ampere* forces its way through the resistance of one *ohm*.

A *watt* is the unit of power. We buy our lamps, for instance, according to the number of watts which will be required to make them "burn" at proper efficiency. The force, or voltage, at which electricity is supplied to a dwelling is a constant quantity—usually about 110 volts. The amount of current which will flow through a lamp will depend, therefore, on its resistance. The higher the resistance, the less current will the pressure be able to force through it. The product of pressure and current, that is, of volts and amperes, gives the number of watts required. For instance, a 50 watt lamp on a 100 volt current will permit a flow of ½ ampere, a 25 watt lamp of ¼ ampere, and a 100 watt lamp of 1 ampere. You are charged on your bills for so many kilowatt hours (K.W.H). A kilowatt is a thousand watts. If you burn ten 100 watt lamps for 10 hours you will receive (or should receive) a bill for ten kilowatt hours.

Wiring for House Lighting. The user of electricity sometimes finds it difficult to understand why it is that he can switch off a light in his house, and thereby apparently break the circuit, and yet other lamps in the house will go on burning. The necessity for being able to do this is obvious, for electric lighting would become impossible if it were necessary to turn on, or off, all the lights in a house at the same moment. It is rendered possible by connecting the lights "in parallel," to use the technical expression of the electrician.

This is best understood by imagining that the current travels through two wires—the first wire brings the current from the main into the house, while the second conveys it from the house back to the main. Joining these wires, by a series of small bridges, as it were, are the wires carrying current to and from the lamps. When all the switches are turned off, there is a gap in all the bridges and no current flows. When one switch is turned on, a gap is closed in one bridge only, and the current flows across it. As more switches are turned on, more and more gaps are closed, and the current flows over more and more bridges. The *force* of the current (voltage) remains the same, but the *amount* of current (amperes) increases with every additional lamp turned on.

As more and more current flows through the

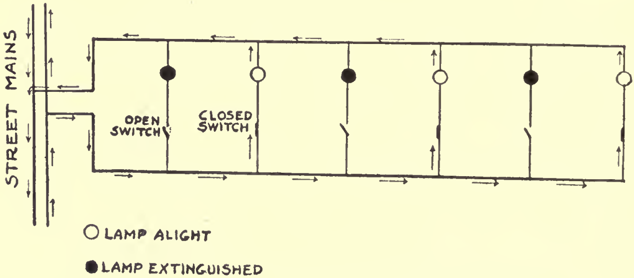


Diagram of Electric Lighting Circuit

wires, there is a tendency for the copper to become hot. If the process were carried to an extreme, the copper wires would ultimately become so hot that they would fuse and there would be great danger of fire. As a precaution against this, every circuit in a house passes through a fuse-box.

Fuses are of various patterns, the commonest household fuse taking the form of a plug. In this plug is fitted a short length of wire, made of a lead alloy, which has a very low melting point. The current flows through this wire, and if the amperes rise above a certain point, the wire becomes so hot that it melts and the circuit is broken. A fuse is a double precaution—firstly, against overloading the wires inside the house, and secondly, against overloading from outside sources, such as lightning, accidental short-circuits, and so on.

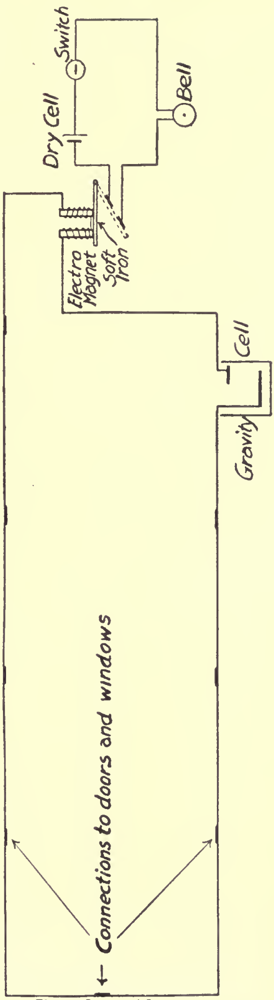
Overloading the Wires. The overloading of a circuit is a common source of domestic lighting troubles. Such articles as electric irons, toasters, and hot-plates permit the passage of very much more current than ordinary lamps. We have seen that a 50 watt lamp on a 110 volt circuit will permit the passage of less than half an ampere. Toasters and irons, however, will take five or more amperes. Suppose there is a ten ampere fuse on a circuit—that is, a fuse which will melt when the current through it rises to ten amperes. Suppose, moreover, that an electric iron is in use in the kitchen, and is consuming six amperes. In the dining-room is a toaster, which also consumes six amperes. Now, it is clear that if the toaster is turned on while the iron is still in use, the total current flowing through the wires will be twelve amperes, and the fuse will promptly melt and break the circuit.

As a rule, all electric appliances have attached to them a name-plate on which the current consumed is stated. If, therefore, you will trace the circuit back to your fuse-box, you can easily determine how many of these appliances you can safely use at the same time, by finding out the value of the fuse on the circuit. The number of amperes which the fuse can take care of is usually stated on the outside of the fuse, but if not, *first cut out the main switch* leading the current into the house, and then unscrew the fuse. You will find the number of amperes stamped on the inside end of the plug. If you wish to replace a burnt out fuse, *cut out the main switch,* remove the old fuse and replace it with another of the *same* value. Remember that it is important to cut out the main switch before doing even the simplest job on an electric lighting circuit. Safety first!

Burglar Alarms. The best type of burglar alarm is what is known as the "closed circuit" system. In this type, the alarm is given when the circuit is broken and not when it is closed. Any tampering with the wires, therefore, promptly gives the alarm, and it is impossible for an intruder to put the system out of commission by cutting or disconnecting a wire.

For this type of alarm it is necessary to have two batteries: a dry battery and a gravity battery. A gravity battery is commonly used in telegraphy, and consists of two plates, one of copper, the other of zinc, immersed in a solution of copper sulfate. By short-circuiting the cell, chemical reaction takes place, producing zinc sulfate in the upper part of the cell. This, being lighter than the copper sulfate, remains in a layer above it, so that the cell is divided into a colorless layer and a blue layer.

The wire from the cell is taken to the various doors, windows or other points which require protection and finally passes around an electromagnet. The electromagnet holds a strip of iron, and when the circuit is broken this strip of iron is, of course, released. An arrangement is made so that when the release occurs, the strip will fall in such a manner as to close a short secondary circuit, which includes the dry battery and an electric bell. This means, of course, that the bell will promptly ring, and give the alarm.



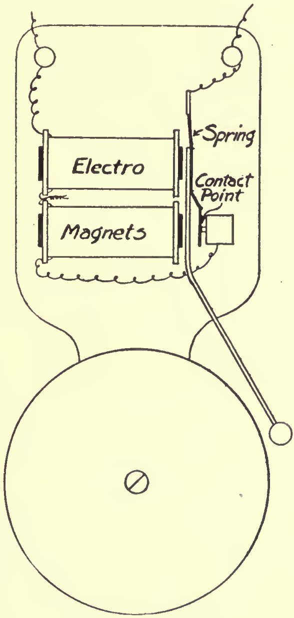
Burglar Alarm

The connections at doors and windows may be made with copper strips, which are brought together when the doors and windows are closed. For the sake of convenience, a switch may be placed in the secondary circuit so that the alarm will not ring during the daytime, when doors will be opened and closed frequently.

Where it is desired only to frighten a burglar away rather than to effect a capture, an excellent form of "alarm" is an arrangement by which the opening of a door or window will turn on the lights all over the house. Such a system serves to awaken every member of the household, and the rapid retreat of the astonished and discomfited burglar is a practical certainty. In any case, a burglar hunt in a fully illuminated house loses nine-tenths of the terrors of a chase in darkened rooms.

The installation of a system such as the above would, of course, be beyond the capabilities of an amateur electrician, and would require the services of an expert.

Electric Bells. The action of an electric bell depends upon the fact that when an electric current passes through a coil of wire wrapped around an iron rod, the iron temporarily becomes a magnet. When the bell-push is pressed, the circuit is closed, the current flows from the batteries to the bell, and passes around two iron rods which promptly become magnetized. As a result a small piece of steel attached to the bell hammer is drawn sharply towards the magnetized iron and the bell rings. The movement of the steel towards the magnets, however, breaks the circuit so that the current ceases to flow, the iron loses its magnetism, and the steel returns to its original position, thus once again closing the circuit, when the whole operation is repeated. This takes place many times a second, each movement of the steel causing the hammer to rap sharply on the bell.

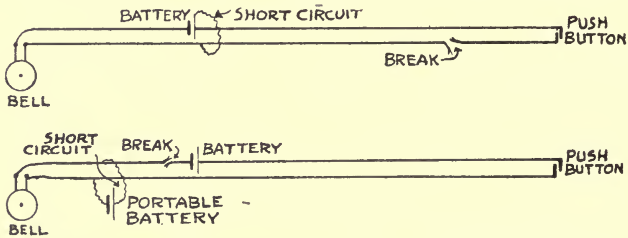


Electric Bell

If a bell will not ring, the cause of the trouble may be any one of the following:

1. Exhausted battery.
2. Loose or dirty connection.
3. The push button fails to make contact.
4. Bell needs adjusting.
5. Broken wire on bell magnets.
6. Broken circuit wire.

To test the battery, connect it by short wires with a bell known to be in good order. If the bell will not ring, the battery is exhausted. To test the bell, connect it by short wires with a good battery. If it will not ring, and if there is no sign of any broken wire on the magnet coils, it evidently needs adjusting. While, in principle, all electric bells are alike, in detail they differ widely, and the exact method of adjustment must be left to the intelligence of the individual. In some bells, particularly the older ones, adjustment is made by means of a screw, held firm by a lock-nut. If the lock-nut is loosened, the screw can be turned either way and the correct position found by trial. In the majority of bells now in domestic use, however, there is no adjusting screw, but only a system of springs. Adjustment is made by bending these springs in such a manner as to move the steel



Method of Finding Break in Electric Bell Wire

close to or further from the magnets, or to change the distance between the spring and the contact point. Before making any such adjustment, it is advisable to clean both the contact point and the spring with a piece of fine emery paper.

If both bell and battery are found to be in good condition, the trouble must be caused by a loose connection, or a broken wire, or by failure of the push-button. First, examine the push-button and make sure that the spring makes good contact when it is pressed in. Clean the contact points with emery paper. Examine the connections and see that everything is tight. Next, examine the connections on the bell and on the battery. If the bell still refuses to ring when everything is clean and tight, the wire must be broken somewhere in the circuit.

A broken wire is sometimes difficult to locate. Before proceeding to more elaborate methods, try to find the break by feeling along the wire with thumb and finger. Examine with special care the places where the wire is fastened to the wall with staples, or where there is a sharp bend in the wire. If the break still defies discovery, proceed as follows:

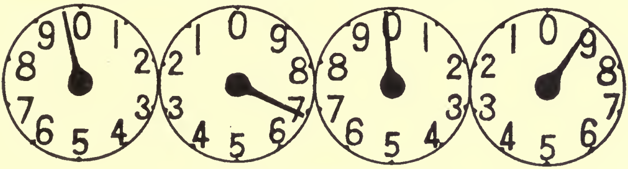
As near as possible to the battery, make a small cut in the insulation of the *return* wire, so as to lay bare the copper wire inside. Next, with a piece of wire make a short circuit between the exposed wire and the terminal of the battery, so as to close the circuit. It is obvious that this should make the bell ring. If it does, the broken wire is between the battery and the push button and by making a series of small cuts in the wire, short-circuiting each time until this procedure fails to make the bell ring, the location of the break can soon be ascertained. If the short-circuiting of the battery and the wire fails to make the bell ring, the break must be between the battery and the bell. It will then be necessary to short-circuit the wires connected with the bell, using a battery in order to make the short circuit. By starting at the bell and working back to the battery, the break can be located.

When found, the broken wire should be very carefully mended—preferably soldered, altho this is not absolutely necessary. Cover the joint, and also all the cuts, with insulating tape, of the kind that can be bought at any hardware or Five and Ten Cent store.

Electric Light Meter. An electric meter measures the amount of current which flows through it. It consists of a tiny electric motor which drives a dial, the dial having others geared with it. The more lights that are turned on, the more current is supplied to the motor and the faster does it revolve, but regardless of its speed of rotation the total number of revolutions which it makes will always be proportional to the amount of current flowing through it.

To read an electric meter is an easy matter, and it is a good practise to take readings at the time when the company's inspector makes his visit so that the readings given on the bill can be checked. There will usually be four dials on a domestic meter, the dial furthest to the right giving the units, that next to it the tens, the next the hundreds, and the one to the extreme left the thousands.

Since the pressure, or voltage, at which the current is supplied remains practically constant, it will be seen that the kilowatts consumed will be directly proportional to the current passing through the meter. It follows that the number of revolutions made by the dials will also be



KILOWATT HOURS.

proportional to the kilowatts consumed, and so the meter gives us a direct reading in "kilowatt hours"—usually contracted to "K.W.H."

Until skill is obtained in reading a meter it is advisable to write the figures down on a piece of paper, reading from right to left instead of from left to right: that is to say, the units should be written down first, then the tens, then the hundreds. The reason for this precaution can be readily understood by considering a hypothetical case. Suppose the K.W.H. consumption was 699. The pointer on the hundreds dial would be so close to the figure 7 that it would be an extremely probable error to read it as 700 instead of 600. Similarly, the pointer on the tens dial would be practically covering the 0 instead of 9, so that a reading of 709 or even 799 would be quite possible. But if the units dial were first read, the fact that it pointed to 9 would prepare one to expect the tens dial to be approaching the figure next highest above that which gave the correct reading; the same reasoning would apply to the hundreds dial and it would be clearly obvious that the reading was 699, not 709 or 799.

Testing the Meter. There must be few householders, and still fewer householders' wives, who have not declared, at least once in their lives, that the "electric meter must be *wrong.*" It seems the most obvious, if not the only possible, explanation of the alarming growth which frequently occurs in the size of the electric light bills. It may be stated, at once, therefore, that the inaccurate electric meter is a rarity, and as a meter tends, like any other machinery, to get dirty in course of time, it is much more likely to "run slow" than to "run fast." A rough test of the accuracy of his meter can be made by any householder in the following way:

First take a careful reading of the meter. Do this in the daytime and make sure that no lights are on and that no current is being used for any other purpose. The motor in the meter should be quite still and none of the dials should move. If there is any movement, a "leak" is indicated and you should promptly inform the electric light company. If there is no movement, turn on a number of lamps of known capacity. Lamps are sold according to the watts they consume, and the number of watts is, or should be, marked on the lamp, so that the capacity of a lamp is easily ascertained. Leave the lamps burning for a definite number of hours, and then take another reading. Figure out the K.W.H. which the lamps should have consumed and see how closely your figure checks the reading of the meter. For instance, suppose you turn on ten 50 watt lamps. Then the total number of watts will be 500. Leave them on for ten hours and the number of watt hours will be $500 \times 10 = 5000$. There are a thousand watts to a kilowatt, so that the number of kilowatts will be $5000 \div 1000 = 5$. Your meter should, therefore, read 5 kilowatts higher than when you started the test. If it shows any great discrepancy you are justified in complaining to the company.

In order to make the test more accurate, it may be run over a number of days, a careful check on the lamps that are used being kept for each day. If electric irons, toasters, vacuum cleaners or other appliances are used, these must, of course, be included in your calculation, as most of these appliances consume very much more electricity than do lamps.

In many cities, there is an official inspector of meters, and on payment of a small fee the city will test any meter which is believed to be incorrect. In a number of the states, the testing of meters is under the supervision of Public Service, or Public Utility Commissions, and application should be made at the State capital to these Commissions, who will supply all information.

High Bills for Electricity. Since the much-blamed meter is so seldom at fault it is worth while to investigate some of the other causes for high bills.

It is clear that bills will be higher in winter than in summer, for the simple reason that the hours of daylight are shorter. It is frequently overlooked, however, that a spell of dull or stormy weather in the summer months will materially increase the consumption of electricity. Lights will be turned on earlier in the evening, and a rainy, as contrasted with a sunny, morning will lead to the turning on of lights for dressing, shaving, preparing the breakfast, and so on. "Many a mickle makes a muckle," and the frequent use of a lamp, even if only for short periods, will soon show its effect on the electricity bill.

Then again, carelessness may result in the burning of lights in rooms not actually in use. Lamps are accidentally left burning in cellars, attics, and other parts of the house which are little frequented. Or, again, lamps of small capacity are replaced by larger ones for the sake of better illumination, and the fact that these lamps will consume more current will be overlooked.

Electric irons and toasters consume a considerable amount of electricity—much more than do lamps. A toaster will consume as much as twelve 50 watt lamps, and an iron almost as much. The careless or extravagant use of these appliances, therefore, will quickly show itself in dollars and cents.

Relative Economy of Tungsten Lamps. Carbon lamps are commonly supplied free, while a small charge is made for tungsten lamps. For this reason many householders continue to use carbon lamps. This is the worst kind of economy. For equal illumination a carbon lamp will consume three times the current required by a tungsten lamp. The householder who uses carbon lamps, therefore, may save a few cents on the first cost, but when he considers the many months during which the lamps will be in use, he will readily see that he will lose many dollars in the long run.

CHAPTER IX

THE WATER SUPPLY

THERE is little doubt that to the majority of the readers of this book the water used in their houses will come through mains from the city reservoir. In their case, the responsibility for the purity of the supply rests upon the city officials, and in these days of careful supervision they can usually have every confidence that the water is free from contamination. When conditions arise which render the water unsafe, prompt warning is given by the authorities.

Many householders, however, are dependent upon a private supply and it is for them that this section is written. The information given below should enable them to protect and possibly improve a supply system already installed, or to install a new supply with every confidence that they are obtaining a water of satisfactory purity.

Water for domestic use must, in the first place, be free from any possibility of contamination with harmful bacteria, and, in the second, be sufficiently low in saline matter to be suitable for use in boilers and for washing purposes; that is to say, it must be moderately soft.

The first requisite is, of course, the most important. A hard water is inconvenient, and sometimes costly, but a water contaminated with sewage is deadly and cannot be tolerated.

A private water-supply will come, almost always, from a well or a spring. Too much risk is attached to supplies drawn from streams or rivers, and these can only be used where a proper filtration system, under constant supervision, can be installed. Such an installation is impracticable for the private house owner, and, therefore, need not be considered.

Wells. The safest water for a private supply is that taken from a properly constructed deep well. The reason for this is obvious. Any bacterial contamination must be of animal origin, and must, therefore, occur on or near the surface. It is true that bacteria from this source will be washed into the subsoil by heavy rain, but the soil will act as a filter and by the time the water reaches the low level of a deep well, it will be in a sufficiently pure condition to drink with no possibility of undesirable consequences. The depth required to effect the purification varies, necessarily, with the nature of the soil, the more porous the soil the greater being the required depth. Even with highly porous soils, however, water which enters a well at a depth of twelve feet is fairly certain to be efficiently purified. If there is a cesspool or leaky drain in close proximity to the well, this statement will not, of course, hold good. But an intelligent man does not sink his well near his cesspool, or dig his cesspool near his well. It may also happen that the soil in a farmyard, or near heavily manured fields, may become so saturated with organic matter extracted from animal excrement that it no longer acts as an efficient filter. These, however, are exceptional cases. In ordinary circumstances, where proper precautions are observed, water from a carefully constructed well twelve feet or more in depth is usually of satisfactory purity.

Construction of a Well. It is clearly of little value that the greater part of the water in a well should enter at a low depth if there is any leakage into the well at, or near, the surface. If the walls of a well are not leak-proof, contaminated water may be gaining entrance in quantities which may appear to be insignificant, but which will be more than sufficient to render the well unsafe. Bacteria are living organisms which multiply with amazing rapidity, and where there is one bacterium to-day there may be a thousand to-morrow. It is clear, therefore, that a very little water, charged with bacteria, will be sufficient to "inoculate" a well, which will, thereafter, become the breeding-ground of countless billions.

If the well from which you draw your water is an old one, the chances are a hundred to one that the walls leak water. In other words, sur-

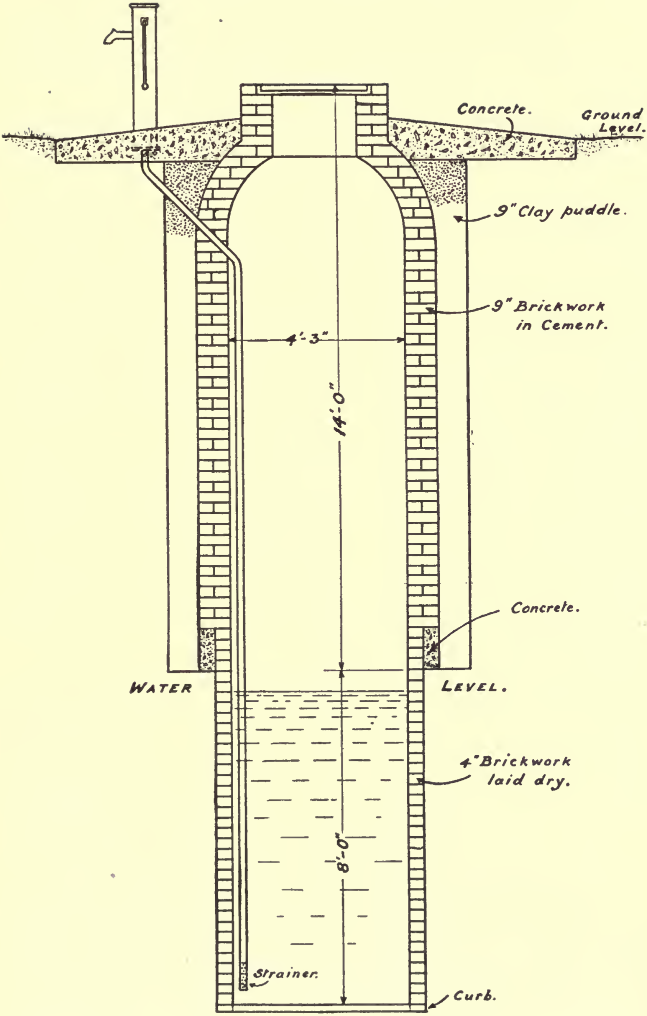


Diagram of Well

face water is gaining access to your well. The water may, of course, still be perfectly free from harmful organisms, and you and your family may continue to drink it for years, and even generations, with no harmful results. But the risk is there. The day may come when rain- or drainage-water will carry into the well the germs of typhoid. If the risk seems to you to be not worth while, the first precaution is to make your well leak-proof. Be quite certain that no surface water can gain entrance through the top, or through the walls, at any depth less than expert opinion advises you is safe.

The upper twelve feet of a well should be constructed of 9″ brickwork set in cement mortar, or of good quality stoneware pipes with cemented joints. The top of the well should be built up 12 inches above the surface of the ground and be supplied with a tight cover of stone, iron, or wood.

Springs. Spring water has a reputation for purity which is not wholly deserved. It is true that water from a spring may be as pure as it is cool and refreshing, but it is just as liable to contamination as water from a well. It is frequently difficult, if not impossible, to trace its origin, and, in certain geological formations, water may travel underground for long distances through fissures in rock or through coarse gravel, where no filtration can take place. Pollution may thus occur at a point far distant from the spot where the spring emerges and for this reason may be entirely unsuspected. Springs arising from a sandy bed are not open to suspicion to the same degree as those from fissured rock, but every precaution should be taken to protect the area around the spring from any possibility of pollution with animal excrement.

Danger Signals. Water from a well or a spring should be carefully observed after heavy rains. If the water shows any turbidity, this is a sign of danger. It is obvious that if solid particles can be carried into the water in such quantities as to be visible to the naked eye, the filtration of the water is very far from being efficient, and a careful investigation should at once be made. Turbidity is sometimes caused by iron. The water may be clear when first drawn, but becomes yellow and turbid on exposure to the atmosphere. This is due to the fact that iron salts are in solution in the freshly drawn water, but become oxidized to less soluble compounds by the air, and are precipitated as a brown suspension. Such turbidity is quite harmless from the standpoint of health.

An offensive odor is another danger signal. Good water should be odorless. Waters from peaty moorlands often have a faintly earthy odor, but this should not be sufficiently marked to be objectionable. Water from a well dug near a gas main is liable to acquire an odor of gas. Care should be taken, therefore, not to lay gas mains within several yards of a well or spring.

The Analysis of Water. Even tho you are entirely satisfied that your water supply is derived from a source which is fully protected from the possibility of sewage contamination, it is advisable to have an analysis made periodically. The regulations governing the analysis of water from private supplies vary in the different States, but it is the general rule that the State will undertake a complete examination whenever the local health officer considers it a necessary precautionary measure. In the words of the New York State Department of Health, for instance: "The Department examines samples of water whenever the results of the examination are likely to be directly applicable to the prevention of disease and the protection of the public health."

If, therefore, you wish for an examination of your water supply, the first step is to get into touch with the local health officer. He will advise you whether or not the State will undertake the examination, and in the event of their doing so he will obtain from the State Laboratories proper containers for the water and will supervise the collection of samples.

In the event of the State being unable, or unwilling, to make the examination, you must submit the water to a private analyst, and in choosing the analyst, choose the best available. The scientific examination of a water-supply is an undertaking requiring knowledge, experience, and intelligence. There are plumbers who profess to be able to test the potability of a water by adding to it various colored liquids, and they will undertake this "examination" for a dollar or two. Keep your dollars in your pocket! The examination by such "experts" is worse than valueless. It is usually misleading. The few extra dollars that a genuine analysis will cost you will be money well spent, and may, in the long run, be true economy. The diseases due to polluted water are of a very expensive variety!

Collecting Samples for Analysis. Before collecting samples for the private analyst, it is well to write to him for instructions. He will probably supply you with containers, and may, if circumstances permit, collect the samples himself, and at the same time make a general examination of the source of supply.

Failing this, observe the following precautions: for a full analysis not less than two quarts should be collected. The containers should be thoroughly clean glass bottles, free from the smallest trace or odor of any previous contents. Fill the bottle with the water, empty it, and then fill it again. Use, if possible, a glass-stoppered bottle. If not, use a new *clean* cork, previously boiled in water for five minutes. Do not touch the neck of the bottle while collecting the sample and do not let the water flow over the hands. Fill within half an inch of the stopper.

If water is taken from a faucet, let it run ten minutes before collecting the sample. If pumped from a well, reject half a dozen pails full before filling the bottle. If the sample is taken with a bucket, clean the bucket thoroughly and then rinse with boiling water.

Place a label on the bottle, or tie it around the neck, having written on it your name, the nature of the water supply (deep well, spring, shallow well or whatever it may be) and the date on which it was taken. It is very advisable for two analyses to be made, one towards the end of a dry spell, the other, shortly after heavy rains. If the sample taken after rain shows any marked falling off in quality, this will indicate that water is gaining access to the supply in an insufficiently purified condition. On this point, however, and on many others, you will do well to rely on the advice either of the Health Officer or the analyst.

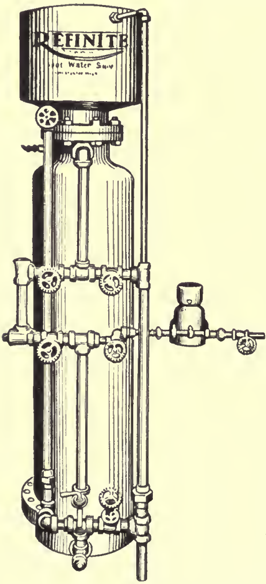
Hard and Soft Waters. The hardness of a water depends upon the amount of calcium and magnesium salts which it holds in solution. These salts cause soap to curdle, and are sometimes present in sufficient quantity to render a water unfit for domestic use. Even in hard waters, the amount of mineral matter in solution is very small, fifty parts of solid matter to one hundred thousand parts of water being unusually high. Soft water may not contain more than five parts a hundred thousand.

Hardness is of two kinds, known as "temporary" and "permanent" respectively. Temporary hardness is caused by bicarbonates of lime and magnesia, and can be removed by boiling, which causes the bicarbonates to decompose into insoluble carbonates, these being deposited on the sides or bottom of the boiler. Permanent hardness is due to chlorids and sulfates, and cannot be removed by boiling.

Effect of Hardness on Health. Many statements have been made regarding the effect on health of salts in drinking water. Kidney diseases have been said to result from drinking excessively hard waters, and dyspepsia has been laid to the same cause. On the other hand, soft waters have been blamed for causing rickets in children and poor physique among adults. The best medical opinion is inclined, however, to discard these theories as being without foundation. Careful investigations have shown that the rate of mortality is uninfluenced by the hardness of the water drunk by the inhabitants of different districts, while the statements regarding kidney disease and rickets have been found to be based on evidence which is wholly unreliable.

A hard water, however, is both inconvenient and expensive. It results in a great waste of soap, while the salts which it contains are deposited in steam boilers and kettles, resulting in loss of heat and deterioration of the boilers or utensils.

Where the only supply available, therefore, is undesirably hard, it is usually worth while to install a water-softening outfit.



Apparatus Used in Softening Water by the Zeolite Process.

Softening Hard Water. As stated above, temporary hardness can be readily removed by boiling. The disadvantages of such a method of softening water in bulk are, however, obvious, and for many years chemists have turned their attention to devising means for removing hardness by chemical treatment.

The earliest chemical softening process was invented by an English chemist named Clarke, who found that temporary hardness could be removed from water by the addition of the correct amount of lime water. There are many modifications of the Clarke process in use to-day, some of which remove both temporary and permanent hardness, and use, in addition to lime, caustic soda, carbonate of soda and other chemicals. Complete outfits are on the market and most of them are stated to give satisfactory results.

Of recent years, a new method of softening water, which has much to recommend it, has come into vogue. In this process, a natural or artificial "zeolite" is used. Zeolite is the chemical name for a silicate of soda and alumina. When hard water is passed over this compound, the calcium and magnesium are removed from the water and replaced by compounds of soda, thus giving a soft water. In course of time the zeolite necessarily becomes exhausted, but it is claimed that it can be completely restored by treatment with a solution of common salt. The apparatus required for treatment of water with zeolite occupies little space, and, as the process is practically automatic, very little supervision is required.

CHAPTER X

DRAINAGE

THE health of the household depends to a great extent on the perfection of the drainage system. If the house is located in a town or city in which the sewer system is complete, connection with this system ordinarily solves the problem of drainage. Unhappily, however, in suburban or isolated districts, the community is likely to grow much more rapidly than the sewer system can develop. Therefore, the house-owner is obliged to resort to the individual drainage system and to depend either upon the cesspool or the septic tank, which is a greatly improved method of drainage and is coming into increasing vogue.

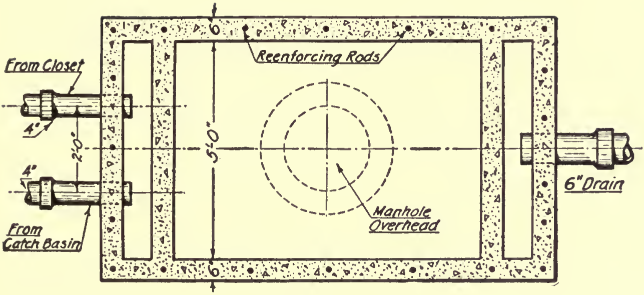
The cesspool, in order to give the minimum amount of care, should be dug in sandy soil, which will allow the liquid matter to drain away. However, this condition is not always possible and cesspools are frequently a source of trouble. The ordinary cesspool is a round pit from 6 to 8 feet in diameter and from 10 to 15 feet deep. It is usually lined with stone or brick which is laid without mortar so that the liquid in the cesspool can soak away through the stone or brick into the ground outside. The top of the wall is usually made in the form of a rough dome with a manhole in the center. This hole should be covered with an iron plate so that the cesspool can be frequently inspected. Too often builders are content to place merely a flat stone over the opening and to grade the earth over it. A result of this is that it is often difficult to find the opening if the cesspool overflows or other trouble occurs.

A greatly improved form of cesspool is one in which two holes are dug either of equal depth or one more shallow than the other. Connection is made between them so that the liquid material which enters the cesspool, with which the drainage-pipe directly connects, overflows at a certain height into the second pool. Trouble is much less likely to occur in this form of cesspool than in one in which a single excavation alone is used. The drain-pipe from the house should enter the cesspool as near the top as possible and with a proper inclination so that the liquid flows readily.

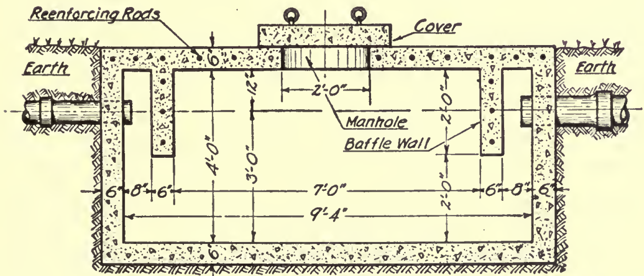
The cesspool is really the most primitive form of drainage and is used only when other methods are impossible. The wise house-owner will not attempt to remedy any trouble which occurs in his cesspool, but will call at once for the scavenger who is equipped with pumps and other paraphernalia for emptying and repairing.

There are some house-owners who are so short sighted that they postpone any action which would enable the sewer system to be extended into their neighborhood, either with the idea of saving the expenditure of money or from carelessness. After several experiences with overflowing cesspools and the attendant discomfort and expense, the alternative of contributing the proper proportional amount for the extension of the sewer system will seem a welcome alternative.

The Septic Tank. The septic tank has developed as a method of disposing of sewage within the last twenty-five years. It is a great improvement over the cesspool and can be installed in new or old houses at comparatively small cost and with very little operating attention. With this system the home may be fitted with the most complete and modern methods of plumbing without fear that the waste cannot be taken care of, as there is no limit to the kind and quality of waste sewage that the system will handle. In many communities large plants are installed to take care of whole sections as a single unit. Mr. B. Francis Dashiell, in *House and Garden,* describes a septic tank system and the methods of its construction: "The septic tank is a container for the reception, purification, and disposal of all kinds of sewage matter. This matter becomes liquefied and is rendered harmless and odorless through anærobic



TOP VIEW

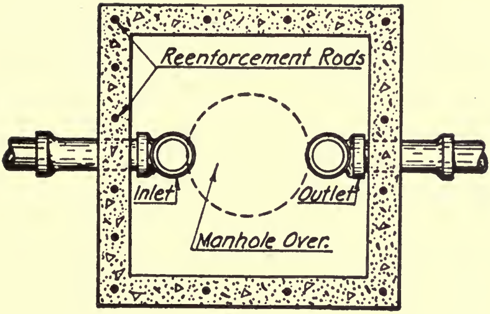


SECTIONAL ELEVATION
SEPTIC TANK.

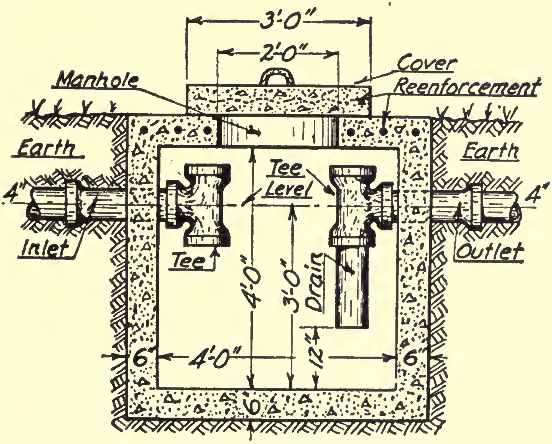
action or the work of a very minute organism or bacteria known as the Anærobiosis which will develop only in an air-tight and dark chamber filled with sewage matter.

"The septic tank is constructed entirely of concrete and vitrified tile drain pipe. There must first be constructed the receiving chamber or catch basin through which the waste water from the sinks and tubs passes, to catch the soaps and greases which come in such water, and must be prevented from passing into the septic tank. A slight fall in the drain pipes from the house is required so that the sewage will flow freely. Any distance from the house will be satisfactory for placing the tanks as there are no odors or unsightly visible portions. In fact, the entire system may be built right under the lawn beside the house without any knowledge of its being there, but of course it is advisable to keep it well away from the source of water supply. The plans call for the bottom of both the catch basin and septic tank to be on the same level, and they need be separated only a few feet or built together with a common wall as desired.

"Holes of suitable size should be excavated where desired and at the proper levels, allowing for drainage, fall, etc. Forms for the sides are set up after the floor or bottoms have been laid and hardened so as to hold light weight without making indentations. The top slabs are put on



PLAN



SECTIONAL ELEVATION
CATCH BASIN

last after the walls are sufficiently firm to hold the weight. The top form lumber can be removed through the manhole after the top has set and hardened several weeks. A preferable concrete mixture is one of the proportions 1:2:4, and mixed to a thin consistency so it will settle easily, thus preventing voids next to the forms and also making a denser surface. Two tile pipes, an inlet and an outlet, are fitted in the catch basin and have tees cemented so as to allow the water to enter and leave without disturbing the top scum of grease that floats on the surface. A length of tile pipe is cemented to the bottom of the outlet tee to remove the liquid from the bottom which is cleaner and clearer. The top of the basin is fitted with a manhole cover so that a bucket may be let down at intervals to remove the grease and sediment that collect about once a year or less.

"The septic tank consists of one large chamber with the inlet pipes from the catch basin and toilet at one end entering side by side. Partitions or baffles are provided so that a crust or scum will form upon the top of the waste matter without being disturbed by the inflowing and outdraining liquids. This crust must not be disturbed, as that would cause the bacterial action to cease until a new one formed. The baffles prevent any currents or motions being transmitted to the surface. A hole in the top is provided so that the tank can be cleaned when required, but a perfectly operating system may not need any attention for years, depending upon the quantity and nature of the wastes handled.

"The outlet end of the septic tank should connect with a tee fitting, the upper end of which connects with a piece of 1-inch iron pipe projecting above the ground as a vent. The lower end of the tee connects to the ground drainage line. This disposal drain, or nitrification system, as it is called, disposes of the clarified and harmless liquid from the septic tank. It consists merely of a line of loosely laid 4-inch tile drain pipe about 150 feet in length and laid with a slight fall so that the liquid will drain slowly along the entire distance, seeping out through the loose joints and far open end. This line should be buried 4 feet or more deep and covered several inches with sand, gravel or stone.

"In using, be careful that no chemicals are employed, especially chlorid of lime, as they interfere with the bacterial action. Plenty of water flushed through the drains will help, on the other hand, as it tends to keep the sewage in a thin watery state which is much to be desired. Manhole covers should be kept cemented tight to prevent gases from escaping and air from entering. There will be no danger of freezing in the coldest climates, as sufficient heat will be developed in the mass. The usual traps should

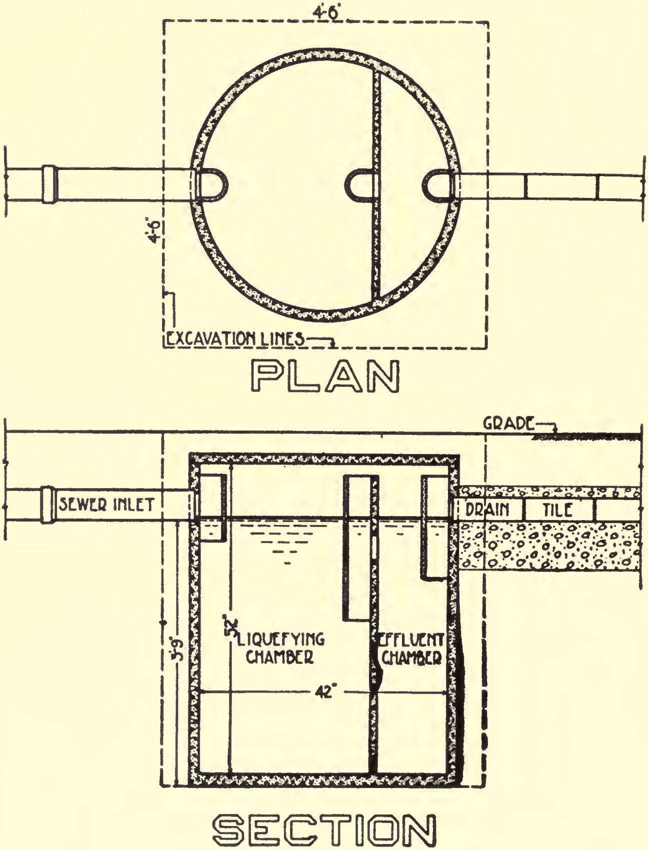
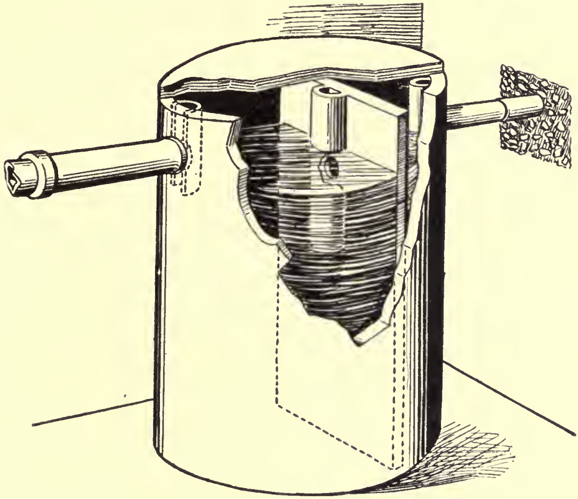


Diagram of Two Compartment Septic Tank

be placed on all of the plumbing fixtures in the house."

The system of the septic tank has been applied to patent septic tank systems which are convenient and of great practical utility. That



Two Compartment Septic Tank

system consists of either a single two-compartment concrete tank, or any larger units of two or more tanks. The first compartment or tank is known as the liquefying compartment, and the second as the effluent compartment. These tanks are constructed of reinforced concrete and are waterproofed to prevent leaking and absorption. The tanks, including the bottom, are made in one piece, thus eliminating any danger due to leaky joints. The tanks are not affected by any corrosive action due to acid in the sewage. They have sufficient depth to insure complete digestion of the sewage and sufficient area is allowed for the formation of a proper bacterial mat.

The sewage is received first in the liquefying compartment, where a greater portion of the bacterial action takes place. By means of a concrete connection, the ends of which extend several inches below the water level in the tank, the digested or liquid sewage is carried from the liquefying compartment into the effluent compartment. Here a further bacterial action takes place and the liquid is led off into the drain tile or nitrification bed, which is laid in cinders or other loose materials from which it passes off into the soil through the joints of the tile. The tile line may come to a dead end in the soil as it is not necessary to allow for any further drainage. The bacterial action which takes place digests practically all the sewage matter, and no chemicals of any kind are required to start or maintain the digestion. With proper use of the system it is seldom necessary to open the tanks when they are once installed. These tanks come in various sizes, from one sufficient to accommodate a family of five to those large enough for industrial establishments or from two to three houses.

CHAPTER XI

PLUMBING

Every man, in his own estimation, is endowed with sufficient intelligence and skill to wield a paint-brush, and few men shrink from simple jobs in carpentry. But plumbing, to the vast majority, is a hidden mystery. They are ignorant of its very elements. A few will venture to insert a new washer in a leaky faucet, or even to clean out a trap beneath a sink. But the same man who will confidently and light-heartedly undertake the painting of his bathroom or the construction of a set of shelves or even a cupboard, will send without hesitation for the plumber if he wishes to make some simple alteration in his water supply, or to replace a burst pipe.

It is difficult to explain this. The principles underlying pipe-fitting are extremely simple. It is not suggested that the designing and installation of the gas- and water-supply for a dwelling can be undertaken with success by any amateur. Such work demands both skill and experience. But elementary plumbing is certainly simpler than elementary carpentry, and the man who can build a kitchen cupboard which will satisfy the critical mind of his wife, may confidently undertake the tapping of his service pipes, and the installation, let us say, of a pipe-line for carrying water to his garden.

Speaking the Plumber's Language. Part, no doubt, of the hesitancy displayed by the average householder in undertaking jobs in plumbing is due to his ignorance of the technical terms employed in the art. He knows nothing of the sizes of pipes used for various purposes, and would as confidently (or as diffidently) ask for a ⅝″ pipe as for a ⅜″, being ignorant of the fact that while ⅜″ is a standard size, ⅝″ is not commonly manufactured. He will find it difficult to explain the difference between a coupling, a union, a bushing, and a nipple. In short, he is dealing with materials regarding which his knowledge is, at the best, very hazy. Let us, therefore, begin with a brief description of piping and pipe fittings.

Pipes used for gas and water inside a house are usually made of wrought iron. Lead and brass are sometimes used, but lead pipes should be avoided with very soft water, as this frequently has sufficient solvent action on lead to bring about symptoms of poisoning in those drinking the water. Iron pipes are divided into two classes—galvanized and black. Galvanized pipes are commonly used for water, black pipes for gas. An especially light black iron pipe is sometimes used for the latter.

Iron piping is sold in lengths of approximately twenty feet, threaded at each end. It is manufactured in standard sizes, the size referring to the *internal* diameter. These sizes are ⅛″, ¼″, ⅜″, ½″, ¾″, 1″, 1¼″, 1½″, 2″, and larger sizes, which are seldom used in domestic plumbing.

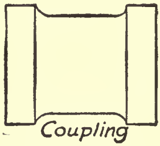
Piping is connected together with *pipe fittings,* and the sizes of these fittings are given in terms of the pipes which they connect. Thus a ½″ coupling is a coupling which will fit a ½″ pipe, altho the internal diameter of the coupling itself will be nearer ¾″ than ½″, due to the fact that it has to fit the *outside* of the ½″ pipe. (See below.)

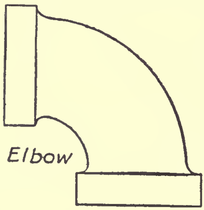
Pipe fittings are of great variety and enable the pipe-fitter to join pipes together at a number of different angles and in many different combinations. The principal fittings are:

1. *Couplings.* Sometimes called "sleeves." A coupling is supplied with every standard length of piping, and is the simplest joint which can be made between two pieces of pipe. It consists of a short joint, threaded internally, into which the pipes to be connected can be screwed.

2. *Elbows,* or *Ells,* are used where one pipe is joined to another at an angle. The standard elbow is one of 90°, but 45° and 60° are also manufactured. The angle in the two latter cases refers to the *external* angle between one side of the elbow and an imaginary extension of

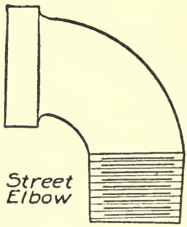
the other side of the elbow. Thus, the angle between two lengths of pipe joined by a "forty-five" is obtuse, not acute, and is actually 180°— 45°, or 135°. The standard elbow is made with female threads only—that is, it is threaded on the inside surface—but a so-called "street" or "service elbow" is also made, having both male and female threads, the former screwing into a coupling or some other fitting, while the pipe itself is screwed into the latter. Another modification is the elbow with side outlet, used to join three pipes, two at right angles to one another in the same plane, and the third meeting them at right angles to that plane.





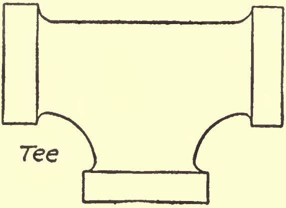
3. *Tees* are used to join three pipes in the same plane, one being at right angles to the other two. A "service tee" has one male thread. A "four way tee" is a tee with a side outlet.

4. *Crosses* connect four pipes in the same plane at right angles to one another. Modifications of the cross are not commonly made.



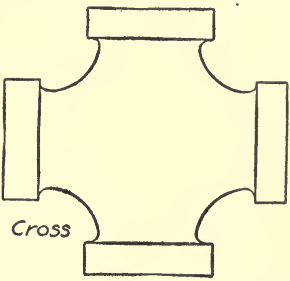
5. *Y Bends* are similar to tees, but are used when one pipe joins two others at an angle of 45° instead of at right angles.

6. *Caps* and *Plugs* are used to close the end of a pipe. *Caps* have an internal thread and screw onto the pipe; *plugs* have an external thread and screw into a coupling or other fitting.

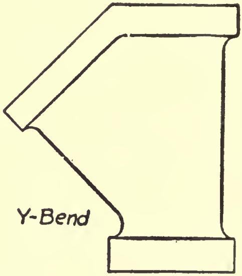


7. *Nipples* are short lengths of pipe, used for a variety of purposes. They vary in length from "close" (threaded, their entire length) up to 12″. The length of a close nipple varies according to the diameter of the pipe. Thus a close ⅛″ nipple is ¾″ long, while a close 2″ nipple is 2″ long.

Unions. A union is a special connection for joining two pipes in a straight line where it is inconvenient or impossible to use a coupling. For instance, suppose one section of a long length of piping should develop a leak and that it was required to insert a new section. It would first be necessary to cut through the leaky section and remove the two pieces of pipe by unscrewing them from the coupling at either end. It would then be found that the new section could not be directly inserted in the gap in the pipe line because it would not be possible to screw one end of it



into a coupling without at the same time unscrewing the other end. In such a situation it is necessary to cut the section of pipe into two pieces, screw each piece into place, and then connect them where they meet by some special joint. With pipes of large diameter, flanges are generally used, but with smaller pipes unions are more common.

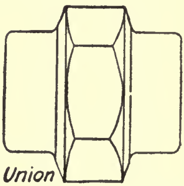


Y-Bend

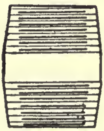
Cap

Plug

A union is really two flanges, one of which is threaded on its outer edge, while the other is fitted with a loose cap, threaded on its inner surface. By screwing the cap onto the threaded flange, the two flanges are drawn together, and in order to obtain a perfectly tight joint a gasket of cardboard, rubber or some similar material is placed between them. A variety of special unions are made, however, which require no gasket. Sometimes one flange is of brass, or the faces of the flanges are ground and tapered, so that a perfectly tight joint is obtained.

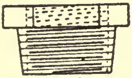


Union

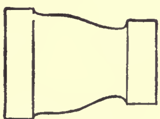


Nipple

Reducing. There are two common methods of connecting a pipe with another of smaller diameter. The first is by means of a reducing fitting. Reducing couplings, elbow, and tees are standard fittings carried by all supply houses. For instance, a 1″-1½″ reducing elbow will be fitted with one thread taking a 1″ pipe, while the other thread will take ½″ pipe. The other method of reducing is by means of a "*bushing.*" A bushing resembles a plug with a hole drilled through it and tapped. A 1″-½″ bushing will screw into a 1″ fitting (for instance, a coupling or an elbow) while the hole in the center will accommodate a ½″ pipe. If the exact size of bushing is not available, the desired reduction can be obtained by the use of two or more bushings. For instance, it is possible to reduce from a 2″ to a ¼″ pipe by means of a series of 2″-1″, 1″-½″, and ½″-¼″ bushings, one screwing within the other.


Bushing

Right and Left-handed Threads. The standard thread on all pipes and fitting is right-handed. That is to say, when a pipe is screwed into a fitting it is turned to the right, or in a clockwise direction. For special purposes, however, left-handed threads are occasionally used, and fittings having right- and left-handed threads can be obtained. For instance, to consider once again the case of the burst pipe, which was


Reducing Coupling

discussed under "unions," let us suppose that one of the couplings into which the new pipe had to be fitted was a right- and left-hand coupling. The right-hand thread would already be screwed in place, and the unoccupied thread would then be left-hand. By cutting a left-handed thread on to one end of our new pipe, we could easily screw the pipe into place, because, by turning the pipe, we could tighten it in both couplings at the same time.

Tools. The tools which will be required will depend, of course, upon the extent of the plumbing operations it is intended to undertake. The number of small jobs that can be carried through successfully with a Stillson wrench and a monkey wrench is astonishing, and these two tools should form part of the equipment of every house-owner. If only one of each variety is purchased, a 10″ size will probably be found most convenient, but two of each will be found well worth while, the Stillson wrenches being 8″ and 14″ and the monkey wrenches 6″ and 12″. In using a Stillson wrench remember that it will grip only when pressure is applied on the handle in such a manner that the jaws are forced toward one another. Do not try to screw the wrench so tightly on to the pipe that it can be turned in either direction. Instead, place the wrench over the pipe in such a manner that the pipe rests snugly, but not tightly, in the center of the jaws. Then, when pressure is applied to the handle, the jaws will close a little and the pipe be gripped tightly.

With these simple tools, it is possible to repair leaky faucets, to clean out traps, to tighten leaky radiators, and even to install quite extensive additions to a piping system, assuming that one is able (as one usually is) to purchase the exact lengths of piping required, already threaded at both ends.

If any considerable piping work is contemplated, however, it will be found necessary to purchase a pipe vise, a pipe cutter and a pipe stock with a set of dies. These are all fairly expensive articles, and they are seldom needed for ordinary household work. For the benefit of the man who prefers to invest his money in tools, rather than spend it on plumber's bills, the following brief descriptions are given:

Pipe-vise. A pipe-vise differs from an ordinary vise in that the jaws move vertically instead of horizontally. The lower jaw is fixed; the upper can be raised or lowered by turning a handle above it. The jaws are V-shaped, the upper V being inverted. The lower jaw consists of two pieces, similarly shaped, with a space between them, into which the upper jaw will fit. The frame in which the upper jaw moves is hinged so that it can be turned back. A pipe is laid in place on the lower jaw, after which the upper jaw is turned over it and screwed tight. On the side of the frame opposite to the hinge is a self-locking latch. The price of a pipe-vise will vary from $3.50 up, according to size and quality.

A *Pipe-cutter* somewhat resembles a stillson wrench in appearance, but the lower jaw is moved by turning the handle. The cutting is done by a small, hard-steel wheel, with a sharp edge. The cutter is placed over the pipe, the edge of the wheel being placed at the exact point at which it is desired to cut the pipe. The lower jaw is then screwed up tight, and the entire cutter is revolved around the pipe. As the edged wheel travels over the surface of the pipe, it cuts a groove. As the groove gets deeper, the jaw is tightened more and more until the pipe is cut clean through. A small-sized pipe-cutter costs about two-and-a-half dollars.

A *Pipe-Stock and Die* is used for threading the pipe after it is cut. Tools for this purpose have been greatly improved in recent years, and elaborate semiautomatic threaders are now on the market. In its simplest form, however, the pipe-stock consists of a double-handled holder, into which dies and collars can be fixed, according to the size of pipe it is desired to thread. The collars and dies are held in place by setscrews, and after adjusting them correctly the tool is placed, collar foremost, over the end of the pipe, and then revolved, while a steady pressure is maintained in order to cause the dies to bite. When a right-hand thread is being cut, the tool is revolved to the right, and vice versa. For a left-hand thread it is necessary, of course, to use left-hand dies. Threading a pipe is a simple matter, but some little practise is required before a good clean thread can be produced, especially on the larger sized pipes. Plenty of oil should be used in order to reduce friction between the dies and the pipes.

A pipe-stock and set of dies can cost almost anything, but a satisfactory outfit for domestic use can be bought for about eight dollars.

Plumbing Jobs. *Curing a Leaky Faucet.* A faucet may leak either at the outlet or around the spindle. The former is a far more common trouble than the latter, and is certain to occur, sooner or later, with any faucet, simply because a washer which will wear forever is yet to be discovered.

To cure a dripping faucet, first cut off the water where it enters the house, which is usually in the cellar. Then unscrew the nut or cap which holds the spindle in place. The spindle can then be lifted out of the faucet. Turn it upside down, and you will find a washer, fixed to the spindle by means of a screw passing through the middle. It is defects in this washer which cause the faucet to drip, and it will be necessary to replace it with a new one in order to overcome the trouble.

Take off the old washer by removing the central screw. This should be done with caution, or you may twist the head off the screw. A new washer of the right size can be bought at any hardware store. These washers are inexpensive, and it is true economy to get the best obtainable. For hot water, leather washers are unsatisfactory, as the leather quickly hardens and fails to make a tight joint, but for cold water, leather can be used. For both hot and cold, however, washers of a hard rubber composition will last for many months or even years. Place the washer over the end of the spindle, fasten it with the screw, replace the spindle, screw up the cap and the job is complete.

Dealing With a Leaky Pipe. If piping is carelessly put together in the first place, it may develop a leak, at one or more of the joints, some time after it has been installed. The only way to deal with trouble of this kind is to tighten the joint by screwing the pipe further into it. It is clear, however, that if the other end of the pipe is also connected with a fitting, making one end tighter will result in making the other end looser. In such a case, the only thing to do is to work forwards either to the faucet or to the nearest union—first, of course, loosening the union—and tighten each joint in turn.

If the leak is due to a burst pipe, the most satisfactory cure is to remove the faulty section and insert a new one. Here, again, the piping will have to be unscrewed, piece by piece, from the faucet or the nearest union. If this is impossible, or inconvenient, the section of pipe must be cut in two either with a pipe-cutter or a hack-saw and the two pieces removed. Two new pieces of pipe will then have to be inserted, connected by a union. In a job such as this, or in any pipe fitting, care must be taken to make allowance for the space occupied by the fittings. For instance, we will suppose that the faulty section referred to above was ten feet in length, including the threads. When sawn in two, each piece will obviously be five feet long, but if the two new pieces are each made five feet long there will clearly be no room for the union which is to connect them. The length of fittings varies according to the size of pipe, and the only safe course for the amateur is to measure the fittings before cutting his pipe, and to make an allowance for them, remembering, of course, that approximately half an inch of his pipe will screw into the fitting. (See table below.)

An example will make this clear. We will suppose that the burst pipe is ¾″. A ¾″ union measures approximately 2″. Deducting this length from ten feet, we have 9′ 10″. But ½″ of each new length of pipe will screw into the union, so we must add 1″ to our total length of pipe, making 9′ 11″, which represents the sum of the length of the two new sections.

Where joints are to be permanent the thread should be smeared with a preparation of white or red lead in oil before being inserted in the fittings. Where the joint is only temporary, graphite mixed in grease will be found satisfactory.

To obtain a tight joint, the length of thread which it is necessary to screw into a fitting varies with the size of pipe. The following table gives the necessary length for pipes from 1/8″ to 2″ in size.

Size of pipe........	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2
Length of thread...	1/4	3/8	3/8	1/2	1/2	9/16	5/8	5/8	11/16

The threads on a pipe should be cut in such a manner that when the pipe has been screwed into the fitting to the depth shown in the above table, it is so tight that it can be screwed in further only with difficulty.

Cost of Pipe. The cost of piping and fittings will necessarily vary with quality and market fluctuations. Half-inch black piping will cost about 5 cents per foot, galvanized, about 7 cents. Three-quarter inch will cost from 1 1/2 to 2 cents per foot more than half inch, and one inch will be about 3 cents dearer still. Half-inch black fittings cost from 8 cents to 15 cents apiece, galvanized, being approximately 50 per cent more expensive than black.

These prices are approximate only, but are sufficient to indicate that the cost of plumbing does not lie in the materials but in labor. The house-owner who can acquire sufficient skill to undertake the simpler plumbing jobs around his house will save many a large bill, therefore.

A burst lead pipe will call for different treatment from that given to an iron pipe. When an iron pipe bursts, it usually does so along its seam, and the crack is, as a rule, so large as to be beyond repair. Hence the need for inserting a new length, as described above. A lead pipe, however, usually bulges at one spot, and develops only a small leak. When the hole is found, the pipe should be scraped clean and then soldered, as described in the section on *Soldering.* Before doing so, however, the pipe should be emptied of water, or the heat of the soldering iron may generate enough steam to blow the molten solder out of the hole.

Replacing Eaves Troughs. Here is a job which few house-owners would ever dream of attempting. Yet there is nothing in it which need present any great difficulty to the ordinary handy man. The most difficult part of the job is the soldering of the corner and pieces, but gutters are now manufactured which can be put together without soldering. These gutters come in ten-foot lengths and fit together by means of folded joints. End pieces, corner pieces, and all necessary fittings are made with these folded joints, and the fixing of the gutters is, thereby, made an extremely simple matter. The gutters are made either for a right-handed or left-handed flow, and care must be taken to purchase the right variety. Water in the gutter should flow from the plain end to the folded end.

Most eaves troughs are made of galvanized iron. Either copper or zinc is much more durable, but the first cost is, of course, higher. Frequent painting of gutters, both inside and out, will prolong their lives, but ordinary paint is not very durable under the conditions obtaining inside a gutter. By using a good grade of bituminous or roof paint, for the inside of the gutter, the life of a galvanized iron trough may be trebled. Two coats of this paint applied every two years will give wonderful results. Care should be taken to keep the troughs clean. An accumulation of rotting leaves will quickly corrode a gutter. When putting them up be careful to give them sufficient pitch to cause any water which runs into them to flow readily and quickly to the outlet.

Cleaning a Choked Trap. All plumbing fixtures which are connected with a waste pipe must be fitted with a trap to prevent odors and noxious gases, from sewers or cesspools, from entering the house. In its simplest form, a trap consists of a U-bend in the waste-pipe. The bend fills with water, thus forming a seal against the passage of gases.

Any trap is liable (and, indeed, likely) to become choked in the course of time with grease and other solid matter carried away with the waste water. In modern houses these traps are usually so placed as to be easily accessible. Moreover, they are fitted with a screw cap on the bottom of the bend, and it is a simple matter to remove this cap and clean out the trap.

Occasionally, in place of the U-bend, a "round trap" is used, having an inlet pipe at the bottom and an outlet pipe at the top. These traps have a cap at the top, which can be easily removed, so that cleaning them out presents no more difficulty than cleaning the ordinary U-bend.

It may sometimes happen, however, that a trap is placed in a position not readily accessible, or the cap may have become corroded to such an extent that it can not be removed without injury to the trap. In such a case the obstruction can frequently be removed with the aid of one of the chemical preparations now on the market. Caution should be observed in using them, however. They consist largely, or entirely, of caustic alkali, and this material has a marked action on glazed earthenware, porcelain, or enameled iron. Great care should be taken, therefore, not to let either the solid or its solution come into contact with the sink itself. On brass, lead, or iron it is harmless.

The action of these chemical cleaners is due to the formation of a soluble soap with the grease. Potash, or soft, soaps are much more soluble than soda, or hard, soaps, so that a solvent containing caustic potash will give better results than one containing caustic soda. In fact, a small can of caustic potash will give as good results as any "secret" preparation, regardless of the claims which may be made for it. The best of these solvents, however, will require time to do its work, and it is advisable to pour the solid, or a strong solution of it, down the pipe and allow it to stand overnight. The probability is that the pipe will be found to be clear by morning, but if it is not a few minutes' work with a "plumber's friend," as the rubber force pumps are called, will usually complete the job.

It should be remembered that the chief value of these chemical solvents lies in their power to remove grease. Where the stoppage is known to be due to some other cause, it will probably be a waste of time and money to try to remove the obstruction with a solvent.

Soldering. To the uninitiated, soldering presents more difficulties, perhaps, than any other odd job around the house. Yet, if the fundamental principles are understood it is one of the simplest of operations.

Soldering is of two kinds: soft soldering, and brazing, or hard soldering. Brazing involves the use of a blast lamp of some kind and is beyond the scope of ordinary household repairs, and so need not concern us here. Soft soldering is performed by means of a soldering-iron, and the solder consists of a mixture of metals—usually of lead and tin, though it may contain bismuth, silver and other metals. Soft soldering can be successfully used in joining tinplate, lead, zinc, copper and some kinds of brass.

A soldering-iron consists of a copper bit held in an iron shank fitted with a wooden handle. Its function is to heat both the solder and the metals to be joined to such a degree that the solder will melt on the surfaces of the metals, causing them to adhere as the solder solidifies.

This sounds very simple, but as the unsuccessful amateur knows only too well, the amount of time, patience, solder, and heat which it is possible to waste in an attempt to join two small pieces of metal is practically unlimited. In soldering, experience counts for much, but knowledge and understanding count for more. Here, then, are a few hints, which should enable any one to solder with complete success. Neatness, combined with success, can only come with practise.

How to Solder. A complete soldering equipment will consist of an iron, solder, a lump of sal ammoniac, a piece of rosin, a small quantity of muriatic (hydrochloric) acid, and some "killed spirits." Killed spirits are made by dissolving zinc in muriatic acid, and consist of a solution of chlorid of zinc. It is possible to get along without either the sal ammoniac or the rosin, but they may help.

The first step in any soldering operation is to tin the bit. This is done by heating to a dull red, filing the four faces of the tip quite bright, dipping in the chlorid of zinc, and then lightly rubbing the tip with the solder, which will melt and flow over the bit. An alternative scheme is to make a small hole in the lump of sal ammoniac and to place a small piece of solder in this hole. After the bit is heated, filed clean and dipped in the chlorid of zinc, turn it around in the hole when the solder will melt and coat the tip of the bit.

When once the bit has been tinned, be careful not to heat it again to redness, or you will have to do the tinning all over again. It is good practise to place only the thick part of the bit in the flame, permitting the tip to project beyond it.

Having tinned your bit, keep it warm, and thoroughly clean the surfaces which you wish to solder. Solder will not stick to surfaces which are greasy or dirty, and it is nearly always necessary to scrape or sandpaper the metal at the point where the solder is to be applied in order to make the surface not only clean but bright. After cleaning the surface in this way add a very little of the chlorid of zinc. Then take your hot iron, dip it for an instant in the chlorid of zinc, and then rub it against the solder so as to melt it. Hold the iron in a horizontal position and allow a globule of the molten solder to run on to the tip. Transfer the solder, in this way, to the metal, and as soon as the tip touches the metal, lift up the handle of the iron so that the solder runs off it on to the metal. Rub the bit over the surface, and the solder will then flow evenly over the spot you wish to cover. Remove the bit and the solder will solidify.

This, in general, is the procedure to be followed in all soldering operations. Certain special features belong to some jobs, which require a little more detailed explanation.

To solder a patch to a metal surface, clean a spot on the surface at least a quarter of an inch larger, in all directions, than the patch. If possible, use a round patch in preference to a square one. Apply a little chlorid of zinc to the under surface of the patch and also to the cleaned metal surface. Hold the patch in position with any convenient tool, and then apply the solder as described above. If the patch is rubbed with the hot iron, the solder will run underneath it, and, on cooling, will cause the patch to adhere.

In *soldering copper or brass* it is frequently advisable to tin the surfaces before attempting to solder. The tinning is carried out in much the same manner as described above for tinning the soldering iron. That is to say, the surface is scraped or filed clean, rubbed over with chlorid of zinc, heated either with a flame or with the iron, and then solder is allowed to run over it. The bit will need to be hotter for copper or brass than for tin plate.

Zinc and Galvanized Iron usually cause some trouble, but they can be successfully soldered if strong muriatic acid is used instead of chlorid of zinc, and if care is taken to keep the iron clean and free from zinc.

CHAPTER XII

SPECIAL APPLIANCES

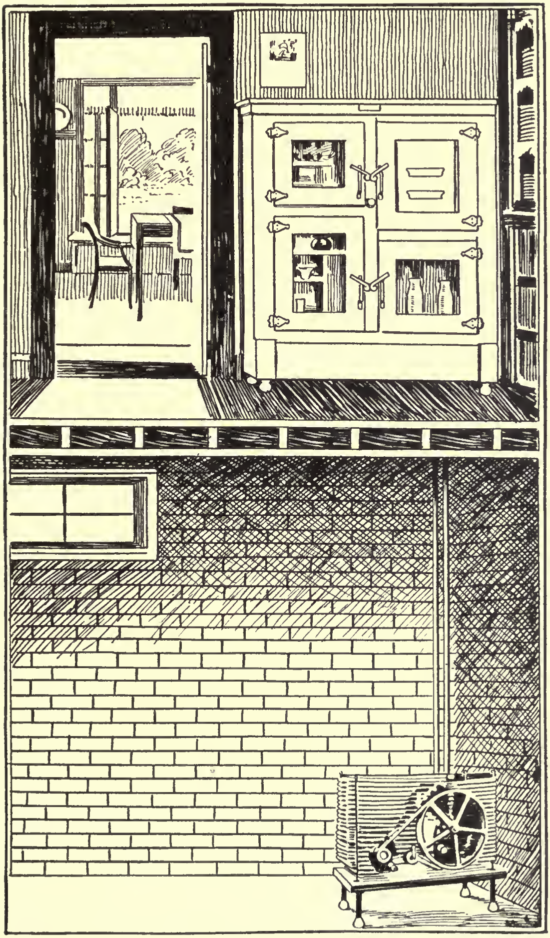
The Iceless Ice-box. The ice-box is a necessary nuisance. The best proof of its necessity is the fact that it is such a nuisance that nobody would endure it unless they were compelled. The overflowing of the drainage water; the discovery that the drain-pipe is plugged with repulsive slime; the iceman who is surly as well as unscrupulous; the heat-wave that arrives on Sunday and leaves one iceless about midnight and with sour milk and liquid butter on Monday morning: these are such common experiences that they have come to be accepted with philosophic patience.

For those who can afford it, however, there now exists the opportunity for freeing themselves from these small but ever-present trials. Drainage water, and with it the plugged drain-pipe, can be abolished. The iceman can be told that he need never again trouble himself to deliver the 100 pound block that dwindles so magically to 75 pounds on its journey from the truck to the refrigerator. As for heat-waves, one can be independent of them, for the temperature of the ice-box remains the same regardless of the temperature outside.

This desirable state of affairs can be brought about by a miniature refrigerating plant, specially designed for use in the domestic ice-box. A tank filled with brine takes the place of ice, and the brine is cooled to a temperature below the freezing point of water by mechanical means. A tray, which can be filled with water, slides into the refrigerating compartment, thus supplying ice for table use.

The method by which the brine is cooled is the same, in principle, as that used in all refrigerating plants. It is a well-known fact that when a gas is heated it expands. The converse is also true—when a gas is caused to expand, it withdraws heat from objects in contact with it. In the refrigerator, therefore, compressed gas is caused to expand, whereupon it withdraws heat from the brine surrounding the coils in which it is contained. It is then withdrawn from the coils, again compressed, and again caused to expand, this cycle of operations being repeated indefinitely.

In the domestic refrigerating plant, sulfur-dioxid is the gas usually employed. It is compressed by means of a motor-driven compressor, and then passes through an expansion valve into coils placed in a brine tank. After withdrawing heat from the brine, it is again compressed. Before passing through the ex-



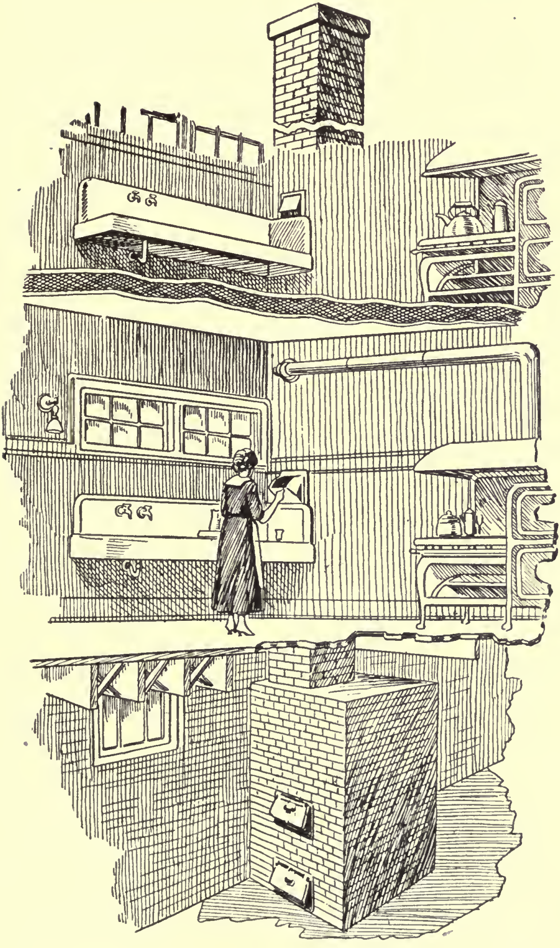
Home Refrigerating Apparatus

pansion valve it is cooled in an air-cooled condenser. Both the brine-tank and the sulfur-dioxid are tightly sealed and need no renewal for many years.

The motor, compressor, and condenser are placed in the cellar and occupy a space about 2′ 6″ x 1′ 6″. The brine tank will vary in size according to the ice-box. The running of the motor is automatically controlled by a thermostat. As long as the temperature of the ice-box remains above a certain point, the motor will run. When the temperature falls to the required point, the motor will stop. When the temperature again rises, the motor will again start running. All that the owner has to do is to give the motor an occasional oiling.

It is claimed that with such an outfit an ice-box will keep colder than with ice, and that the temperature will not fluctuate. Other advantages are freedom from dampness, cleanliness, and the possibility of producing pure ice from one's own drinking water.

At the time of writing the cost of such an outfit is from $350 upwards, according to capacity. The cost of running, as compared with that of ice, will vary in different localities. In New York, where electric power is comparatively cheap and ice comparatively dear, the operating cost would be about 30 per cent less than the cost of ice.



Home Garbage Incinerator

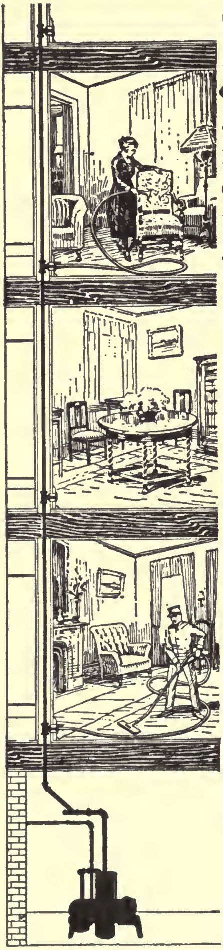
Abolishing the Garbage Can. If the ice-box is a necessary nuisance, the garbage can may surely be described as an unavoidable evil. Even in the best managed households, it is a malodorous, untidy, dirty piece of furniture. The whole business of the collection and removal of garbage has long been recognized as obnoxious, but until recent years it has been looked upon as unavoidable.

A system has now been devised, and tried with complete success, by which household garbage can be destroyed in the very place where it is produced, without the formation of unpleasant odor or other undesirable consequences, thus doing away with the necessity for a garbage can. The garbage is destroyed by burning, *the fuel being supplied by the garbage itself*. It is claimed that it has been clearly demonstrated that in the waste from a normal household there is more than enough combustible material in the form of paper, rags, and the like, to dry out the moisture from the remaining portion of the garbage. When dry, nearly all garbage is readily combustible. The system, therefore, consists in reducing garbage to ash, and it is stated that the ash accumulates so slowly that it does not call for removal more often than once in every three months.

The equipment required for this process is as follows. A receiving hopper, which can be opened or closed at will, is placed in the chimney flue in the kitchen and, if desired, on the upper stories of the building. Garbage of every description (including bottles and tin cans) is dropped into these hoppers, and falls down to the incinerating chamber, which is nothing more than an enlargement of the base of the chimney, fitted with grates of special design. The garbage is allowed to accumulate for about a week and is then burned *from the top downwards.*

The claim is made that the special arrangement of grates, which permits the material to burn downwards, eliminates any possibility of the formation of noxious odors. The odor of burning garbage is due to the formation of gases which are incompletely burned. By keeping the fire on top of the material, any gases produced must pass through the flames, and are completely consumed. Moreover the fire sterilizes the entire flue and the garbage will not decay between burnings because it is "smoked," just as preserved meat was smoked according to the well-known process.

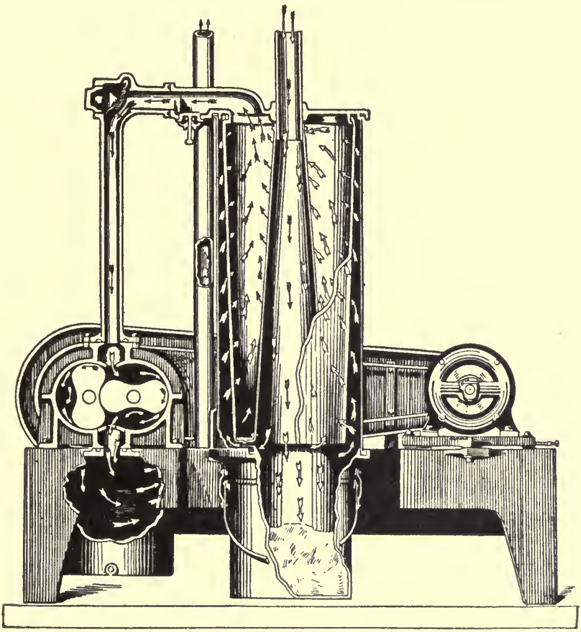
This system, therefore, makes it possible to throw away any refuse matter immediately, without permitting it to accumulate in a garbage can, and reduces the labor involved to the process of removing a canful of ashes about four times a year. Since the garbage supplies its own fuel, the cost of installation is practically the only cost.


Vacuum Cleaner Equipment

Vacuum Cleaner Equipment. The great superiority of the system of cleaning by suction, over the old method of sweeping and dusting, is now universally recognized. None the less, the ordinary portable household vacuum cleaner has certain disadvantages. In the first place, it carries its own motor and dust-bag, and is, in consequence, more or less cumbersome. In the second place, it is noisy, and the peculiar whirring hum which is characteristic of it is trying to the nerves of many people.

For these reasons, among others, the portable vacuum cleaner has been classed with the individual fireplace, and the prophecy is made that "central" vacuum cleaning will be as common, in a few years, as central heat. Be that as it may, the systems already on the market in which the vacuum apparatus is installed in the cellar, and connects by piping with every room in the house, have much to recommend them.

The equipment consists of a motor, suction pump and dust separator (all of which are installed in the cellar) connected to the upper rooms by piping. This piping terminates in



Suction Pump and Dust Collector in Vacuum Cleaner System

special fittings which are inserted in the baseboard. The fitting consists essentially of a metal inlet equipped with a cover, and when it is required to make use of the cleaner, it is only necessary to lift the cover and insert in the inlet the end of a flexible tube carrying the cleaning tool.

Since all the moving machinery is in the cellar, the actual cleaning process is absolutely noiseless. Moreover, the part carried by the operator contains no motor or dust-bag, but consists of nothing but a flexible tube with the usual metal attachment. For this reason, it is much more easily and conveniently handled than the ordinary household cleaner.

The pipes leading to the cleaner are, of course, always dry, and will not, therefore, "sweat" in the same manner as water pipes. They can, therefore, be placed in any part of the house with perfect safety, and it is seldom necessary to break partitions or plaster in order to install them. In fact, their installation is usually a very simple matter, and they can be run through partitions, between walls, through ventilating flues, unused chimneys, or other convenient locations.

A good grade of stationary cleaner is very durable—much more so than the portable cleaner—and should last about a lifetime. The machinery requires a minimum of attention, an occasional oiling being all that is necessary, and the accumulated dirt can be removed periodically in the bucket into which it is automatically deposited. The stationary cleaner is necessarily more costly than the portable, but in convenience and efficiency it leaves the portable machine far behind.

Air Moisteners. The chief disadvantage of heating by means of steam and hot-water radiators, is the dryness of the heat which they produce. This dryness is not only uncomfortable and unhealthy; it is also destructive in the warping effect which it has upon woodwork and furniture.

By a very simple contrivance, these ill effects can be to a large extent overcome. A corrugated galvanized iron reservoir is hung behind the radiator, where it is hidden from view. The reservoir is periodically filled with water, and as it fits closely against the coils of the radiator, the water is rapidly heated and evaporated.

A modified form of this air moistener can also be obtained where a hot air furnace is used. For floor registers, a round pot, having a cone-shaped central core, is inserted in the register box; for wall registers, a corrugated reservoir, very similar to those already described, is used.

The Hot-Water Supply. An ever-ready supply of hot water adds so greatly to the comfort of the home that it is not surprizing that much attention has been given to devising means for supplying it. As a result, the house owner has a choice of many alternate systems, and while it is an easy matter to decide that a hot-water supply is necessary, it is not quite so easy to make a choice among the many systems and to feel that one has chosen the best. The following brief review may prove helpful:

There is first the ordinary boiler connected with the kitchen range. This is too familiar to need description here. Suffice it to say that in those households where a kitchen fire is kept burning all day and every day, this system is about the simplest and most economical that can be devised.

But the coal-fired kitchen range is losing its popularity. More and more houses are being built with no coal range, the cooking being done by gas. Even those houses in which a coal range is installed are usually equipped with a gas range in addition, and the coal range is used less and less frequently. A hot-water system which only functions spasmodically is very little better than no system at all, so that there is an almost universal demand for some alternate scheme.

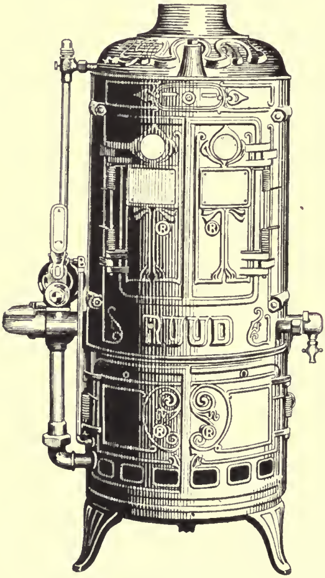
The next most obvious system is a coil or heater connected with the furnace. Many modern furnaces are equipped with these heaters, and it is only necessary to connect them with the boiler to obtain a plentiful supply of hot water. A modification of this system has recently been introduced which can be used in connection with any steam or hot-water furnace. By this scheme the fire-pot coil is replaced by a heater outside the boiler. Boiling water from the furnace circulates through this heater and heats the supply of household water, which in turn circulates within the heater. The furnace water does not come into direct contact with the household water, but merely serves as the heating medium.

Any system connected with the furnace gives satisfaction, as a rule, as long as the furnace is in use. But there is the rub. It is no great hardship to get along without a hot-water supply in the middle of the summer, but in those intermediate seasons, the late spring and early fall, when the furnace is not being used, lack of it is something more than an inconvenience.

To meet this condition, the small separate coal furnace was devised, burning just enough coal to keep the boiler filled with hot water. These small furnaces, once again, are satisfactory enough, but the necessity of having to tend a furnace, no matter how small, during the warm months, is depressing to the most optimistic of house-owners.

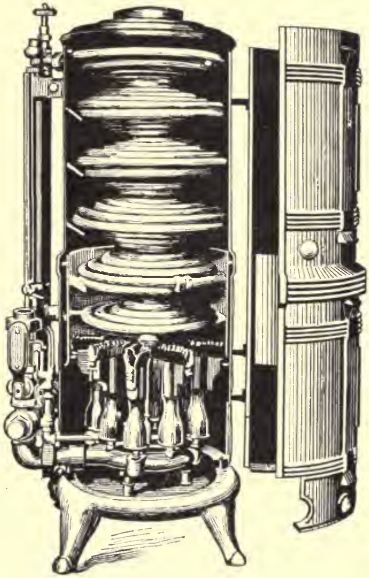
Next, there is the gas-heater, connected with the boiler, and lighted whenever a plentiful supply of hot water is needed. This intermittent heater, in conjunction with a coil or heater connected with the furnace, is about as good a system as can be devised where economy is the prime consideration. But it is not luxurious. The gas-heater is seldom used except for the bathtub or the laundry; for the smaller daily ablutions, either cold water is used, or water is heated by the kettleful, over a gas-ring.

This leads us to the automatic heaters. In its simplest form, the automatic gas-heater burns continuously, the flame being raised or lowered automatically by means of a thermostat connected with the boiler. In principle this is excellent, but it has two drawbacks which sometimes assume serious dimensions. In the first place such a system is extravagant. It heats water when it is not needed—an objection which applies in some degree, of course, to the heaters connected with furnaces. Secondly, when the water is very hot and remains so for some time (when, that is to say, very little is being used) the flame is automatically turned so low that there is considerable risk of its "popping back" or even being accidentally blown out altogether.



Outside of Hot-Water Heater

The next step, therefore, was the invention of the "instantaneous" heater. By this system a small pilot light is kept burning continuously. The opening of a hot-water faucet, in any part of the house, automatically turns on the gas supplying a number of powerful bunsen burners placed beneath a series of copper coils through which the water passes. The heat from these burners is sufficient to render the water, flowing through the coils, piping hot, and, of course, the supply continues just as long as the faucet remains open. When the faucet is closed, the supply of gas to the burners is cut off, and only the pilot is left burning.



Inside of Hot-Water Heater

The better types of instantaneous heaters are fitted with a thermostat by which the temperature of the water is regulated regardless of the amount withdrawn. Thus, if two faucets are opened at the same time, the thermostat will admit a sufficient quantity of gas to heat the extra quantity of water being drawn, and as soon as one faucet is closed the gas will be lowered accordingly. The thermostat will also control the flow of gas to the burners if the water pressure control happens for some reason to fail. The thermostat, therefore, makes for safety as well as economy.

There is no denying that these instantaneous heaters leave little to be desired as far as efficiency is concerned. They do the work that they claim to do. They give an unlimited supply of hot water at any hour of the day or night. Their main disadvantages are that their first cost is fairly high (from $100 up, according to size) and they are somewhat extravagant. Regardless of the quantity of water drawn, the burners will light just as soon as the faucet is turned. This necessarily involves some waste. The long copper coils and the length of piping leading to the faucet hold a considerable quantity of water, and when a small quantity is drawn, as, for instance, for washing the hands or for some cooking operation, the quantity heated may be very much more than the quantity used.

In actual practise, however, it is found that when these heaters are used intelligently the cost is not unduly high. There is room, however, for recklessness and extravagance, and in the house where "hired help" is employed, it will be well to check undue waste by installing a spring hot-water faucet in the kitchen.

A still more recent innovation combines some of the features of the old constant temperature gas-heated storage tank with the more modern instantaneous heater. By means of a special appliance, any ordinary gas water-heater may be made automatic. The device keeps the water in the boiler at a practically constant temperature, but instead of burning a little gas all the time, the heater is turned completely out until the temperature of the water falls to a certain desired level. The automatic device then comes into operation, the gas is turned full on, and is ignited by a pilot light as in the case of the instantaneous heaters.

This system has certain advantages. It can be installed in connection with the ordinary gas-heater, and there is, therefore, no need to scrap equipment which is probably in perfectly good condition. The burner does not ignite every time the hot-water faucet is opened. The ignition of the burner does not depend upon the flow of water, but upon its temperature. This system can, therefore, be used to advantage in conjunction with a coil in the furnace or a "water-back" in the kitchen stove. As long as the furnace or the stove is hot enough to keep the water at the desired temperature, the automatic appliance does not function. If the furnace or the stove cools off, the gas burner is automatically ignited and brings the water to the right temperature again.

The supply of hot water is not, of course, unlimited, as it is in the case of the instantaneous heater. If a very heavy drain were made on the supply so that the boiler was quickly and completely emptied, a short time would be required to heat the cold water which would flow into the boiler to replace the hot. This is a condition which is not likely to arise, however, in the average household, unless the capacity of the boiler is too small for the house.

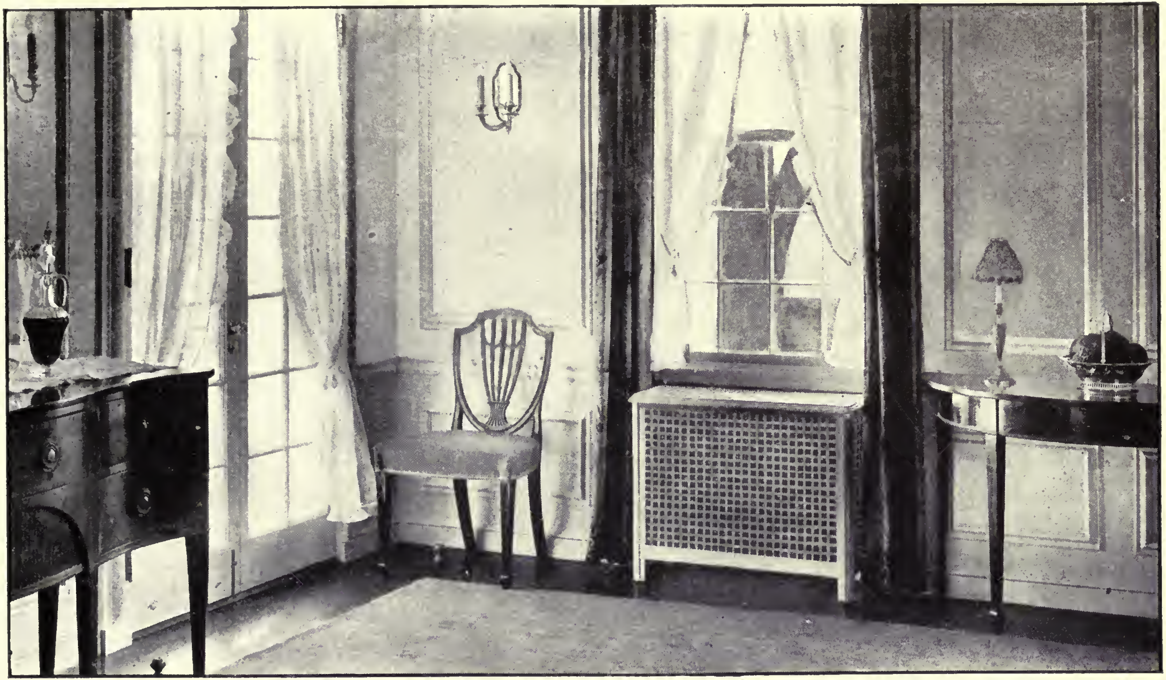
A more serious disadvantage is the same as that occurring with the old constant temperature gas-heater—water may be heated without being used. About three quarters of the water in the boiler is heated and is maintained at a constant temperature. This water is, of course, continually losing heat by radiation, so that an appreciable loss is bound to occur. To offset this, the manufacturers of the appliance supply an insulating cover for the boiler which reduces the loss considerably. Claims are made that this system is very economical of gas, but it is difficult to see that it can have any great advantage, from this standpoint, over the instantaneous heater. The first cost, however, is very much smaller, being, on an average, less than one-third that of an instantaneous heater.

Hiding the Radiator. Even the most enthusiastic advocate of steam- or hot-water heating has never claimed that radiators are beautiful. The man who, for the sake of the comfort they give, has to live with them, tries to ignore them while knowing in his heart that they are the ugliest things in his house. He may try to beautify them with a coat of gold or silver, or make them less conspicuous with a somber paint intended to blend with the color scheme of the room, but do what he may, the radiators remain an obtrusive, ugly piece of furniture, suitable enough, perhaps, for a machine-shop, but hopelessly out of place in a home.

To hide them seems, at first thought, impossible, because covering them means cutting off the heat. And the fact may as well be faced that any kind of an enclosure *will* reduce heating efficiency to a greater or less degree. But, with a properly designed radiator enclosure, the loss of heat is very small, and to a great many people the added beauty of the room is worth the loss of a little heat or the cost of a little extra coal.

If, therefore, you feel that you belong to this number, you will find that great ingenuity has been used in designing enclosures to hide your radiators. In its simplest form the enclosure consists of a three-sided wooden frame, with a top, both front and top being fitted with open grilles of pleasing design. Such an enclosure is as obvious as it is simple, but none the less it can be made very much more pleasing to the eye than the bare radiator. If you wish for something more inspired, your radiators can be hidden behind what is, apparently, a book-case with leaded glass doors, or beneath a charming window-seat, or they may form the base of your wife's china-closet. Regardless of the type of enclosure, there are certain fundamental laws regarding their use which must be borne in mind. The first, and most important, is that satisfactory heating with an enclosed radiator depends upon proper circulation of air through the enclosure. There must be an opening at the bottom to admit cold air and another at the top to let out the heated air, and the opening at the top should be proportionate to that at the bottom. The second law is that where a top opening is not possible, as in the case of a window-seat, for instance, the opening must be in front and a curved metal sheet must be used to deflect the heat through this opening.

There is clearly much scope for originality in devising means of hiding radiators while obtaining from them all the heat one desires, and it is a very much simpler matter to make the necessary arrangements when designing a new house than it is to hide radiators in a dwelling where they are already installed. Nevertheless, it is entirely possible to accomplish even this, and the house-owner, whose sense of beauty is more or less continuously outraged by the obtrusive radiator, will find it worth his while to investigate just what devices are on the market for rendering this useful but ugly article less conspicuous.



RADIATOR ENCLOSURE

Installing a Shower-Bath. If no house is complete without a bathroom, no bathroom is complete without a shower-bath. It is not so long ago that the man who proclaimed that he preferred a shower- to a tub-bath was considered either a freak or a poser. But those days are past. It is now recognized that a shower-bath is not only more invigorating,—it is more cleansing. Fresh water constantly pours upon the body, washing away all impurities, and producing a sensation of cleanliness and well-being which the tub-bath can never give.

Shower-baths can be installed, of course, in every degree of elaborateness. If you are building your house regardless of cost, you can have a separate compartment for your shower-bath, lined with white tiles, enclosed with a plate-glass door, and fitted with one head-spray and six adjustable body-sprays, guaranteed to deliver the water to your priceless body at every imaginable angle, the whole being controlled by a special mixing-valve, by which the temperature of the water can be raised or lowered to any desired degree (recorded, before your eyes, on a built-in thermometer) between 50° and 150° F. If you are just an ordinary citizen whose bathroom and purse are of limited dimensions, you can, at the expenditure of a surprizingly small sum, obtain a portable shower-bath and curtain, which you can erect yourself, and you will probably obtain just as much satisfaction from it as your richer brother will from his shower *de luxe.*

The great advantage of the so-called portable shower, apart from its low cost, is that it can be installed without tearing up the bathroom. In most cases, a screw-driver is the only tool required for the installation. The "plumbing" involved consists of fixing the hose to the faucet by means of a clip and thumbscrew, and the whole job can be completed in fifteen minutes.

One other suggestion before we leave the subject. The ordinary head-shower is sometimes unpopular with the women of the household because, with it, there is difficulty in avoiding wetting the hair. The type of shower which sprays water onto the body in a semi-horizontal manner usually finds more favor with them. It is claimed that with this type of shower, no curtain is needed because the water strikes the body at such an angle that it runs directly downward into the bath. This may be true if the user is of a placid disposition and takes his shower-bath in a calm and dignified manner. With most men, however, the sensation of water raining onto their bodies causes them to inflate their chests, and fling their limbs about generally. In any case, a shower-bath loses a good deal of its fun if one has to bear constantly in mind the need of avoiding violent activity, so that the curtain will usually be found well worth the slight extra cost.

CHAPTER XIII

THE GARAGE

THE dictionary defines a garage as "a place for housing automobiles," which is about as good a definition as one could get. But it will be seen that the term covers a multitude of structures. It may be a wooden shack, or a ten-story palace—if it serves to house an automobile it is a garage.

The subject is, therefore, a big one for treatment in a book of this size and character, and it is necessary to restrict this chapter to certain definite limits, or it may grow to occupy more than its rightful space. Here, then, as elsewhere in this book, the aim will be to place before the reader such information as will enable him to make a decision for himself, rather than to offer him a ready-cut scheme, with plans, costs and specifications, for any particular type of garage he may desire.

Fundamental Considerations. The first decision to make is the amount of money one is willing to spend. And here, it must be admitted, a great many car-owners make a false move. They have a very natural and perfectly understandable tendency to economize unduly. Having spent a large sum of money on a car, they hesitate to spend a further large sum on a house to keep it in. The car itself, so to speak, fills their eye, and the garage accommodation seems secondary. Anything that will keep the rain off, they feel, will serve.

For many reasons such an attitude is a mistake. The very fact that the purchase of a car involves a considerable expenditure, is one good reason why it should not be cheaply housed. The money spent on a car is not lost. The car can always be sold, and sooner or later the day will almost certainly come when it *will* be sold, and then the better it has been housed the higher price will it fetch. A cold, draughty garage may cause not only unlimited discomfort, but considerable expense. A frozen radiator, or "gummed up" pistons, may mean costly repairs, while the drain on a battery in starting up a half-frozen car is very considerable.

Then, again, the fact must be faced that a car is what the experts call a "fire hazard." There is always, of necessity, a great deal of highly combustible matter within a garage, and if the building itself is also highly combustible there will be danger of fire spreading from the inside, or of the car being destroyed by fire carried from adjacent buildings. For the sake of the ease of mind which it gives, a fireproof garage is worth all it costs.

Finally, comes what is perhaps the most important consideration of any. A cheap garage thrown together near a dwelling is an eyesore. It will be out of keeping with the architecture of the house, and so far from adding to the value of the latter, it will tend to cheapen its appearance and make it less attractive to a prospective buyer—especially after the garage has begun to fall to pieces, as it quite certainly will at the end of a few years. On the other hand, a permanent structure, well built, attractive, fireproof, and in keeping with the adjacent property, will always be an added selling feature. Money spent on a good garage, therefore, may legitimately be considered an investment rather than an expenditure.

Location. Unless the garage is built of fireproof materials it must stand away from the house. In most cities, a fire department ordinance compels such separation of house and garage, and even where such laws do not exist, ordinary caution demands that a wooden structure for housing an automobile shall not adjoin a dwelling.

Where the garage is built of concrete, hollow tile, stone, or brick, however, there is no reason why it should not be adjacent to the house itself; it may, in fact, form part of the house, thereby rendering comparatively easy the often difficult problem of keeping it warm in winter. Where the position of the house permits such an arrangement, it is an excellent plan, and one which is growing in popularity, to build the garage beneath the porch, or to connect it with the cellar at the side of the house. Before such an arrangement is possible, of course, it is necessary that the house should stand well above the street level. In fact, it is a decided advantage for the level of the cellar floor to be above street level so that the level of the garage floor can be below that of the cellar, because gasoline vapor is heavier than air and tends to sink. If, therefore, the cellar floor is below the level of the garage floor, there will be a tendency for any gasoline vapor, which may escape from the car, to finds its way into the cellar where it may be dangerous and will quite certainly be objectionable.

Where the house is on the street level, the garage must necessarily be built either at the side or the rear of the house. The choice of location will depend so much on conditions, which will vary in every case, that little can be said regarding it. No matter where the garage is built, however, it should be made to blend, as far as possible, with the house. If the house is of stone, do not build the garage of brick. Use not only similar materials, but let the general lines of the building be of a similar character. In other words, avoid making the garage look as though it were an afterthought.

Materials. A garage may be built of stone, brick, concrete, concrete blocks, hollow tile, wood, or galvanized iron. Enough has already been said to indicate that the writer is opposed to the use of wood because of its inflammability. Nevertheless, it must be admitted that it is possible to build a warm and picturesque garage of wood at a lower cost than with any other material. Where the house is of frame construction, or of frame and stucco, a garage of similar materials will look well. But it must not, or should not, be erected near the house.

The galvanized iron garage is cheap, fireproof, and hideous. Also, it is very cold in winter. Its cheapness is the best thing about it. So-called "portable garages" are frequently built of galvanized iron, and where a temporary structure is required they give fair satisfaction. That is to say, they protect the car from rain. It is difficult to say more in their favor. Their "portability" is open to question. It is the general experience that after they have once been erected it is seldom possible to take them apart, move them, and reerect them with any degree of satisfaction. They are cold, at the best—except in summer when they are hot as an oven—and after a second erection they will be draughty as well.

Between concrete, bricks, stone, and hollow tile there is little to choose. All that has been said earlier in the book with reference to these materials for houses applies equally to garages.

The choice will be determined by the character of the house which the garage will adjoin.

The *foundations* will always be of concrete. The *roof* may be of concrete, reinforced with metal lath, or of reinforced concrete beams and tiles, or may even be of wood, covered with pitch and gravel, or with shingles, provided there are no rooms directly over it.

In a small book written by A. Raymond Ellis, and published by McBride, Nast & Co., entitled "Making a Garage," there is a description of a somewhat novel method of construction which has much to recommend it. The method is comparatively cheap, the resulting garage is fireproof, and with a little ingenuity on the part of the builder can be made attractive in appearance. A somewhat similar method is described in *The American Motorist,* February, 1921, page 8, in an article by William Walton. For a full description of the method, the reader is referred to either of these sources, but in brief it may be said that a framework is built either of ordinary galvanized iron pipes or of steel channels. Wire lath is then fastened over the framework so as to make a complete cage. On the outside of the lath cement mortar is laid on heavily, while the inside is plastered and smoothed. A second coat of mortar on the outside is followed with a coat of pebble-dash or some similar finish. The roof can be made either of wooden rafters with roll roofing, or of shingles, or of the same materials as the walls.

Size. The size of a garage will depend, of course, largely on circumstances. If you wish for accommodation for one car only, you will build sufficiently large to give you comfortable room, and that is all. If the necessary space is available, however, it is usually worth while to give consideration to the building of a garage large enough for two or more cars. In any city or large town, it is usually an easy matter to rent space in a garage, and the income from this source may represent an appreciable return on the investment.

We will assume, however, that a one-car garage is what you have in mind. The first thing to decide is to build it large enough for any car—not necessarily for the particular car which you own. Some day you may sell your Ford and buy a Packard. Then you may wish your garage was larger. In any case, you may wish to sell your house at some future date, and if a prospective buyer should come to an adverse decision on the sole ground that your garage is too small for his car, you will feel very disgusted with yourself for having exercised a paltry economy when building.

The following dimensions will take care of any pleasure car made at the present time: Height, 10 ft. Height of doors, 9 ft. Length, 20 ft. Width, 10 to 12 ft. If you intend having a bench in the garage, use the latter width.

Accessories. The nature of the internal arrangements of your garage will depend a good deal upon the nature of yourself. If you know nothing of the mechanical details of your car and take it to a public garage for repairs of every description, a single shelf and a rag-can will be about all the furnishings you will need. If, on the other hand, you are something of a mechanic and hold the opinion that nobody can take as good care of your car as you can yourself, you will need, quite certainly, a tool bench, several shelves, and, if possible, an inspection pit, and a block and tackle.

Few private garages have an inspection pit. They cost money—that is no doubt the reason. But any one who has done much work on a car will readily admit that lying on one's back is not the most comfortable or most efficient position for making mechanical adjustments. Provided you can afford it, a pit is well worth while. With it, you will be able to do better work with greater convenience. Make it large enough for comfort and be careful to let it have an outlet at the rear. Gasoline has a habit of accumulating in pits, and a spark from your work may ignite it when you least expect it. Then you will want to get out of your pit at more than average speed. So have a back exit and also arrange vents from the pit to the outside air.

The size of your bench will be largely a matter of personal taste. A good size is five feet long and two feet wide. Benches can now be bought completely equipped with every tool an amateur motor mechanic could possibly need.

If possible, have a water connection in your garage. If it adjoins the cellar this should be easy and the added convenience will be well worth the small extra expense. And by all means let your garage be lighted with electricity. Do not make the common mistake of having the light in the center of the ceiling. With a closed car, or an open car with the hood up, a light in this position is almost useless. Place it on the side wall—preferably at the left of the bench. Fit it with a two-way socket—one for the permanent light, the other for an extension.

If you wish to make your garage complete, you will add a block and tackle fixed securely to the ceiling, an electric air-pump, and a gasoline tank beneath the ground outside the garage. In most cities, there are very strict fire regulations regarding storage of gasoline, and before taking any steps to construct your own tank you would do well to consult the fire department.

Fire Prevention. One is forced to the conclusion that the average car-owner fails to realize the risk of fire inevitably connected with his car. The peculiar property of gasoline which enables it to be used as a source of power is its inflammability. Its vapor will travel far. It is very mobile and will leak readily from the tiniest crack in a container. Moreover, it is a common practise to mix alcohol with the water of the radiator to prevent freezing in winter. The car is brought in from a run with the radiator hot. In this condition, it will act as a still, and if the radiator cap is not perfectly tight, alcoholic vapor will escape into the garage. Alcohol is only slightly less inflammable than gasoline.

Again, oil-soaked rags are a definite source of danger from spontaneous combustion. The man in the street is apt to scoff at this suggestion, but the writer can speak from personal experience of the very real nature of this danger. Oily rags may lie around for months, and even years, and cause no trouble; or again, they may catch fire spontaneously in a single night. In spite of this, oily rags or waste are thrown into a corner of the garage, placed upon a shelf or stuffed into the pockets of the car. You may do all these things and "get away with it," but sooner or later somebody is going to have a fire from spontaneous combustion, and the somebody is just as likely to be you. Have a fireproof, self-closing can in your garage and throw all your dirty rags into it immediately after use. They will do no harm in the can. Even if they catch fire they will only smolder because there will not be enough air present to cause a blaze. Moreover, the closed lid will prevent the fire from spreading. A small can will cost only three or four dollars, but it may prevent a three or four thousand dollar blaze. If you haven't a self-closing can in your garage, buy one to-day.

That is rule Number 1. Rule Number 2 is: *No Smoking.* This should require no emphasis, but car-owners and their friends are careless to the point of insanity in this matter. We have seen a man priming his car with an open can of gasoline, at the same time holding a lighted cigaret in his other hand. The man still lives because a wide-awake friend snatched the cigaret away before the explosion came, but we doubt if the smoker realizes even now how near he was to sudden death. We have seen a group of men, all smoking cigars, approach a smashed car to inspect a leaking gas-tank. These men were at large, and one of them was the driver of a car, so presumably they were sane and of average intelligence. But it is difficult to believe it.

A garage is about as good a place to smoke in as a powder-magazine. That fact should be realized by all car-owners, and they should impress it on any one who enters their garage with a lighted pipe, cigar, or cigaret. Naked flames of any description must never be brought into a garage. Do not strike a match and hold it over your radiator to see if it is full of water. It may contain alcohol, or a trace of gasoline may have leaked from the pistons into the cooling water. In either case an explosion may follow which may damage the car and yourself and may even set fire to the garage. Use a flashlight or an extension, and let the extension be protected with a wire cage.

Finally, have in your garage, or your car, or both, a fire extinguisher of some kind. Chemical extinguishers are best. If you do not want to spend the money on a patent extinguisher, obtain one or more long, narrow bottles with wide mouths. Fit them with corks. Into the center of each cork screw an eye or a hook and pass a large nail or piece of wood through it. This will form a handle. Fill the bottle with carbon tetrachlorid. In the event of fire, yank out the cork by means of the handle, hold the bottle firmly at the bottom, and hurl the heavy liquor at the fire.

A Warning. A word of warning in conclusion. Never run the engine with the garage doors closed. The exhaust gases from a car consist very largely of carbon monoxid, an odorless but extremely poisonous gas. So much publicity has been given to this fact that it should be common knowledge. Yet, every few months, there is a report in the newspapers of a car-owner being found dead in his garage from this cause. So the warning is repeated here. If you run your engine in the garage, be sure that there is an ample supply of fresh air. Opening the window is not enough. Open the doors.

CHAPTER XIV

RECIPES

It has been a little difficult to know what to include and what to omit in this chapter. There are in existence volumes of several hundred pages devoted entirely to formulas and recipes. It would have been easy to make this chapter as long as, or longer than, all the rest of the book, but the aim has been to select such information as the average householder will be most likely to need.

A house more than five years old in which vermin is unknown probably does not exist, and so fairly full directions will be found for exterminating the commoner varieties. The handy man who works around his house will be fortunate—or shall we say exceptionally careful—if he avoids staining his clothes with paints, greases, and so on. Hence the removal of stains is treated in some detail. Formulas are given for such commonly used materials as whitewash, cements, mucilage, and so on.

Most of the recipes given here have been tested and found satisfactory by one, or both, of the authors. In those cases where personal experience was lacking, they have consulted the best available authorities, or have given alternative formulas.

Exterminating Vermin. *Ants.* It is very common for ants to enter a house and get into cupboards or boxes where food is stored. It is usually difficult to get rid of them as they swarm in such numbers that even tho hundreds are destroyed, thousands more will come to take their place. Many remedies have been suggested. Pepper, borax, powdered tobacco, mustard, camphor, sulfur, and many other substances having a strong odor all have their advocates. It has also been suggested that one should track the ants back to their nest and then destroy it with boiling water; an excellent method where successful!

One of the neatest methods of extermination is to soak small sponges in sweetened water and place these where the insects swarm. The ants will crawl into the sponges and as soon as a good number has been collected the sponge is dropped into boiling water. It is then again soaked in sweetened water and the process repeated. If the exterminator has more patience than the ants, this process may rid a house of the pests completely.

A similar method is to smear lard over a plate, permit the ants to accumulate, and then to hold the plate over an open fire. The lard melts and drops into the fire and the ants go with it.

Where it is desired to destroy an ants' nest in the lawn, the best method is to make a few holes in the nest with a stick and then pour into each a small quantity of carbon bisulphid. Then close the holes with earth. The liquid will quickly volatilize and penetrate to every part of the nest, poisoning the insects.

Remember that carbon bisulphid is highly inflammable and its vapor explosive.

Bedbugs. These peculiarly loathsome insects may gain access to the cleanest of houses through baggage or the laundry; or, in closely populated districts, they will even migrate from one house to another. As with all insects, persistence is necessary to exterminate them once they have gained entrance. Wooden bedsteads should be avoided. Thoroughly spray or paint the cracks and joints in the bed and the crevices in the floor and any other place where the insects may hide with one of the following: gasoline, kerosene, benzin, or a mixture of 1 ounce of corrosive sublimate dissolved in a pint of denatured alcohol and 4 ounces of turpentine. Repeat the spraying at least four times with an interval of three days between each. An ordinary oil-can can be used as a sprayer.

Where a room is badly infested, fumigation with burning sulfur may give good results. For every 500 cubic feet use 4 ounces of sulfur. Close all windows and stop the cracks by pasting over them strips of newspaper dipped in water. The burning of the sulfur can be carried out by one of two methods, either of which will give good results. By the first method place an open pan of red hot coals on a pile of bricks in a large basin of water—this to prevent fire. Then sprinkle the sulfur over the coals, retreat hurriedly and close the door.

By the second method, place the sulfur in the pan, pour over it about a dessertspoonful of denatured alcohol and ignite. Retreat as before. Leave the room tightly closed for at least four hours.

Remember that the fumes of burning sulfur have a strong bleaching action and may, therefore, affect colored wall-paper, curtains, and so on.

Mice and Rats. Mice are easily caught, altho it will frequently be found that an almond, or some other nut, or a piece of corn or apple will form a more attractive bait than the conventional cheese or bacon rind. Rats, however, are as difficult to capture as mice are easy. No matter how temptingly a trap may be baited, a rat will not go near it as long as he can see that it is a trap. Camouflage is the only solution. Place the trap in a sack, tucking the neck of the sack into the mouth of the trap. Then sprinkle a few grains of corn, crumbs of bread or cheese, or any food beloved by rats on the outside of and around the trap. Inside, place some larger pieces of the same food, taking care that the wires of the trap are so completely covered with the sack that the rat's suspicions will not be aroused. You may not catch him for a day or two, but if you leave the trap long enough he will grow used to it, lose his suspicions and some fine night enter it in search of the bait.

The U. S. Department of Agriculture recommends the use of oil of rhodium, sprinkled on the bottom of the trap. This is said to form an attraction which the rats "cannot refuse."

An even more scientific method of getting rid of them is to place on the ground near their holes a layer of moist caustic potash. The rats will get this onto their feet, which will make the feet sore. The rats will then lick their feet, getting the caustic onto their tongues, and still greater discomfort will result! This will (according to the theory) make them so disgusted with the neighborhood that they will leave in disgust and spread the news among their friends and relatives. This sounds far-fetched, but it is stated, on good authority, to give excellent results. The weakness of the scheme, assuming that it works, is that the rats are not destroyed, but only driven away.

Roaches. Roaches can be exterminated provided they are attacked with sufficient persistence. It is frequently thought that one, or at most two, applications of insect-killer will exterminate a complete colony of roaches and when failure ensues the poison is blamed. To rid a house completely of this pest, the fight should be kept up for several weeks, with relentless persistence.

By far the simplest and most efficacious poison for roaches is borax. Scatter freely around the sink, into cracks, along the baseboards, on shelves and wherever the insects are seen. The borax is harmless to human beings, so that it can be left around without fear of harmful results to any one or anything, except the insects.

Another good poison is made of a mixture of red lead, corn flour and molasses. This, of course, is poisonous to human beings. Virulent poisons, such as corrosive sublimate, Paris green, arsenic, or phosphorus should be avoided. They are exceedingly dangerous and no more efficacious than borax.

Water-bugs. Shake a tablespoonful of turpentine with a quart of water and pour down the waste-pipes at intervals of a few days.

Whitewash. The following formula is given by the U. S. Department of Agriculture and is excellent for use in chicken-houses and for similar purposes.

Slake half a bushel of quicklime with hot water, cover to keep in steam. Strain through a fine sieve. Add a peck of common salt dissolved in water; 3 pounds of ground rice boiled to a paste; stir in, while hot, ½ pound of Spanish whiting, and 1 pound of glue dissolved in water.

Add 5 gallons of hot water, stir thoroughly, and use hot after the mixture has stood for several days.

A similar mixture, and one that gives good results, is made as follows: Soak 1 pound of glue overnight and then dissolve by heating over boiling water according to standard practise. Add 20 pounds of good grade "natural" whiting. Dilute to the desired consistency. It is important that natural whiting be used, as the so-called artificial whiting, which is a by-product from various chemical industries, has poor covering power and is liable to peel off the wall or ceiling on which it is used.

In the second formula given above a mixture of china-clay and whiting can be used, using 4 pounds china-clay to 16 pounds whiting.

Cement for Glass or Porcelain. Dissolve casein in four times its volume of silicate of soda (water-glass). Apply thinly to the edges of the broken article (previously warmed), press the edges together and allow the cement to set.

Other cements can be made by mixing white of egg with lime or plaster of Paris. For instance, mix plaster of Paris with one-fourth its weight of freshly slaked lime; then form a paste with white of egg and use immediately.

A mixture of equal parts of powdered casein and slaked lime made into a paste with water is stated to form a good cement.

Stove and Furnace Cement. To stop a crack in the iron casing of a stove or furnace, use a mixture of iron filings and water-glass (silicate of soda), using sufficient iron filings to give a thick paste. Work into the crack and use enough to give a coating over it. The heat of the stove will cause this cement to fuse and thus form a very tight joint.

Another good cement for use with metals or stone is made by mixing litharge and glycerine to a stiff paste. The cement sets very rapidly and must be used immediately. It is particularly valuable for cementing metal into stone, iron to wood, and for similar purposes. It will not withstand high temperature but is unaffected by moderate heat.

Rubber Cements. Cut pure rubber into small pieces and leave them to soak in carbon bisulphid. They will swell and gradually go into solution. At least twenty-four hours will be required for complete solution. Stir or shake occasionally and keep the vessel tightly stoppered. Remember that carbon bisulphid is very volatile and highly inflammable.

Sometimes rosin or rosin and beeswax are added to the above cement. Formulas vary, but the following is typical: To every ounce of rubber use 2 ounces of rosin and ½ an ounce of beeswax. Dissolve the rubber first in carbon bisulphid and when solution is complete, pour in the solution of rosin and beeswax, also dissolved in carbon bisulphide. Mix thoroughly.

Mucilage or Liquid Glue. Use best quality glue, soak in water for several hours until it is thoroughly swollen, then dissolve by heating in the usual way. (See chapter on *Carpentry.*) To the clear glue, add an equal volume of strong vinegar, and, when cool, one-fourth of the volume of denatured alcohol. As a preservative, add a little alum dissolved in water.

Adhesives. An adhesive which is satisfactory for many purposes can be readily prepared by dissolving dextrin in hot water to the consistency of a syrup. A small quantity of oil of cloves can be used as a preservative.

Pastes. 1. Mix one hundred parts of flour with two parts of powdered alum. Add enough cold water to form a smooth paste. Then pour on boiling water until the paste begins to thicken. At this point stop pouring and stir very thoroughly.

2. Make a thin glue, containing about ¼ ounce of glue to a pint of water. Take 2 ounces of starch, make into a smooth paste with cold water, and then pour on 1 pint of boiling water. Add the glue, and heat the mixture with constant stirring until the liquid becomes thick. Add oil of cloves or carbolic acid as a preservative. Remember that carbolic acid is a powerful poison.

3. Dissolve soluble starch in ten times its weight of boiling water. On cooling, the clear

solution will solidify to a white paste. Oil of cloves can be used as a preservative. (Note. "Soluble starch" is a special form of this substance, prepared by soaking it in dilute hydrochloric acid for several days.)

Putty. Ordinary putty usually consists of a mixture of fine whiting and boiled linseed oil. A better product contains white lead in addition. The following formula gives a good putty: Fine whiting, 3 parts, white lead, 1 part, mixed with boiled linseed oil to proper consistency. Add a little litharge as a dryer. If a putty is required which will not get too hard and brittle, add a very little olive oil.

To keep unused putty from hardening, store under water. *To soften* putty which has hardened, break it up into small pieces, put it in an iron vessel with enough water to cover it, add a little raw linseed oil and boil. Stir thoroughly. The putty absorbs the oil and when the mixture has cooled the water can be poured off and the putty worked up with a knife or in the hands.

Soft Putty. A product which will remain soft indefinitely and which is, therefore, very useful for plugging cracks between fly screens and for other temporary work, can be made by melting vaseline and slowly working in fine whiting until a putty of the desired consistency is produced.

The Removal of Stains from Fabrics. There is no universal solvent for stains. Before attempting to remove a stain, therefore, every effort should be made to ascertain its nature. Then, with the following facts in mind, an intelligent selection of a solvent can be made:

1. Grease and oil of all kinds, paint, varnish, tar, and all similar materials can be best removed by the use of such organic solvents as benzin, acetone, carbon tetrachlorid, ether, or gasoline.

2. Benzin, acetone, ether, and gasoline (and their vapors) are highly inflammable and must be used with caution. Carbon tetrachlorid is non-inflammable; it is, in fact, a powerful fire extinguisher. It is, therefore, safe and usually very effective in removing stains due to the above substances. It is sold under a variety of trade names.

3. These organic solvents seldom have any action on the coloring matter used in fabrics, or harmful effect on the fabric itself.

4. Alkalies have an injurious effect upon wool and silk; acids, upon cotton and linen. On the other hand, alkalies can be used with comparative safety on cotton and linen, and acids on wool and silk. In this connection, remember that artificial silk must be classed with the vegetable fibers as it is made from cotton, or some similar form of cellulose. The commonest alkalies are caustic soda (soda lye) and ammonia. The commonest acids are oxalic, citric, acetic, hydrochloric (muriatic) and sulfuric.

The following specific directions may be found a useful addition to the above:

Grease and Fats. Use carbon tetrachlorid if possible. Failing this, one of the other organic solvents mentioned above. Place the fabric on a pad of clean cloth and drop the solvent onto the stain with a glass rod or dropping bottle. Dab the stain with a piece of cloth, and finally rub thoroughly with a dry cloth. A bad feature of organic solvents is that they have a tendency to spread in an ever widening circle, carrying some of the grease with them, finally producing a large faint stain where previously was a small distinct one. To check this the fabric should be rubbed thoroughly with a dry cloth as the solvent is dropped onto it. It may even be necessary to dip the entire piece of fabric into the solvent in order to remove the final traces of the stain.

Ink Stains. Usually difficult to remove. Most inks contain anilin dyes, and any chemical which will bleach and remove the ink will also bleach or remove the pattern of the fabric. On silk or woolen fabrics try oxalic acid or dilute hydrochloric or sulfuric acid. On cotton and linen use acetic or formic acid. Oxalic acid may also be used with caution. Wash thoroughly after operation is complete so as to remove all traces of acid.

Iron Mold. Mix equal parts of cream of tartar and citric acid. Moisten the stain, place the fabric on a warm surface and rub in the powder with a pad of cloth. Wash thoroughly. Or use a solution of oxalic acid or tartaric acid.

Bloodstains. Wash well with lukewarm water and in the case of cotton and linen goods follow, if necessary, with a little bleaching solution. But patient washing with lukewarm water will usually be all that is necessary.

Scorch Stains. Wash well. Then soak for a few minutes in a two per cent solution of potassium permanganate. Rinse and soak in a ten per cent solution of sodium bisulfite. Add a little hydrochloric acid if necessary. Wash thoroughly.

CHAPTER XV

SAFETY IN THE HOUSEHOLD

The house-owner has many responsibilities. In addition to the routine care of keeping up proper repairs, there is always present in his mind the possibility of danger from fire and accident. It is true, of course, that in the case of the individual house-owner, the risk from fire or accident is relatively small, but unfortunately one never knows when fire is going to occur or accidents to happen. The chief safeguards are wise and proper precautions. The Bureau of Standards, of the United States Department of Commerce, has made a careful study of the subject of safety in the household, and from the valuable circular prepared as a result of these investigations, the material in the following pages is largely taken.

Fires

Their Causes and Prevention. The chief risk to be guarded against, in the house, is fire. The number of fires averages over 400,000 yearly, and in these over 5,000 lives are lost. By far the larger number of fires are due chiefly to carelessness and negligence. Some, of course, are the result of natural causes, such as lightning, and a few are due to incendiaries. The National Board of Fire Underwriters has gathered statistics to show that the average loss by fire for the last forty years has been about $2 a year. This amount should be at least doubled to cover the amount of fire protection. If to this is added $3 per capita paid to insurance companies over the excess in return from them, the approximate cost to the American public, to each man, woman, and child for fire loss, is found to be $7 per year, or a total cost of nearly three-fourths of a billion dollars. This does not include the loss of business through rebuilding, loss of wages, and retarded growth. Fires occur annually in about two per cent of the total number of buildings.

The fire loss per capita in the cities of the United States is from five to ten times that of many of the European cities. This is due largely to the rapid growth of the American cities, accompanied by a lack of proper building precautions.

In an investigation made into the causes of about 190,000 fires during the years 1909 to 1915, it was found that about 22% were due to unknown causes, about 8% to faulty and ill-cared-for chimneys, about 8% to the careless use of matches, and about 6% to adjoining fires. Other causes were lightning, defective flues, carelessness in the use of cigars and cigarets carelessly thrown down, defects in heating apparatus, and bonfires. Many fires are caused also in the use of kerosene and gasoline, and many result from spontaneous combustion. These and other causes of fires, and the methods of preventing them, are discussed in the following pages.

Unknown Causes. The large percentage of fires due to unknown causes is very striking. There are two reasons why there should be unknown causes of fires. One of these is that people wish to hide the causes of their imprudent acts. The other is that some fires happen when no one is around. With increased education in fire prevention and protection, the number of fires due to unknown causes should be very much reduced.

Defective Chimneys and Flues. One of the most elusive and menacing hazards of building construction is that due to chimneys and flues. The importance of good construction has already been referred to. The chimney should be frequently inspected, and cleaned when necessary. Combustible materials should be kept away from the hearths, doors of ash-pits, etc. Chimney fires are very difficult to extinguish, as they frequently get into the structure surrounding the chimney.

Matches. The third in the list of causes of fires is matches. Like oil, fireworks, and many other substances highly inflammable, matches cause disasters and death through incautious handling. Countless children are burned to death because they play with matches, setting fire to their clothing.

There are several varieties of matches in common use. One frequently used is the familiar parlor-match; another is the safety-match. The wind-match and other varieties are used to a less extent.

The safety-match is advocated by many national associations and is almost exclusively used in Europe. Safety-matches are safer than parlor-matches, but some care must be exercised in their use. If the box is left open while striking a match a spark may easily ignite the remainder of the matches in the box. Many painful experiences and scars are the result of handling matches in this manner.

Many fires are caused by matches thrown loosely into drawers, onto tables, mantels, etc., from which they may fall onto the floor and be ignited in various ways. Many fires also result from throwing lighted matches onto floors, into waste-paper baskets, rubbish piles, open cellarways, openings in sidewalks, etc. Burning matches should be entirely extinguished before being thrown away.

In purchasing matches for household use, care should be exercised to secure a good quality, as many of those offered for sale have properties which render them undesirable.

Among these properties may be mentioned a tendency for the head to fly off, and the glowing of the wood after the flame is extinguished. The safest type of match is that which can be struck only on the box. If this type is not acceptable, a parlor-match whose head can be ignited only by friction of the extreme tip against any kind of a surface should be chosen. Both types can be secured with strong splints treated to prevent afterglow, and this quality should be insisted upon.

Cigars, Cigarets, and Pipes. The discarded lighted match, cigar, or cigaret is a familiar sight to everybody. The flipping of these articles without regard for inflammable material which they may set on fire has given origin to the expression that "every smoker is a fire hazard." If one must smoke, he should at least exercise care in regard to the match fire, and to sparks from lighted cigars, cigarets, or pipes. Such sparks, and lighted cigar or cigaret ends, create the same hazards as the lighted matches referred to in the preceding paragraph.

There are certain places where smoking should never be permitted. These include barns, garages, certain kinds of manufacturing establishments, in the vicinity of oil or gasoline tanks, and many other places where there are materials which flash or burn readily. It is fortunate that many persons do refrain from smoking where the hazard is very evident, but it is surprizing how many persons we see each day who forget and carelessly or willfully neglect to observe precautions which make this hazard such a dangerous one for others who have to endure the results of these bad habits.

Spontaneous Combustion. This is a danger against which it is generally considered difficult to guard, because fires from this cause usually occur when no one is present. However, in most cases it requires only ordinary care and good housekeeping to eliminate this cause of fires. Oily clothing thrown on the floor of a closet may readily cause a fire from spontaneous combustion.

The elimination of unnecessary bundles in "heaps and piles" would greatly reduce the number of these so-called unavoidable fires. Oily and greasy rags, particularly those which have been used with furniture polish or floor oil, should either be kept in closed metal containers or immediately destroyed.

Newly mown hay is a frequent cause of fire, and many barns are unnecessarily burned because their owners are too anxious to store the crop, or attend to it too late in the season. In the barn more perfect ventilation will often remove heat which otherwise will cause a rise in temperature. Thus we find that thick layers of hay, like thick bundles of rags and clothing, are more frequent offenders than are thin layers.

Stoves and Heating Appliances. The improper construction, installation, or maintenance of stoves, ranges, and furnaces are frequent causes of fire. Many fires may be avoided by observing the following precautions: Selecting stoves which have legs or supports providing air spaces of at least 4 inches if the stoves are to be placed on combustible floors; locating such heat appliances well away from combustible partitions or woodwork, and, where this can not be done, placing screens to protect the adjacent woodwork; placing sheet metal or other noncombustible materials under stoves at the front; having fireplaces and flues properly constructed and properly lined and pointed to prevent sparks from communicating fire to woodwork outside the flues; running stovepipes as far as possible from unprotected walls, floors, and other woodwork, and surrounding them, where necessarily passing through partitions or appliances, with thimbles which provide air spaces about the pipes; surrounding the stovepipes with suitable flanges where passing into the chimneys; frequent inspection of stovepipes to detect rust holes, and regular cleaning of the stovepipes. Fuel should be kept at a sufficient distance from the stove or furnace, openings in chimneys should be kept covered with metal caps when not in use, and any cracks which develop in chimneys or flues should be at once repaired.

Grease Fires. The combination in the kitchen of fire to cook food, grease (one of the worst inflammables used about the household), and the flimsy garments of the housewife or servant constitutes one of the most serious fire hazards. But these things do exist side by side, and the result is that one of the most frequent causes of fires in homes is grease used in cooking.

What is the cure for grease fires? Unfortunately there is no way of preventing them except by heeding the time-honored warning, "Be careful." Even with the utmost care grease fires may occur. In every case the second time-scarred warning should be to "Be prepared." Water will not extinguish a grease fire. Such a fire must either be smothered by covering it, or put out with a fire extinguisher. For this purpose the tetrachlorid type is superior, as water solutions tend to scatter the burning grease.

Rubbish Fires and Bonfires. It is common practise to dispose of combustible rubbish, such as discarded papers, by burning it. It is also common, especially among children, to burn similar materials and scrap-wood in bonfires for the fun of seeing the blaze. The attraction of flames seems to be innate in the human being, and children will take many chances in dealing with fires because they do not appreciate the hazards to which they are exposed. It seems almost hopeless to expect that children may be kept away from bonfires, even if it be desirable. The better plan is to teach them how to take care of themselves and how to manage a fire so that it will not constitute a source of danger. Many hundreds of children are burned to death by having their clothing set on fire by bonfires. It is particularly hazardous for little girls whose dresses are made of flimsy materials which ignite easily. Consequently, children who are permitted to play without supervision should always be dressed in practical clothing which would not be easily ignited. They should be taught to keep away from the side of the fire toward which the flames may be blown, and should also be instructed what to do in case the clothing catches on fire.

Rubbish and waste paper should not be burned in bonfires, especially on windy days, but should be burned in containers which are commonly constructed of open metal work. Such fires should not be fed while they are blazing high and those near the fire should keep to the windward side of it. Fires should not be lighted close to fences or outbuildings.

Kerosene. While an extremely useful device, the kerosene lamp has its attendant dangers, many of which can be avoided by cleanliness and care in handling.

With the quite volatile illuminating-oils formerly sold (before the present large demand for gasoline arose) explosive mixtures were readily formed in the lamp or near it. Loosely fitting wicks or improper construction of the lamp permitted access of these explosive mixtures to the flame, causing frequent explosions. This source of danger, while still present, has been greatly reduced by the less volatile kerosene now sold.

The practise of permitting the wick to stand above the wick-holder when the lamp is not in use allows the oil from the top of the wick to creep over the side of the lamp, producing a dirty condition which also promotes the possibility of accident.

If there is not a special extinguisher on the lamp, the wick should be turned down until it passes into the holder, but not far enough to cause it to fall into the oil container. The small flickering flame will then die out.

To avoid the possibility of filling a lamp with gasoline the latter should never be kept in a can similar to that used to contain the supply of kerosene.

The following are a few suggestions for handling kerosene:

1. Keep kerosene in a metal can.

2. Keep the can closed and at a distance from the stove.

3. Keep kerosene away from fires. Its use for starting a fire is dangerous. Pouring it onto a fire is almost sure to cause an explosion

which may set the house on fire and possibly result fatally.

4. Before use, repair all parts of an oil-lamp which are defective. Cracked or broken lamp-chimneys should be replaced. These may cause improper burning.

5. Fill lamps and oil-stoves by daylight; never while lighted.

6. Place lamps on a secure level surface, or hang them from substantial supports.

7. Adjust lamps so as properly to burn the oil. Turning the flame too low or too high will cause the oil to burn improperly, usually manifesting itself by a disagreeable odor.

Gasoline. The three liquids, gasoline, benzin, and naphtha, differ only slightly, from a fire or explosion standpoint. At ordinary temperatures all of these liquids readily give off vapors which burn furiously. When any considerable quantity of the vapors becomes mixed with the air, violent explosions may occur if a flame is brought near. The heavy vapors from these liquids settle at or near the floor, so that opening a window may not remove the dangerous hazard for a considerable time.

Gasoline is a volatile oil which evaporates on exposure to the air at ordinary temperatures. One gallon of gasoline, entirely vaporized, produces about 32 cubic feet of vapor. If it be liberated in a room so that there is a mixture of from 1.4 to 6 per cent gasoline vapor with air, a dangerous explosive mixture is formed. As the vapor is much heavier than air, it takes a comparatively small amount of vapor to form this explosive mixture in the lower parts of the room. It is, therefore, a material which should be handled with considerable care and should not be used for cleaning or other purposes inside the house, or if it is, the container should never be left open, and the room should be so thoroughly ventilated as to remove the air and vapors rapidly; otherwise, a lighted match or cigar within such a room may cause a very serious explosion. Even friction of the garments while they are being cleaned may produce an electric spark which may be sufficient to ignite the vapor. Where gasoline in some quantity is stored or used it is recommended that carbon-tetrachlorid type extinguishers be kept handy.

A use of gasoline in the household which has been common in the past is as a fuel in the gasoline stove. With the advent of satisfactory blue-flame kerosene stoves and the increase in the price of gasoline this use has fortunately decreased, for the gasoline stove forms one of the greatest hazards found in the household. Extreme care is necessary in using this type of stove. The supply tank should never be filled while the stove is in operation, and when it is filled care is necessary that there should be no overflow so that vapors of gasoline will be present when the stove is afterwards lighted. The supply tank should never be completely filled, since if the gasoline has been kept out of doors or in an outhouse, as should always be the case, it may expand upon being brought into a warm room and an overflow may develop even tho the tank is not completely filled at the beginning. To avoid all trouble from this source it is best to discard the gasoline stove altogether and substitute some other form of fuel. The same remarks apply to gasoline torches, such as are sometimes used for lighting, altho this use is principally confined to outdoor service.

An automobile, which is a storage place for gasoline, with the ever-present possibility of leaks, constitutes a serious fire- or explosion-hazard, especially in closed spaces and in the presence of lighted matches, cigars, etc. Automobiles should be housed in buildings preferably of fire-resisting construction and not in buildings used for other purposes, such as barns.

Running the engine in a small garage may result in contaminating the air sufficiently to cause illness or even death by gas poisoning.

It is found that electrical charges of considerable magnitude may be produced when gasoline is filtered through chamois skin, and also through other insulating filtering media. Greater charges are produced when the air is cold and dry than when it is warm and damp.

When the air is dry and cold, it is extremely difficult to avoid the production of static charges of electricity when the gasoline is filtered through chamois skin. The amount of static electric charge produced is so much less when the gasoline is filtered through fine wire gauze that the hazard is practically eliminated.

When insulated from the ground and the tank, the funnel receives an electric charge of one sign while the gasoline running into the tank carries an electric charge of the opposite sign. If then the funnel is brought near the metal of the tank a spark passes between the funnel and the tank, and if the mixture of gasoline vapor and air at this point is an explosive one, an explosion may result.

In addition to the electric charge produced by filtering the gasoline, charges may be produced by the friction of clothing against the cushions of automobile seats, by gloves against other materials, etc.

The danger due to the production of charges in both of these ways may be avoided by touching the funnel against the metal tank at some distance away from the opening before inserting the funnel into the tank, and then inserting it into the opening in the tank in such a way that it remains in metallic contact with the tank until the filtering is completed. The funnel should not be lifted out of contact with the tank while the filtering is in progress. These two precautions prevent the accumulation of charges of opposite sign on the funnel and the tank, respectively, and thus eliminate the possibility of the passage of an electric spark between the two.

Several accounts of explosions due to the passage of electric sparks produced in the ways above discussed have recently been reported in the newspapers. The cause for this hazard has only recently been recognized, and it is no doubt true that a number of explosions classified as unknown have been due to this cause.

The reason that such explosions are not more frequent is that the conditions are seldom just right to cause an explosion, due to the fact that the gasoline vapor and air mixture at the point of passage of the spark is not of exactly the right proportions to produce an explosive mixture, such mixtures not being explosive unless the components are present in certain proportions. If the mixture contains too little or too much gasoline vapor, it is not explosive.

Carbon tetrachlorid (also used in fire extinguishers) has been substituted for gasoline in many instances where a combustible liquid is not desired, as in cleaning fabrics, and it is generally considered equal to gasoline for such purposes. The principal objection to its more widespread use is that the cost is several times that of gasoline, but the safety features which it possesses make its use desirable whenever practicable.

To decrease the cost and yet have a cleaning liquid which is reasonably free from the fire- and explosion-hazard, carbon tetrachlorid is often mixed with gasoline. In making mixtures of this kind, it is to be remembered that the more volatile naphthas require a considerably higher percentage of the carbon tetrachlorid to render them reasonably safe than do those of lower volatility. A mixture of equal parts of gasoline and carbon tetrachlorid is frequently used. If the naphtha is very volatile (e. g., 70° Baume), the mixture should contain at least 60 per cent, and for 76° Baume naphtha at least 70 per cent carbon tetrachlorid. With such mixture there is no serious fire or explosion hazard from open containers, altho the mixtures will burn when spread out over surfaces of fabrics.

The following are a few suggestions for use when handling gasoline:

1. Keep gasoline outside of the house even tho safety cans with self-closing lids are used.

2. Mark the container for gasoline in large letters "GASOLINE."

3. Use gasoline outside the house, removed from flames, and so that the vapors will be carried away as rapidly as possible.

4. Keep all open lights, burning matches, lighted cigars and cigarets as far away from gasoline as possible. Keep gasoline away from lighted stoves.

5. Treat articles cleaned with it with the

same care observed with the gasoline until the vapor has been entirely removed.

6. Do all cleaning in the daytime and never in the vicinity of open flames, burners, or fires of any kind.

7. Throw discarded gasoline outside on the ground and not into sinks or drains.

Fireworks. The number of deaths and accidents attributable to the use of fireworks on Independence Day totaled as many as 5000 only a few years ago. The growth of public opinion in favor of a "safe and sane celebration" and the enforcement of laws in thickly settled communities has reduced this number to less than one-third. The number of accidents is still inexcusably large and the use of fireworks should be further discouraged. If fireworks are, nevertheless, used they should be carefully stored and handled. Because of their explosive nature, it is dangerous to leave fireworks packed or unpacked in a room with an open light, or to scratch matches or smoke cigars in such a room. It should be remembered that powder grains will shake out of packages during shipment and scatter around the packing-box. The box is similar to an open powder-bag until cleaned out. It is important to unpack fireworks in a safe place and if they are not to be used immediately to cover them with a piece of canvas, rubber blanket, or some incombustible material.

One must guard the main supply of fireworks from sparks or open fires, and from other persons, especially if they carry lighted punk or cigarets or other open lights.

A few buckets of water, or a connected garden-hose, at hand when setting off fireworks may serve to prevent a disastrous fire or explosion.

When little children, especially girls with sheer and easily ignited dresses, play with fireworks they should be carefully watched and supervised by older persons.

Many fires are caused when toy balloons which carry a flaming torch alight on buildings, haystacks, etc. The sending up of such balloons is nothing less than criminal carelessness.

Celluloid and Similar Materials. Celluloid is the trade name of a manufactured product which is a familiar material about the household. Some other trade names of similar materials are pyralin, xylonite, fiberoid, and viscoloid. Some of these materials are colored and others are nearly transparent.

These materials differ from guncotton and similar explosives in degree rather than in kind and under suitable conditions readily burn and may be explosive. If heated somewhat above the boiling point of water, decomposition takes place so rapidly that the material heats itself to a point where ignition or explosion occurs. After ignition, these materials will frequently continue to burn after they have been plunged into water. A hot curling-iron, or even the heat of a steam-radiator, may be sufficient to cause ignition of these materials. Many persons have been seriously burned by the use of combs, collars, and other celluloid articles.

Motion-picture films have the same general composition as the materials mentioned above, and municipalities have drawn up elaborate specifications to regulate their use so as to minimize the fire-hazard.

It is not to be understood that, with reasonable care, celluloid and similar materials constitute any unusual source of danger. They are not to be condemned by the public any more than would be petroleum or other hazardous materials, but it is desirable that their highly inflammable nature be known so that they may be handled with care when used about the house or worn on the person.

Christmas Trees. The hazard incident to the illumination of Christmas trees is especially serious, and often results in serious injury and even death. The decorations are frequently made of materials which readily burn. Some of these are explosive. The use of quantities of paper festoons, celluloid ornaments, and cotton to represent snow on trees, daily becomes a greater menace due to the drying out of the trees. Where lighted candles are arranged for decorative illumination or are carried around the tree by children wearing highly inflammable dresses, combinations are effected which often bring a sad ending to an otherwise joyous occasion.

When it is realized that all of these things may be made safe and just as attractive by substituting fire-resistive materials for those generally used, there is no excuse for the continuation of such dangerous practises. For example, some of the ornaments used may be treated with fire-resistive solutions which will remove much of the attendant hazard.

If you must use open lights about your tree, remember that they should be carefully watched during the entire time they are burning. Handling or touching the tree at such a time may cause the decorations to fall into a lighted candle. Removing a present from a lighted tree may precipitate something else into a lighted candle. Drafts of air may cause ornaments or portions of the tree to sway directly into the flame. It may be impossible to check the burning of any celluloid ornaments even with fire-extinguishing liquids and devices.

A lighted candle dropped onto a floor covered with cotton is liable to cause a very serious flash-fire which will set the whole room in a blaze within a few seconds. Miniature electric lamps are much safer if illumination is to be used on the tree, especially if the lamps are on a low-voltage circuit. In many localities Christmas tree lighting-outfits, consisting of a number of miniature incandescent lamps on flexible cord for connection to the lighting circuit, are not permitted.

The electric wiring on trees should be carefully installed by some one familiar with the hazards incurred.

The custom of wrapping electric incandescent lamps with cotton, or other readily inflammable materials, is extremely dangerous.

Benzin Stove-Polish. During a period of eight years prior to 1915 there were more than 400 serious accidents in the United States due to the use of benzin stove-polish. In 1914, in Illinois alone, five women were burned to death through the explosion of the common benzin stove-polish. There are many benzin stove-polishes manufactured which are made of nearly the same ingredients, the only difference being in the name. The principal advantage of benzin is in causing the polish to dry quickly, and this consideration recommends it to certain housewives, especially those who find it difficult to complete their work in the available time. The hazard of using this material is, however, so great that it should be entirely banished from the home. While the directions usually state the polish should not be used on a hot stove, housewives are accustomed to getting best results with other polishes on stoves which are at least warm, and the directions are likely to be ignored. Even if the stove is cold there may be a hazard due to an open light in the room in which the polish is used, and since benzin vaporizes even at a low temperature, this may result in an explosion. When the polish is contained in a glass bottle the hazard is even greater than when it is contained in a metal can, since the glass may be dropped and broken.

The hazard of the benzin stove-polish is fully realized even by the manufacturers who place it on the market, but, until it is entirely prohibited, these manufacturers feel it necessary to supply a polish of this class in order to compete with other manufacturers. Most of the manufacturers, however, themselves recommend the use of other types of stove-polishes, whether in liquid, powder, or paste form. It is better to take a few more minutes to polish the stove than introduce the hazard of the benzin stove-polish.

Incendiarism. Incendiarism, even in those States having most energetic and efficient fire-marshals, is a still too common crime. The number of convictions actually secured is relatively small in comparison with the number of fires attributed to this cause. Stringent laws, rigidly enforced, must be supplemented by wise insurance regulations and by a strong public opinion, in order to adequately cope with this crime and to reduce to a minimum the number of fires due to it.

How to Prevent Fires. The following suggestions have been prepared for the prevention of fires. If these were followed by every one, the fire waste in the country would be very materially reduced. Attention to these apparently trivial things would result in a material reduction of the fire waste.

1. Keep matches out of the way of children. Teach them the dangers of playing with fire.

2. Avoid throwing *lighted cigars, cigarets,* and *matches* into wastepaper baskets or other places containing inflammable materials.

3. Make it a point to *know how to get out* of every building you enter. This precaution may save panic and much confusion in case of fire.

4. Avoid the filling of *lighted lamps*. Avoid the use of *kerosene* to light fires. The application of heat to kerosene results in the generation of gases which are very explosive.

5. Provide a sufficient number of metal cans near stoves and furnaces to receive the *hot ashes.* Provide a different type of cans for *rubbish. Never mix.*

6. Avoid *toy wax candles.* Each year the number of deaths of children due to placing *candles* on *Christmas trees* produces a sad ending for an otherwise joyful season.

7. Keep *greasy* and *oily rags* in tightly closed metal boxes provided in one place for the purpose.

8. Avoid hanging *lace curtains* and other

draperies near *gas jets* or other open flames. The draft from nearby windows may cause fires quick to spread and difficult to extinguish.

9. Use *gasoline, naphtha, or benzin* for cleaning, if at all, out-of-doors and during the day. These liquids quickly evaporate, and the heavy inflammable gases formed quickly settle in spaces below windows and in corners.

10. Place substantial fire-resisting *guards* in front of all woodwork about *sources* of *heat*. The open flames of gas, kerosene, alcohol, and gasoline stoves should be particularly shielded.

11. Keep all *open flames* away from *gas leaks*. Explosive mixtures of gas and air are quickly formed at such places, and they only need a lighted match or taper to cause disastrous results.

12. Permit only experienced persons to *install* or repair *electrical fittings* and *appliances*. There are definite rules for wiring, which if known and observed will prevent electrical fires.

13. Avoid placing articles made of celluloid, pyralin, xylonite, fiberoid, viscoloid, and similar materials, such as collars, combs, toilet articles, etc., upon or near sources of heat, as they are very likely to cause fires. Great caution should also be exercised when articles made of such materials are worn upon the person.

14. Turn the current off after using an *electric pressing iron*. Avoid leaving portable electric-heating devices unattended.

What To Do in Case of Fire. 1. Collect your thoughts. Keep your mind on what you are doing. Act quickly.

2. Summon help if any one is within calling distance.

3. If the blaze is small and you think you can put it out by devices which are available, either

a. Use a fire extinguisher;

b. Use a woolen blanket or rug to smother the fire. Keep the air from the fire;

c. Throw water on the fire from a pail, using a broom if it be conveniently at hand. If not, splash the water with the hands. Do not use water on an oil or grease fire; use sand or earth from flower-pots; use a carbon-tetrachlorid extinguisher if available;

d. Beat down any draperies, curtains, or light materials causing the blaze, using a broom or long pole. (Using the bare hands may cause serious burns. A wet broom is much more effective.)

NOTE. It is very dangerous for women to stamp out fires on account of the nature of their clothing.

4. Unless you are very sure that you can handle the fire without help, notify the fire department or have some one else do it. Many have been sure until too late.

Teach each member of the family the method of sending in a fire-alarm. In many cities it is necessary only to call the fire department on the phone. In others it is necessary to send an alarm at a corner firebox. The methods employed for turning in alarms are often not understood, and as seconds count it is important that they should be studied before fires occur.

The telephone number of the fire department should occupy a conspicuous and permanent place at each phone. In giving information about a fire over the phone, one should carefully consider what he is doing. The few seconds lost in doing this are positively not wasted. What the fire department wants to know is (a) the number of the house, (b) the name of the street or road, and (c) the nearest street corner.

It is not surprizing that in their excitement people give incorrect information at such times, or else just say that the house is on fire. It is essential that the thoughts should be collected sufficiently to give adequate information before hanging up the receiver.

5. Cut off all draft, closing doors, windows, and closets in the room, and use available methods of fire extinguishing as mentioned above.

6. Tie a wet towel or any other material (preferably of wool) over the mouth and nose if you are fighting the fire and are exposed to smoke or flames. It is said that more people lose their lives by suffocation than through burning.

7. Place yourself so that you can retreat in the direction of a safe exit without passing through the burning area. Unless you can do

something worth while, get out of the building. Investigate afterwards.

8. If necessary to go through a room full of smoke keep close to the floor. It is usually better to crawl on the hands and knees, keeping the mouth close to the floor. The drafts and currents cause the smoke to rise and the air nearest the floor is usually the purest.

9. Do not jump from a high window. Use a rope or life-line. To slide down a rope, twist the rope around one leg and, holding the feet together, regulate the speed of descent. Otherwise the hands may be painfully injured, especially if the height is great. Sheets and other articles of bedding will often provide a life-line if knots are carefully made so that they will not slip. An extra loop in the knot may avoid this danger. Tie the rope or life-line to a bed or other article of furniture which will not pull through the window. The line should not be thrown out of the window until the instant it is needed.

Persons with Clothing Afire. A person with clothes afire will only make conditions worse by running. Particularly avoid running out of the house. Running fans the fire.

If your clothing is on fire, quickly wrap yourself in some heavy material and roll on the floor. A rug, shawl, bed cover, portière, or coat will serve the purpose well. It is better to put out the fire in this manner than by the use of water, unless a considerable body of water is close to hand.

If you see a person with clothing afire, wrap him up and roll him over. It will often be necessary to throw him down on the floor by force, due to the fear which the blazing clothing causes.

Precaution Against Fires in the Construction of Houses. 1. All steam, water, gas, and hot-air pipe should be properly located and installed.

2. There should be two separate exits from each of the upper floors of larger buildings.

3. The elevator, dumb-waiter shafts, and other vertical openings should be suitably separated from the remainder of the structure so that they will provide safe exits, or so that they may be closed in case of fire.

NOTE. Engineers interested in fire prevention are seriously considering the advisability of a concerted effort toward requiring inclosure of stairways in all apartment houses, and even in the upper stories of homes.

4. The heating arrangements, including furnaces, boilers, and stoves, should be isolated, and protective measures should be adopted to prevent fire originating at such devices from being quickly communicated to the remainder of the building.

5. The electric and gas installations should be carefully installed and inspected so as to

minimize danger from defective wires, unsuitable switches, outlets, and sockets, leaky pipes and burners, and other defective devices where the electrical energy and the gas are utilized.

6. Suitable safeguards should be provided against the dangers from heating devices and open flames to be used about the premises.

7. Suitable fire-stops should be provided in the construction of the walls to insure against rapid spread of fire.

NOTE. Continuous air spaces under floors and in walls, which permit fire to smolder for a long time, often without being noticed, should be avoided.

8. Windows, doors, and other external openings should be protected against fire from nearby windows in the adjacent or from opposite windows in the same building.

NOTE. Wire glass often affords an excellent means of protection where such exposure exists.

9. Suitable party and parapet walls of fire-resisting construction should always be provided between houses built in rows.

10. Roof construction, which provides an inflammable place for firebrands from outside fires to alight, should be avoided.

NOTE. A striking illustration is the wooden shingle roof, by means of which many conflagrations have been spread.

11. Wooden lath on thin joists, a construction which burns through rapidly, should be avoided.

12. The use of wooden and other inflammable materials about chimneys should be reduced to a minimum, and continuous vertical air spaces should be eliminated by means of incombustible fire stops.

13. Woodwork surrounding hot-air pipes, flues, and registers should be properly protected by incombustible material.

14. Wooden beams and joists resting upon party or fire walls should be separated by firestops from similar beams on the opposite sides of these walls so that fire can not be communicated readily between these structural members through the walls.

15. Suitable seasoned timber should be selected to avoid dryrot, and the use of sapwood in places subjected to dampness should be avoided.

Fire-Fighting Devices. The fire-fighting devices should always be located conveniently, and for small dwellings this usually means in or near the kitchen. One of the simplest and most effective fire-fighting devices for dealing with fires in their early stages is a pail of water.

There is usually some one around when a fire starts. Also, fires are so small at the start that the prompt application of a small amount of water, the use of blankets, or similar simple expedients can be adopted to quench what might later develop into a severe conflagration.

It is certainly possible to hang fire-buckets in some convenient and accessible place in each household. In mills, buckets with round bottoms have often been adopted to prevent their use for other purposes.

Any one who has tried to throw water from a bucket knows the difficulty of throwing the water just where it is needed. Unfamiliarity with the operation and excitement of the moment have much to do with this. A partially filled pail may often be used more effectively. A cup- or ladle-full is easily handled and will often do more good than a bucket of water misdirected. The hands can also be used to advantage for throwing the water where it is most needed. Again, a broom can be used to apply the water in a finely divided state, which is often satisfactory for the purpose. The broom is also useful for tearing down draperies and reaching a fire with less danger to the person. A broom may be kept with the water-pail for this special purpose. A suggestion has been made to provide water-faucets in the house to which a garden hose can be conveniently connected, or, better, permanently attached.

Fire Extinguishers. There are many kinds of fire-extinguishers on the market, each of which has its advantages as well as its disadvantages. Fire-extinguishers have one considerable advantage over water-pails, in that they are serviceable only for one purpose and therefore are less likely to be removed from their proper places or rendered inoperative. Two types are particularly useful for small fires. One uses bicarbonate of soda and sulfuric acid, and is often called the "soda-acid extinguisher," by which name it will be referred to in this section. The other depends for its operation on the use of carbon tetrachlorid, either pure, or mixed with other substances. The essential features of the fire-extinguisher are an outer cylindrical container of copper with riveted and soldered joints; a cap which closes the charging aperture (this cap has a handle which provides a means for handling the extinguisher and for removing the cap by means of a screwed joint); and a discharge nozzle which is secured to a short length of hose by means of a coupling. Inside the cylindrical container there is a holder or cage for a glass bottle. In the usual form of this extinguisher, known as the loose stopple type, it is only necessary to turn the extinguisher upside down to cause the liquid to be forced through the hose.

The *instructions* appearing on the outside of a fire extinguisher should be carefully *read and followed.*

The operation of the soda-acid extinguisher is as follows: When the extinguisher is turned upside down, the loose-fitting stopple drops away from the mouth of the acid bottle, allowing the sulfuric acid to flow from the bottle into the soda solution in the container, liberating carbon-dioxid gas. This gas generates considerable pressure, which the container is designed to withstand. The pressure propels the liquid with great force through the hose. Both the water and the carbon dioxid have a fire-extinguishing value.

The only special care required in using extinguishers of this type is to maintain them in an upright position until the vicinity of the fire is reached, and then to turn them over as directed on the container and squirt the extinguishing liquid at the fire. In spite of the simplicity of the directions on the containers, it is not uncommon for people in their excitement at the time of a fire to immediately turn them over and carry them to the place of the fire. They are, of course, chagrined when they reach the fire to find that the liquid has been wasted. It is, therefore, recommended that when installed people read the directions on the container, and also show everybody around the house, who might have occasion to use the extinguisher, how to do it.

In the carbon tetrachlorid type of extinguisher the liquid is ejected from the extinguisher into the fire, usually by some kind of pump. When the liquid used in such an extinguisher comes in contact with fire, a heavy vapor is formed which acts as an incombustible blanket proportionate in size to the quantity of liquid used. There are many forms of this type of extinguisher which have more or less utility, depending chiefly on whether they are operative when they are wanted. The forms using a liquid pump have proved generally reliable. Indeed, this is a fundamental necessity for all fire-extinguishing devices.

All fires should be attacked from the edges, where there is less motion of the air, rather than at the center of the fire, where the upward draft is greater. This applies equally to all extinguishers, and only less so to a water-hose stream on account of the large amount of water used.

Comparative Value of the Two Types of Extinguishers. In purchasing a fire-extinguisher one should consider (1) its efficiency in extinguishing fires, and (2) weight and ease of handling.

The carbon tetrachlorid type of extinguisher is particularly efficient in dealing with grease fires in kitchens, oil or gasoline fires, or electrical fires, where the application of water may be very undesirable. The soda-acid extinguisher is advantageous in dealing with most other types of fires, such as wood-fires and rubbish-fires, especially after they have grown to somewhat larger size than can be controlled by the carbon tetrachlorid extinguishers in the small size usually sold. On the other hand, the small size and weight of the carbon tetrachlorid extinguishers give them the advantage as concerns ease of handling and, hence, speed in getting them into action before the fire spreads. This is particularly important where women or children may need to use the extinguisher. It has been found that there is an apparently strong incentive to try the action of the pump from time to time with the result that the liquid is gone when it is really needed. This is no fault of the extinguisher, but the possibility should be guarded against. On the other hand, occasional trials of the extinguisher tend to familiarize the household with its use, and to assure that it remains operative, and such trials are much more conveniently made with the carbon tetrachlorid than with the soda-acid type.

Fire Retardants. The British Fire Prevention Committee has published the following formula for making curtains and draperies non-inflammable:

2 pounds sulfate of ammonia,
4 pounds chlorid of ammonia,
3 gallons of water.

It is probable that this solution will have to be applied after each washing.

Whitewash Fireproofing Mixture. The following whitewash mixture (known as United States Government whitewash mixture) is often used as a fire-retarding coating over interior wooden surfaces:

> Slake ½ bushel of quicklime with boiling water, keeping it covered during process. Strain and add 1 peck of salt dissolved in warm water; put 3 pounds of ground rice in water and boil to a thin paste; ½ pound of powdered Spanish whiting; 1 pound of clean glue dissolved in hot water. Mix well and let stand for several days. Keep in kettle or receptacle, and apply as hot as possible with a whitewash- or paint-brush.

Accidents in the Household

Where gas and electricity are used in the house, there is always a possibility through carelessness or other causes that accidents will happen. Some of these are likely to be serious, and it is worth while to consider the nature of the remedies to be utilized when they occur.

Gas. Accidents from gas may occur: 1, through asphyxiation from unburned gas; 2, by asphyxiation from the products of incomplete combustion; 3, by burns; 4, by destruction of property by fire; and 5, by explosions, which may be accompanied by fire or injury.

Asphyxiation. Asphyxiation by gas is comparatively common. It is caused by imperfect combustion of gas, or by leaks due to defects in the gas-fixtures. As the odor of gas is very strong, the danger to persons who are awake is comparatively small. Most of the accidents occur during the sleeping hours. The action of the gas is very subtle; therefore, any one who persists in staying in the room after the gas is smelled, may not suspect that he is running any risk, even when he is on the point of losing consciousness. The seriousness of gas asphyxiation depends somewhat on the age and health of the person. Children and invalids are much more quickly affected than healthy adults. Care should be taken against burning gas in such a way that it "flashes back" and takes fire inside of the burner, for when burning in this manner, likelihood of the escape of products containing carbon dioxid, which is the poisonous agent of gas, is very great.

Treatment for Gas Asphyxiation. When a person has been overcome by gas, the most important thing to do is to provide him with fresh air, either by carrying him outdoors or to another part of the house, or by thoroughly ventilating the room in which he has been found. The doctor should be summoned at once, and the gas company should be informed so that the cause of the trouble may be promptly remedied. Special facilities which the company often has for the treatment of persons thus overcome may be available. While waiting for the doctor, artificial respiration should be applied, unless the patient is breathing regularly. Such stimulants as whisky, brandy, or other alcoholic drinks should never be administered, but if the patient is conscious and able to swallow, he may be given a dose of phosphate of soda, bromo seltzer, or other gas-forming drinks.

The treatment of restoring breathing in gas-poisoning is similar to that employed in drowning or electric shock, except for the need of removal for fresh air in the case of gas-poisoning. This method of artificial respiration is described in the section dealing with accidents from electricity. When this method is used, no time should be wasted, for every moment's delay is serious. As soon as oxygen can be available, it should be administered with the proper face-mask, through any breathing device. However, no mechanical device should be used except those operated by hand, and those which can not produce high pressure or even slight suction on the lungs. If it is necessary, this artificial respiration should be kept up without stop for two hours, or longer, until natural breathing is restored. If natural breathing stops after being restored, the artificial respiration should be used again.

Fires and Explosions. Fires which result from the use of gas are very similar to those which occur with other fuel. Gas appliances in general are so designed that if properly installed, no danger of fire need result. One should remember that the gas-flame is extremely hot and that the products of combustion carry away a large quantity of heat which may produce dangerous conditions, if proper precaution is not afforded, either by heat insulation or adequate spacing of appliances, flues, etc., away from wood, lath, plaster and other combustible portions of the house. Gas can not explode unless it is mixed with air. Therefore, the only danger of explosion comes from permitting mixtures of gas with air in such proportions that an explosion results. Even in this case there is no danger of explosion unless a flame, electric spark, or some highly heated substance comes in contact with the mixture.

Gas Leaks. All leaks of gas, however small, may be dangerous. Altho the quantity escaping may not seem large enough to cause asphyxiation or explosion, there is no means of finding this out without an analysis of the mixture. Thus, one should never regard an air-gas mixture as safe, and even when a slight escape of gas is noticed steps should be taken at once to prevent further leakage and guard against explosions or asphyxiation.

The most important rule in searching for gas leaks is never to use a lighted match, candle, lantern or other ordinary lighting appliance. Even the switch operating the electric light may cause a sufficient spark to set fire to the explosive mixture and thus cause disastrous results. The escaping gas should never be ignited, for unexpected pockets of explosive mixtures may exist.

When a leak is located and if it is apparently not large enough to fill the room with gas, the only precaution necessary is to stop the leak with soap and to notify the gas company. If the leak is larger, however, and the gas fills the room, no time should be lost in putting out all lights or fires, in opening the windows, and in warning all people who may be in the room to leave it, and if necessary, to go out of the house altogether.

If, on opening the door into the basement or adjoining room, it is found to have a stronger odor of gas than the room in which the leak is located, it is safer not to enter. If there is no fire or flame burning in the room, it is safer to close the door and wait until the gas con pany's man arrives. If it is necessary to enter the basement or room in order to extinguish lights, or rescue persons sleeping or unconscious, no lights should be carried, and a watcher should be stationed outside to summon aid in case the person first entering should be overcome. Since gas travels sometimes for a considerable distance, it may be found at points far removed from the real source of the leakage. Gas in dangerous quantities may pass through the foundation walls of buildings, from the street under frozen ground into the basement, or from the basement of an adjoining building. It may also pass through party or partition walls, and through floors, as from the basement to the first floor rooms.

Care of Meter and Piping. If the meter- and gas-pipes are properly installed and tested, there is usually little danger, and they should require no attention from the householder. Only men skilled in such installation should be employed. If the house-owner suspects serious defects in the piping of his house, he should ask the city plumbing inpector of the gas company to determine if the work is properly done and safe. After the leaks have been repaired, the house-owner should notice whether the nature of the repair is permanent or temporary. A permanent repair usually consists of the replacement of a new part in the defective portion. A pipe of generous size should be used.

Gas pipes should not be placed on outside walls, or where stoppage may be caused by ice or liquids condensed by the gas during cold weather. Inflammable materials and rubbish should not be placed near the meter, since a fire in such materials would be likely to melt the meter and its connections, and the flame of escaping gas might greatly increase the extent of the fire. The meter should never be installed near a furnace, since a leak in the meter or connections might lead to fire or explosion.

The gas-meter is an instrument of precision and it should never be tampered with or exposed to strain. The practise of some users of gas of partially closing the shut-off cock at the meter is not advisable, since it is likely to cause the various appliances to operate improperly. It is well, however, to know the location of the meter shut-off cock, and to have a wrench handy with which to close it in case of necessity. After the cock has been once shut off, it should never, under any condition, be turned on again by the house-owner. The gas company should be notified and requested to turn on the gas. This precaution is so important that in some cities even expert gas-fitters are not allowed to turn on the gas, unless actually in the employ of the gas company.

Whenever gas is to be turned into the house-piping, care should be taken to make sure that there are no gas-burners open in any room before the gas is turned on. Great caution should be exercised in putting coins in the slot meter when the flowing of gas resulting from the previous coin has been used up. Another coin should never be introduced in the meter unless it is absolutely certain that there are no open burners. Many accidents have resulted from the lack of care in this matter.

Dangers From Electricity. Accidents of electrical origin may be classified in three groups—shocks to persons, burning of persons, and burning of property. A fair understanding of the causes of electrical accidents requires some appreciation of the meaning of the terms electric current, voltage, and circuit.

Shock. Electrical shock is the name given to the physiological effects on the human body produced by the passage of electric current through any portion of it. Small shocks may be manifested by very slight tingling sensations in the part of the body through which the current passes, or frequently in minor muscular contractions which become more severe and even painful as the amount of the current increases. Severe shocks may cause muscular contractions which will throw the person down more or less violently, or throw him against neighboring objects, thus causing bruises or fractures. And, in extreme cases, the shock may actually injure the muscles affected or even check or stop heart action. Another rather common effect of severe shocks is to stop the process of breathing. If breathing is not started again within a few minutes, it may result fatally, and proper methods to restore breathing need to be very quickly applied. This can often be done when the victim of a shock is apparently lifeless, by applying the first-aid method given in another part of the book.

Slight shocks are sometimes administered by physicians because of their stimulative effects.

Heavy shocks are more or less harmful according to the severity, even if unconsciousness or other visible effects do not result. The severity of the shock depends upon several factors, increasing with the voltage which is applied and with the area of the contacts made by the electrical circuit with the body, since both factors permit an increase of current flow. On the other hand, the severity of the shock is reduced as the resistance of the portion of the body coming into electrical circuit is increased, since this would tend to prevent the flow of a large amount of current.

The amount of this resistance depends partly on the portion of the body coming into the electrical circuit but largely on the character of the contact surfaces, whether large or small and whether wet or dry. A contact with the dry skin of the hand, for instance, especially where calloused, will give very high contact resistance, tending to reduce the shock, whereas a hand or other part of the body moist with perspiration or from other cause will give comparatively low contact resistance and correspondingly greater shock when other conditions are the same. A lineman with dry calloused hands might safely handle a wire which would give a serious or fatal shock to a child or woman or even to himself if it touched a damp wrist. Where large blood vessels are close to the surface of the body, as at the wrist, the resistance will usually be less than elsewhere. The resistance within the body, and therefore the amount of current flowing under a given voltage or pressure, depends much upon the course of the current through the body, whether the blood vessels lie along or across the path of the current. If along the path of the current the resistance is low and the seriousness of the shock relatively great.

Another factor of great importance in determining the severity of the shock is the course of the current as related to vital organs of the body, a current passing from finger to finger of one hand, for instance, having usually only a local effect; whereas, when passing from one hand to the other the course of the current may lie through the vital organs, the heart, or the central nervous system, and be much more likely to cause serious results. A similar serious result might follow were the path of the current from the neck to the foot or even from the hand to the foot.

Contact Burns. When a current passes through any portion of the human body, besides the shock effects mentioned above, there may sometimes be, if the intensity or duration of current through any part of the body fluids or tissue is very great, a serious structural change of the fluids or tissues, possibly enough to cause permanent functional disturbances or even the destruction of vital tissue. Only rarely, however, even in the most severe and even fatal shocks, will there be serious internal changes of this kind.

Much more frequent injuries from contact with live parts are electrical burns which result in the following manner: Where the area of surface contact of the body with an electric circuit is very small, the current, which within the body may be distributed over a wide path and along fluid paths of low resistance, may be so concentrated in the small surface area where fluids are absent or quickly dried up as to cause a local burn. Accompanying severe shocks there is frequently more or less destruction of external tissue at the point of contact by burning. Often, however, where the shock effects are very slight, or tho severe have only temporary effect, the burning at the points of contact may be serious and its effects last a considerable time, possibly with some disfigurement. With large areas of contact, as where persons are in bathtubs and touch live electrical fittings with wet hands, contact burns may be absent, because the contact resistance is low, but the amount of current passing through the body will be greater and the shock and other internal effects will be greater also.

Precautions to Prevent Shocks from Electrical Devices. Both electrical shocks and the kind of electrical burns and internal injuries mentioned above are caused by the passage of an electrical current through the body and are entirely impossible if a circuit is not *completed* through the body. The mere contact of some *one* part of the body with some portion of an electrical circuit will *always be harmless* unless through contact of some *other* portion of the body with some *other* part of the electrical circuit or with some other conducting surface—the ground, plumbing, or the like—a completed circuit is made through the body and a current thus permitted to flow from one surface of the body to another. The precautions to be observed in electrical installations, as outlined hereafter, are intended to minimize the probability that the person will accidentally make an electrical circuit through his body and to minimize the danger if one or even more contacts *do* occur.

Before touching any electrical device such as a portable cord or device or a switch (these being most often handled), persons of careful habit will see that they are not *also* touching any other part of the electric circuit or its devices and will so far as possible *use only one hand* on the device. They will also at such times avoid standing on or leaning against plumbing fixtures, tubs, radiators, basins, or even standing on cement or brick basement floors not covered with dry wood or rubber platforms. Outside of buildings careful persons will avoid touching any wire or other conducting object which may by any possibility be itself touching an overhead electric wire at some other point. By such precaution persons will avoid allowing the body to become a portion of an electric circuit.

The protective measures applied to the indoor and outdoor wiring as a means of preventing the likelihood of shocks, burns or internal injuries, and of reducing their severity where for any reason shocks still occur in spite of reasonable safeguards in the manner of installation, will be taken up in some detail later in this chapter. They consist of, first, the complete isolation of high-voltage wires; second, the use for wiring within buildings, and thus more or less accessible, of only comparatively low voltages, together with the prevention of higher voltages on this interior wiring by various means, usually by connecting one point of the low-voltage circuits to the ground; third, the provision of certain specified insulating coverings over all wires and other current-carrying parts of electrical installations; fourth, the grounding where practicable of external metal parts of electrical devices which may be handled. The insulating coverings serve to prevent contact of persons with live parts, even at low voltages, and the grounding serves to prevent existence of *any* voltage between the wire or part grounded and the ground or grounded objects which a person may touch at the same time.

Flesh Burns. A kind of electrical burn other than the contact burns mentioned above may result without the body coming into contact with more than *one* part of an electric circuit, or even *without a single* contact through proximity of the body to electrical arcs. These arcs may be caused in a number of different ways; for instance, where one of the older types of an attachment plug is partly removed from its receptacle the hand may be burned by the arcing or flashing. Such disconnection should always be done quickly and with the hand held away as far as possible from the point where the circuit is broken. Then, too, where wires are in close proximity and the intervening insulation is in any way exposed to mechanical injury or to the action of moisture, oil, or other deteriorating agency, the breakdown of the insulation may occur, causing arcing, as well as danger of shock. As will be later more fully developed, the protection of house-wiring installations against injury to the wire insulation is highly important, and is in practise accomplished to a satisfactory degree by observance on the part of electrical installers of suitable installation requirements, particularly those of the National Electrical (Fire) Code, if reasonable care is observed by the users of the electrical appliances.

Fires. The fire dangers of electricity arise largely in the same way as do the last class of electrical burns considered above, with the difference that the arcing, instead of burning some person who may happen to be touching the arcing part or be in its vicinity, may set fire to surrounding fabrics or less often to the surrounding floors and other woodwork; or, if the arcing is long-continued, hot metal or burning insulation may be thrown upon neighboring fabrics or building material with the same result. The precautions necessary in the installation of wiring and devices to prevent fires from this cause will be considered in some detail later.

Another and much less frequent cause of electrical fires is the overheating of electrical conductors or electrical devices which, while designed for carrying a limited current, become overloaded from some cause and carry more current than is safe. The design of such equipment necessarily requires that the normal operating temperatures either of wiring or devices be *very much lower* than the high temperatures at which danger of igniting surrounding material will occur, since any temperature even approaching this will soon make the insulation useless as such and destroy the usefulness of valuable apparatus or wiring. To prevent the passage of too large currents the electric circuits are provided in practise with fusible cutouts which, by the melting of metal strips when too great a current flows, will interrupt or *cut out* the circuit so protected. The fact that there is *any* existing hazard from too heavy current in wires and devices is a result of the replacement of the proper fuses by improper materials or too large sizes, either by an uninformed owner or by a careless contractor or lighting company. The object, of course, has been to avoid the *trouble* of frequent fuse replacements, whereas the blowing of a fuse *should* be followed by an investigation and, if possible, removal of the overloading which gave rise to the operating of the fuse. The overloading of wires and blowing of fuses might be caused, for example, by the attachment of too many or too large devices, or by too sudden starting of motors, or by excessive friction in the motors or machines they drive.

It may be stated further that the fuse itself may become a cause of electrical fires as well as electrical burns if its operation under any condition permits the scattering of hot fuse metal. For this reason fuses of a type not having the fusible metal strip incased have been for a considerable time prohibited in this country unless in tight cabinets. It is desirable and in many instances required that such fuses, even tho of a type having the fusible strip incased, be themselves inclosed in suitable metal cabinets as additional precaution against fire. Certain other possible causes of electric fires will be referred to in the later discussion on interior wiring installation methods.

Resuscitation in Electric Shock. Use a long *dry board, or a dry wooden-handled rake, or broom* to draw the person away from the wire, or the wire away from him. *Never use metal or any moist object.*

By touching the person one may receive the shock himself. Cases have occurred where several persons by attempting to rescue other persons from contact with a live wire, without understanding how to do so safely, have been themselves fatally injured.

When a person, unconscious from electrical shock, is entirely clear of the live wire which caused the injury, do not delay an instant in attempting to revive him. Turn him on his stomach, face sidewise, pull his tongue out of his throat, if he has partly swallowed it, as sometimes happens, and immediately induce artificial breathing of the victim by pressing down firmly, but not roughly, on his lower back ribs at the rate of about *15 times per minute,* continuing until the doctor or other competent person arrives. If the doctor is delayed or suggests no better action, do not give up the effort but *continue this artificial respiration for hours.*

Remember that *the lungs should not be compressed too many times a minute.* Apply the pressure every four or five seconds by a watch, or each time the worker's own breath is exhaled at moderate rate.

It is very important that all persons should learn approved methods of resuscitation by actual practise so that their efforts to revive unconscious persons may be carried out intelligently and without panic. The same methods may be used to revive persons unconscious from partial drowning or from asphyxiation by gas. The method outlined above is generally known as the prone pressure method.

CHAPTER XVI

TABLES OF WEIGHTS, MEASURES, AND TEMPERATURES

The following tables are selected from Circulars published by the Bureau of Standards and from other reliable sources. The first table shows the weight per bushel established by law of the various States, and that established by the United States for customs purposes only. A complete list is printed in Circular No. 10 of the Bureau of Standards, only those commodities being given here which are of more common use in the everyday transactions of the household. This list is correct, as established by law, including those passed at the sessions of the various legislatures up to the summer of 1916. Information concerning later revisions of laws as to bushel equivalents may be obtained from State authorities. Inquiries directed to the Bureau on this and other related subjects will receive attention.

SELECTED LIST OF LEGAL WEIGHTS (IN POUNDS) OF THE BUSHEL OF VARIOUS COMMODITIES

	Apples [2]	Dried apples	Beans [2]	Beets	Carrots	Shelled corn	Corn meal [2]	Cotton seed	Cranberries	Cucumbers
United States....	[3] 50	....	60	....	....	56	[3] 48	....	....	....
Alabama	....	24	60	....	....	56	46	32	....	....
Arizona	....	....	....	....	....	....	....	....	....	....
Arkansas	[4] 50	24	60	....	....	56	48	33 1/3	....	....
California	....	....	....	....	....	52	....	....	....	....
Colorado	....	....	60	....	....	56	50	....	....	....
Connecticut	48	25	60	[5] 60	50	56	50	[6] 44	....	....
Delaware	....	....	....	....	....	56	[7] 44	....	....	....
District Columbia..	....	....	....	....	....	....	....	....	....	....
Florida	[4] 48	24	[8] 60	....	....	56	48	[9] 32	....	....
Georgia	....	24	[10] 60	....	....	56	48	30	....	....
Hawaii	....	....	....	....	....	....	....	....	....	....
Idaho	[4] 48	24	60	56	50	56	....	....	....	....
Illinois	[4] 50	24	[10] 60	60	50	56	[12] 48	32	33	48
Indiana	....	25	60	....	....	56	50	....	33	....
Iowa	48	24	[13] 60	56	50	56	48	....	....	48
Kansas	[4] 48	24	60	56	50	56	....	....	....	....
Kentucky	....	24	[10] 60	....	....	56	50	....	....	....
Louisiana	....	....	....	....	....	....	....	....	....	....
Maine	44	25	60	60	50	....	50	....	32	....
Maryland	[4] 50	28	60	....	50	56	48	....	....	....
Massachusetts ...	48	25	60	60	50	56	50	[6] 44	32	....
Michigan	48	22	60	....	....	56	50	....	40	....
Minnesota	[4] 50	28	60	50	45	56	....	....	36	....
Mississippi	....	26	[10] 60	....	....	56	48	[6] 32	....	....

Missouri	48	24	60	....	50	56	50	33	....	48
Montana	45	....	60	50	50	56	50	....	....	....
Nebraska	[4] 48	24	[10] 60	56	50	56	50	....	....	....
Nevada	[4] 48	24	60	56	50	56	48	....	....	....
New Hampshire..	48	25	[16] 60	60	50	....	50	....	32	....
New Jersey	50	25	60	60	50	....	....	....	....	....
New Mexico	45	24	60	56	50	56	50	32	....	48
New York	48	25	60	....	50	....	50	[6] 44	....	....
North Carolina ..	[4] 48	24	[18] 60	50	....	....	48	[19] 30	....	....
North Dakota ...	50	....	60	60	....	56	....	....	....	....
Ohio	48	24	60	56	50	56	48	....	....	....
Oklahoma	48	24	60	....	50	56	50	32	....	48
Oregon	45	28	....	....	....	....	....	....	....	....
Pennsylvania ...	45	25	[13] 60	56	50	56	50	....	40	50
Rhode Island	48	25	60	50	50	56	50	[6] 44	....	....
South Carolina ..	[4] 50	24	....	50	....	....	50	[21] 30	....	48
South Dakota ...	48	24	60	56	50	56	50	....	....	48
Tennessee	[4] 50	24	[13] 60	50	50	56	[7] 50	28	....	48
Texas	45	28	[10] 60	....	....	56	....	32	....	....
Utah	....	....	....	....	....	....	....	....	....	....
Vermont	48	....	60	60	50	56	50	....	32	48
Virginia	....	28	[10] 60	....	....	56	48	32	....	....
Washington	[4] 45	28	....	....	....	....	....	....	....	....
West Virginia ...	[4] 50	24	60	....	....	....	48	[6] 44	36	50
Wisconsin	50	25	60	50	50	....	50	....	35	[23] 50
Wyoming	....	....	....	....	....	....	....	....	....	....

[1] See also "Indian corn."
[2] Not defined.
[3] For customs purposes only.
[4] Green apples.
[5] Sugar beets and mangel-wurzel.
[6] Sea-island cotton seed; upland cotton seed, 30 pounds.
[7] Bolted; unbolted, 48 pounds.
[8] Shelled.
[9] Sea-island cotton seed, 46 pounds.
[10] White beans.
[11] Native blue-grass seed; English blue-grass seed, 22 lbs.
[12] Unbolted, 48 pounds.
[13] Dried beans.
[14] Sweet corn.
[15] Indian corn in ear.
[16] Small white beans.
[17] Cracked corn.
[18] Soy beans.
[19] Sea-island cotton seed, 44 pounds.
[20] Bolted or unbolted.
[21] Seed of long-staple cotton, 42 pounds.
[22] Red and white.
[23] Green.

SELECTED LIST OF LEGAL WEIGHTS (IN POUNDS) OF THE BUSHEL OF VARIOUS COMMODITIES (*Continued*)

	Onions [1]	Onion sets	Parsnips	Peaches [1]	Pears [1]	Green peas, unshelled	Peas [1]	Potatoes	Sweet potatoes	Timothy Seed	Tomatoes	Turnips [1]
United States	....	....	....	50	50	....	[2] 60	[2] 60	....	....	....	....
Alabama	....	....	....	....	....	....	60	60	55	....	....	55
Arizona	....	....	....	....	....	....	....	....	....	....	....	....
Arkansas	57	....	....	....	....	....	60	60	50	60	....	57
California	....	....	....	....	....	....	....	....	....	....	....	....
Colorado	57	....	....	....	....	....	....	60	....	45	....	....
Connecticut	52	....	45	....	....	....	60	60	54	....	....	[3] 50
Delaware	....	....	....	....	....	....	....	....	....	....	....	....
District Columbia	....	....	....	....	....	....	....	60	....	....	....	....
Florida	56	....	....	[4] 54	60	....	....	60	60	....	....	54
Georgia	57	....	....	....	....	....	60	60	55	45	....	55
Hawaii	....	....	....	....	....	....	....	....	....	....	....	....
Idaho	57	....	50	48	....	....	[5] 60	60	50	45	56	55
Illinois	57	[6] 30	50	48	58	32	[8] 60	60	50	45	56	55
Indiana	48	....	55	....	....	....	....	60	55	45	....	55
Iowa	52	[6] 28	45	48	45	50	[8] 60	60	50	45	50	55
Kansas	57	....	52	48	....	....	[5] 60	60	50	45	56	55
Kentucky	57	[9] 36	....	....	....	....	60	[10] 60	55	45	....	60
Louisiana	....	....	....	....	....	....	....	....	....	....	....	....
Maine	52	....	45	....	58	28	60	60	54	....	56	[3] 50
Maryland	52	....	....	[12] 40	....	....	[13] 60	60	60	45	60	60
Massachusetts	54	....	45	48	58	28	[14] 60	60	54	45	56	55
Michigan	52	....	....	....	....	....	60	60	56	45	....	58
Minnesota	54	28	42	48	45	....	60	60	55	45	50	55
Mississippi	57	....	....	....	....	....	60	[10] 60	54	45	....	55

Missouri	57	[15] 28	44	48	48	56	[16] 60	60	56	45	45	[3] 42
Montana	57	....	50	....	45	....	60	60	....	45	....	50
Nebraska	57	25	50	48	....	....	[5] 60	60	50	45	56	55
Nevada	57	....	50	48	....	....	[5] 60	60	50	45	56	56
New Hampshire..	52	....	45	48	58	....	60	[10] 60	54	45	56	55
New Jersey	57	....	....	50	....	....	60	60	54	45	....	....
New Mexico	57	[6] 30	42	48	48	....	60	60	50	45	50	56
New York	57	....	....	....	....	....	60	60	54	45	....	....
North Carolina ..	57	28	50	50	56	30	60	[10] 56	56	45	56	50
North Dakota ...	52	....	....	....	....	....	60	60	46	45	....	60
Ohio	56	28	50	48	....	....	60	[10] 60	50	45	56	60
Oklahoma	57	[15] 28	44	48	48	56	60	60	55	45	45	[17] 60
Oregon	....	....	....	....	45	....	....	6c	50	....	....	....
Pennsylvania	50	28	50	48	50	56	60	60	54	45	60	60
Rhode Island	50	....	50	48	....	....	[18] 60	60	54	45	56	50
South Carolina ..	[20] 56	28	50	50	36	[1] 30	....	....	50	....	56	50
South Dakota ...	57	30	42	48	....	50	60	60	46	45	50	55
Tennessee	[20] 56	[21] 28	50	[22] 50	[23] 56	30	60	60	50	45	56	50
Texas	57	....	....	50	....	....	....	60	55	45	55	55
Utah	....	....	....	....	....	....	....	....	....	....	....	....
Vermont	52	....	45	48	58	28	60	60	54	45	56	60
Virginia	57	28	50	....	....	....	[24] 60	60	56	45	60	55
Washington	....	....	....	....	[18] 45	....	....	60	....	....	....	....
West Virginia ...	55	....	42	48	....	....	....	60	54	45	56	....
Wisconsin	50	....	44	48	48	....	60	60	54	45	56	42
Wyoming	....	....	....	....	....	....	....	....	....	....	....	....

1 Not defined.
2 For customs purposes only.
3 Common English turnips.
4 Green peaches.
5 Shelled, dry.
6 Top sets; bottom sets, 32 pounds.
7 Roasted; green, 22 pounds.
8 Dried.
9 Bottom onion sets.
10 Irish potatoes.
11 German and American.
12 Peaches (peeled); unpeeled, 32 pounds.
13 Cowpeas; dried peas, 60 pounds.
14 Smooth; wrinkled, 56 pounds.
15 Top onion sets.
16 Including split peas.
17 Common English Turnips, 42 pounds.
18 Green.
19 German, Missouri, and Tennessee millet seeds.
20 Matured onions.
21 Bottom onion sets.
22 Matured.
23 Matured pears, 56 pounds; dried pears, 26 pounds.
24 Black-eyed peas.

TABLES OF WEIGHTS AND MEASURES

Apothecaries' Fluid Measure

60 minims	=1 fluid dram
8 fluid drams	=1 fluid ounce
16 fluid ounces	=1 liquid pint
8 liquid pints	=1 gallon

(British measures differ from above)

Apothecaries' Weight

20 grains	=1 scruple
3 scruples	=1 dram
8 drams	=1 ounce
12 ounces	=1 pound

Avoirdupois Weight

27 11/32 grains	=1 dram	
16 drams	=1 ounce	
16 ounces	=1 pound	
25 pounds	=1 short quarter	
28 pounds	=1 long quarter	
4 quarters	=1 hundredweight	short hundredweight=100 pounds; long hundredweight=112 pounds
20 hundredweight	=1 ton	short ton=2000 pounds; long ton=2240 pounds

Circular Measure

60 seconds	=1 minute
60 minutes	=1 degree
90 degrees	=1 quadrant
4 quadrants	=1 circle or circumference

Cubic Measure

1728 cubic inches	=1 cubic foot
27 cubic feet	=1 cubic yard
144 cubic inches	=1 board foot
128 cubic feet	=1 cord

Dry Measure

2 pints =1 quart
8 quarts=1 peck
4 pecks =1 bushel
1 barrel (for fruit, vegetables, and other dry commodities)= 7056 cubic inches=105 dry quarts

Linear Measure

12 inches	=1	foot
3 feet	=1	yard
5 1/2 yards	=1	rod or pole
40 rods	=1	furlong
8 furlongs	=1	statute mile (1760 yards, or 5280 feet)
3 miles	=1	league

Linear Measures (special)

1000 mils	=1	inch
72 points	=1	inch
4 inches	=1	hand
7.92 inches	=1	surveyor's link
9 inches	=1	span
6 feet	=1	fathom
40 yards	=1	bolt (cloth)
10 chains	=1	furlong
6080.20 feet	=1	nautical mile=1.1516 statute miles

Liquid Measure

4 gills	=1	pint
2 pints	=1	quart
4 quarts	=1	gallon
31 1/2 gallons	=1	barrel
2 barrels	=1	hogshead

Paper Measure

For small papers the old measure is still in use:

24 sheets=1 quire
20 quires=1 ream (480 sheets)

For papers put up in cases, bundles, or frames the following measure is now used:

25 sheets=1 quire
20 quires=1 standard ream (500 sheets)

Square Measure

144 square inches	=1	square foot
9 square feet	=1	square yard
30 1/4 square yards	=1	square rod or perch
160 square rods	=1	acre
640 acres	=1	square mile
36 square miles	=1	township (6 miles square)

Surveyor's Measure

7.92 inches	=1	link (Gunter's or surveyor's)
100 links	=1	chain (=66 feet)
80 chains	=1	mile

Surveyor's Area Measure

625 square links	=1	(square) pole or square rod
16 (square) poles	=1	square chain (surveyor's)
10 square chains or 160 square rods	=1	acre
640 acres	=1	square mile
36 square miles	=1	township

Time Measure

60 seconds	=1	minute
60 minutes	=1	hour
24 hours	=1	day
7 days	=1	week
365 days	=1	year
366 days	=1	leap year

Troy Weight

24 grains	=1	pennyweight
20 pennyweights	=1	ounce
12 ounces	=1	pound

Carat (for precious stones)=200 milligrams. The carat was formerly an ambiguous term having many values in various countries.

Karat (fineness of gold)=1/24 (by weight) gold. For example, 24 karats fine=pure gold; 18 karats fine=18/24 pure gold.

International Metric System

In the international metric system the fundamental unit is the meter—the unit of length. From this the units of capacity (liter) and of weight (gram) were derived. All other units are the decimal subdivisions or multiples of these. These three units are simply related; e. g., for all practical purposes 1 cubic decimeter equals 1 liter and 1 liter of water weighs 1 kilogram. The metric tables are formed by combining the words "meter," "gram," and "liter" with the six numerical prefixes, as in the following tables:

Prefixes		Meaning			Units
milli-	=	one thousandth	1/1000	0.001	"meter"[a] for length
centi-	=	one hundredth	1/100	.01	
deci-	=	one tenth	1/10	.1	
unit	=	one		1	"gram"[a] for weight or mass
deka-	=	ten		10	
hecto-	=	one hundred		100	"liter"[a] for capacity
kilo-	=	one thousand		1000	

[a] One meter=39.37 inches; 1 liter=1.0567 liquid quarts; 1 gram=0.035 avoirdupois ounce.

UNITS OF LENGTH			UNITS OF CAPACITY		
millimeter=	0.001	meter	milliliter=	0.001	liter
centimeter=	.01	"	centiliter=	.01	"
decimeter=	.1	"	deciliter=	.1	"
METER=	1	"	LITER=	1	"
dekameter=	10	"	dekaliter=	10	"
hectometer=	100	"	hectoliter=	100	"
kilometer=	1000	"	kiloliter=	1000	"

UNITS OF WEIGHT (OR MASS)

milligram=	0.001	gram
centigram=	.01	"
decigram=	.1	"
GRAM=	1	"
dekagram=	10	"
hectogram=	100	"
kilogram=	1000	"

UNITS OF AREA

The table of areas is formed by squaring the length measures, as in our common system. For land measure 10 meters square is called an "ARE" (meaning "area"). The side of one are is about 33 feet. The hectare is 100 meters square, and, as its name indicates, is 100 ares, or about 2 1/2 acres.

COMPARISON OF ENGLISH AND METRIC SYSTEMS

11 meters=12 yards
1 inch=25.4 millimeters
1 mile=1.6 kilometers
1 kilometer=⅝ mile
1 kilogram=2.2 lbs.
1,000 kilograms=approx. 1 long ton
1 U. S. hundredweight=45½ kilograms
1 liter=approx. 1 quart (1.0567 quarts)
1 gallon=nearly four liters (3.785 liters).

TABLE OF THE EQUIVALENTS OF THE COMMON CAPACITY UNITS USED IN THE KITCHEN

Units	Fluid drams	Tea-spoon-fuls	Table-spoon-fuls	Fluid ounces	1/4 cup-fuls	Gills (1/2 cup-fuls)	Cup-fuls	Liquid pints	Liquid quarts	Cubic centi-meters	Liters
1 fluid dram equals..	1	3/4	1/4	1/8	1/16	1/32	1/64	1/128	1/256	3.7	0.004
1 teaspoonful equals..	11/3	1	1/3	1/6	1/12	1/24	1/48	1/96	1/192	4.9	0.005
1 tablespoonful equals	4	3	1	1/2	1/4	1/8	1/16	1/32	1/64	15	0.015
1 fluid ounce equals..	8	6	2	1	1/2	1/4	1/8	1/16	1/32	30	0.030
1/4 cupful equals....	16	12	4	2	1	1/2	1/4	1/8	1/16	59	0.059
1 gill (1/2 cupful) equals	32	24	8	4	2	1	1/2	1/4	1/8	118	0.118
1 cupful equals......	64	48	16	8	4	2	1	1/2	1/4	237	0.237
1 liquid pint equals..	128	96	32	16	8	4	2	1	1/2	473	0.473
1 liquid quart equals.	256	192	64	32	16	8	4	2	1	946	0.946
1 cubic centimeter equals	0.27	0.20	0.068	0.034	0.017	0.0084	0.0042	0.0021	0.0011	1	1/1000
1 liter equals	270	203	67.6	33.8	16.9	8.45	4.23	2.11	1.06	1000	1

APPROXIMATE VOLUME IN CUBIC FEET OF 1 TON OF COAL

Size	Tons of 2240 pounds		Tons of 2000 pounds	
	White ash	Red ash	White ash	Red ash
Egg	39.3	42.3	35.1	37.7
Stove	39.6	42.7	35.4	38.1
Nut	40.4	43.1	36.0	38.5
Pea	41.9	43.9	37.4	39.2
Buckwheat	42.3	44.4	37.7	39.6

WEIGHT OF 1 GALLON AND OF 1 CUBIC FOOT OF WATER

One Gallon of cold water weighs approximately... 8 1/3 lbs.
One Cubic Foot of cold water weighs approximately 62 1/3 lbs.

STANDARD TIME

The United States is divided into four "time sections." The Eastern section includes all territory between the Atlantic Coast and an irregular line drawn from Detroit to Charleston, S. C. The Central section includes all territory between the last-named line and an irregular line from Bismarck, N. D. to the mouth of the Rio Grande. The Mountain section includes all territory between the last-named line and nearly the western borders of Idaho, Utah and Arizona. The Pacific section covers the rest of the country to the Pacific Coast. Standard time is uniform inside each of these sections, and the time of each section differs from that next to it by exactly one hour. Thus at 12 noon in N. Y. City (eastern time), the time at Chicago (central time) is 11 A. M., at Denver (mountain time) 10 A. M., and at San Francisco (Pacific time) 9 A. M.

COMPARISON OF FAHRENHEIT AND CENTIGRADE THERMOMETERS

Centigrade	Fahrenheit
—30	—22
—20	—4
—10	14
0	32
10	50
20	68
30	86
40	104
50	122
60	140
70	158
80	176
90	194
100	212

To convert from Fahrenheit to Centigrade, subtract 32, multiply by 5 and divide by 9.

To convert from Centigrade to Fahrenheit, multiply by 9, divide by 5 and add 32.

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