DEPARTMENT OF COMMERCE

CIRCULAR

OF THE

BUREAU OF STANDARDS

S. W. STRATTON, DIRECTOR

No. 75

SAFETY FOR THE HOUSEHOLD

[1st Edition]

Issued January 10, 1918

PRICE, 15 CENTS

Sold only by the Superintendent of Documents, Government Printing Office, Washington, D. C.

WASHINGTON
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FIG. 1.—*The prone-pressure method of resuscitating a person who has received an electric shock*

The same method is used in case of drowning after the lungs are emptied of water, and in the case of asphyxiation. (See p. 56.) Asphyxiation also calls for oxygen treatment. Note that the tongue should be pulled forward, as it is sometimes partly swallowed in the muscular contraction following the shock. (See rule 10, p. 40)

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SAFETY FOR THE HOUSEHOLD

I. INTRODUCTION

1. Purpose

The purpose of this circular is (1) to emphasize the seriousness of certain risks frequently occurring in or about the home, (2) to give simple methods of care and caution to protect life and property from such hazards, and (3) to stimulate interest in public measures to provide safety for the household and the community. The aim is not to cause undue anxiety but rather to suggest means to remove the causes for alarm. Caution alone is not enough, since many of the dangers are not even known. Few know, for example, that to turn on an electric lamp while one hand is on a water faucet may result in instant death from electric shock. Some knowledge of the more common hazards is essential to their removal, and proper care and caution along the lines suggested in this circular will decrease any sense of danger incidentally caused by the necessary recital of the hazards.

2. Modern Hazards in the Home

The hazards of the home have increased in modern times from the service of gas and elecrticity and the use of such dangerous articles as matches, volatile oils, poisons, and the like. The use of energy in the home necessarily involves some risk. If the technical features of the installation are carefully planned and the proper care is exercised in utilizing such energy, the hazards in the modern home can not be said to be serious.

3. Standards of Safety

The necessity for suitable measures to avoid dangers from electricity and gas has called for standards of safety for such utility service. The Bureau of Standards has formulated such standards. Circular 54, National Electrical Safety Code, is already issued, and a circular is in preparation upon standards of safety for gas service. In a special investigation recently completed, the Bureau formulated standard methods for protecting buildings against lightning. The results are published in Bureau of Standards Technologic Paper No. 56, Protection of Life and Property Against Lightning. The Bureau is also engaged in investigating the fire-resisting properties of materials. The present circular, written

for the household, is in a sense a by-product of the technical work of the Bureau upon the hazards from electricity, gas, lightning, and fire. It was deemed desirable to present these phases of household safety in a somewhat popularized form for general distribution.

4. Safety Cautions

The precautions described are intended to give for each hazard a series of short hints or rules phrased in a positive rather than a negative form. In some cases both positive and negative rules are given. Sound psychology suggests a proper action and not merely inaction. What to do should be stated, as well as what not to do. There should be stimulation to actions which insure safety as well as caution against actions which involve risk, as the former promote safe conduct, while the latter induce fear.

5. Safety-First Movement

There is a nation-wide "safety-first" movement to promote habits of carefulness and caution. One aim of this circular is to give wise guidance in forming such habits and to specify effective home equipment and installations to minimize the risks involved. Rules can not be made or learned for the infinite variety of risks, so that the development of carefulness, a sense of responsibility, alertness, intelligence, skill, and self-reliance is more potent than a volume of rules which must be studied and memorized. Nevertheless, good rules are a powerful means of educating employees and the general public.

The movement for "safety first" has found expression through industrial establishments, in the schools, and in the press. Employees in factories and children in the schools are taught fire drills, first aid, and methods of meeting hazards. This circular is designed to present the subject to adults and thus aid the growing movement for safeguarding life and property from avoidable accidents. It is believed that thousands of human lives could be saved and countless accidents avoided each year if the precautions suggested are followed.

6. Standards for the Household

This circular completes the series of three publications covering the subjects of household measurements, materials, and safety, which represent the Bureau's contribution to the growing literature on the technology of the home—a subject of the most vital concern to every family. These circulars are as follows: Bureau of Standards Circular No. 55, Measurements for the Household (149 pages), issued August 28, 1915; Circular No. 70, Materials

for the Household (259 pages), issued December 5, 1917; and the present circular No. 75, Safety for the Household (127 pages). The Bureau invites suggestions as to the form or subject matter of any section of these circulars, especially from instructors in home economics in high schools and colleges.

The Bureau acknowledges the hearty cooperation of many experts who have given helpful suggestions to make these circulars more effective in promoting household efficiency. The general public, for whom this circular is written, is earnestly invited to correspond freely with the Bureau upon any phase of the subjects treated. In later editions, the latest facts concerning the most approved practice will be included to keep pace with technical advance in these subjects.

II. ELECTRICITY

1. SAFETY OF PROPER APPLICATION OF ELECTRICITY

Electricity is one of the most conveniently applied forms of energy for household processes and activities. It is used not only to illuminate the home, but to supply power to various small motor-driven apparatus and to supply heat to cooking appliances and other small heating devices. In addition to the great convenience and adaptability of electricity for such purposes, it has the further important advantage, when properly used, of increased safety over many of its predecessors and competitors for rendering like service, such as candles, oil lamps, acetylene, and gasoline, for lighting; gasoline for power; and coal, oil, or gasoline stoves for cooking and heating. It does away with the use of matches and the use within buildings of substances such as coal oil and gasoline, which of themselves impose a greater or less fire hazard whenever stored within the building.

Notwithstanding all this, there are serious possible hazards to both life and property from electric wiring and devices if wrongly installed or mishandled. These will be here considered, so that the careful householder may realize the maximum degree of safety in his electrical installation which the development of modern methods of wiring and modern designs of appliances make available to him. The current which passes through wires can not be seen, but the considerable amount of power sent over them can be appreciated by its effects in supplying lamps, motors, and heating appliances. It can thus readily be understood how an electric current may cause fatalities or fires if diverted through the human body or through combustible materials, and the record of electrical accidents shows that there is, in many cases, need of greater care and precaution on the part of the users of electricity in the home, as well as of the general public, utility companies, and electrical workmen.

Because the convenience of electricity is extending its use so rapidly, and because our highways and buildings are being equipped with networks of wires, some definite ideas as to the nature of electrical dangers and how to avoid them should be familiar to every householder and to every child old enough to play or work unattended. Each person will thus have it largely in his

own power not only to avoid shocks and burns to himself, but frequently to warn others against dangerous places and practices.

2. WHAT ARE THE 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. The simple analogies between an electric circuit and a line of garden hose may be of assistance in this connection.

(*a*) Analogy Between Flow of Electricity and Water

The line of hose determines the path of water flow, just as the metallic wire determines the path of the electric current. The force which causes the water to flow is the height of the water surface in the reservoir or standpipe above the hose nozzle, while that which causes the electric current to flow is the voltage (or electrical pressure) on the wires entering the building. The opening of the nozzle of the hose corresponds to the closing of a switch on one side of the electrical circuit. Just as the opening of the hose nozzle allows water to flow from the high-pressure water supply to the open air where no pressure exists, so the closing of the electrical switch allows current to flow from the wire under higher electrical pressure to the other or to the ground. A leak in the hose covering allows water to escape and corresponds to a breakdown of the insulating covering which confines the electrical current to its designed circuit. This escaped current may cause personal injuries or fires as outlined in what follows. The analogy is by no means complete, but it serves in place of a long technical exposition.

(*b*) 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. (See Fig. 1, frontispiece.) This can often be done when the victim of a shock is apparently lifeless by applying the first-aid method given in rule 10 on page 40.

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 a hand to a foot.

(*c*) **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 tissues. Only rarely, however, even in the most severe and even fatal shocks, will there be serious internal changes of these kinds.

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 though 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.

(*d*) **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 overhead electric wires 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 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.

(*e*) **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

FIG. 2.—*Illustrating danger from shock when in contact with an electrical fixture having an exposed metal frame which is not grounded*

Note insulating ring at *C* in back of fixture. The path of the possible current from *A* to *B* is roughly indicated by the broken lines across the body. This condition sometimes happens when a fixture wire with broken insulation comes in contact with the exposed metal part of an ungrounded fixture. (Installation rules eliminating this possible hazard have been formulated by the Bureau of Standards)

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 practice 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,[1] if reasonable care is observed by the users of the electrical appliances.

(*f*) **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 practice with fusible cut-outs which, by the melting of metal strips when too great a current flows, will interrupt or

[1] Published by National Board of Fire Underwriters, 76 William Street, New York City.

cut out the circuit so protected. The use of such fusible cut-outs is required by the National Electrical Safety Code, Circular No. 54 of the Bureau of Standards, and by the National Electrical (Fire) Code, and they are required to be proportioned suitably to the size of the circuit wire and equipment which they are designed to protect as will be later more fully described. 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 though 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.

3. PRIVATE ELECTRIC LIGHTING PLANTS

(*a*) Household Generators and Batteries

Electrical energy for use in the household or on the farm is usually obtained from the distribution circuits of electric-lighting companies where these circuits are available. There are, however, many farms which such lines do not reach. Electrical energy for lighting has so many advantages over other forms of energy that farmers and others to whom energy from the distribution circuits of lighting companies is not available frequently install isolated power plants. Wherever possible it is more desirable to locate them in a separate smaller building or inclosure rather than in the house, barn, or other principal building, since they

involve the use of a gasoline or oil engine together with an electric generator.

Where oil or kerosene engines are used for these private plants the hazard is much less than with gasoline engines of similar capacity. The mixture of gasoline vapor with air is very explosive and may be easily ignited by lanterns, matches, or flashes caused by opening electric switches used with a power plant. If a private plant is placed in the home or other main building, the character and amount of fuel deserves very careful consideration.

Power plants of this type installed by persons on their own premises have increased in number very rapidly in recent years. The fact that such plants are scattered and are seldom within any regular inspection jurisdiction may have a tendency to encourage careless installation practice on the part of those who do the installation work. It is consequently necessary that careful attention should be given to secure proper equipment and proper installation.

When the proper precautions are followed, an electric plant is much safer than an acetylene or gasoline lighting plant. The use of electricity also permits the application of electric power to operate washing machines, churns, water pumps, etc. With a water system in the house means are available for quickly extinguishing a fire before it gains much headway, and power available for pumping is thus an added element of safety. It is customary to provide small electric lighting plants with storage batteries so that it will be necessary to run the plant only at intervals in order to have current available at all times.

Where storage batteries are used in this connection a few precautions should be observed. Metal objects should not be placed on the shelves or over a storage battery where likely to fall across the connections and cause a spark or a large local current. Batteries should be placed in a light place where they are easy of access and where they will be well ventilated. It would be preferable to have cells covered were it not for the fact shown by experience that when inclosed they do not receive the proper attention.

(*b*) **Safe wiring and appliances for small power plants**

It is common to install small lighting plants for operation at about 30 volts. This is approximately one-fourth of the voltage in common use by electric light companies and is chosen because

a storage battery having only 16 cells is sufficient. To operate at the customary higher voltage would require 3.5 to 4 times as many cells of storage battery, the individual cell of which, however, would be of smaller capacity. By using a small number of cells the plates in the battery can be made thicker, permitting a longer life, while the initial cost and the cost of renewals will be less and the batteries will require less care.

A system using this low voltage requires wiring especially suited to it. Since the wiring in the ordinary city house is installed for a system using 110 or 120 volts, the farmer must make sure that the electrical contractor who does the work is informed as to the voltage and kilowatt capacity of the plant and proper methods of installation. He must not permit the fact that it is possible to use cheaper materials to lead to an inadequate wiring system. He should require that the job when completed will pass inspection by a regular electrical inspector. When the work is finished it will be worth while to have an inspector go over it, even though it be necessary to have such an inspector make a special trip from a considerable distance for the purpose. He should also require that his lines be properly fused with respect to their carrying capacity.

The 30-volt system under consideration has the advantage over the more customary 110-volt system that it involves no danger from electrical shock in case of accidental contact with the wires. The low-voltage system has the disadvantage, however, that in order to supply the same amount of power to lamps, motors, or other current-consuming devices a larger current is required than for a 110-volt system. There is a fire hazard connected with both which may be reduced to a minimum by proper installation by competent persons together with the inspection previously mentioned.

The 30-volt system can be made safe if certain precautions are followed. Since larger currents are employed when the voltage is smaller, the conductors *must* be larger to carry this larger current. A system for 110 volts uses smaller current and smaller wires and such wires would not be satisfactory for a 30-volt system. Larger wires and accessories mean a more expensive wiring installation, but this is offset by the lesser cost of the power plant and the lesser cost for battery maintenance.

It must be remembered also that while the low-voltage system will be satisfactory for operating lamps and motors which are properly installed and connected, it will not be feasible to connect

heating devices, such as electric toasters, coffee percolators, and flatirons, to the sockets which have been installed for lamp connections. This will be clear by considering an example. The ordinary size of flatiron requires 5 amperes, when used on a system of 110 or 120 volts. A flatiron for doing the same work on a 30-volt system will require about 18 amperes. This current is too much to use on an ordinary lamp socket and is very likely to overheat it and create a serious fire hazard. If it is desired to use such heating devices in the house, it will be necessary to install special separate circuits using wire of a size not smaller than No. 10. A 20-ampere receptacle should be placed in the wall and a 20-ampere attachment plug should be used at the end of the flexible cord attached to the heating device. Possible future requirements should be anticipated and not less than two of these special circuits should be installed when the house is wired.

Lighting fixtures should be obtained which are wired with a size of wire not smaller than No. 16. Except in fixtures no wire smaller than No. 12 should be used with a 30-volt system. If the equipment, including switches, sockets, and ordinary lighting fixtures, is of the kind which would be installed for a 110-volt system, there will be a serious danger in afterwards making connections to such lighting fixtures for such heating devices as flatirons.

In view of the conditions just outlined, it is well for anyone installing such a private plant to give serious consideration to the advisability of installing a plant for 110 volts. As has been noted above, this involves a greater cost for storage battery and it will also involve a greater cost for storage-battery maintenance. At the same time it will permit the installation of less expensive wiring and equipment in the building and it will also have the advantage that if service later becomes available from the extension of the lines of an electric lighting company into the community, such service may be utilized without any change in the lamps or in heating devices such as flatirons. If such a change in source of power is made with a 30-volt system, it will be necessary to secure new lamps, etc., suited to the higher voltage.

Since the lines of most electric lighting companies are supplied with alternating current, it will be necessary to secure new motors regardless of the voltage, for a storage-battery plant supplies direct current.

The fact that farmhouses are usually solitary in location so that they do not have the benefit of public fire protection makes the minimizing of the fire hazard a prime consideration. The lack

also in such locations of regular inspection service throws a greater responsibility upon the householder for making a selection of equipment which will be less likely to involve any fire hazard.

4. ELECTRICAL HAZARDS OUTDOORS AND THEIR AVOIDANCE

While the hazards of small power plants in or near the home are serious and often impose hazards on the building wiring, and the alternative method of securing electrical energy by connection to distribution circuits is therefore generally to be recommended, there are still certain hazards to the members of the household that may arise through defective construction or maintenance of these outside distribution circuits. Electrical wiring outside of buildings is, of course, mostly so well isolated above or below the street as to call for very little observance by the ordinary householder. It is installed and maintained by the public utility serving the community and presumably with adequate precautions. Yet there are certain general features of outside wiring construction which should be appreciated by the public, so that individuals can supplement the installation precautions by their own reasonable vigilance and prudence.

(*a*) Isolation of High-Voltage Circuits

For the high voltages ordinarily used in distribution of electrical energy, certain precautions are necessary for the safety of the public and of service, such as careful isolation of the circuits on poles at suitable elevation above streets and with suitable clearances from buildings near which such wires run. These necessary clearances are such as will permit vehicle traffic to be safely carried on and will make the ordinary repairing, painting, and cleaning of buildings safe. The necessary clearance distances are covered thoroughly in the rules of the National Electrical Safety Code.[2] Every householder can assist in increasing the safety of the community by reporting to the electric service company or other proper authority any wires which have fallen in the street or broken or sagged down so as to be within reach of passers-by or of vehicles, or any excessive leaning over of poles and their wires toward buildings. The limb of a tree, if across wires and hanging within reach of the public, offers, although to a less extent, the same kind of hazard that the high-voltage wire itself would offer were it excessively sagged or hanging broken so as to be within reach. These conditions are most likely to occur during or after sleet storms, heavy winds, or electrical storms.

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[2] Circular No. 54 of the Bureau of Standards.

FIG. 3.—*Illustration of possible danger to children climbing electric light poles*

Note that the steps ordinarily inaccessible from the ground are of ready access from the fence railing. Parents and schools should instruct against this practice

(*b*) **Danger of Contact with Overhead Wires**

These reductions in the safe clearances of overhead wires, as a matter of fact, constitute the only danger to the public from outside wires and are responsible for a considerable number of fatalities annually, largely of children who have not been properly instructed to avoid such wires or of older persons failing to observe reasonable prudence. In this connection, it should be understood by all members of the household that the *insulating covering on high-voltage wires can not be depended upon* for safety of persons touching them. It is not feasible to maintain reliable insulating coverings on swaying overhead wires, such insulating coverings as they do have serving principally to minimize the probability of short circuits between wires and their consequent breakage when crossed by fallen twigs or by other wires. The fact that persons have touched low-voltage wires inside the house without injury does not mean that wires of similar appearance outside the house can be handled with impunity.

The flying of kites near overhead wires has also been responsible for some accidents, particularly where wire or tinsel has been used in the kite string either for strength or ornament. Parents should instruct their children not to throw objects such as sticks, strings, or pieces of wire over the high-voltage wires, since even if the child is not shocked, this may short-circuit the wires and make them fall upon other wires or in the street, thus causing danger to others. Children should also be particularly warned against the climbing of poles or trees near which electric wires pass, since this does away entirely with the protection afforded by their clearance from the earth surface and from buildings.

Still another not infrequent cause of injury to the public has been the careless raising of well-drilling outfits or well casing, or even of long metal rakes or pipes into the overhead wires which have sufficient clearance from the ground for all ordinary purposes.

(*c*) **Third Rails**

Where third rails on the fenced rights of way of electric railways are not provided with overlapping guards, approach to them is dangerous, and children in particular should be instructed to keep away, notwithstanding their harmless appearance and similarity to ordinary rails.

(*d*) **Tree Trimming**

A matter in connection with outside wiring, where the householder can effectively assist in securing his own safety and that

of the community, is in seeing that near his own dwelling particularly and in general throughout the community trees are not allowed to grow up into the overhead wires. He should also see that where the wires are near the lower part of the trees, branches are not allowed to grow near them. In fact, sufficient clearance should be allowed for the swaying of the trees in the wind, and particular caution should be taken that if any parts of the trees are above the wires, all dead limbs above should be cleared away. Sometimes communities have a tree warden whose duty it is to trim the trees, and when any condition is observed where any portion of a tree is likely to come in contact with the wires, this should be reported to the warden or service company. Besides the probability that swaying branches may break the wires or sag them so that they will come within reach of passers-by, there is also the lesser hazard caused by contact of a wire with some portion of the tree by which leakage down the tree trunk may result in more or less danger to those who may touch it in passing.

(*e*) **Extra Precautions During and After Storms**

It may be added that during and after severe storms, either sleet, wind, or electrical, it is well to avoid contact even with trees through which wires pass, since there may be a wire in contact with some branch of the tree. Persons should also at such times avoid touching poles, since the insulators supporting high-voltage wires on the poles may have been broken or punctured by the lightning and the wire may be uninsulated from the pole. Guy wires supporting the poles should also be avoided, since live wires may have sagged against them as a result of the breaking of insulators or of the overstretching or breaking of the wires under stress of wind or ice. As above stated, the householder and his children should also be on the lookout for fallen or hanging wires and, besides avoiding these, should report them immediately to the proper authority.

5. ELECTRICAL HAZARDS OF INTERIOR WIRING, AND THEIR AVOIDANCE

(*a*) **Restricting Voltage and Current**

While the use of comparatively high voltage is usually necessary for distribution of electrical energy throughout a community, the use of such high voltages within buildings where the electrical devices are close to persons and often to combustible material would be very unsafe. Therefore, the current, if distributed at the higher voltage, must be transformed to a lower voltage before entering the premises, and the prevention of entrance of the high

FIG. 4.—*The fallen wire serves as an object of curiosity, especially where dangerous voltages cause flashing at the contacts with the earth*

The false sense of security given by the presence of an apparently insulating covering has also caused many fatalities. One injured child said he thought it was a stick of licorice

voltage must be assured. As before noted, an excess of current in the wires of the interior wiring system must also be avoided. The safeguard against the latter is provided by fuses, as shown above under the heading "Fires" (p. 15), and again mentioned below (p. 27).

(*b*) **Grounding Circuits**

The safeguard against the high voltage, where necessary, is accomplished by the grounding of the low-voltage circuits connected to the interior wiring. By grounding is meant the effective connection of one wire of the circuit to the ground through some medium such as a water-piping system. This grounding, if properly done, will prevent any abnormal increase in voltage in the interior wiring, either above the earth or above the plumbing and other piping, basement floors, etc., within the building, which are intimately connected with the earth. If the low-voltage circuits entering buildings are exposed to any possibility of leakage from high-voltage circuits, either by contact in overhead line construction or by breakdown of transformer windings, this connection of the low-voltage circuit to the earth becomes essential, and to be reliable it must be made in accordance with certain definite requirements varying with the current capacity of the high-voltage circuits to which the low-voltage circuits are exposed. Requirements for the method of making such connections are given in section 9 of the National Electrical Safety Code.

The ground connections should generally be multiple ones, and in most cases it is preferable, because of the desirability of securing accessibility of the connection and of frequently inspecting it to assure its continued effectiveness, that the connection be made at the point of entrance of the wires to the building but outside the main switch and fuse. The householder should see that any wire or metal strip used as a ground connection from the service wires to the water pipe within his building is never disturbed by members of the household or by workmen about the premises. The security of the house wiring against high voltages for which it is not designed may be largely dependent on the integrity of this ground connection.

(*c*) **Insulating Coverings**

Suitable precautions having been taken where necessary against the entrance of high voltages, the entire wiring within the building is next designed for the moderate voltages which have been found by long experience to be safe for general use, usually either 110 or 220 volts. As noted in a foregoing part of this chapter, a

considerably lower voltage, instead of affording greater safety, is liable to produce serious fire hazards. To prevent leakage from wires or fittings, insulating coverings are used on wires and insulating linings in fittings, and certain spacings are maintained between the wires of opposite polarity and between current-carrying parts of connected fittings throughout the building.

To protect the wire insulation from mechanical injury and moisture as well as to prevent contacts with it by persons, and thus to secure the longest life for the wiring system as well as the greatest security from shocks, the inclosure of all fixed wiring in conduit gives the greatest measure of protection. Where hollow studded partitions or hollow joisted wood floors exist, a good degree of protection against deterioration of wire installation and contact of persons with fixed wiring can be secured by the concealment of wires within such partitions and their support away from the inner surfaces of these wiring spaces on porcelain knobs and tubes. Of course, such wiring affords little security against fire if these wiring spaces are allowed to be filled during construction or later with loose plaster, wood chips, or other materials in contact with the concealed wires. In subsequent work on such partitions or floors the householder should take care to see that wires are not disturbed by the workmen. Open fixed wiring should generally be avoided even in attics and cellars, where its objectionable appearance does not prevent its use, unless the open wires are well out of reach of persons and unlikely to be disturbed or injured by the moving of implements, furniture, or other objects. Children should be instructed as to the danger resulting from touching or disturbing such wires. Where open wiring is used within reach of persons, the danger of disturbance may be minimized by surrounding it with substantial wood boxing well spaced from the wires. This should be closed at the top, except for tubes through which the wires pass, and should be so arranged at the bottom as not to retain either moisture or dust about the wires.

Portable wires to lamps, pressing irons, fans, and other electrical devices used about the house can not, of course, be either out of reach or guarded by exterior metal covers. For this reason the insulation of such wires is more subject to deterioration by mechanical injury and moisture than fixed wires. Portable wires in general impose a greater shock hazard than other parts of the electrical installation. It is largely on account of such wires that the grounding of circuits as above mentioned is so necessary

and that the use of sufficiently low voltages for interior wiring is essential. Even the 220-volt circuits impose a considerably greater shock hazard than the 110-volt, where many portable devices are involved, since their protection can not be as complete as that of fixed wiring. A satisfactory degree of protection is, however, provided by the use of heavy fibrous covers over the insulating coverings of portable cords, and where cords are used only as pendants by placing them sufficiently high and making them sufficiently short so that they can not be much handled or moved about.

(*d*) **Shock Hazards of Portable Cords**

The deterioration of such cords, varying with the moisture and the amount of handling to which they are subjected, should be very carefully watched by the householder, and when any abrasion of the protective covering is noted, the conditions should be promptly corrected. If the cord is very much bent or kinked in handling, there is also the possibility that some of the cord strands will be broken and will later pierce the insulating covering and the outside protective covering, thus exposing these almost invisible strands to the contact of persons and imposing a shock hazard on the users. For the above reasons cords should be made as short as convenient, and where practicable, so located and used as not to be within reach of radiators or set tubs, kitchen ranges or sinks, bathroom fittings, cement basement floors, or other objects well connected with the ground, whereby a person touching the cord may become a part of an electric circuit and receive a shock. Where the surfaces are very damp and especially where the air may be moist with steam, as in bathrooms, kitchens, and laundries, the conditions are especially bad for the deterioration of the cord as well as for the severity of shock in case the cord is abraded or otherwise injured. For this reason cords should have special waterproof coverings where used in laundries, bathrooms, and similar places, and in general the floor on which users stand in such places should be covered with dry wood, rubber, or other insulating material, and caution observed in handling the cord.

The use of such cords with portable devices by persons while in bathtubs, or who are likely to touch laundry tubs, kitchen ranges, or other grounded objects, is particularly dangerous, the danger being increased in cases of persons in bathtubs by the fact that a large surface of the body in the tub is in contact with the conducting water. Accidents under these circumstances frequently prove serious or fatal.

(*e*) **Shock Hazards of Portable Devices**

The same general considerations that apply to the use of portable *cords* in various locations apply to a considerable degree to portable *devices* in these same locations. While using them, members of the household should keep away from grounded objects, and they should avoid using them at all where they can not keep away from grounded objects. For instance, an electrical vibrator should never be used by a person in a bathtub. Of course, where such devices as electric pressing irons are used, the fact that most of the metal parts, which might be accidentally touching the live wires within, are very *hot*, will often deter persons from making any considerable contact with the iron, so that the standing on a damp floor or the touching of a set tub while using an electric iron will not usually impose a serious life hazard even after the insulation within the iron has deteriorated or accidentally broken down. However, accidents from this cause *have* occurred and precautions, such as the use of a dry wooden platform and keeping away from laundry tubs, are advisable. With both cords and portable devices the need for observing precautions is very much greater with 220 than with 110-volt circuits.

(*f*) **Removal of Shock Hazard of Portable Cords and Devices**

Methods are being sought and devices may probably be developed that will largely remove the shock hazard from portable cords and devices through the use of an outer grounding wire in the cord, this being connected to the frame of the portable device and assuring the maintenance of its potential close to that of the earth. Such cords and devices have not yet, however, been marketed to any considerable extent.

(*g*) **Fire Hazards by Overloading Wires**

Besides the shock hazard, there is possible a fire hazard from overheated wires due to passage of too great current through them. This, as before noted, is guarded against in practice by the use of fusible cut-outs. As all the current of the installation passes through the incoming or service wires, they will be the largest, and the main fuses must be of such a size as to protect them against overheating. Within the building the circuits are so subdivided as to minimize the amount of energy which can be expended in any short-circuit between wires or in any fitting, caused by the breakdown of insulation from mechanical or other causes. These smaller circuits also have fuses of a size corresponding to the current-carrying capacity of the wires, and the devices are so constructed as also to be reasonably protected against excessive cur-

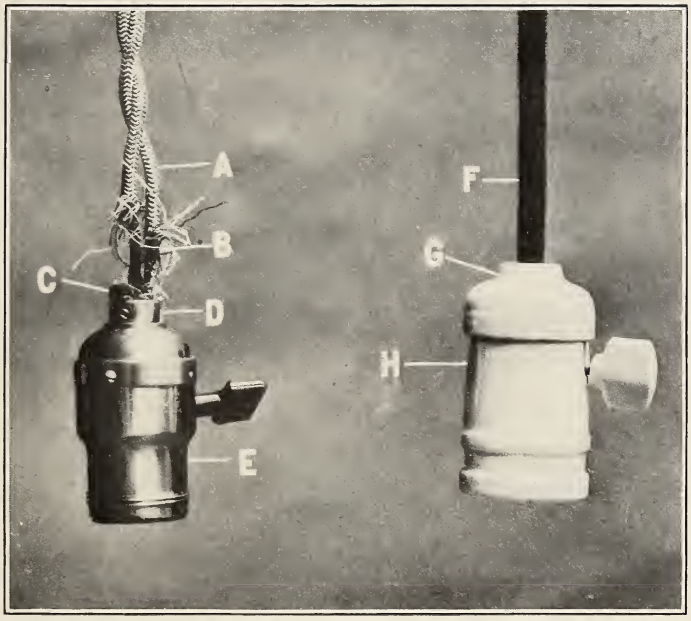

FIG. 5.—*Examples of bad and good methods used in portable lighting*

Note the broken bushing at *C* in the brass socket *E*, exposing the nonreinforced lamp cord *A* abraded at *B*, by the cutting edges of the brass threads in the neck of the socket *D*, injuring the insulation and exposing the live wire in contact with the metal socket. A person using the socket may receive a shock. A nonabsorptive insulating socket, such as the porcelain one *H*, which is shown wired with reinforced lamp cord *F*, will insure adequate protection to the cord by the rounded neck *G* and to the user

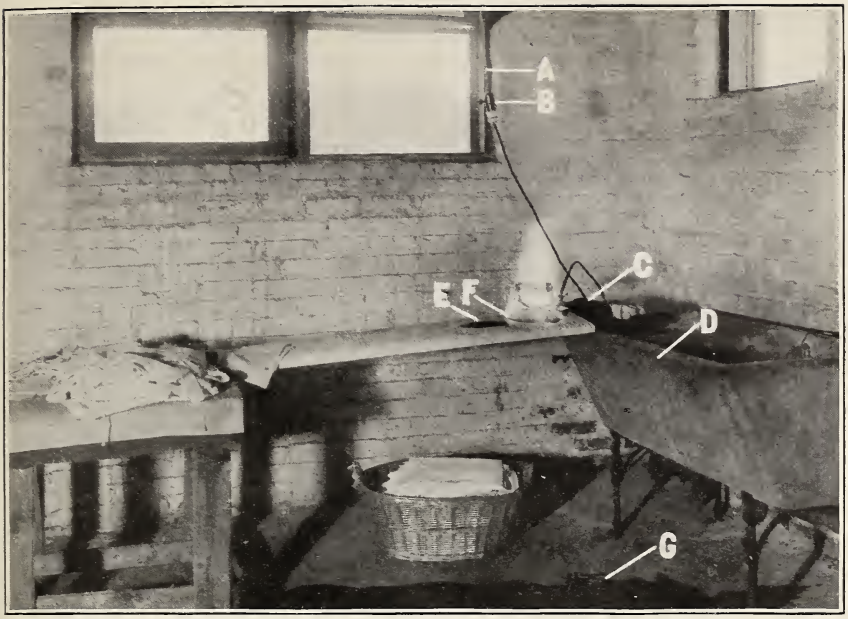

FIG. 6.—*An improperly equipped and inadequately protected arrangement*

Note the metallic shell socket *B* with nonreinforced lamp cord *A*, the necessary proximity of the worker to the grounded laundry tubs *D* and the damp concrete floor *G* which exposes a condition exceedingly favorable to receiving shocks. Carelessness is indicated in leaving an iron on the board while connected to the service, as indicated by *E* and *F*, where the stand *C* should have been used, giving rise to fire hazard. This is probably one of the most frequent causes of electrical fires

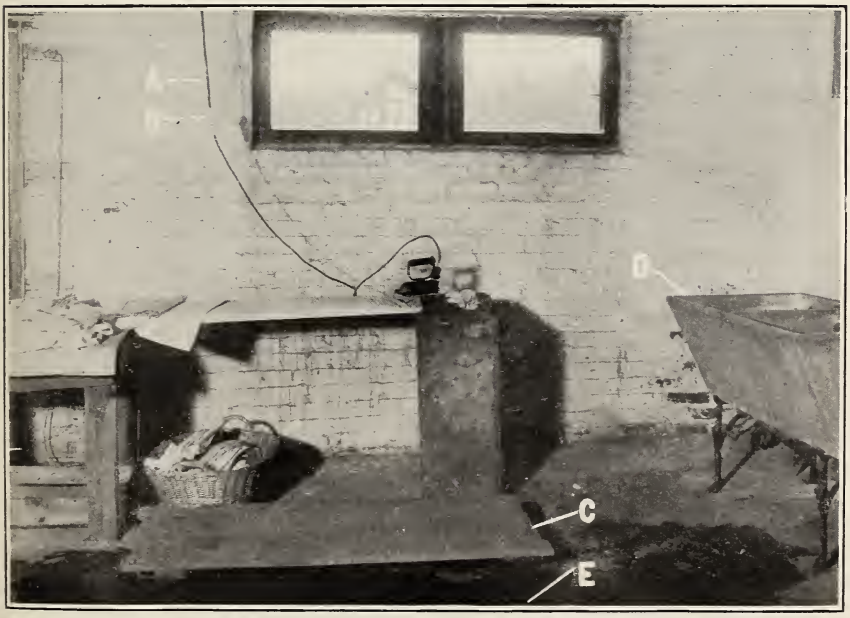

FIG. 7.—*A properly equipped and adequately protected arrangement*

The porcelain socket *B* with its reinforced cord *A*, the dry wooden platform *C*, and the distance of the worker from the grounded laundry tubs *D*, all contribute to safety. Note the protection afforded by the wooden platform from the wet concrete floor *E*

rent by the fuses employed. In the interest of economy a standardization of these small circuits has taken place, and the maximum size of fuse permissible is 10 amperes with 110-volt circuits and 5 with 220. The size of wire may, of course, be larger for mechanical or other reasons, but should never be smaller than would be properly protected by these fuses.

(*h*) **Improper Fuses**

When fuses blow they should be *properly* replaced. This means replacement by a fuse of proper *character* as well as proper size. Unsuitable elements may explode and possibly throw molten metal on surrounding inflammable materials or wood floor. If the fuse is too large so that devices fed through it are not protected by it, they may overheat and cause fires, or possibly their insulation may break down and cause a shock hazard or the burning of persons by arcs. The householder should *see that blown fuses are replaced only by fuses of suitable size and style.* The proper sizes for small circuits are given above. For the larger circuits, including the service wires, the rating of fuse should be proportioned to that of the wire. As the householder will often be unfamiliar with the sizes of wires in use, the *inspection of the fusing of the different circuits by the proper authority should be made before the installation is originally accepted* from the wiring contractor, and occasionally thereafter. If for any reason the blowing of fuses is frequent, *there is something wrong* with the installation, and this should be found and removed, The trouble should not be allowed to continue by the insertion of larger fuses.

(*i*) **Hazards in Handling Fuses**

In replacing fuses where any metal part used for carrying current can be touched, as is the case for instance with cartridge fuses, the installation should provide a switch the opening of which will disconnect such current-carrying parts from the circuit. In many of the older house wiring installations, the disconnection of the circuit to make safe the changing of fuses can be accomplished only at the main switch to the building, and this is a satisfactory arrangement except that it necessitates the cutting of the entire building out of service where possibly one circuit only out of many needs attention. A more convenient arrangement is to *have each fusible cut-out arranged with a separate switch whose operation will disconnect it.* It goes without saying that the main switch should thus protect all the fuses in the building, including the main fuses. Devices are now marketed to some extent which in new installations well accomplish the purpose of safety by inclosing both

switch and fuse in a cabinet so arranged that the switch can be operated without opening the cabinet and that the fuses are inaccessible until the switch has been opened.

(*j*) **Hazards of Switches and their Location**

The protection of live parts of switches is important in securing the safety of the household since these, next to portable devices, are the most handled portions of the electrical equipment. Their protection is satisfactorily accomplished in most modern installations by the inclosure of switches under the flush plates of metal wall boxes, with only insulating buttons projecting, or by the use of snap switches usually with fiber-lined metal covers. Where snap switches are used in damp locations and particularly in bathrooms, the covers should be of porcelain or other material not so likely as is a fiber lining, to become conducting under the damp conditions found in such locations. The use of open knife switches is generally confined to cabinets intended to prevent their short-circuiting by metal utensils about the house. Unless well away from grounded plumbing, radiators, or basement floors, the use of switches having live parts covered is to be recommended, even in cabinets; or the same end may be accomplished by the use of one of the switch and cabinet combinations in which the switch is operable from without.

Switches should be placed in convenient locations. This is especially true of the main switch which is installed for the purpose of cutting off the building wiring from the source of electrical supply. In case of fire, severe lightning storms, or other emergency, or where a house is to be left unoccupied for long periods, the main switch should be opened, thereby cutting off the building from the source of electrical supply. In opening this main switch, care should be taken not to touch bare metal parts. The probability of touching live parts is absent in some of the newer types, which are arranged to be operated from the outside of an iron inclosing box. It should be the duty of the occupants of the house to familiarize themselves with the location of the main switch and the method of operating it.

(*k*) **Hazards of Metal Fixtures**

A further precaution which may be taken in the interior wiring installation is the placing of electrical fixtures out of reach of persons who may be touching grounded objects such as bathtubs, radiators, etc., or the *grounding of such fixtures*. The insulation of such fixture frames does not offer reliable protection, since one of the wires within may unexpectedly be in contact with such an

ungrounded frame and make it alive. Where conduit is used as a mechanical protection for wires, it should, of course, be carefully grounded. Where fixtures are connected to a conduit system, their grounding through the conduit system is easily accomplished. Where fixtures are on a concealed knob and tube system or an open knob system, the grounding becomes somewhat more difficult, but in all new installations this safeguarding can be readily accomplished without an expense greater than is warranted by the protection secured for the members of the household against chance leakage from the circuit wires to the fixture frames and the shock hazard imposed in this way. Where the difficulty of grounding is too great, however, the fixture can either be isolated so as to be beyond the ordinary reach of persons, or in some cases fixtures entirely of porcelain or other insulating material may be used instead of metal.

Where drop cords with key sockets but without wall switches are used in such locations, particularly in bathrooms, where many grounded plumbing fixtures are within reach and the body surfaces are often wet, sockets of porcelain will usually be necessary until the introduction of grounded outer wires in flexible cords makes the effective grounding of metal-shell sockets on such cords generally possible and their use safe in such locations. Where fixtures or sockets are necessarily in these locations, even if within reach, switches should be provided at convenient points so that the turning on and off of the lights will be done at the switch rather than at the fixture.

(*l*) **Hazards of Incorrect Wiring Changes**

It is presumed that the original house-wiring installation has been installed by responsible and competent persons and has been inspected to assure against defects which might cause life or fire hazard. This is just as necessary, usually more so, with house wiring served from a power plant on the premises as when served from distribution lines. The householder should particularly discourage changes or additions to his wiring except where made by thoroughly competent persons, and the practice followed by some householders unacquainted with proper electrical construction methods of making such changes themselves should be strongly condemned. Additions to the circuits may overload them seriously and require larger fuses than are safe and changes may be made in such a way as to lower the insulation of the circuit and so encourage arcing or complete breakdown of the insulation, thus imposing a shock hazard which did not exist before.

As has been previously noted in section 3, the dangers from overloading are much more serious on the 30-volt farm-lighting systems than on the ordinary 110 or 220-volt lighting systems, and much greater care is therefore necessary, particularly where any circuits are to be extended. Wire which might be purchased of a dealer who was not informed of the class of service for which it is to be used is likely to be proper for 110 volts but may be entirely too small for the 30-volt circuits.

6. HAZARDS OF HOUSEHOLD ELECTRICAL APPLIANCES

(*a*) Character

Many household electrical appliances are purchased *after* the wiring and fixtures have been inspected, and in the selection of such fittings care should be taken to *see that they are suitable for the purpose intended*, and where devices have been submitted to examination and test by a competent authority and found to comply with the requirements of the National Electrical Safety Code and the National Electrical (Fire) Code, such devices should be given the preference. Cords and devices which constitute a very serious life or fire hazard are sometimes sold by uninformed and often by unscrupulous dealers. Cords with very thin insulating covering or insufficient protective covering are too frequently seen, as well as portable lamps loosely put together and having rough edges over which the portable wires must pass. Electrical stoves have been seen with insulation to their frames so poor and with frames so little raised above the surface on which they stand as to make the accident hazard through touching the frame and the fire hazard to objects beneath them very serious.

Since household appliances are liable to be handled in use, their design and construction should be such that no terminals or other current-carrying parts are left exposed to contact by the user. In selecting wall receptacles a type should be chosen which does not have exposed live parts or permit of the fingers being placed in contact with live parts at any time. It is advisable always to *purchase devices from responsible* electrical dealers. If ordering devices from a dealer in another community or one who is not familiar with the kind of current and voltage used in your house wiring, see that correct information on these points accompanies your order. When in doubt it is wise to request advice and an inspection by the proper authority before using new devices.

(*b*) **Use**

Besides being sure that the electrical appliances selected and used are of safe type, the householder should see that the members of the household observe proper caution in their use.

A rather common hazard is the overloading of fixtures by the attachment of purchased appliances. Large numbers of electric appliances are coming into use because of their convenience and intrinsic safety as compared with heating and power appliances depending on other forms of energy. Lighting fixtures quite generally, however, are designed with small arms and small wires suitable for supplying current to lights, but not large enough safely to supply some of the larger appliances or several of the smaller ones. A single socket can rarely with safety be made to supply a flatiron and toaster simultaneously through the use of a double socket or current tap, plug, or other similar device such as is commonly sold to permit more than one attachment.

Even the main fixture wire where the fixture has more than one socket is rarely suitable for supplying more than one device, and it would be found generally advisable to attach such appliances to entirely separate fixtures. It would be still more safe to provide special heating circuits which have wires of proper capacity. With the increasing use of appliances the practice of adding these circuits to existing installations and of running such circuits in addition to the lighting circuits in all new installations is becoming more frequent. An additional reason for using these special circuits is that where more than one appliance is used in one of the lighting circuits, fuses which have been installed to properly protect these lighting circuits are likely to blow out and to be replaced, sometimes at the suggestion of those more interested in the sale of appliances and current than in safety, by fuses too large to properly protect the smaller wires and fixtures of these lighting circuits.

It is apparent, of course, that devices safe for one community are transferred by uninstructed householders to another community where the character of current and voltage so differs as to cause a hazard in the use of the devices. This condition sometimes exists where devices suitable for a direct-current circuit are later attached to an alternating-current circuit in another community or vice versa.

Then, too, many devices are *safe for temporary use, but need to be turned off* when their temporary use is ended. This is particularly true of many heating devices. Pressing irons left on ironing

boards and not turned off have been the greatest cause in recent years of electrical fires, by burning slowly through any combustible material beneath. Teakettles, chafing dishes, and other devices for boiling liquids become overheated and dangerous if left connected to the circuit after the liquid has boiled away. Electric-lamp bulbs become very hot when free radiation is interrupted, and where these lamps can be carried about so as to come in contact with curtains, carpets, woodwork, clothing, or bedding the use of suitable inclosing wire guards is essential. Paper or cloth articles should never be placed against such lamps, and such materials should be used for lamp shades only if very liberal ventilating space is left between the shade and the lamp bulb.

(*c*) **Heating Pads and Quilts**

Heating pads and heating quilts have been developed for both household and hospital use. The former are intended to be used as a substitute for hot-water bottles, the latter to eliminate the necessity or undesirability of a heated sleeping room. They are not to be regarded as presenting no hazardous features in their use and therefore should, if used at all, be used with caution.

It is inadvisable for one to fall asleep with, or place a heating pad with current turned on, under heavy bed clothing, for a cumulative effect of heat may be produced (since the heat is confined under bed clothing), causing a high enough temperature to set fire to easily ignitible material; when used in the open this effect can not occur. Together with this, there is also the possibility of loose or broken connecting cords arcing and setting fire to the bed.

Regarding heating quilts, it may be said that the same cumulative effect of heat, if covered with other blankets or comforters, may occur in certain spots if current is left on, the same as in the case of pads, whereas if placed on top of the bed this hazardous feature is absent. But in both cases there still exists the possibility of broken or loose connections, either inside of the quilts or in connecting cords, with their attendant hazards.

Inspection departments have reported fires and injuries from the use of these devices, and insurance companies discourage their use.

(*d*) **Electrical Toys (Toy Transformers, etc.)**

There are many electrical toys on the market, in the purchase and use of which certain precaution is necessary. These toys are most in evidence during the Christmas holidays. Their increasing use has brought about the development of devices for use on

house-wiring circuits to reduce the voltage of the house wiring to a safe voltage for use with toys and to avoid the excessive cost of dry batteries and their frequent replacement. With alternating-current service, small transformers are obtainable for accomplishing both purposes. *With direct-current service it is impracticable to secure a truly safe supply for electrical toys*, or to effect a material saving over the entirely safe dry batteries. Before purchasing electrical toys, therefore, it is well for persons to ascertain whether their electrical service is alternating current or direct.

If alternating-current service is supplied, selection should be made of a transformer which is entirely inclosed in an iron or other case. Some now on the market have openings in the case for ventilation, through which fire originating in the windings may be communicated to combustible objects in the vicinity. The transformer should always be provided with a permanently attached, heavily insulated cord, and an attachment plug for connection to lamp sockets or receptacles. The transformer arrangement should be such that the higher voltage terminals are entirely inaccessible, and it is very important that the higher and lower voltage windings should be entirely separate with no connection. If the purchaser is in doubt as to the safety of the device, it should be remembered that it is always better to ask advice of the local inspection authority than to run the risk of accident to one's family or home.

The purpose of the toy transformer with alternating-current service is to produce a voltage of 10 to 15 volts, suitable for toy operation, in place of the 110 to 220 volts used on the house wiring. If the transformer is properly constructed and connected, persons operating the toys will come in contact only with this low voltage while handling the secondary terminals of the transformer or the toys and their wire connections. Even though such a voltage is ordinarily entirely harmless as regards shock, the current produced may be large. For this reason the transformer selected should preferably have its low-voltage terminals guarded to prevent flashes and possible burns or fires. It is also important that the current from the low-voltage winding be limited by fuses which will prevent too great current in the toys used or in transformer.

Certain precautions which follow should, of course, be observed in the use of transformers to avoid burns or fires. The low-voltage terminals should never be connected in any way to a

lamp socket or receptacle on the house wiring, as flashes would occur, very high voltage might be caused, and even if no shock, burn, or fire resulted, the fuses in the house circuit might be blown and damage result to the transformer. The low-voltage wires should not be connected directly together, as this will tend to cause flashes that might result in damage. Unless the fuses recommended above are provided at the low-voltage terminals (which is not the case with many transformers now marketed), connecting these together will overheat the transformer so as to quickly destroy its effectiveness and the safety it provides against shock. For the same reason the tracks of electric toy railways should not be short-circuited by laying metal objects across them. The transformer should never be connected to a direct-current circuit, nor left connected to any circuit when not in actual use.

The purpose of toy resistances with direct-current service, like that of the transformer with alternating current, is to produce the toy operating voltage of 15 volts or so in place of the 110 or 220 volts used on the house wiring. The high-voltage and low-voltage windings, however, can not be kept separate, as is possible with toy transformers, and *danger of shock or fire is always present.* This will be a minimum if two resistances are used, one in each wire of the circuit. The dealer should be able and willing to inform the purchaser on this point.

In using toys supplied through a direct-current resistance device it is well to avoid touching or standing on water or steam pipes, radiators, stoves, or other metallic objects. It is, of course, somewhat problematical whether children may be depended upon to observe this degree of precaution.

(*e*) **Wiring for Temporary Display Lighting**

Temporary display wiring, such as that for Christmas-tree lighting and other temporary decorative illumination in or about the house, should be confined to materials that are specially suited to such uses. Flexible cords with miniature or other sockets distributed along their length and festooned over trees or about rooms are particularly liable to suffer injury to their insulating coverings, and in some cases where the fittings are improperly designed the live parts of the lamps or sockets are exposed to contact. Only cords having very substantial protective coverings over the insulation proper and with both the insulating and the protective covering in good condition should be put into use, and careful inspection should be made from time to time during use to make sure that no injury has occurred that will be likely

to cause either fire or life hazard. In this connection it may be noted that a large proportion of the Christmas-tree lighting outfits now on the market, and arranged with plug connectors to fit the sockets in the house wiring, have only a very thin insulating covering and are as a matter of fact suitable for use only with low-voltage batteries, instead of the higher voltage house circuits. Outfits having thicker insulation and more suitable for connection to house wiring are on the market, usually at somewhat higher prices.

Display wiring should, of course, be connected to the house circuits in a proper manner. For the larger displays this frequently requires the provision of special means of connection, which should be arranged for under the supervision of competent wiremen. As soon as the display is permanently discontinued, it should be removed so that it can not later be accidentally connected after it may have become dangerously deteriorated.

The presence of decorations in the immediate vicinity of lamps and fuses is to be avoided. Cotton batting or other highly inflammable material is dangerous because of the temperature rise when touching incandescent-lamp bulbs. Tinsel and other metallic decorations frequently give rise to hazards by working their way into the live parts of the sockets or fuses. Because of these hazards, it is highly desirable that such decorations be placed at a sufficient distance away from electrical wiring, fixtures, and grounded surfaces. If the electrical decorations are at all extensive, it may be advisable to have the installation inspected by the proper authority.

(*f*) **Amateur Wireless Installations**

Installations of wireless systems should be made only by thoroughly competent electricians familiar with all the rules applying to such installations, as given in the National Electrical (Fire) Code. Of course, as therein required, every such *wireless system should be kept disconnected from the aerial wires when not in use and effectively grounded* at such times. This can be done by use of a double-throw, single-pole switch outside the building. The aerial should also be kept connected to the ground and not attached to the wireless apparatus inside the house during severe electrical storms. If such installations are to be connected to building wiring, the possible overloading of the house wiring or the introduction of some other hazard on the ordinary wiring system should be carefully avoided.

Where persons not thoroughly competent to install house wiring undertake the installation of wireless systems, the entire wireless system should always be inspected by the proper inspection authority before a connection to the house wiring system is permitted. Antennæ should be kept entirely away from all overhead electric-light or telephone wires, whether carried on poles, attached to buildings, or carried over buildings, and should always be run at right angles to these light or telephone wires, in order that interference between the two systems be avoided. Contacts with such overhead wires in storms would endanger members of the household as well as persons passing underneath the outside wiring.

Even if the person installing the wiring for the wireless system is thoroughly competent to do house wiring, inspection of the installation for the wireless system by the proper inspection authority should generally be arranged for, so that the safety of other persons and other properties may not be endangered through some chance oversight. It is, of course, to be taken for granted that the installations will always be made in accordance with any local ordinances in effect regarding such construction, and that where permits are called for these will have been obtained before the construction is begun.

Transmitting stations are required to be licensed by the Federal Government, and information concerning the obtaining of licenses can be secured from the Bureau of Navigation, Department of Commerce, Washington, D. C., or from the radio inspector in charge of the district in which the wireless system is located.

7. SAFETY PRECAUTIONS

[Recommended for the observance of the public while in the vicinity of electric lines or electric circuits.]

Although electricity is undoubtedly the safest available agency for producing light, heat, and power, nevertheless many accidents still occur in its use because of improper installation or careless handling of electric wiring and appliances. Careful observance by the public of the precautions outlined below would undoubtedly save hundreds of lives annually, besides avoiding many serious injuries and preventing the loss of hundreds of thousands of dollars worth of property. In order to make these suggestions as widely useful as possible, their distribution by service companies, schools, and societies is recommended.

(*a*) Outside the Home

1. Never touch a wire or any electrical device which has fallen on a street, alley, or lawn, or which hangs within your reach, if

there is any possibility that it may still be touching any overhead electric wire.

Any such wire or device may be dangerous, or may become so at any moment by leakage from other wires either nearby or at a distance. Even a damp or green branch hanging from an overhead wire may be alive. Throughout the country as a whole many people are killed annually by touching fallen wires, the conditions being especially bad during or just after wind, ice, or electrical storms, since wires are more apt to be broken and in contact at such times. Some of these persons come in contact with the wires without seeing them; others, overconfident of their ability, attempt to remove the wires without proper appliances.

When such a wire is seen, watch it closely from a safe distance and warn others away from it. Have some one notify the electric-light company or the city electrician. *Insulated overhead wires should be treated the same as bare wires*, since the insulation quickly becomes defective in outdoor use.

This action will safeguard others and possibly some of your own family or friends.

2. Avoid touching the guy wires which are used to anchor poles to the ground, or the ground wire run down wood poles. Never try to jar arc lamps, nor touch the chains or ropes supporting them. During and after storms do not touch even poles, if wet.

These wires, chains, or poles may be receiving leakage current from the live wires overhead, although no evidence can be seen of such leakage by sparking or otherwise These dangers are greatly increased during and after storms on account of possible fallen wires, broken insulators, and the wet surfaces of the poles.

3. Never climb a pole or tree on or near which electric wires pass. Never touch such wires from windows nor while on roofs. Also never raise a metal pole, rake, or pipe, or a metal-bound ladder, so that it comes in contact with overhead wires. Do not use a metal-bound measuring rule or a measuring tape (which may contain wires woven into it) near electric circuits or apparatus.

Warn children against climbing poles or standing on pole steps.

While these warnings may seem unnecessary, many persons, among them many children, are killed annually while trespassing on poles or by climbing in trees and coming in contact with wires passing through the trees. A number of persons are also killed by touching live wires, passing above roofs or near eaves, either with the hand or with shovels, rakes, or other tools they are using. Still others are fatally injured by leaning out of windows and touching wires passing near the windows.

4. Never throw strings, sticks, or pieces of wire over the electric wires carried overhead. Also, never fly kites near overhead wires, nor throw sticks or stones at insulators.

Besides the danger to oneself, one may short-circuit the wires, causing them to fall, or one may cause enough current leakage to set fire to property near at hand or at a distance, and thus endanger the lives of many persons.

(*b*) **Inside the Home**

5. Do not touch or disturb any electric wiring or appliances in buildings, except such as are intended to be handled.

Keep furniture and materials away from interior wires, or see that the wiring is in conduit or otherwise adequately protected against mechanical injury.

Abraded insulation is a too prolific cause of personal injuries and fires, and this often results from disturbance of originally well insulated wires. If in doubt about the condition of wiring and appliances, have them inspected by the city electrician or other electrical authority.

After using portable heating appliances, *turn off the current before leaving them.*

Pressing irons, in particular, frequently cause fires where left on ironing boards by slowly burning through combustible materials beneath.

Water-heating devices also sometimes become dangerously overheated and set fire to adjacent woodwork after the water has boiled away.

Where electric lamps can be moved about so as to come in contact with combustible materials, always see that they have substantial wire guards.

Even if not moved about, the placing of such substances as paper or cloth over lamp bulbs is likely to result in fires. An electric lamp gives out enough heat to set fire to combustible materials against it.

6. Never touch those interior live metal parts of sockets, plugs, or receptacles which are used to carry current. In handling electrical devices, use the insulating handles which are provided for that purpose.

Persons are sometimes killed or injured in their own homes by carelessly or recklessly touching bare current-carrying parts, especially where the devices are of bad design or poorly maintained. Touching such parts is particularly dangerous, if the hands are wet by perspiration or otherwise, and so make good contact, as is likely to be the case in bathrooms and laundries. The hands of children are usually moist enough also to increase this danger.

It is important that only reliable makes of electrical fittings, in which the interior live parts are normally guarded against contact, should be used.

While in bathrooms, toilet rooms, kitchens, laundries, basements, or other rooms with damp floors, stoves, heaters, steam or hot-water radiators, or pipes which may be touched, avoid touching *any metal* part of lamp sockets, fixtures, or other electrical devices, since it may accidentally be alive.

The thorough grounding of these metal parts will obviate all danger from this source, but in the present state of development of electrical installation methods, grounding of such parts is frequently impracticable.

While in a bathtub never touch any part of an electric cord or fixture, even if it is a nonconductor. When using the telephone,

FIG. 8.—*Illustration of the possible danger from shock by the passage of electricity from the metallic ungrounded fixture C (see insulating ring at base of fixture A), through the body to the grounded water faucet at B*

Path of electric current is indicated by broken line through body

avoid touching stoves, radiators, or any other of the metal objects above mentioned, particularly during electrical storms.

In handling electrical appliances in bathrooms, toilet rooms, or under the other special circumstances listed above, a dangerous current through the human body is much more liable to be set up than in drier places having less exposed plumbing. It is, therefore, necessary to keep in mind the possibility that exterior metal parts of electrical appliances may be receiving leakage current from the live parts within.

If the location is frequently damp, as in bathrooms and laundries, the insulation in electrical devices is also much more likely to become defective and to permit such leakage. Especially dangerous is the handling of lamp sockets, portable vibrators, or similar electrical appliances while in bathtubs, since the surfaces of the body are very wet and the insulation is particularly liable to be deteriorated.

Unless lamps or other devices in such locations need to be moved about as they are used, it is usually advisable to have them located out of reach, if practicable, and at any rate to have them controlled by wall switches, so that the devices themselves require no handling whatsoever. Such wall switches should, of course, be located, in general, near the room entrance or otherwise well away from all plumbing or other grounded fixtures.

7. Never try to take electric shocks from the wiring in buildings or on streets, nor induce others to take such shocks.

A shock which appears harmless to one person may be fatal to another, who may have a weak heart, for example. A second shock may be fatal even to the first person, if received for a longer time or under different circumstances. For example, a harmless shock may be received by a person whose hands and feet are dry, and a fatal shock might be received by the same person from the same wire if his hands or feet are wet.

8. Avoid touching bare or abraded spots on flexible cords attached to electric lamps, pressing irons, or other portable devices. Handle all cords carefully in order to avoid such injury to their insulation. Do not hang them on nails or over fixed wires. Always have them repaired or replaced by a competent electrician when any injury to insulation is observed.

Where toasters, fans, pressing irons, or other devices are moved about so that the cords receive more or less hard usage, use only cords with heavily reinforced coverings to protect the insulation. In damp places use only cords having a heavy waterproof outer covering.

In buying any cord or portable device, inquire whether it has been inspected and approved by the proper authority.

Many persons are injured in their homes and places of employment by contact with the wires of cords. Sometimes the insulation has been worn or broken off, and sometimes the fine wires of the cord have been broken by frequent bending and have afterwards pierced through the insulating covering to the outside of the cord and are, although almost invisible, a source of danger.

Unscrupulous and ignorant dealers sometimes sell cords or appliances which are defective, or assemble them in such a way that they are dangerous. It is best always to have devices inspected by the proper authority before use.

Cords constitute one of the most difficult sources of hazard to remove, since their use is necessary for the many portable devices needed by the public. They should however, be as short as can conveniently be used in any case, thus minimizing the danger entailed by their use.

9. Never touch a person who has been shocked while he is still in contact with the electric circuit, unless you know how to remove him from the wire, or the wire from him, without danger to yourself. Have some one immediately call the nearest doctor and the lighting company.

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.

10. 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 practice 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.

(*c*) General.

11. Always be on the lookout for fallen wires, broken insulators, broken or leaning poles, broken arc lamps, open manhole openings in streets, or other defective conditions of electric lines outside buildings. Notify the electric-lighting company or the city authorities of such conditions, as well as of any sparking or burning about wires. Notify them whenever wires are seen in contact with trees or passing very close to windows, fire escapes, or eaves.

Also report any shocks that may be accidentally received, whether from outside wiring or from that in the home, however slight the shocks may seem. Always warn anyone who is believed to be in danger near electric wires or devices, either outdoors or indoors.

An early report to the lighting company or the city authorities regarding dangerous conditions or slight shocks may prevent serious fires or save one's own life or that of some other person.

See that trees in the community are regularly and carefully trimmed so that live wires do not come in contact with them.

The rubbing of the tree on wires is liable to injure and break them, allowing live wires to fall within reach of the public. Dead branches above electric wires should also be removed, as they may fall upon the wires and short circuit them, so that they fall in the street.

The observance of dangerous tree conditions and a report to the tree warden, the lighting company, or the city authorities, may prevent fires or loss of life from this cause.

12. Never employ anyone to do any wiring unless he is properly qualified and authorized to do such work. Do not attempt to make any changes in wiring, adjust electrical appliances, or do similar electrical work, or even to replace fuses unless thoroughly familiar with electrical materials and methods and so qualified to do such work properly and with safety to self and others.

An electrician who is not familiar with accepted standard practice or does not adhere to it in his installation and repair work is a menace to the safety of one's house and family.

8. TYPICAL ACCIDENTS FROM NEGLECT OF SAFETY PRECAUTIONS

As will be noted, the following accidents could have been easily averted by simple precautions on the part of the person involved. The immediate application of resuscitation methods, as outlined on page 40 would have avoided most of the fatalities recorded in the following cases. Never forget under similar circumstances to attempt resuscitation without delay.

1. On April 3, 1915, a cotton-mill employee on his way home thoughtlessly picked up a broken electric wire in a New England city. The wire was alive and he was killed.

2. On April 7, 1915, a man was walking along the street in a small town of a southern State and stooped down to pick up a telephone wire which had fallen in his way. Although he probably did not suspect it, the wire was crossed with an electric light wire. He was killed.

3. On April 12, 1915, a man in a rural district of Illinois went into his chicken yard and found a telephone wire lying upon one of the coops. Instead of notifying the telephone company, he attempted to remove it, and received a shock which resulted in his death. The wire was crossed at some point with a high-voltage electric wire.

4. On July 3, 1915, a man in a large western city was out walking in the early evening and noticed an arc light sputter and go out. He attempted to display his knowledge of such things, climbed the pole to shake the lamp, and was electrocuted.

5. On July 30, 1915, a boy 10 years of age was electrocuted when he leaned against a metal electric-light pole. The pole was alive owing to a defect of some kind, probably a broken insulator caused by a storm.

6. On June 11, 1915, a boy noticed that an electric arc light had gone out and climbed the iron pole with the idea of repairing it. When almost to the lamp he touched some live part. He was killed.

7. On May 13, 1915, in a large western city, a boy 14 years of age climbed a pole during a game with other boys and came in contact with a live wire. He was electrocuted.

8. On May 22, 1915, in eastern New York, a boy climbed a tree to rob a bird's nest. He was killed by contact with a live wire while in the tree.

9. On June 1, 1915, in a western city, a man was lifting a pump casing from a well; there were electric wires overhead, and he carelessly allowed the casing to come in contact with them while he had hold of it. He was killed.

10. On April 17, 1915, a boy was out fishing, and in making a cast his line became entangled in some electric wires. In order to get the fishing line, he took a forked stick and pulled the wires down so that he could reach them. He was electrocuted when he took hold of them.

11. On July 4, 1915, two boys were constructing an experimental telegraph line between their homes in a small town in Illinois. The wire they were stringing had to be passed over an overhead electric-light line. While they were doing this, their wire came in contact with one of the supply wires and one of the boys was killed.

12. On March 11, 1915, in eastern Pennsylvania, a man wrapped an electric lamp in a towel and took it to bed as a warming pad. He fell asleep and was awakened by his bed being on fire.

13. On November 30, 1915, in a large western city, an electric iron was not turned off when the ironing was finished. It became overheated and set fire to the table and adjoining woodwork. The loss was $2000.

14. On February 9, 1915, in a large western city, an incandescent electric lamp left burning in a clothes closet set fire to some of the clothing and caused considerable damage.

15. On June 7, 1915, in a small city of Utah, a man was taking a bath and was using an electric vibrator while in the bathtub. He was found dead with the vibrator still operating in his hand.

16. On June 15, 1915, a man was working upon an automobile in a garage in a city of Oklahoma, when he accidentally touched a defective electric-light cord suspended from the ceiling. The shock threw him to the floor and his skull was fractured.

17. On May 26, 1915, a woman was killed while holding an electric vacuum cleaner and answering a telephone call. There was a defective switch on the cleaner making its frame alive. A servant had received a slight shock from the cleaner a short time before and had so informed the woman, who then took hold of the machine to show the servant that there was no cause for fear. She should have heeded the servant's warning.

18. On August 17, 1915, in Illinois, a laundress while opening a small motor switch received a shock which killed her. She had touched one of the live blades of the switch with one hand while her other hand was on an iron pipe rail.

19. On June 2, 1915, in Iowa, a boy 13 years of age took a piece of wire and thrust it into a transformer to show another boy that he could stand the shock. He was electrocuted.

20. A man of southern Canada had the habit while under the influence of alcohol of touching the terminals of a knife switch at his place of employment. He had been warned against the danger of such practice, but on November 3, 1915, failed to heed the warning. He was electrocuted.

21. An elevator operator in a western State discovered that because of some defect in the elevator a shock could be felt by touching the elevator cage and a vertical run

of water pipe close to the elevator door at the same time. He thoughtlessly induced the janitor of the building to touch the elevator cage and the water pipe. The janitor was electrocuted.

22. On July 21, 1915, in Pennsylvania, a young boy 10 years of age was dared by his companions to climb an electric-light pole. He climbed the pole and came in contact with a live wire and was killed.

23. On July 10, 1915, in California, a woman was ironing with an electric iron. The cord from which the insulation was worn came in contact with her arm, causing a severe shock and setting her sleeve on fire.

24. On June 7, 1915, in Texas, a young man was killed while trying to release a man who was being shocked from an electric wire. The man he was attempting to release was not seriously injured, as he wore rubber shoes.

25. On March 30, 1915, in California, a man went into his back yard and accidentally came in contact with a broken live wire and was electrocuted. His wife attempted to rescue him with bare hands and was killed, as was also a neighbor who likewise tried to rescue the man and wife. A dry wooden rake handle would have made the rescue work safe.

26. On July 1, 1913, in Pennsylvania, two men were electrocuted by a fallen electric wire while trying to remove it with bare hands from the path of an approaching woman. They should have warned her and kept away themselves.

27. On May 21, 1915, the proprietor of a store in a small town of Illinois, not realizing the danger, asked one of his clerks to climb a pole to repair a telephone wire which was crossed with a high-voltage wire. The clerk obtained a safety belt and climbed the pole, coming in contact with the high-voltage wire. He was killed.

28. On May 18, 1913, in Illinois, a young man was installing electric wires in his own residence, a work for which he was not fitted. He was electrocuted by contact with a live wire.

29. On December 6, 1915, in a large western city, a janitor made some repairs to an apartment dining-room fixture. A short-circuit resulted, causing a fire and considerable damage.

9. TYPICAL CASES OF RESUSCITATION AFTER ELECTRICAL SHOCK

The following cases of resuscitation are representative of what can be accomplished by the simple prone pressure method of artificial respiration and show that efforts to resuscitate should always be made and long continued upon persons who are apparently dead from electric shock, asphyxiation, or drowning.

1. On May 24, 1914, a service-company employee received a shock from a 2300-volt wire. He was so badly burned that his left arm was afterwards amputated at the shoulder. One of his companions immediately began to give him manual artificial respiration according to the prone pressure method (see Rule 10, p. 40), while others summoned a physician. The physician reached the scene of the accident within one-half hour and immediately pronounced the man dead. The lineman who was working on him refused to give him up and continued the work of resuscitation in the ambulance on the way to the hospital, where two other physicians also pronounced him dead. The lineman insisted that he was not dead and continued his work for another hour and a half, when the man began to show signs of life and was finally fully resuscitated. The injured is now no worse for the experience, except for the loss of his arm.

2. On July 2, 1914, an employee of a public-utility company received a direct shock from a 33 000-volt wire which seriously burned the top of his head and also one heel. A fellow employee who was with him at the time immediately began giving

manual artificial respiration according to the prone pressure method. In the meantime a doctor was summoned and pulmotor sent for, but before the arrival of the doctor and pulmotor the patient had been resuscitated by his fellow employee and removed to a hospital, and after a time was entirely recovered from the effects of the shock.

3. A schoolboy, on May 18, 1915, came in contact with an 11 000-volt wire while up in a tree trying to reach a bird's nest. He was resuscitated by railroad employees, who were near at the time, by the prone pressure method of resuscitation and without the aid of a physician. Resuscitation was accomplished in about 45 minutes.

4. On August 4, 1915, an employee of a public-service company came in contact with live parts at 33 000 volts while working upon a lightning arrester and was rendered apparently lifeless. A companion at once began artificial respiration and the man was soon conscious.

5. A trolley lineman, on July 22, 1916, received a shock from a 500-volt trolley circuit and was thought to be dead. His foreman, however, immediately began efforts for resuscitation by the prone pressure method and was successful in less than half an hour. The next day the lineman was able to resume work.

6. On November 29, 1916, a substation operator was working upon a 33 000-volt feeder and received a shock which caused him to fall 15 feet to a concrete floor. The local superintendent immediately applied artificial respiration, regardless of efforts of two doctors to prevent him, and continued it until the man regained consciousness. Another doctor, who had had some experience with similar cases, arrived shortly and assured the superintendent that his action and knowledge of the prone pressure method were undoubtedly responsible for saving the man's life.

7. On April 6, 1915, in Massachusetts, a boy picked up a broken electric wire and was apparently dead from shock, but was revived by artificial respiration.

8. On June 6, 1915, in Colorado, a boy took hold of an electric wire and was rendered unconscious and his pulse could not be felt. He was, however, successfully restored by artificial respiration.

9. On May 9, 1915, in California, a man was knocked down and rendered unconscious by an electric shock of 2300 volts. The prompt application of resuscitative methods restored him after he was apparently dead.

III. LIGHTNING

1. EXTENT OF HAZARD FROM LIGHTNING

An investigation by this Bureau shows that of the total number of fires in the United States, at least 3 per cent are due to lightning. The property loss each year from such fires amounts to more than $6,000,000. This, however, does not represent the total loss. To find the total loss an indeterminate sum must be added to cover the destruction of live stock and damage to buildings where no fire occurs. Lightning, therefore, appears as an important cause of loss of property, and to protect against it measures should be taken which are in proportion to the damage which arises from it. It is obvious, of course, that to protect all buildings would lead to excessive expense. Most of the fires, however, occur in a few classes of buildings and property, and if these were protected, the loss would in large part be obviated.

The structures most liable to fire by lightning are those which are, of themselves, inflammable or have inflammable contents. Oil tanks, barns, and churches head the list as far as fires by lightning are concerned. It may be added that where equal numbers of barns and houses are struck, practically four times as many barns as houses are fired.

2. PROTECTION OF PROPERTY

A means of protection against lightning is provided in the lightning rod invented in 1752 by Benjamin Franklin, to whom the world would owe a debt of gratitude, even though this invention constituted the whole, instead of a small part of his services to humanity. For after 160 years of use, the right of the lightning rod to a place among the most useful devices at the command of mankind has been firmly established. All recent investigations point to the fact that if due care is given to its installation, a lightning rod may be expected to function perfectly in ninety-nine cases out of one hundred, on barns and other buildings where very little metal enters into the construction, and in from eighty to ninty cases out of one hundred on houses and other buildings where there are chimneys and metallic masses which tend to make protection more difficult. But even where the rod does not function perfectly, or is imperfectly installed, the damage will

generally be much less than if there were no rod at all. Where one wishes to avoid loss by lightning, therefore, lightning rods should be used. The probability is that as good service will be obtained as with any device subject to mistakes in its installation, and to wear and tear by the weather. Protection should be provided on all buildings which are, of themselves, inflammable, or have inflammable contents, or in which persons are likely to be during thunderstorms. It should also be provided on structures which are of historical value, or the loss of which would cause secondary losses impossible to cover by insurance. This presumes, of course, that such buildings are located in places where many thunderstorms occur. There are places where such storms are not known, or occur very infrequently, and here a lightning rod is unneccessary.

To illustrate the manner of installing lightning rods a few diagrams are given below, and also a short description of the materials and methods found most suitable:

(*a*) **General**

In assembling rods it is preferable that all parts be made of the same kind of metal to avoid corrosion by galvanic action in the presence of moisture.

(*b*) **Rods**

Rods may be made of either copper or iron, although iron must be galvanized to prevent corrosion. Copper rods should weigh not less than 3 ounces per linear foot, while the weight of iron rods should be not less than 5 ounces per linear foot. The greater weight of iron is required because of the greater tendency of iron to corrode. The material may be in the form of stranded cable, solid wire, or tube, or in star section, a form sold by many lightning-rod manufacturers. Star-section rod is usually made of iron.

(*c*) **Fasteners**

The devices used for securing rods to buildings may be in the form of straps held down by nails or screws, or in the form of a screw with a forked top which can be closed over the rod. The latter usually gives the greater security.

(*d*) **Points**

Points should preferably be solid, although shell points give fair service. The shape of points should approximate a sharp-pointed cone about 6 inches high with a diameter of base equal to the diameter of the elevation rod.

(*e*) **Elevation Rods**

Elevation rods, or the rods which, with the points, serve as air terminals for receiving the discharge, should be solid and somewhat heavier than the other conductors. The height of elevation rods should be such as to place the point at least 12 inches above the object being protected.

(*f*) **Braces**

Elevation rods should be braced against the force of the wind by means of tripod braces made of one-fourth inch round iron, either galvanized or copper clad, to prevent corrosion.

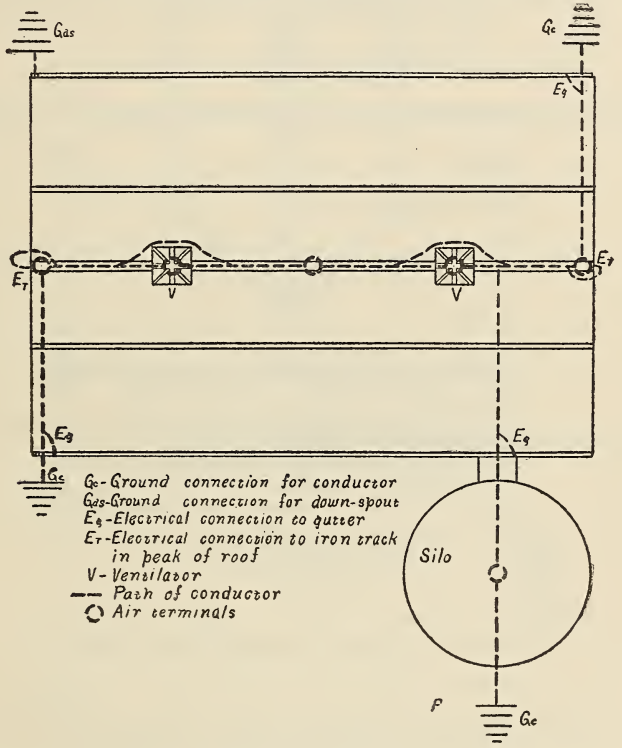

FIG. 9.—*Roof plan of a rectangular barn with shingle roof, showing course of lightning rods and location of air terminals*

(*g*) **Joints**

Joints between sections of rods should be secure, both electrically and mechanically. Loose or otherwise defective joints are to be avoided.

(*h*) **Location of Air Terminals**

Air terminals with points should be placed at all chimneys, ventilators, gables, and other projections where lightning is

likely to strike, and at intervals of not more than 25 feet along ridges and parapets. Points should be directly above, or at least within 2 feet of, the object being protected.

(*i*) **Coursing of Conductors**

Conductors should be run along ridges and parapets, and over flat surfaces if need be, so as to connect all of the air terminals together. At least two down conductors should be provided for each system, with additional down conductors if the total number of air terminals exceeds six or the building is more than

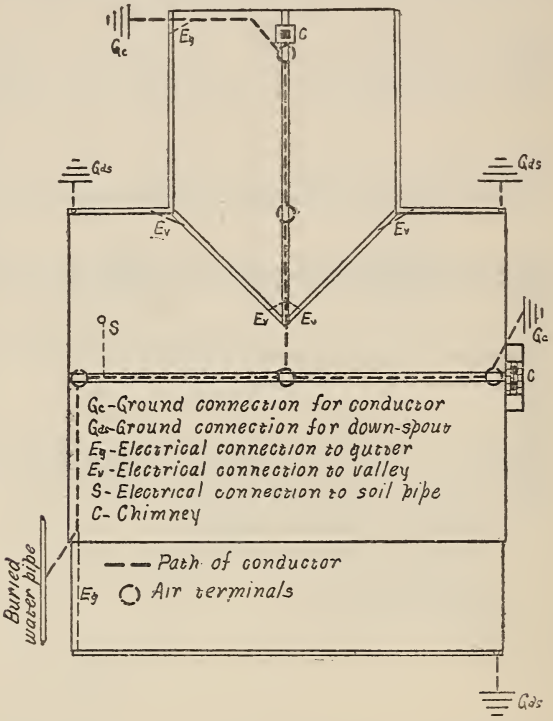

FIG. 10.—*Roof plan of house, showing installation of lightning rods with connections to gutters and valleys and ground connections for down spouts*

100 feet long. The arrangement of down conductors should be such as to space them as nearly uniformly about the building as practicable, and also such that a lighting discharge to any air terminal has at least two paths from the foot of the terminal to ground.

Sharp bends in conductors are to be avoided. The radius of the sharpest bends must not be less than 8 inches. Conductors should pass around obstacles of considerable height, such as chimneys and ventilators, and not over them. Where air terminals are on top of chimneys or ventilators, they may be con-

nected to conductors by branches brought down on either side, as in the case of the barn in Fig. 9.

(*j*) **Ground Connections**

Thorough grounding of a lightning-rod system is essential to its proper operation. Such grounding may be done as follows: At the foot of every down conductor a section of three-fourths inch galvanized-iron pipe may be driven to a depth of 10 feet, the pipe plugged 3 or 4 inches below the top, the lower end of the down conductor inserted, and the pipe poured full of melted lead. Or, if a copper rod is used, the lower end may be extended into the ground to a depth of 10 feet by first making

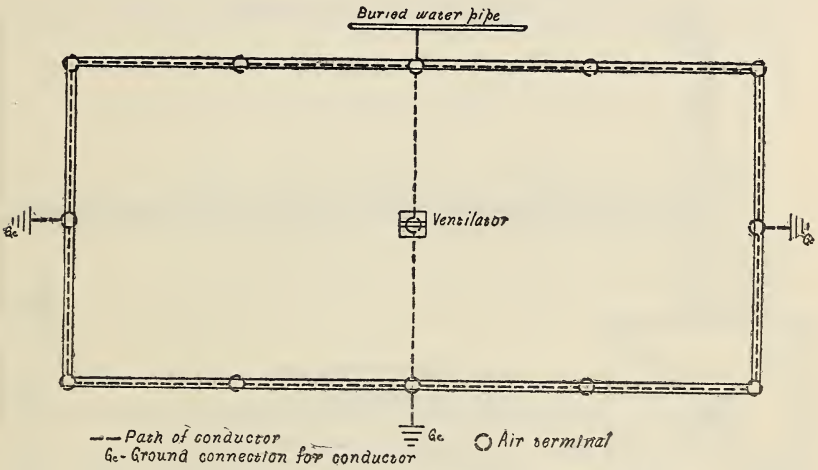

FIG. 11.—*Roof plan of a flat-roofed building, showing installation of lightning rods. Roof surrounded by a parapet*

a hole with a bar or auger. If the soil does not permit driving pipes, a trench may be dug and 15 or 20 feet of the rod buried in it.

Where a buried water pipe is available one of the down conductors should be connected to it at some point outside of the building. (See Figs. 10 and 11.)

(*k*) **Interconnection of Metal**

Every metal part of appreciable size on the exterior of a building should be made a part of the lightning-rod system by connecting it to the rod at the upper (or nearest) end and grounding it at its lower (or farthest) end. Metal on the interior which comes within 6 feet of down conductors, or projects through the roof, should also be connected to the rod. (See Figs. 9, 10, and 12.)

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(*l*) **Protection Against Corrosion**

Where any portion of a rod is exposed to chimney gases or other corrosive agencies, it should be protected by covering it with lead.

(*m*) **Protection of Live Stock**

To protect live stock from lightning discharges received through wire fences, the fence should be grounded at intervals of 300 feet. Ground connections can be made by driving one-half inch galvanized-iron pipe to a depth of 4 or 5 feet in the ground and tying it to the fence with wire. The electrical continuity

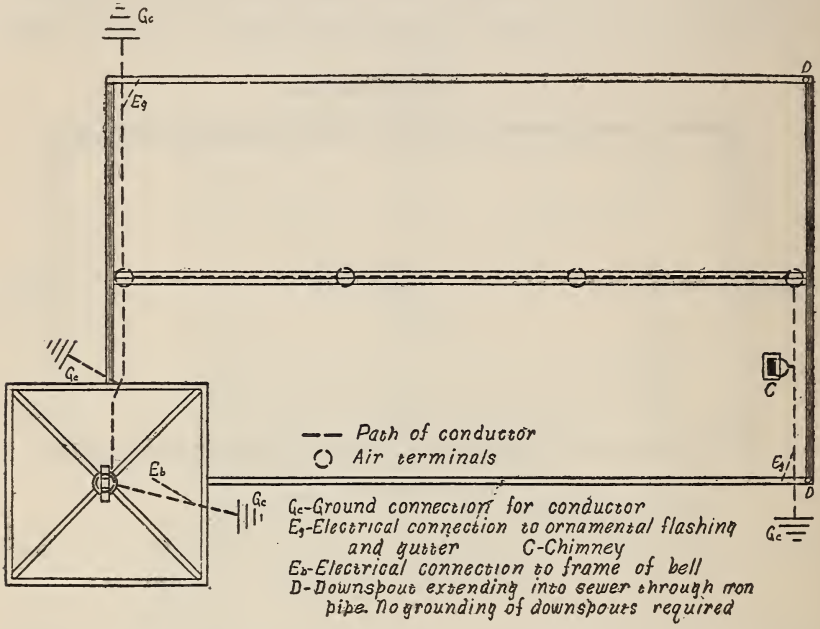


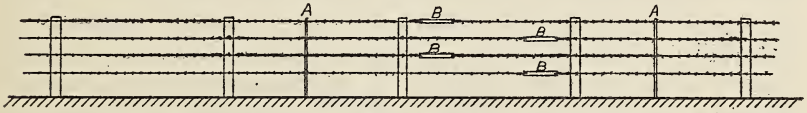
FIG. 12.—*Roof plan of a church, showing installation of lightning rods with an electrical connection between rod and bell*

should also be broken up at intervals of 1000 feet by cutting the wires and inserting short lengths of seasoned wood. (See Fig. 13.)

The diagrams mentioned above show the course of lightning rods and locations of aerial terminals on what are designated as "roof plans" of a number of buildings of common types of construction. By roof plan is meant that the building is shown as if one were above it and looking directly down upon it. Wherever a ground connection is shown it is supposed that the conductor is run around the eaves and down the sides of the building into the earth.

3. SAFEGUARDING LIFE

Coming now to the protection of life against lightning, it may be stated that lightning leads to relatively few deaths and injuries as compared with other causes. It has been shown by this Bureau that in the United States approximately 1500 persons are affected by lightning each year, of which one-third are killed and the rest injured. But as an offset to this, we have the fact that the life hazard from lightning is operative only for a short time. It is doubtful whether the average person is exposed to danger from thunderstorms for more than a dozen hours each year, whereas, if the danger were operative continuously, several hundred times as many persons might be expected to be injured or killed, as shown by the figures given above. Hence, during a thunderstorm the life of a person is menaced to a greater degree than most people are aware, unless refuge is taken in a safe place.



A-One-half inch galvanized iron pipe driven 5 feet deep and tied to fence-wires with No.10 B&S gauge galvanized iron wire. Pipes driven at ends of each section of fence and at intervals of 300 feet.

B-Sections of seasoned wood 2"by 2"by 24" inserted at intervals of 1000 feet to break up the continuity of the fence wires.

FIG. 13.—*Method of protecting live stock against lightning from barbed-wire fences by grounding and sectionalizing the wires*

With regard to safety from lightning, there is no place which may be regarded as absolutely safe unless it is of such character that, even though a stroke of lightning does fall upon it, no harm will come to the occupants. For no object in the path of a thunderstorm can be assumed to be immune to lightning. It does not pick or choose to any great extent among objects upon which to fall, but strikes whatever is in its way. Places which may be regarded as perfectly safe are rooms entirely surrounded by metal, rooms under ground, or in a steel-framed building. Here, even though lightning strikes, the chances that it would penetrate to the interior are negligible. The next safest place is a well-rodded house. But even in a rodded house some precautions must be observed in order to secure the maximum reduction of danger. For instance, when a thunderstorm is in progress one should keep away from those parts of outside walls near the places where lightning conductors pass into the earth, and also away from stoves, fireplaces, chimneys, screened doors and windows, and telephones. It should be added, however, that these precautions

are suggested in the case of rodded houses merely as a means of eliminating practically all danger, because whether they are observed or not the degree of danger existing is comparatively slight.

In unrodded houses, on the other hand, an appreciable degree of danger exists, and to avoid it as much as possible the same precautions should be observed as in the case of rodded houses, but more rigidly. It is essential to safety to keep away from the vicinity of down spouts on the exterior of the house, and metallic masses on the interior of the house and near the walls, such as radiators, stoves, and safes. For a stroke of lightning following a down spout, or a lightning rod or any metallic conductor, may jump to metallic objects near by, and a person sitting in the path of the discharge is not unlikely to be injured. Briefly, when one is in the house and a thunderstorm is in progress, take a position as near the middle of the room as practicable, well away from the objects named above, and retain it until the storm is over, or at least until the lightning discharges are appreciably lessened in intensity. This is about all one can do, and even so it seems that unless a house is well protected against lightning there is considerable danger if it is struck. There is hardly any place in an unprotected house to which lightning will not penetrate, although in modern houses containing water and gas pipes, steam or hot-water heating pipes, and other extensive metallic conductors which are connected to earth, the danger to life is not as great as in houses not so equipped. These conductors act, in a measure at least, as a protection against lightning, since they form more or less of a grounded metallic screen about the occupants.

It may be well to mention here that small metallic objects within houses, as, for instance, scissors, knives, and other small implements and tools, are not likely to attract a discharge of lightning. One may, therefore, use these during thunderstorms without increasing the danger from lightning.

Moreover, there is no danger in lying on an iron bed during a thunderstorm; that is, there is no increase of danger over that existing with a wooden bed. The impression is abroad that to occupy an iron or brass bed during a thunderstorm is to invite injury, or even death, but the fact is that these beds are safer than any other. They form a metallic screen on one side of the occupant, the effect of which would be to divert the lightning if it should enter the room.

With regard to currents of air, there is no danger from these unless they are very warm or moist, or contain some kind of vapor which acts as an exceptionally good conductor for lightning.

There is no danger, for instance, of lightning following a stream of air blowing into a house through a screened door or window. In fact, during the thunderstorm season, the temperature within houses is so near that of the outer air that a stream of air into or out of a window or door offers no better path for a stroke of lightning than the surrounding air. While thunderstorms are in progress, therefore, doors and windows may be opened for ventilation without increasing the danger from lightning. Rising streams of smoke, however, or vapor from sweating hay in barns or from live stock, may afford a better path for lightning and should be regarded as dangerous.

4. DANGER OUT OF DOORS

Outdoors the danger is much greater than in houses, even though the latter are unprotected. It is desirable to keep away from lone trees, barbed-wire fences, long wire clotheslines, and other prominent objects which are likely to be struck by lightning, or, having been struck, may carry the lightning a long distance. Open sheds or small outbuildings away from larger buildings are almost as dangerous as lone trees. When caught outdoors in a thunderstorm, either keep to the open away from trees and fences or make for thick timber. When near lone trees the temptation is to get under them to obtain protection from rain, but a wetting is a trivial matter compared with a stroke of lightning, and a person who takes refuge under a lone tree invites a serious accident. Thick timber, however, is different. There a person may get under a tree in comparative safety, because it is no more conspicuous than its fellows, and hence not likely to be singled out for a stroke.

5. PROBABILITY OF RESUSCITATION IN CASE OF LIGHTNING STROKE

If, in spite of all precautions, a person has been injured by lightning, the clothing may be torn to ribbons, the flesh may be seared and burned, or even broken and lacerated. In every such case nothing should be taken for granted. As in the case of all other electrical accidents, a physician should be sent for as soon as possible, and in the meantime every effort should be made to restore the patient by artificial respiration and to treat his burns or wounds in accordance with the principles set forth under the section on safety from electrical accidents.

It may be stated that if those who have been struck by lightning and eventually given up for dead and had proper restorative measures applied at once, many of them would have been restored to life. This statement is well borne out by authenticated cases of persons being restored who were apparently past recovery.

IV. GAS

1. GENERAL NATURE OF GAS ACCIDENTS

Like many other sources of energy, gas must be used carefully, for in careless or reckless hands it is a possible source of great danger. However, practically all accidents with it are readily preventable by the observance of simple precautions. In fact, the householder should realize that gas when carefully and properly used is perfectly safe and that the user is almost invariably responsible for any fire or accident which may occur.

In the utilization of gas in the household several kinds of accidents may happen. These may be grouped under five headings: (1) Asphyxiation by unburned gas; (2) asphyxiation by the products of incomplete combustion; (3) burns to persons; (4) destruction of property by fire; and (5) explosions, which may or may not be accompanied by fire or injury to persons. The following sections point out the more important of the precautions that should be taken to prevent such unfortunate occurrences. Many of these precautions are already familiar to practically every user of gas, but the frequent recurrence of accidents from well-known causes makes it evident that a repetition of the warnings is desirable.

It is necessary that the householder not only carefully observe the precautions, but that he should also give careful instruction to members of his household, including the servants and children, so that the fullest measure of protection may be afforded.

2. ASPHYXIATION BY GAS OR ITS PRODUCTS

The effect of breathing an atmosphere containing illuminating gas depends upon the amount of the gas in the air and the length of time of exposure. When the proportion of gas is large and the time of exposure long, the person becomes unconscious and may eventually die from the effects.

The gas has a strong odor, very noticeable at the start, but if a person for any reason remains in the room containing the gaseous atmosphere, he soon loses to some extent the ability to judge by the odor whether or not the air is heavily charged with the gas. Therefore, anyone who persists in staying in the room after the gas is smelled may in a little while not suspect that he is running any risk, even at the moment when he is on the point of losing

consciousness. Frequently no other warning than the initial smelling of the gas precedes the loss of consciousness.

The seriousness of the results in such case depends somewhat upon the age and health of the person. Children and invalids are much more quickly affected than healthy adults.

The constituent of the gas that causes the most serious effect is carbon monoxide. It has a strong chemical affinity for the hæmoglobin of the blood, the substance that normally transports oxygen from the lungs to the body tissues. When the hæmoglobin has taken up carbon monoxide it can no longer carry oxygen; and if a large percentage of the blood is thus affected, the person is overcome and eventually dies unless proper measures are promptly taken for his treatment. If a person so affected is promptly supplied with fresh air or oxygen, so that the carbon monoxide can be eliminated, recovery is prompt and complete. Since the chances of recovery decrease rapidly with time, prompt treatment is very essential.

When gas burns completely, only water vapor and carbon dioxide are formed as the products of combustion, and neither of these is poisonous. Of course, a large amount of oxygen from the air is used up in the process, hence a poorly ventilated room no longer has the usual quantity of oxygen and the air may become objectionable for breathing if gas has been burned in large quantity, even when the air contains no poisonous gases. This is true of all fuels and makes clear the need for proper flue connections and adequate ventilation in rooms where heating appliances are installed.

If the burning of the gas or other fuel is interrupted before all of the constituents are combined with oxygen to form carbon dioxide and water, there is given off as one of the products of the partial-burning carbon monoxide the same dangerous constituent that occurs in the unburned gases. If these products of partial burning of the gas are breathed, they produce exactly the same effects as if unburned gas with the same relative quantity of carbon monoxide had been inhaled. The well-known fear of "furnace gas," which results from the partial burning of solid fuel and which also contains carbon monoxide, is amply justified by the very serious effects of breathing it. The same fear should extend to the breathing of the products of combustion from any device from which there is likelihood of escape of the products of partial burning. To guard against the formation of such products of partial combustion is important, but the greatest security can be

had only if adequate flue connection is provided for these types of appliances, so that all of the products of combustion may be carried out of the room.

Very few gas appliances for domestic use when in good condition will give products of partial combustion. Those in which the flame is chilled by coming in contact with cold surfaces, such as the coils of a water heater where this contact is purposely arranged in order to secure speed in heating the water, always give off objectionable products of incomplete combustion, and the appliances of these types should always be connected to a flue. If any gas appliance that is not attached to a flue begins to give an unusual odor, or to act in any way differently from its ordinary behavior, a dangerous condition should be suspected.

Particularly one should guard against burning gas in such a way that it "flashes back" and takes fire inside of the burner, for when burning in this manner the likelihood of escape of products containing carbon monoxide in dangerous quantities is very great. In a later section means for avoiding the difficulty of flashing back into the burner will be discussed. Such burning of the gas is evident by the noise which usually accompanies it. The odor of the products of such burning is also distinct; it somewhat resembles furnace gas, but more commonly is spoken of as the "odor of burning metal." All users of gas should learn to recognize this odor and should be on their guard whenever it is noted, for the quantity of carbon monoxide in the air from the products of such burning is often much greater than when unburned gas itself escapes, since the odor of unburned gas is so much more objectionable to most persons that small quantities are more quickly recognized. In this connection one should remember that an extremely small percentage of carbon monoxide is sufficient to cause serious results.

3. TREATMENT OF PERSONS OVERCOME BY GAS

When a person has been overcome by gas or by the products of its combustion, the first and 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 the person has been found. Whichever means will most quickly accomplish the result should be utilized, for moving a person who is overcome by gas is not at all harmful.

As soon as the patient has been supplied with fresh air a doctor should be summoned and the gas company should be called, so that the cause of the trouble may be promptly remedied and the

special facilities which the company often has for treatment of persons thus overcome may be made available. While waiting for the doctor artificial respiration should be applied, unless the patient is breathing regularly. Under no circumstances should stimulants such as whisky, brandy, or other alcoholic drinks be administered; but if the patient is fully conscious and able to swallow freely, he may be given a dose of phosphate of soda, bromo seltzer, or other gas-forming drinks that will produce belching.

The treatment to restore breathing in case of gas poisoning is identical with that for electric shock or drowning, except for the necessity of removal to fresh air in case of gas poisoning or the elimination of water from the lungs in the case of a drowning person. The method of artificial respiration is that described in the electrical section of this circular. (Rule 10, p. 40; and Fig. 1, frontispiece.) When applying this method much time should not be wasted by stopping to loosen the clothing, for every moment's delay is serious. As soon as oxygen can be made available it should be administered with proper face mask through any breathing device; however, no mechanical resuscitating device should be used unless it is of a form operated by hand and one that can not produce a high pressure or induce even slight suction effect on the lungs. The prone pressure method referred to above with administration of oxygen is generally the best procedure.

If necessary, the artificial respiration should be continued without interruption two hours or longer, until natural breathing is restored. If natural breathing stops after being restored, use artificial respiration again.

4. FIRES AND EXPLOSIONS

Burns to persons do not frequently result from the use of gas, but a few special precautions, brought out in the various sections following, will assist in avoiding the ignition of clothing or the hair from such accidents.

The causes of fires that result from the use of gas are very similar to those that occur with other fuels. Gas appliances, in general, are so designed that if properly installed no danger of fire need result. Nevertheless, the householder 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 protection is not afforded, either

by heat insulation or adequate spacing of appliances, flues, etc., away from wood, lath and plaster, and other combustible portions of the dwelling. Such protection is usually not expensive and there is no excuse for neglect of suitable precautions.

If gas be unmixed with air, it cannot under any circumstances be caused to explode. Therefore, the only danger of explosion comes with permitting mixtures of gas with air in such proportions that an explosive product results. Even when such explosive mixture is formed there is no danger of explosion unless a flame, electric spark, or some highly heated substance comes in contact with the mixture, However, the only safe practice is never to allow such a mixture to be formed; but if found all the precautions given in the next section should be taken.

5. LEAKS

Any leakage of gas, no matter how small, may be dangerous. Although the quantity of gas escaping may appear to be insufficient to cause asphyxiation or explosion, there is no means for determining this without an actual analysis of the mixture. Hence, one should never regard an air-gas mixture as safe, and when even a slight escape of gas is noted steps should be taken at once to prevent further leakage and to guard against explosions or asphyxiation of persons.

The first and most important of all rules is: Never search for a gas leak with a match, candle, lantern, or with the aid of any other ordinary lighting appliance. Even the switch operating an electric light may cause a sufficient spark to ignite an explosive mixture and thus cause disastrous results. Never try to locate the point of leakage by igniting the escaping gas, for unexpected "pockets" of explosive mixtures may exist, as between joists, beneath stairways, or close to the ceiling, and these may be exploded without warning. It is safer to open the windows or take other precautions—in the dark, if need be—having some one outside the affected room on the watch to render assistance if necessary. Not only is there danger of explosion, but the use of a lighted match near a lead meter connection or at the soldered seams of a meter may cause a tiny invisible flame at a point of leakage, and this tiny flame may melt the lead or solder, causing a larger leak and eventually a serious fire.

The very first thing to do, when the odor of gas is noticed, is to search for the leak. If this is quickly located (by applying the nose) at a leaking gas cock or piece of rubber tubing, and if it is evident that the leakage is so small as not to permeate the

room, no other precaution need be taken than the temporary use of soap to stop the leak and a notification to the gas company, so that a permanent repair may be made. Tubing that is cracked or that has loose ends, even though leaking very slightly when first noticed, should be immediately put out of use.

If, on the other hand, the odor of gas seems to permeate the room, and the definite source of the leakage can not be located quickly, thus arousing the suspicion that the gas may be coming into the room through the floor or walls, and that in the basement or another room it may be even worse than it is in the room where it is first noticed, no time should be lost in extinguishing all lights or fire, in opening the windows, and in seeing that all persons who may be in the room are warned to seek a part of the house where there is no odor, or, if necessary, to leave the house altogether. These precautions should be taken on the bare suspicion that the leak may be serious in its character and before any investigation of basement or adjoining rooms is undertaken.

There should be no taking of chances or waiting for a second impression or confirmation that the odor is not increasing or is dying away. Second impressions may mislead, owing to the fact that the nose loses its sensitiveness when subjected for a while to a gaseous atmosphere.

If on opening a door into the basement or an adjoining room, the odor there seems stronger, it is safer not to enter. If there is no fire or flame burning in the room, and if it is unoccupied, it is safer to close the door and leave the premises, if necessary, to wait until the gas company's man arrives. If it seems important that the basement or room should be entered as to extinguish lights or to rescue persons sleeping or unconscious, no *light should be carried*, and a watcher should be stationed outside to summon aid in case the person first entering is overcome.

Since gas travels sometimes for a considerable distance, it may be found at points far removed from the real source of leakage. Gas in dangerous quantities may pass through the foundation walls of buildings, as from the street under frozen ground into the basement, or from the basement of an adjoining building, and also through party or partition walls, and through floors, as from the basement to first-floor rooms.

6. CARE OF METER AND PIPING

In the use of gas the householder is little concerned with the equipment by which the gas is carried from the gas company's mains to the appliances where it is burned, so long as the gas supply

is adequate. This equipment includes the service piping by which the gas enters the building, the meter for measuring the gas, and the house piping. When properly installed and tested the meter and piping are not a source of danger and should require no attention from the householder, and in general this equipment should not be disturbed. In case of failure of the gas supply or leakage *the gas company should be notified*, and the correction of the trouble left to its representative or to an experienced gas fitter.

There are certain details in the installation of the meter and the piping system which require special experience not always possessed by plumbers that do not make a specialty of gas fitting, and it is essential that all of the installation be made in a workmanlike manner and in accordance with the best practice, and that it be thoroughly tested for tightness after being installed.

Since details apparently trivial may be very important in insuring both safety and satisfaction in the use of gas, the householder should not undertake to do the gas fitting or appliance installation work himself, unless he is certain that he understands exactly how the work should be done and has available the tools which are necessary for proper work. In many cities ordinances are in force which forbid such work by anyone except registered or licensed workmen, and only such men should be engaged. The householder is especially warned against opening any plugged or capped outlets while the gas is turned on. To do so allows the escape of large quantities of gas, and one may be quickly overcome before the opening can again be closed.

If the householder finds any appearance of serious defects in the piping work in his house, he may well ask the city plumbing inspector or the gas company to determine if the work is properly done and safe.

Certain defects can readily be detected and if noted should be corrected. For example, the pipe should be securely fastened in place so that the joints can not be strained by movement of the pipe. The pipe should not sag or be bent in any way to permit a low point in which water could collect and partly shut off the gas. No electrical connections should be permitted to any part of the gas-piping system; the "ground wires," of telephone, electric conduits, etc., should, of course, be properly grounded, but *not* on the gas pipes.

Especially after repairs of leaks have been made, the householder should observe whether the nature of the repair is permanent

FIG. 14.—*A poor gas meter installation*

Meter unsupported; connections strained by objects leaning against meter and forcing it out of place; meter cock practically inaccessible because of its position in the corner behind the meter

or not. A permanent repair usually consists of a replacement by a new part of the defective portion of the system. Temporary repairs, such as wrapping the pipe with tape or cloth bandages or the use of such adhesive materials as soap or wax, may be resorted to in an emergency; but such makeshifts should not be allowed to remain for any length of time, ordinarily not even over night. The householder should insist that a permanent, first-class job be done without delay. Furthermore, old piping that is nearly rusted through should be promptly replaced before there is any danger of leakage, which occurs most frequently at the joints first, for it is there that the pipe is weakest and also most subject to rusting.

The gas fitter should be encouraged to use pipe of generous size which will insure an adequate supply of gas for satisfactory operation of present and probable future installations. It costs very little more at the start to put in the larger pipe during construction of the building, whereas later it may be very expensive to substitute the larger size needed for new appliances or even to give satisfaction with those already installed.

Gas piping should not be placed in outside walls or where stoppages may be caused by ice or liquids condensed from the gas during cold weather.

The house piping in basements is sometimes used as a support for clothes lines, and so severe a strain is put on it that breakage of the piping or leaks in the joints may result. The same results are likely to occur if wood, coal, or other material is piled against piping.

Inflammable materials and rubbish should not be placed near the meter, since a fire in such material would be likely to melt the meter or its connections and the flame of the escaping gas might greatly increase the extent of the fire. A 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 especially should never be tampered with or subjected to strains. It is an instrument of precision and is usually constructed of sheet metal which will not resist hard knocks or strains. It is generally one of the weakest parts of the piping system, because breaking of its case will cause the leakage of gas. The householder should, therefore, allow the company to install the meter where, in their judgment, it will be safe from mechanical strains, falling objects, and other harmful conditions such as excessive heat, cold, or moisture. Meters are frequently

placed on shelves or other supports to take the weight off the connections. Such support should never be removed.

The practice of some gas users 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. Similarly, the installation of so-called "house governors" or "regulators," except those installed on the inlet side of the meter by the gas company, is not justified; these devices may seriously obstruct the flow of gas in the piping or may dry out and permit leakage of gas. 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; but having once shut off the gas *it should not, under any consideration, be turned on again by the householder.* The gas company should be notified and requested to turn on the gas. This precaution is so important that in some cities even experienced gas fitters are not allowed to turn on the gas unless actually in the employ of the gas company.

Whenever the gas is to be turned into the house piping, the householder should assist the gas company representative in making sure that there are no gas burners open in any room before he turns on the gas. In case there are any rooms which can not be entered to make sure of this, do not allow him to turn the gas on. A serious instance of neglect of this precaution is known which occurred in one of our large cities not long since. The customer did not take this precaution, but assured the gas man that everything was all right, and insisted that he turn on the gas, which, unfortunately, he did. A few hours later the householder's son was found dead in his room, asphyxiated by gas from an open jet.

Similarly, great caution should be exercised in putting coins in a slot meter when the flow of gas resulting from the previous coin has all been used. The householder should never introduce another coin in the meter until absolutely certain that there are no open burners. Regrettable accidents have resulted in many cases from lack of care in this matter.

7. PURCHASE AND INSTALLATION OF APPLIANCES

Considering the vast number of houses in which gas appliances are used and the relatively few accidents which result, it is evident that the use of gas has been made very safe indeed. The accidents which occur result almost invariably from carelessness, ignorance, or failure to observe the necessary precautions in the purchase, installation, and use of appliances.

Many accidents are caused by the use of inferior appliances. There are many devices of this class on the market, for the reason that some manufacturers have endeavored to satisfy the demand of certain classes of customers for low-priced goods. There is, of course, always a temptation to buy the cheaper article, but it is frequently found that a cheap appliance is both dangerous and inefficient. This is clearly exemplified in the small single-burner hot plates and in the quality of the flexible tubing which can be purchased from any of the small neighborhood stores. It is strongly recommended that only those appliances be bought which are made by well-known manufacturers who are generally most careful in conforming to safety requirements. These can usually be purchased from the gas company. In the long run these appliances will be more economical to operate than those purchased from the dealer, who does not always realize the essentials required for safety.

The difference between a good appliance and a poor one will not always be evident to the purchaser. Some of the characteristics of poor appliances will be mentioned in this circular; but in general, the purchaser must depend upon the dealers who have the reputation of handling only high-quality products. Almost invariably the gas company is such a dealer; and the gas company is not only selling gas and sometimes also appliances, but it is selling service as well. It knows that service is obtained only by the use of the best appliances and is most of all interested in having its customers supplied with satisfactory equipment to insure their continued use of gas. In any cases of doubt, the advice of the gas company should be secured, even if the appliance is not actually purchased from it.

The installation of appliances is also a matter which should be given careful attention In general this work should be intrusted only to the gas company or a gas fitter of recognized ability. There are certain types of gas-using equipment which require special knowledge for their installation, and a reliable workman will know just how the job should be done to insure safety and satisfaction to the customer. In order that the householder may satisfy himself as to the safety of the appliance which he may have installed, the important points connected with each type of appliances will be treated briefly. Obviously, however, the very wide variety of uses of gas necessitates a large variety of appliances, and the precautions to be considered with one type will not always apply to all. In cases of uncertainty the customer must be guided by the advice of those most experienced in the special problems.

When installing a gas appliance there are four general considerations to be observed: (1) Determine that the location is suitable for the work intended; (2) make tight and strong gas connections; (3) adequately protect combustible material by proper spacing or insulation; (4) provide for proper disposal of the products of combustion.

It would seem that these four things are almost too obvious even for mention, but persistent violations of good practice in these particulars make it evident that further emphasis on them is needed.

In order that a location be suitable for the appliance, it is necessary that the convenient operation of the device be insured. When awkward or difficult operations are necessary, the likelihood of accident is thereby greatly increased. One should also see to it that excessive drafts are not going to interfere with the operation by blowing out the flame or causing it to flash back and burn inside of the burner.

Location of appliances in small confined spaces is, of course, bad; and in extreme cases, for example, where a large water heater is placed in an unventilated closet, the flame may actually be smothered out by exhaustion of the oxygen in the air. Many cases, less extreme but still serious, result when such heaters are placed in bathrooms, sleeping rooms, etc., without proper provision for ventilation.

The need of tight gas connections is obvious. To insure them it is only necessary to place the appliances on a secure foundation with pipe connections properly made without strains. The use of flexible tubing for connections should be avoided, but where pipe can not be employed, a good flexible tube properly connected is safe. (See the later section on "Flexible tubing," p. 79.)

Gas appliances are, in general, much more easily installed properly to safeguard wood floors, combustible walls, and other parts of the house or its furnishings than are coal or woodburning stoves; and this has led to a carelessness with gas appliances that is often serious. The householder should remember that under many circumstances, especially with cheap appliances, the risk of fire may be greatly increased by neglect of simple and inexpensive precautions.

The fire-prevention section of this circular describes the various methods of covering or protecting combustible materials that may otherwise be subjected to a dangerously high temperature. These rules apply to gas appliances as well as others.

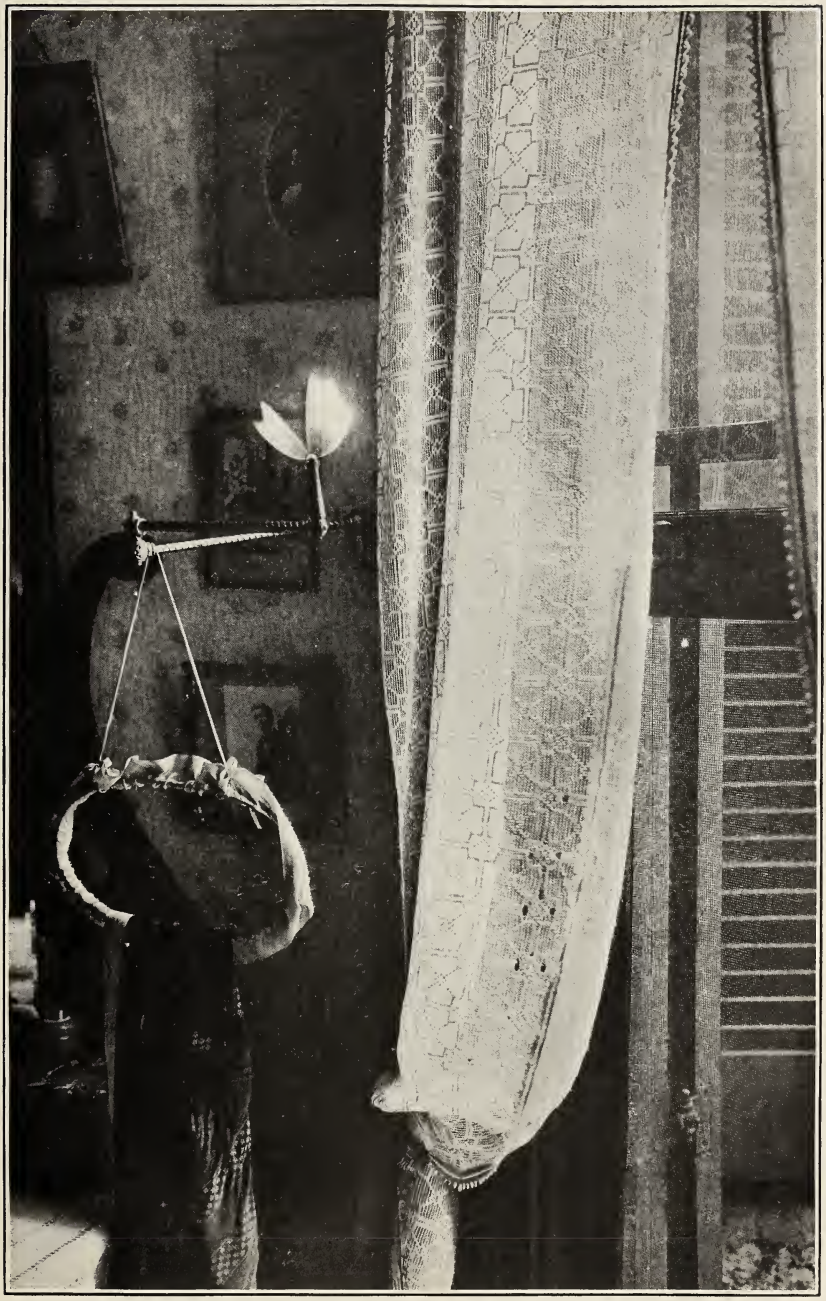


FIG. 15.—*Gas burner on a swing bracket*

A dangerous type of installation which is rapidly being discarded. The flame is likely to be swung against the wall or furnishings. The installation of any gas fixture, especially an open flame burner, so near to window curtains which may be blown into the flame is highly undesirable. Clothing or other objects should never be hung on a gas fixture

Intermittent use of appliances, as is customary with gas, of course reduces the danger of fire, but after repeated heating a combustible material becomes very dry and thus more easily charred or set on fire.

With gas ranges, water heaters, and other common domestic apparatus it is rarely necessary actually to install a fireproofing material, for by proper spacing between the device and the wall or floor all danger is eliminated. Whenever practicable to do so, appliances should be set on legs of adequate length fully to safeguard the floor; and it is generally much cheaper and easier to set the range 6 to 10 inches from the walls on both back and sides than it is to install insulating material. However, if any appliances must be placed so close to the floor or wall that after long operation at full capacity this combustible material gets too hot to touch comfortably with the hands, some additional precautions should be taken. A sheet of asbestos covered with sheet metal, painted to match the wall or trim, and neatly installed is neither expensive nor unsightly. It certainly should be used behind and under appliances more often than is customary. The appliances should be placed so that there will be a circulation of air up between the appliance and the wall, when possible, for this greatly aids in keeping the wall cool.

Usually shelves should not be placed above a stove or heater, but where necessary they should be carefully protected on the under side from the heat. Such shelves are particularly dangerous if covered with paper.

Curtains hanging too near gas burners, especially near open-flame lights, are such a frequent cause of fires that the insurance companies generally report these accidents in a separate group of the classifications. Surely one should prefer in this matter, as in the case of lace shelf paper, to sacrifice appearance slightly in order to secure safety.

The question of disposal of the products of combustion is an important one, especially with large appliances, but there is no reason why this can not be readily and safely accomplished in practically every case. In the first place a good appliance should be used and should be properly adjusted and cared for. However, the danger of incomplete combustion occurring to some extent with all blue-flame heating appliances is sufficient to justify careful attention to the matter of flue connections for these devices.

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8. CARE OF APPLIANCES.

In a great many households spaces behind and around the appliances are used for the storage of brooms, mops, buckets, cloths, and such household necessities. This should not be done, since it is extremely easy for these articles to become raised to a dangerous temperature. A great step forward will be gained if the householder remembers that a gas appliance is not like a coal stove, for although when not in use the appliance is practically cold, yet on lighting it quickly attains a temperature which will set fire to combustible materials in contact with certain parts of it. Of course, care should be taken to keep rubbish, paper, or dirt from collecting around or under an appliance. This is not only unsanitary but also dangerous as a cause of fire.

Appliances should be kept clean. Not only does this help to increase the efficiency, but also it helps to render them safer. If the burners are allowed to become plugged with grease and dust, or if the mixing shutter or chamber is allowed to become clogged with dust, poor combustion will follow and a yellow flame depositing soot and carbon, for example, on the cooking utensils will result. All appliances should be regularly cleaned in a careful manner, and if out of adjustment the householder should call upon the gas company to readjust them unless he can himself do a thoroughly satisfactory job.

9. FIXTURES AND LIGHTING APPLIANCES

There are two general classes of gas lights in use, the open-flame gas jet, which is now becoming less commonly used, and the mantle light. The former is perhaps the simplest of gas-burning appliances. Since it is often used without globe, shade, or any other attachments, the exposed flame may cause fires unless certain precautions are taken. Many fires have been caused by lace curtains, draperies, and other inflammable materials blowing into the flame. To avoid this danger, open-flame lights should not be installed near windows or other places where draperies may be placed; and even if some distance intervenes, it is well to fasten the curtains so that they can not blow into the flame. The same precautions apply to mantle lamps, but to a smaller extent, since the globes or other glassware help to keep the draperies from the flame.

A feature of open-flame gas lights which deserves attention is the kind and construction of the burner tip. Frequently tips are broken, and in such cases the flame, instead of spreading out in

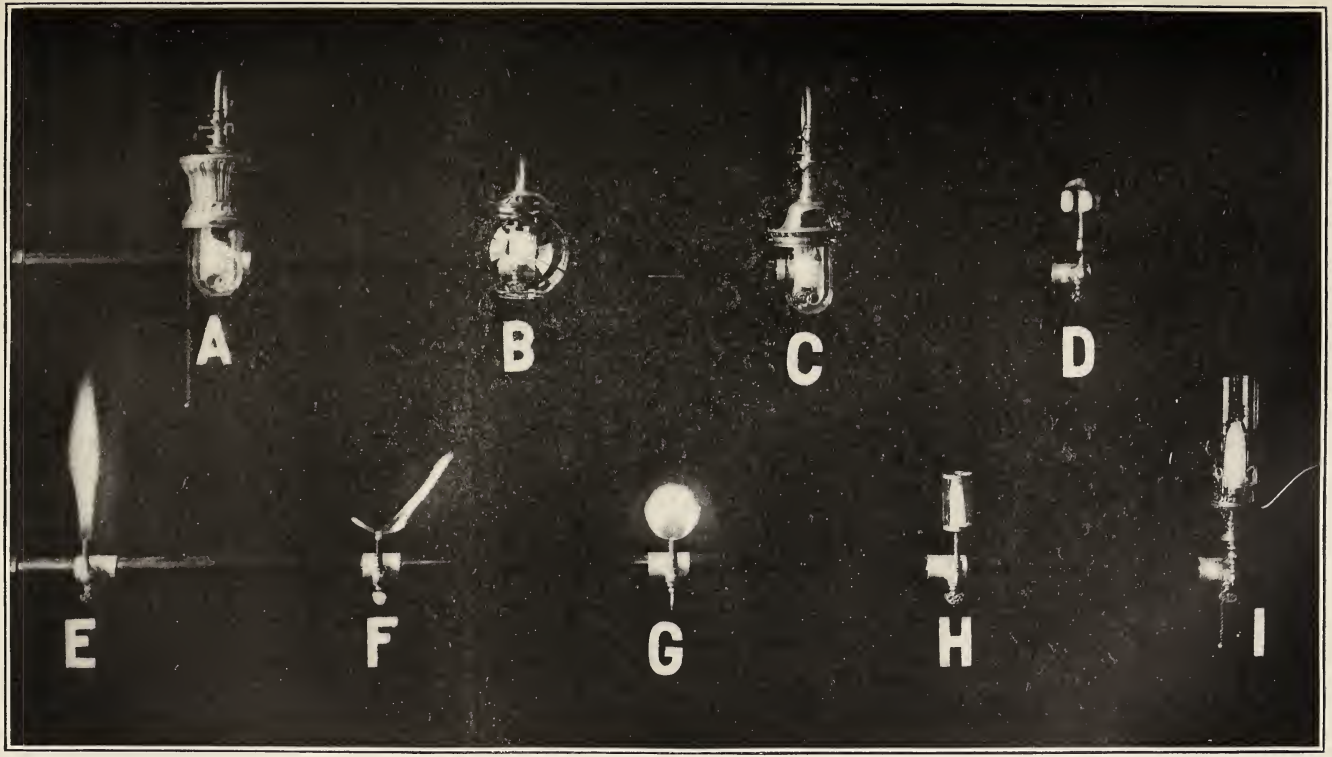


FIG. 16.—*Types of small gas-lighting units*

A, high-grade inverted mantle lamp with stack, a recent development; *B*, cheaper type of inverted-mantle lamp, has no thermostat and only crude gas regulation; *C*, usual type of high-grade inverted mantle lamp with thermostat and good gas regulation; *D*, C. E-Z. mantle lamp; *E*, open-flame burner, with lava tip missing; long, smoky flame is easily blown about by drafts and may easily set fire to surroundings; a burner in this condition is not only dangerous but extremely inefficient; *F*, open-flame burner with broken or dirty lava tip causing deflection of flame, likely to set fire to surroundings; the tip is of a type likely to be lost; *G*, well-formed open flame; tip is so fastened that it can not be easily broken or lost; *H*, junior upright mantle lamp, with mica chimney; *I*, high-grade upright mantle lamp of usual type with gas adjustment device

usual shape, may form one or more long, slender jets which may overheat some of the surrounding materials. Occasionally a burner may be seen in use with no tip at all. This is very bad indeed, not only because of the great fire risk, but also because of the large loss in efficiency which results. If open-flame lights are used at all, they should be so constructed that the tips can not be readily broken or lost.

The gas mantle lamp, which is supplanting the open-flame light, is much more efficient for practically all locations, and is safer. Mantle lights are practically always used with glass chimneys, shades, or other glassware, and even with the slight additional first cost, are more economical to use than open-flame lights. Some of these lamps are lighted by a small constantly burning gas flame called the pilot. This flame sometimes is extinguished, and gas then escapes unburned into the room. While the amount is usually small, it is not to be disregarded; and if upon entering a room a strong smell of gas from an extinguished pilot is noticed, the room should be well ventilated before the flame is relighted.

The glassware of gas lamps should be maintained in good condition, for not only may glass falling from a broken globe injure some one, but also, if highly heated, it may ignite any combustible material on which it falls. Carbon collecting on the mantle because of dirt in or improper adjustment of the lamps also is a serious matter; it is accompanied by a great loss in efficiency, and if hot pieces of the carbon fall from the lamp they may set fire to furnishings. A lamp showing such carbon deposits should be cleaned and adjusted.

An especially bad type of gas-lighting appliance, which is not as common now as formerly, is the swing-bracket fixture. The disadvantage of this article is the danger that the flame will be thoughtlessly swung near to combustible materials. Fires have often resulted from the use of these fixtures, and their installation is prohibited by law in some localities. Where the use of swing brackets can not be abandoned, suitable stops to limit the swing should be provided.

Another point, which should be mentioned in connection with gas lamps as well as other gas appliances, is the importance of having every burner cock fitted with a stop pin, so that it can not be turned on by turning too far around, when the intention is to shut off the gas. Accidents have been often caused because there was no definite stop position. Fixtures without such stops should be considered unsafe and either repaired or replaced by good fixtures.

As with other appliances, the greatest satisfaction and economy in use will result if the lamps and fixtures are well constructed of good materials. Very cheap fixtures must of necessity be made of light materials, and the decrease in strength and quality of workmanship makes the likelihood of leaks developing very great. Especially in the selection of combination gas and electric fixtures, a high-grade appliance should be secured. However, price is not a sure guide to quality, for the cost is more often determined largely by the ornamentation or size than by the workmanship, suitability of materials used, or the correctness of design. The specifications for fixtures recommended by the two national gas associations are an excellent guide; these can be secured by application to either of the secretaries.

Even with well made and strong fixtures there is often great temptation to subject the arms of the fixture to undue strain; especially one should avoid hanging anything on the fixtures. They are not intended as hooks for clothing and can not be safely so used, for there is danger not only of breaking them but also of allowing the clothing hung on them to take fire or to catch on the cocks, and thus allow gas to escape in the room.

Another common cause of strains on gas fixtures is the use of pull-chain stopcocks which have become stiff. These are not only likely to cause leaks, but may also result in shocks that will break the mantles. The remedy is cleaning and lubrication of the cock plug with cock grease or graphite, to permit easy operation. A fixture hung too low often is subject to strains or likelihood of breakage, and it is also objectionable because of the danger to persons who may strike their heads on it while passing beneath. On the other hand, if a fixture is hung too high for convenience in lighting the gas, strains may be placed on it or shocks may break the mantle when someone carelessly tries to reach it from the floor.

Burners should not be installed in any position where combustibles will come in contact with them, nor should any gas lamp be installed close to a combustible ceiling unless a suitable ceiling shield is provided to prevent the ceiling from overheating.

When a hose connection for an appliance is placed on the same outlet with a bracket light, care should be taken that the two control cocks are not so close together that there is danger of the wrong cock being turned on and left open by mistake. The two cocks should be at least several inches apart and preferably be placed at different angles to avoid likelihood of mistake.

A fixture placed where a door may swing against it is also dangerous, for it may be broken off or may set fire to the door. An effective doorstop is the best remedy, if it is not feasible to place the fixture elsewhere.

In selection of gas table lamps one should endeavor to get an appliance with a broad heavy base, for such is much less easily overturned. The tubing to be used and the method of its connection should be carefully considered also. This subject is discussed in the section on pages 79 to 80.

10. COOKING APPLIANCES

No matter what kind of fuel is used for cooking there are certain general precautions that should be taken, and practically all accidents which occur during the use of gas would in reality also occur with any other fuel. By observance of certain simple precautions, gas for cooking may be made fully as safe as any and more convenient than most other fuels.

Several types of gas ranges are in use at the present time, and the safety or danger of these appliances lies partly in the details of design and construction. The gas associations have recently worked out a standard specification for gas ranges, and a range which is guaranteed by a reliable dealer to be in compliance with these specifications is a safe appliance to buy. If there is uncertainty as to the compliance of a particular range with these specifications, it is well for the purchaser to observe the following points of construction which will be included in an approved range and which are of special significance from a safety standpoint. However, full compliance with the specifications can be judged only by careful examination by an expert in gas-range construction.

One of the most important safety features of a gas range is the arrangement of the oven burners and the provision which is made for lighting them. Some ranges are on the market in which there are two sets of burners at different levels in the same oven, one set for broiling and the other for baking. This construction is not to be encouraged, since complete combustion of the gas at the upper burners is not usually possible if the lower burners are operated at the same time on account of vitiation of the air supply to the upper burners by the combustion products from the lower burners. An oven constructed in this manner should not be employed unless a suitable locking device prevents the use of both sets of burners at the same time.

The oven burners of a gas range consume a comparatively large volume of gas in a given time and some safe means should

be provided by which the housewife may light them. All gas ranges should be so constructed that the oven door must be opened before the oven burners can be lighted; and no range should be regarded as satisfactory in which the gas can not be lighted quickly after it is turned on. Failure of the gas to ignite immediately may result in an accumulation of a mixture of gas and air, and this causes a small explosion that may ignite the clothing or burn the hands or face of the user.

To make lighting of the burners safe and easy, a "runner" is often provided; this is, a small arm projecting from the main part of the burner to a point convenient for lighting the gas. The flame started on this runner travels over all the burners and ignites the gas at all of the burner openings without making it necessary to bring a match to them. If a pilot burner of good design is provided, this also greatly reduces the difficulty. The pilot burner should be of such a type that it will ignite the gas at the main burners instantly, and it should in no way interfere with proper combustion of gas in those burners.

A gas range should be so constructed that the housewife can easily see whether the burners are lighted at any time, preferably without even opening the oven or broiler door. In all cases the oven door should be so constructed that it will open readily of itself if any pressure occurs inside the oven. The effects of any slight gas explosion in the oven, should one occur, are thus rendered less harmful.

Ranges in which the flames sometimes lick up on the outside when the oven door is open are very unsafe. This condition can generally be corrected by readjustment of the burners; but if not, a better appliance should be substituted.

The cocks on ranges are an important part of the appliance and should be well made and carefully kept in order. They should have a stop pin to prevent turning too far when the intention is only to shut off the gas, and a spring washer to hold the plug firmly in place is desirable. Any loose or dirty cocks should be cleaned or repaired promptly.

The cleaning and adjustment of the burners to maintain a clear blue flame is also important. In such adjustment the small flame at each orifice on the burner should be distinct and have a sharply defined inner cone. It is not desirable, however, to open the air shutter so wide as to make the flame noisy or to permit flashing back of the flame.

A well-constructed gas range is so well insulated internally that it should not become hot enough, even after continued use, to be likely to ignite combustible materials if kept reasonably distant from it. A comparatively small free air space between the stove and the floor and walls will usually suffice to make the danger from fire negligible. However, a range should not be set close (not less than 6 to 8 inches) to a lath and plaster or other combustible wall; and if the range does not leave at least 6 inches clearance between its base plate and the floor, the floor should be covered with some nonconducting fireproof material. Usually a one-quarter inch layer of asbestos board covered by sheet metal can be installed at small expense and without making an unsightly appearance.

The use of a suitable flue connection for gas ranges, while by no means universal at the present time, is recommended, especially if the range is installed in a small kitchen. The larger the amount of gas burned, the larger is the volume of combustion products given off and the greater the advisability of carrying them out of the house.

It is especially important that the outlet from the oven for escape of products of combustion be never closed; for if a free escape for these products is not provided, they will smother the flames, and then unburned gas will escape with consequent danger of explosion or asphyxiation of persons. Some persons have an idea that closing the vent opening will save heat, but the fact is that it only serves to produce this very dangerous condition.

The proper way to save the heat is to burn the gas only when needed and then at the lowest rate that will accomplish the desired work. The flame should not lick up around the kettles but should be turned down so that the water will boil only slowly. No more rapid cooking can be done with excessively rapid boiling than with a slower boiling, and hence the slowest rate which will do the desired work is the best. This will result not only in economy but also increased safety, for the combustion with the flame in contact with a large vessel filled with cold water is often incomplete.

It is necessary also to guard against turning a burner too low, for it may blow out or flash back, and thus cause bad results. Especially after a burner has been turned down one should be sure the flame is actually burning before turning on more gas.

It is hardly necessary to remind the housewife of the importance of keeping inflammable materials away from a gas range. For

example the range should not be used to dry clothing or other articles if this can be avoided. If necessary to use the range or oven for drying clothing, one should be careful that the articles do not become overheated or slip down on the flame and thus become a source of danger for the entire building. They should not be hung on the oven or oven door.

Few housewives need to be warned of the danger of overheating deep fat when making doughnuts, fritters, etc., or the paraffin used for sealing preserving jars; but the great concentration of heat in the gas flame and the rapidity with which materials are heated by gas may catch the cook off her guard, especially if she happens to be accustomed to a coal fire. Another occurrence which should be guarded against is the likelihood of a vessel of water or other material boiling over and extinguishing the gas flame, thus allowing the gas to escape into the room unburned. The housewife should be cautious about leaving a vessel filled nearly full of liquid over the full flame of a gas burner when her duties call her elsewhere.

Persons frequently light the front burners of a range first and then reach over them to light the rear burners. This is very dangerous if the person is wearing a long flowing sleeve. In order to minimize the danger the rear burner should always be lighted first, after which the front burner may be lighted. At the present time there are flash-pilot devices on the market which can be attached to almost any range. This obviates the necessity of lighting each individual burner and therefore removes the hazard. Small cerium lighters can also be used to great advantage both of safety and convenience; they reduce the fire hazard materially by making the use of matches wholly unnecessary.

In lighting a gas oven a few simple precautuons should be taken to assure safety. The oven door should first be opened and then a match lighted before turning on the pilot. After the pilot is lighted the gas at the main burners should be turned on quickly. It should then be ascertained that the oven burners are actually lighted before turning off the pilot. In case the oven burners light back at the air mixer when turned on, the gas should be shut off at once and then turned on again before the pilot is extinguished. If this lighting back occurs frequently, it is an indication that the air shutter is too wide open, and the trouble may be remedied by closing it slightly. However, it should not be closed far enough to produce a yellow flame. In case the match flame goes out before the pilot is lighted, the gas

should be immediately turned off and another match procured and lighted before the gas is turned on again. In case no pilot is provided, the same precautions should be observed with even greater care. One burner at a time should be turned on and lighted. There should be no hesitation about turning the burners on full and applying the match flame immediately.

11. WATER HEATERS

Water heaters are usually comparatively larger consumers of gas while actually in operation than other domestic gas appliances, and there are some special features connected with them which need special mention. Like other gas equipment, good quality is an essential for safety and economy. Among the essential features of a good water heater from the safety standpoint, the following should be particularly noted:

Every water heater should be provided with a flue connection so that it can be connected to a suitable chimney or flue. In many localities this is made mandatory by law. The flue should be as short and direct as possible, so that the heater may be installed as near as possible to the chimney or flue. The flue connection should be of ample size, should be kept clear, and should not be hampered by any damper except in cases where the draft is very strong. (See section on "Flues," p. 77).

A heater that has two sets of burners, one above the other in the same combustion chamber, is generally unsafe since combustion of the gas on the upper burner can not be complete in the presence of combustion products from the lower one. Such a heater, even though connected to a flue, is hazardous; for any obstruction or back draft in the flue might cause partially burned gas to escape into the room.

Among the other features of construction, which should be insisted upon by the purchaser of a water heater, is that it be provided with a pilot for lighting it, unless it has a door which allows full access to the burner for lighting. As in lighting a gas oven, it is well to have a lighted match ready before turning on the gas. If the match flame goes out before the gas lights or if the burner lights back at the base, the gas should be turned off at once, and after waiting a moment, the lighting tried again. In the case of a water heater with a continuously burning pilot, do not attempt to relight the pilot, if for any reason it goes out, without first closing the main supply valve. The flow of gas from the main burners of such heaters is so large that failure to

observe this precaution may result very seriously. Especially in case of an automatic heater this precaution is very necessary,

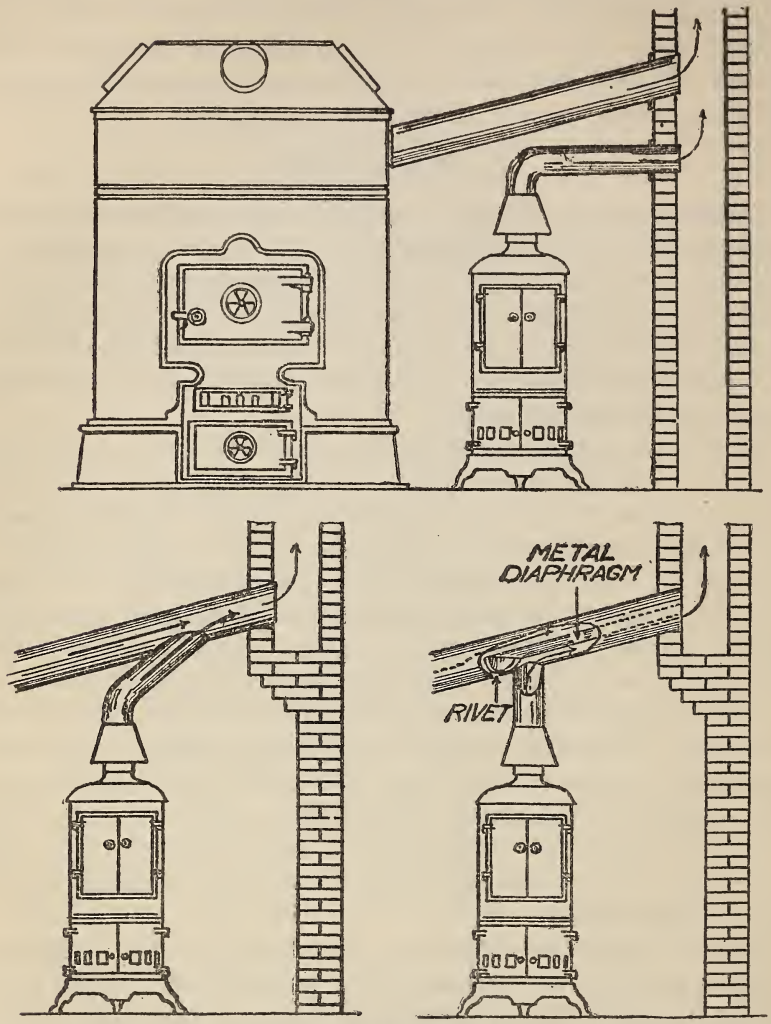
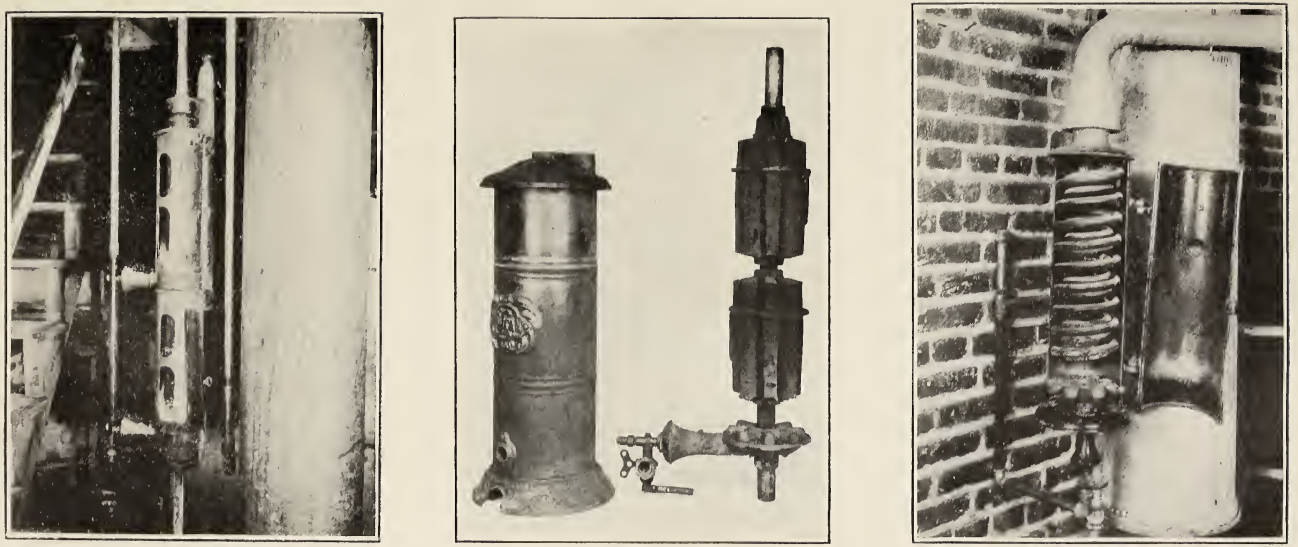


FIG. 17.—*Three methods are shown for connecting a water heater to a chimney to which a furnace is already connected, as recommended by the National Commercial Gas Association.*

and if gas has been escaping into the heater unburned for some time several minutes should be allowed to elapse after closing the main burners before attempting to relight.[3]

[3] If upon lighting a water heater the flames have yellow tips and the gas has not lighted back inside the burner, it indicates that not enough air is entering through the air mixer. In such a case the air mixer should be gradually opened until the yellow tips of the flames disappear and the flames burn vigorously, with distinct, pale-blue inner cones. These inner cones should not be long enough to strike against parts of the heater. If adjustment of the air mixer does not remove the yellow tips, it indicates the presence of dirt or other obstruction in the air mixer.



a *b* *c*

FIG. 18.— *Water heater installations*

(*a*) Old-type heater, objectionable in that flames impinge directly against cold internal water tube making combustion incomplete. Undersize flue connection, without back-draft hood. Small doors prevent convenient access to heating surfaces and burners for cleaning

(*b*) Old-type heater, objectionable because the burner and heating surfaces are not readily accessible; notice the carbon deposits on the heating surface showing that the burner was not properly adjusted, perhaps because the flame was not visible to the operator. This heater was removed from service after having caused the death of three persons

(*c*) Modern tank heater, equipped with copper-heating coil, draft hood, and adequate sized flue connection. Notice the full length door which permits easy access to the burner and heating surface for cleaning

When having a water heater installed, as in the case of a gas range, the work should be done by an expert, and the heater should not be set near any inflammable materials without adequate heat insulating materials between. The installation of a water heater in a bathroom or sleeping room, even with a flue connection, should be avoided whenever possible.

12. ROOM HEATERS AND GRATES

Room heaters may be divided into two classes, the yellow-flame type and the blue-flame type. Assuming that the combustion of gas is complete, there is no objection to either type and no more heat is derived from burning the gas in one manner than another. In the installation and use of either type of heater, the same general precautions apply as are described for ranges and water heaters. It is necessary to get good combusion, to provide escape for the products, to guard against fire to the dwelling and its furnishings, and to prevent burns to persons.

A small yellow-flame heater in which the flames do not strike against any surfaces is safe for use in well-ventilated rooms with out a flue, provided it is well made and suitably placed or insulated so that none of the surroundings can become overheated, Such yellow-flame heaters are generally best for portable appliances which can not be connected to flues. With such heaters special precaution should be taken to prevent the contact of combustible house furnishings, such as draperies, with the flames or the hot surfaces of the heater. No such heater should have exposed flames so placed that they might set fire to the clothing of persons standing near.

An essential feature of a blue-flame heater is arrangement by which part of the air necessary for burning the gas is mixed with the gas inside the burner, just as in the burners of a gas range. The air is drawn in by the flow of gas at the air mixer, and any interference with this mixer may become a source of danger unless the heater is connected to a flue. Without such connection there is danger that poor design, sudden air drafts, or large changes in gas pressure may cause the gas to light back at the mixer, causing incomplete combustion and the discharge of dangerous gases into the air.

Generally speaking, blue-flame heaters should be connected with a flue. However, there are some heaters of this type of such good design and constructiou that they may safely be used without a flue for such auxiliary heating as any of these small heaters are

adapted for. The use of a flue necessarily makes a heater stationary, and flexible tubing should not be used, but the heater should be connected to its gas supply by solid piping.

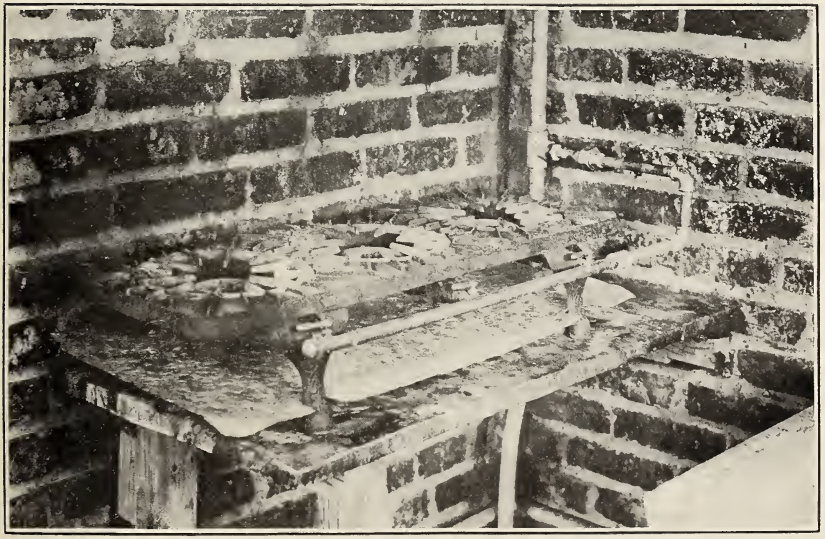
In the installation of fireplace heaters, one should not be deceived by the false fireplaces, such as those so commonly found in cheap, rented houses. In such false fireplaces, only those heaters should be used which are constructed like portable heaters, and they must, of course, be carefully insulated. One should insist that the gas logs or gas grate be installed in a regular brick fireplace such as would be used for coal or wood fires. This will not only provide good fire protection, but also furnish a good flue connection.

13. LAUNDRY AND MISCELLANEOUS GAS APPLIANCES

There are other gas-burning appliances in domestic use aside from those already mentioned. They are generally safe, for reasonable exercise of care will absolutely eliminate all danger, provided, of course, that such appliances are well constructed; but there are few special comments to be made concerning them. Among the more common of these appliances are gas irons, hot plates, laundry stoves, garbage incinerators, and clothes driers. The gas iron and the hot plate are perhaps the most frequently met with of these appliances.

The gas iron is necessarily connected with its gas supply by flexible tubing, and this necessitates some attention. There should be a convenient point of attachment of the tubing to the gas-piping system. The very common practice of connecting the iron by slip end tubing to an overhead gas fixture is not advisable. Frequently the connection is not tight and the weight of the tubing and motion of the iron back and forth is likely to put an undue strain on the fixture, eventually causing leaks. The connection of the tubing to the iron is another matter of importance, since if weak it is likely to pull off. It is preferable that a locked connection between the hose and iron be used to avoid this danger. It would seem hardly necessary to warn the housewife against leaving a gas iron standing on the ironing board with the gas turned on; however, this practice is by no means unusual. It is perhaps oftener that the housewife disconnects the gas iron when done with it, and while it is still hot, wraps the tubing around the iron and puts it away. There is seldom any danger of fire from this practice, but the hot iron causes the tubing to deteriorate very rapidly, so that it soon becomes leaky. Even the so-called metallic tubing should not be treated in this manner, since the

A poor installation; the hot plate is connected by flexible tubing with insecure ends of poor quality. Notice that gas supply is turned on at the pipe which would result in leakage if rubber ends split. The hot plate stands on a wood shelf with no protection between the burners and the shelf, which has been charred. Papers, matches, etc., are seen lying dangerously near to the burners



The same installation with defects corrected. The hot plate is connected with solid piping; the shelf has been covered with metal; a metal baffle has been placed between the burners and shelf top and the combustible materials have been removed

FIG. 19.—*Gas hot-plate illustrations*

tubing usually depends for its tightness upon a thin strip of rubber in the folds of the metal spiral. When this is destroyed by heat the tube will leak. It is usually inadvisable to leave a gas iron burning, even if on a fireproof stand, when called away to another part of the house, since if the iron lights back at the air mixer, this not only results in incomplete combustion but also is likely to overheat the end of the tubing.

The use of a hot plate or laundry stove presents the same conditions, in general, as the use of the top burners of a range, but the hot plate is often an inferior article which, on account of the conditions frequently attending its use, presents some hazard. Hot plates are frequently employed in small unventilated kitchenettes, being placed on a table or shelf and connected by flexible tubing. In some of the cheaper hot plates, the burners are only a few inches above the top of the table. To be safe, a hot plate should have the burner at least 6 inches above the table top and 3 or 4 inches below the burners should be a baffle plate to protect the table from heat. The hot plate should be placed at least several inches from a combustible wall, or the wall should be protected by a layer of asbestos covered with sheet metal. The use of tubing is not to be recommended for hot plates; the connection should be by solid piping whenever practicable. If tubing is used, care should be taken that the gas is always shut off at the pipe as well as at the appliance.

The garbage incinerator heated with gas becomes very hot when in use and discharges its combustion products at a high temperature; consequently, even though it be only one of the small form attached to the kitchen range, it needs suitable protection for its surroundings and a well-constructed flue.

14. FLUE CONNECTIONS

Whenever a blue-flame appliance is used, it is desirable that it be provided with a suitable flue if practicable. It is recommended, therefore, that all gas-range ovens be connected with flues, and it is absolutely essential that no water heater be installed in any part of the house without a flue connection. The installation of such appliances without flue connections in small rooms, such as bathrooms, is especially dangerous; it is, in fact, prohibited by law in many cities. In some cases a canopy is also an aid to good ventilation, especially over gas ranges where it serves to remove the odors of cooking as well as the products of combustion of the gas. The canopy must, of course, be connected to a flue. It is also

important that it be as short and direct as possible, free from unnecessary bends and other obstructions. For example, there should usually be no damper in a flue to a gas appliance, as such damper, if closed, would result in smothering of the gas flame. However, occasionally where the draft is very strong or where the gas flue connection may interfere with the draft for another appliance, a damper is necessary; and in such cases one should be provided which can not be tightly closed. This is accomplished by having one or two good-sized holes through the damper or by arranging it to fit the pipe very loosely. Of course, the damper must be open when the gas appliance is in use.

In any case protection against back draft should also be provided, so that such draft may not entirely prevent escape of the products of combustion and smother out the flames, thus acting just like a stoppage in the flue. A safeguard against the serious results of back draft should be used, in the form of a back-draft hood or safety collar in the flue. These devices are arranged to give escape for the products of combustion out of the flue into the room in case the normal outlet is closed to them. They thus largely eliminate the bad effect of an occasional back draft; but, obviously, no such device will correct a flue which never "draws," and for such flues other means must be adopted.

In general, it is best to have gas appliances connected to independent flues rather than to connect them to the same flue as the furnace or other coal or wood burning heating device. However, when a good chimney connection can be secured no other way, it is better to use a furnace flue than to have no connection. In such cases one of the three methods of connection shown in Fig. 17, p. 74, should be used.

It should be remembered that the products from burning gas, although ordinarily cooled down to safe temperatures in the appliance, are sometimes very hot, and all the precautions should be observed in installing a flue connection for gas appliances that would be necessary with the stovepipe of a coal or wood stove. For this reason the practice, which sometimes exists, of ending a flue connection in a closet or attic or running it through wood walls or partitions without the use of a spacing sleeve should not be permitted. To end a flue within the house might in some cases cause an accumulation of unburned gas which could subsequently be ignited and cause a disastrous explosion. The danger of contact of a heated flue pipe with combustible materials is obvious. For the same reason the hanging of clothes or cloths on flue pipes to dry is not safe.

15. FLEXIBLE TUBING

Gas connections made with flexible tubing have been frequent sources of accident to life and property, and these have resulted in municipal regulation and stricter requirements by fire-prevention authorities. A number of gas men are endeavoring to develop a satisfactory standard for gas-tubing construction. This has already resulted in improved construction, and there are now available several types of tubing which, if used with care, may be considered safe.

It is undoubtedly more convenient to connect many appliances with flexible tubing, while some appliances from the nature of their use require such connection. However, appliances should be connected with pipe wherever it is possible, for it can be depended on to remain tight and is really cheaper in the end. Where tubing is absolutely necessary only the best should be used, and one should not let a difference of a few cents in the price influence him into buying inferior tubing, when it is a question involving the health and safety of the household.

For special purposes where extreme flexibility is required, there are a few rubber tubings of good quality which are safe, but for general purposes such as connecting up room heaters and hot plates, the tubings built up around a rubber-packed metallic core and covered with various layers of waxed paper, cotton fabric impregnated with gas-tight compound, etc., will be most satisfactory and safe.

A good grade of tubing of this type should be strong enough, so that it will not crush if one accidentally step on it, it should not pull apart if subjected to a considerable strain, and it should remain gas tight if bent or twisted.

There is more chance of leakage at the end connections than in the tubing itself and metal connections should be used wherever possible.

When rubber ends are necessary, they should be of good-grade rubber, which will not harden and split as any made of cheap scrap rubber will do. The rubber end should be of correct size to fit the appliance or fixture connection on which it is to be used and should be firmly attached to the tube best by means of a metal piece which is securely screwed into the corrugations of the metallic core.

Tubing should be attached without kinks or twists. The tubing should not be subjected to more than moderate heat and should be guarded from pulls or strains. It should be immediately rejected when any signs of wear or defects appear.

If the tubing end pushes onto the metal nozzle easily, it is evident that it may pull off easily by accident. It is therefore dangerous and should be discarded even if the rest of the tubing seems good. Accidental slipping off of the tubing from the metal nozzle is the cause of many fatal accidents, and every time such a joint is made by pushing the rubber end over the metal nozzle the householder should realize the importance of slipping it on so far and securing it so tightly that there is no danger of its accidentally coming off.

One should not be deceived by the flexible metal tubing which appears wholly noncombustible, for the joints of some of this tubing are made tight by a thin rubber thread which serves as a packing. This packing is readily damaged by heat and hence this tubing like other varieties must not come in contact with the hot parts of an appliance nor be allowed to hang above the appliance while in operation or until some time after the gas is turned off and the appliance is cool.

Certain very cheap appliances are so built that the end of the tubing by which they are connected is attached close to the mixing chamber of the burner. In such cases the tubing is certain to be damaged, perhaps even burned or melted completely off, if the gas flame flashes back and burns in the mixing chamber. Such appliances must be connected with pipe or have an extension piece of metal screwed on the burner, so that the rubber end is kept at a safe distance from hot parts.

With appliances that are connected with flexible tubing the shut-off should be only in the piping, except on portable lamps equipped with by-pass and pilot or on appliances having more than one burner where the burners require individual control, for which a shut-off on the appliance end of the tubing may also be needed. When the gas is shut off at the piping there is no chance for escape of gas in case of damage to the tubing when the appliance is not in use. The wall outlet to which an appliance is to be connected with flexible tubing should be so placed as to reduce to a minimum the passing to and fro across the tubing, and the flexible tubing used should be of the minimum practicable length. Tubing fastened overhead should not be hung where anyone passing under it is likely to strike it. When a shut-off must be placed close to the floor or in other position where it might otherwise be turned on by accident, one should be used on which the key is fitted with a safety snap or locking device.

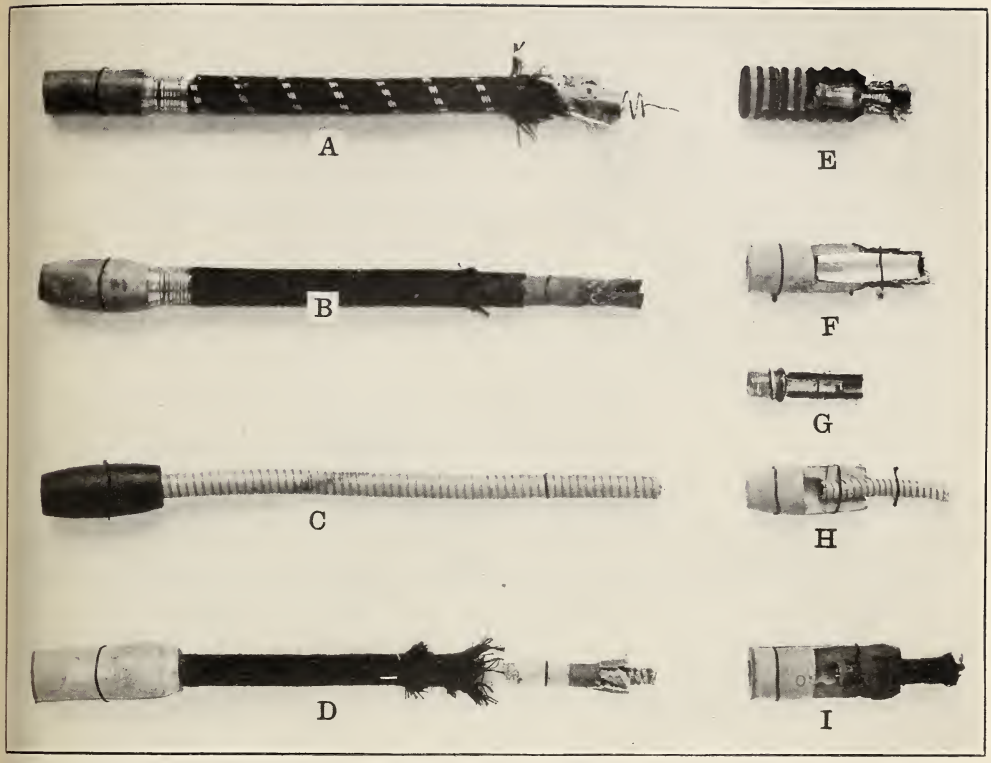


FIG. 20.—*Various types of flexible tubing and tubing ends*

(*A*) A dangerous type of tubing constructed of paper, covered with glue, on a wire spiral, the whole covered with a cotton braiding giving it a good outside appearance. The glue soon hardens and cracks upon bending the tubing. One manufacturer of tubing says of such material, "The demand is very largely for the cheapest tubing that can be turned out that will stay tight long enough for it to be sold"

(*B*) This tubing, constructed like a garden hose of cotton fabric impregnated with rubber, is flexible, gas-tight, but dangerous if subjected to high temperatures

(*C*) The common type of metallic tubing, which depends for its tightness upon a rubber thread packing within the metal spiral. This rubber thread deteriorates with age, especially if overheated, causing small leaks in the tubing which might allow dangerous quantities of gas to escape, though not presenting much fire hazard

(*D*) A very good grade of flexible tubing constructed of a gas-tight metal core covered with successive layers of paper, fabric, glue-glycerine compound, paper, and two braided coverings. It has the advantages of a metallic tubing of type (*C*) with some additional durability due to the superimposed layers

(*E*) A very satisfactory type of tubing end piece if constructed of good quality materials. It consists of a threaded metal tail piece, one end of which is screwed into the tubing and the other end is screwed into the rubber end piece, making the connection about as strong as the tubing itself

(*F*) A common, but not always satisfactory, connection, consisting of a wood tail piece glued into the tubing and rubber end. The gas passage is unduly restricted. The strength and durability depend upon the quality of glue used and the care with which the end is attached

(*G*) An all-metal end piece screwed into the tubing; a very satisfactory connection where it is not necessary to connect and disconnect frequently. In attaching to an appliance care must be taken not to get the threads crossed

(*H*) Tubing is glued into rubber end piece directly. The strength of this type of attachment is usually small and leaks are very frequent with it

(*I*) Metal tail piece is screwed into end of tube and is held in rubber end piece by corrugations which fit corresponding corrugations in the rubber. This is usually a satisfactory method of attachment

16. ACETYLENE

Acetylene is a hydrocarbon gas commonly used for lighting and occasionally for cooking and heating in locations where electricity and city gas are not available. Since it becomes an explosive compound under certain conditions it must be handled with care; especially it is necessary to guard against subjecting the gas to more than 15 pounds pressure. In all particulars the safeguards against explosion of acetylene-air mixtures are the same as for mixtures of city gas and air. Great care must also be taken in the storage of the calcium carbide from which the acetylene is generated; this material must be kept dry or this gas is given off. The selection of a good acetylene generator is very important and in general only those devices which have been examined and listed by the Underwriters' Laboratories (Inc.), of Chicago, Ill., should be used, since nearly all the high-grade generators manufactured in this country have been so examined and listed by this testing laboratory.

The Annual Proceedings for 1916 of the National Fire Protection Association include a set of rules which are of greatest interest to the householder in selecting and installing acetylene generators. The rules relate to selection, installation, care, and operation of acetylene generators, including such details as foundations, space about generators, ventilation of generator rooms, protection against freezing, water supply, drain connections, vent or relief pipes, accessibility of generator to unauthorized persons, storage of carbide, and similar subjects. It is recommended that the full instructions be obtained from the secretary of this association by all who have or intend to install these devices.[4]

[4] Address National Fire Protection Association, 87 Milk Street, Boston, Mass.

V. FIRE HAZARD IN THE HOUSE

1. SERIOUSNESS OF THE FIRE HAZARD

The destruction of life and property by fire is a constant waste of human and material resources which the Nation as a whole can ill afford and which is fraught with vital and momentous consequences to the individuals directly involved. Enormous sums are spent each year in providing men and equipment for fire fighting, and yet the annual loss continues to mount from year to year until it has reached proportions which it is hard to realize. It has been estimated that over 5000 lives are lost in the United States each year from fire—the number of fires total nearly 400,000, or about 40 per hour.

The enormous losses by fire each year are due largely to the carelessness and negligence of the people, although some are the result of natural causes, such as lightning, and a few originate in incendiarism. A large proportion of fires, like accidents, are preventable, and a moderate amount of knowledge and care are all that is necessary to greatly reduce the losses. The proper construction of buildings, care in preventing fires, and limiting their spread when started would reduce the toll of lives and property now chargeable to lack of precaution, to negligence, ignorance, and carelessness.

According to statistics gathered by the National Board of Fire Underwriters, the average fire loss per captia for the last 40 years has been about $2 per year. It has been estimated that the above amount must be increased by another $2 to cover the cost of fire protection. If we add to this figure $3 per capita paid to insurance companies in excess of returns from them, we obtain an approximate cost to the American public of $7 per year for each man, woman, and child. This represents a total cost of nearly three-quarters of a billion dollars per year, and does not include the loss of business during rebuilding, loss of wages, and retarded growth.

Based on an estimate of 20 000 000 establishments, including dwellings, in this country, and of about 400 000 fires each year, it will be seen that fires occur annually in about 2 per cent of the total number of buildings.

It has been estimated that the direct fire loss per capita in our cities is from five to ten times that in many of the European cities.

In this connection it is only fair to expect that such should be the case, in view of the rapid growth of our cities, which would have been unduly hampered by legislation enforcing the same type of construction required abroad. On the other hand, it is reasonable to expect that in the future the adoption of reasonable fire-resisting construction and fire-prevention measures will materially reduce this very great disparity in fire waste.

The public sometimes loses sight of the fact that insurance only distributes the fire loss, which still remains as an indirect tax upon the people, and which causes an increase in the cost of living.

That there is a very large toll of lives due to fire is generally recognized. It is unfortunate that the various States do not report their losses in the same way, so that the figures can be added. As an instance of how great the number is, the fire marshal of the State of Illinois reported 387 deaths due to burning in 1913 and 287 in 1914. During the latter year the losses were distributed as shown in Table 1.

TABLE 1.—Lives Lost as the Result of Fires Due to Various Causes

[Report of State fire marshal of Illinois, 1914.]

Starting fires with kerosene	39
Clothing ignited by stoves and grates	39
Clothing ignited by matches	34
Gasoline explosions	27
Clothing ignited by bonfires	27
Burned in burning buildings	26
Clothing ignited in manner unknown	24
Gas explosions	13
Clothing ignited by kerosene lamps	12
Electrocuted or burned with live wires	9
Dynamite explosions	9
Fireworks display explosions	6
Stove-polish explosions	5
Clothing ignited by sparks from pipes	4
Struck by lightning	4
Clothing ignited by lighted candles	3
Fireworks setting clothes on fire	2
Motion-picture film explosions	2
Clothing ignited by Christmas trees	2

The above losses correspond to 4.8 deaths per 100 000 of population for 1914 and 6.6 per 100 000 for 1913, or about one-half of 1 per cent of deaths from all causes.

2. FIRE AND SPONTANEOUS COMBUSTION

Rapid combustion accompanied by the evolution of heat and light as manifested by the presence of flame is briefly termed "fire." Combustion is the process of rapid chemical combination of the

combustible material with the oxygen of the air. Many substances combine slowly with the oxygen of the air at ordinary temperatures, liberating heat, but the action is so slow that there is no appreciable rise of temperature. Some familiar examples are the tarnishing of metals and the drying of oils in paints. With other substances, phosphorus, for example, the action is so rapid that the temperature is raised, which further increases the rapidity of the action, and so on until the substance ignites without the application of a flame; that is, *spontaneous combustion* takes place. With many other materials in which the oxidation is relatively slow, spontaneous combustion may still occur if the loss of heat is sufficiently prevented. Materials of this character are particularly hazardous, and this explains the reason why oily rags and waste are dangerous materials to have lying around the home. There are many fuels, textile materials, oils and varnishes, hay, grain, and similar materials which are subject to spontaneous combustion.

To show how easily fires may be started by spontaneous combustion, a few illustrative tests were made with oily rags and waste such as are often found in rubbish piles about households. The oily matter on the rags consisted of homemade floor polishes and paint oils. The tests were purposely made, starting with liquids and rags at ordinary temperature, and the specimens were grouped in the manner exhibited in Figs. 21 and 22, to particularly illustrate the danger lurking in rubbish piles.

The pile in the upper part of the figure was smoking when the photograph was taken, although the color of the background prevented it from showing clearly in the picture. The charring of this material is readily evident on its upper surface.

3. SAFEGUARDING AGAINST THE FIRE HAZARD

The danger from fire may be greatly diminished by proper installations within buildings, by suitable construction of buildings, by due attention to surrounding conditions, and by provision for fire-extinguishing equipment to handle fires in the early stages. These matters will next be briefly considered.

(*a*) Selecting or Building a Home

The general rules or ordinances governing building construction, and sometimes more detailed information, can usually be obtained from local building departments. Many of the national associations have issued excellent specifications which may be obtained for the asking. For instance, the National Board of Fire Underwriters[5] has issued a code of suggestions for

[5] National Board of Fire Underwriters, 76 William Street, New York, N. Y.

FIG. 21.—*Illustrating spontaneous combustion on oily rags and waste*

Upper sample charred and beginning to smoke

FIG. 22.—*Showing blaze due to spontaneous ignition of one of the samples*

the construction of dwelling houses. Fire hazards can often be very materially reduced by simple changes in plans, or by providing fire-fighting equipment. Such changes in plans may involve little or no increase in cost. Where an increase in cost of from 10 to 25 per cent is feasible many important features of fire-resistive construction may be incorporated into the plans. The architect should always be consulted by the prospective builder as to the possibilities along these lines.

The following recommendations all have a more or less important bearing on the fire hazard, and should receive due consideration when selecting or building a home.

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 advisibility 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 near-by 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 fire brands 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 fire stops 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 dry-rot, and the use of sapwood in places subjected to dampness should be avoided.

CHIMNEYS AND FLUES.—One of the serious fire hazards is that due to *defective chimneys and flues*. Good construction will minimize this hazard and will render the formation of cracks later, due to vibration, loading, settling, or expansion and contraction, less likely. The important elements that enter into *good* construction are too detailed to be treated here. The National Fire Protection Association [6] has issued a small pamphlet under the title "Chimneys and flues," and has suggested a model ordinance governing such constructions.

EXPOSURE FIRES.—The remedy to be applied for the hazards of "exposure" fires is usually found in fire-resistive construction. This means a relief from the danger from fires in adjoining buildings and a step toward elimination of conflagrations. Many of the present types of dwelling construction in this country constitute hazards which frequently result in a very serious community disaster when a fire originating in one building spreads to neighboring buildings and gets beyond control of the fire-fighting facilities of the community.

Municipalities are making an effort to fight spread of fires by requiring the people to construct the external walls and decorations

[6] National Fire Protection Association, 87 Milk Street, Boston, Mass.

of their homes only of brick, concrete, and other fire-resisting materials, using fire retardants such as wired glass in hazardous openings. It is generally found that the elimination of the frame building, and particularly the shingle roof, results in a material decrease in the number of exposure fires.

The shingle roof is a particular manace which is always ready to receive fire brands from other buildings. It is not surprising that its use is prohibited in many localities. Not infrequently a fire brand is lifted high in the air and carried several blocks before alighting on another building. Thus new fires are often started which have all the possibilities of causing serious conflagrations. Many prosperous communities, and even whole cities, have been destroyed through this manace.

Other features of building construction can be mentioned to indicate the hazards of exposure fires. These include the use of fences, barns, porches, and other frame additions to brick or otherwise fire-resistive buildings.

(*b*) **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.

Anyone 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 a 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

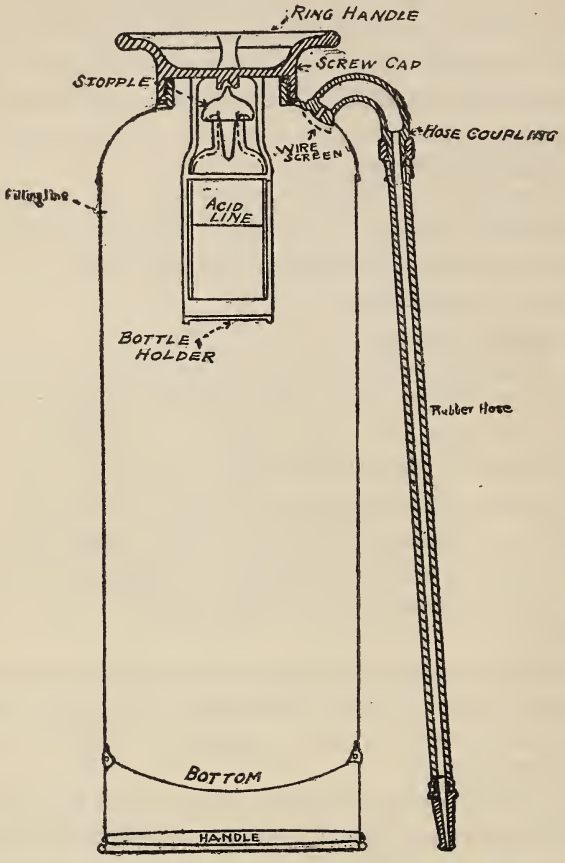


FIG. 23.—*Sectional view of a soda-acid fire extinguisher*

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 sulphuric 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 tetrachloride, either pure, or mixed with other substances.

FIG. 24.—*Soda-acid fire extinguisher, held upright until fire is reached*

FIG. 25.—*Soda-acid fire extinguisher, inverted at fire and set into action*

Fig. 23 shows the internal construction of the soda-acid extinguisher as it is made by a large number of manufacturers. An extinguisher of this type appears in Figs. 23, 24, and 25. The essential features of this 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 sulphuric acid to flow from the bottle into the soda solution in the container, liberating carbon-dioxide 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 dioxide 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-tetrachloride type of extinguisher the liquid is ejected from the extinguisher into the fire, usually by some kind of pump. Figs. 26 and 27 show one of the forms in which this extinguisher is made. 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.

Fig. 26 shows the *wrong* way to direct the liquid on a fire; that is, at the flames themselves.

Fig. 27 shows the *correct* way to direct the liquid from a fire extinguisher on a fire, directing the stream at the place where it will do the most good; that is, at the material which is burning.

Figs. 24 and 25 illustrate the method of handling the soda-acid type of fire extinguisher, viz, carrying it in the upright position until the scene of the fire is reached and then inverting it to set the extinguisher into action.

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, (2) weight and ease of handling.

The carbon-tetrachloride 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-tetrachloride extinguishers in the small size usually sold. On the other hand, the small size and weight of the carbon-tetrachloride 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-tetrachloride than with the soda-acid type.

FIG. 26.—*The wrong way to use a fire extinguisher*

FIG. 27.—*The right way to use a fire extinguisher*

(*c*) Fire Retardants

The British Fire Prevention Committee has published the following formula for making curtains and draperies noninflammable:

2 pounds sulplate of ammonia
4 pounds chloride 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 one-half 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; one-half 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.

4. CAUSES AND PREVENTION OF FIRES

(*a*) Statistics Relating to Causes of Fires

An important preliminary step toward reducing the fire waste is a careful analysis of the causes of fires and of the occupancies in which such fires occur. Table 2 is a tabulation of the assigned cause of 189 228 fires reported in State fire marshals' reports for 19 States during the years 1909–1915. Table 3, from similar sources, gives the nature of the occupancies in which fires occurred. This table shows that over half of the fires occurred in places of abode.

TABLE 2.—Assigned Causes of Reported Fires

Causes of fires	Fires	Per cent of total
Unknown causes	40 824	21. 57
Smokestacks, chimneys, soot	14 645	7. 74
Matches	14 449	7. 63
Adjoining or exposure fires	10 751	5. 68
Sparks:		
Unclassified	7986	.....
Locomotives	1721	.....
Total	9707	5. 13
Overheated materials	9263	4. 90
Ignition:		
Flaming materials	1553	.....
Gasoline and benzene	2978	.....
Hot grease and oil	4221	.....
Tar and rosin	354	.....
Total	9106	4. 82
Lightning	8460	4. 47
Defective flues	7957	4. 20
Cigars, cigarettes, and pipes	7712	4. 08
Incendiary:		
Unclassified	5435	.....
Burglars	24	.....
Pyromania	8	.....
Tramps	426	.....
Total	5893	3. 11
Children:		
Matches	4959	.....
Mischievous	277	.....
Playing with fire	89	.....
Christmas trees	426	.....
Total	5751	3. 04
Spontaneous combustion	4758	2. 51
Heating apparatus:		
Stoves	2781	.....
Furnaces	1500	.....
Total	4281	2. 26
Rubbish	2141	.....
Bonfires	2120	2. 25
Electricity	4191	2. 21
Lamp and lantern accidents	3694	1. 95
Miscellaneous causes	2766	1. 46
Explosions:		
Unclassified	1044	.....
Chemical	69	.....
Dust	6	.....
Oil and gasoline	465	.....
Gas	928	.....
Total	2512	1. 33
Wood near sources of fire	2350	1. 24
Grass, forest, and stubble	1993	1. 05
Ashes and hot coals	1991	1. 05
Open:		
Fires	475	.....
Lights	853	.....
Fireplaces and grates	351	.....
Total	1679	.....
Gas	569	.....
Gas jets	1099	.....
Gas and gas jets	1668	.....
Thawing water pipes	1392	.....
Engine and boilers	1330	.....
Fireworks	1191	.....
Candles	1180	.....
Friction, hot boxes, etc	664	.....
Automobiles	502	.....
Torches and mechanics' torches	305	.....
Laundry and flat irons	192	.....
Floods	155	.....
Films	141	.....
Fumigating	109	.....
Lime slaking	25	.....
Unclassified	1380	.....
Total percentage of causes under 1 per cent	.....	6. 32
Total	189 228	100. 00

TABLE 3.—Occupancies in Which Fires Occurred

Occupancies	Fires	Per cent of total	Occupancies	Fires	Per cent of total
Dwellings	105 616	45.39	Offices	2370	1.02
Barns, stables, and liveries	22 654	9.74	Shops	2334	1.00
Stores	19 250	8.27	Lofts and business buildings	1733	.75
Tenements	13 087	5.62	Restaurants	1659	.70
Factories	8039	3.45	Theaters and motion-picture houses	1532	.66
Sheds	4973	2.14	Saloons	1516	.65
Automobiles	4943	2.12	Schools, colleges, and seminaries	1225	.53
Apartments, flats, boarding and rooming houses	3658	1.57	Dwellings with other occupancies	1208	.52
Drug establishments	3317	1.43	Miscellaneous	25 307	10.83
Warehouses and storage	3120	1.34			
Hotels (with some hospitals)	2652	1.14	Total	232 707	100.00
Garages	2514	1.08			

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.

(*b*) 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.

(*c*) Matches

The third named in the list of causes of fires in Table 2 is "matches." Note also the association of matches with children later in the table. 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 on the floor and be ignited in various ways. Many fires also result from throwing lighted matches on 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.

(*d*) **Cigars, Cigarettes, and Pipes**

The discarded lighted match, cigar, or cigarette 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, cigarettes, or pipes. Such sparks, and lighted cigar or cigarette 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, 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 surprising how many persons we see each day who forget and carelessly or

wilfully neglect to observe precautions which make this hazard such a dangerous one for others who have to endure the results of these bad habits.

(*e*) **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 just as thick bundles of rags and clothing are more frequent offenders than are thin layers.

(*f*) **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 set on wood floors with the metal extending beyond the 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.

(*g*) **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 tetrachloride type is superior, as water solutions tend to scatter the burning grease.

(*h*) **Rubbish Fires and Bonfires**

It is common practice 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.

(*i*) **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 practice 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 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 to properly 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.

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(*j*) Gasoline

The three liquids, gasoline, benzine, 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.[7] 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-tetrachloride 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

[7] George A. Burrel, "Hazards in Handling Gasoline," Bureau of Mines Technical Paper No. 127, p. 10; 1915.

though 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, although 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 tetrachloride (also used in fire extinguishers, as previously noted) 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 tetrachloride 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 tetrachloride to render them reasonably safe than do those of lower volatility. A mixture of equal parts of gasoline and carbon tetrachloride is frequently used. If the naphtha is very volatile (e. g., 70° Baumé), the mixture should contain at least 60 per cent, and for 76° Baumé naphtha at least 70 per cent carbon tetrachloride. With such mixture there is no serious fire or explosion hazard from open containers, although the mixtures will burn when spread out over surfaces of fabrics.[8]

[8] See carbon tetrachloride as a cleaning and solvent agent; also see National Fire Protection Association Quarterly, Oct., 1917, p. 173, 1917.

The following are a few suggestions for use when handling gasoline:

1. Keep gasoline outside of the house even though 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 cigarettes away from gasoline. 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.

(*k*) **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 cigarettes 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.

(*l*) **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.

(*m*) **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 practices. 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. (See the electrical chapter, p. 34, for precautions to be observed.) 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.

(*n*) Benzine 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 benzine stove polish.[9] In 1914, in Illinois alone, five women were burned to death through the explosion of the common benzine stove polish. There are many benzine stove polishes manufactured which are made of nearly the same ingredients, the only difference being in the name. The principal advantage of benzine 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

[9] Illinois fire marshal.

hazard of using this material is, however, so great, that it should be entirely banished from the home. While the directions usually state that 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 benzine 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 benzine 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 polish. This recommendation should be followed and only fireproof polishes, whether in liquid, powder, or paste form, should be used. It is better to take a few more minutes to do this work rather than introduce the hazard of the benzine stove polish.

(*o*) **Lightning.** (See p. 45.)

The hazards to life and property due to lightning and the methods of protection therefrom are considered in a separate publication entitled "Protection of Life and Property Against Lightning," Bureau of Standards Technologic Paper No. 56. Statistics seem to establish as a fact that the percentage of fires due to this natural cause is very much less in rodded than in unrodded buildings. Whether the rods are of copper or iron makes little difference; the important point is proper installation, including location and grounding. The subject is also treated in another part of this circular.

(*p*) **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.

5. WHAT CAN THE PUBLIC DO TO DIMINISH THE FIRE WASTE

From the foregoing considerations of the causes of fires and of safeguarding against the fire hazard, it will be seen that most fires can be prevented by (1) good construction, (2) care in installation, (3) care in handling, (4) good housekeeping, and (5) suppressing criminal intention.

Thus, our chimney fires, exposure fires, and even lightning fires may be obviated to a large degree by good construction.

Care in installation has been recognized as the reason why we now hear of comparatively few fires due to electrical devices. The same will apply to gas, lamps, engines, and boilers.

Handling open flames and inflammable materials carefully will have a noticeable effect upon the number of fires from those causes.

The dangers due to spontaneous combustion, rubbish and bonfires, ashes and hot coals, open flames and lights, and to carelessness in general will largely yield to good housekeeping.

The sentiment of the community in dealing summarily with incendiarism will have a useful effect in dealing with tramps, pyromaniacs, mischievous children, and misguided individuals.

It might thus be said that nearly all fires are preventable, and it is reasonable to look forward to a marked diminution in their number. With the observance of suitable precautions, it should be possible to free ourselves from the greater portion of the heavy yoke with which the fire waste burdens us.

One commendable effort to arouse public enthusiasm to reduce the fire waste consists in the setting apart of one particular day each year for the special consideration of "Fire and accident prevention." October 9 has been selected by most States as it is the annniversary of the great Chicago fire, and therefore serves as a fitting reminder of what suffering and property loss a conflagration may cause.

There is also a strong movement in many localities to reach the household through the children. The school training includes explanations of the domestic fire hazards. Frequently children are asked to act as "fire wardens" of their homes, and the results have been very encouraging.

The following suggestions have been prepared in the form of 14 fire cautions. If these were universally and adequately observed by everyone, the fire waste in the country would be materially reduced. Attention to these apparently trivial things

on the part of large numbers of people will 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, cigarettes,* and *matches* into waste-paper 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 near-by windows may cause fires quick to spread and difficult to extinguish.

9. Use *gasoline, naphtha, or benzine* 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. (See chapter on "Gas dangers, p. 54.")

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. (See chapter on "Electric dangers, p. 10.")

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.

6. WHAT TO DO IN CASE OF FIRE.

First. Collect your thoughts. Keep your mind on what you are doing. Act quickly.

Second. Summon help if anyone is within calling distance.

Third. If the blaze is small and you think you can put it out by devices which are available, either

(*a*) Use a fire extinguisher; or

(*b*) Use a woolen blanket or rug to smother the fire. Keep the air from the fire. Or

(*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-tetrachloride extinguisher if available. Or

(*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.)

Fourth. Unless you are very sure that you can handle the fire without help, notify the fire department or have some one else do this. Many have been sure until too late.

Teach each member of the family the method of sending in a firealarm. 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 fire box. 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 surprising 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.

Fifth. Cut off all draft, closing doors, windows, and closets in the room, and use available methods of fire extinguishing as mentioned above.

Sixth. 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.

Seventh. 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.

Eighth. 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.

Ninth. 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, portiere, 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 near.

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.

VI. HAZARDS ARISING FROM THE USE OF CHEMICALS

The hazards arising in the household from the use of dangerous chemicals, either separately or in mixtures with inert matter, as well as those from materials in themselves actually or supposedly harmless which may become contaminated, may be considered for convenience under the following two heads: (1) Dangers from materials in common use without thought of risk, since they, in themselves, are harmless, and in some cases necessary for existence. The contamination of the water supply by means of lead or bacteria or the formation of ptomaines in food are examples. (2) Dangers from materials of unknown or not generally known properties and composition in more or less restricted use. The hazards arising from the use of rodent poisons, disinfecting and fumigating materials, or from the careless storage or use of dangerous chemicals such as caustic soda or corrosive sublimate may be considered in this class.

Apart from the hazards due to the corrosive or poisonous properties of materials or certain ingredients of mixtures coming under the two classes mentioned, those arising from other properties, such, for example, as the use of liquid fuels or other inflammable materials, are considered in another section.

Volumes have been written upon the hazards of the first class, especially those having to do with the water and food supply, and it is beyond the scope of this circular to do more than point out their existence, giving in some cases general directions for their avoidance. As is well known, the term "poison" is entirely relative, the poisonous action depending upon the amount involved. Some of the most dangerous and active chemicals are used in small quantities for medicinal purposes. Substances of this character should be used only under a physician's direction and will be considered in this circular only in so far as they are used commonly for other than medicinal purposes. Only the hazards that are very common owing to the widespread use of certain drugs and medicines will be considered.

1. DANGERS FROM MATERIALS IN GENERAL USE

(*a*) **Water**

The purity of the water supply for a household has long been recognized as of vital importance. The introduction of chemical impurities, however, is unimportant in comparison with the dangers of bacterial contamination. In thickly settled regions where dangers from such contamination are likely to be greatest, the water purification becomes a public-service function. In places where the householder must look to his own water supply and where in general the possibilities of contamination can be reduced to a minimum by cleanliness and certain precautions, it is sometimes necessary, in order to assure satisfactory water, to filter through sand or charcoal, to boil, or in some cases even distill the water. Water for drinking or cooking purposes should never be run through lead pipes or stored in lead-lined containers, as the accumulative effects of small quantities of lead taken into the system are very disastrous. Tin or any alloy used for this purpose should contain no more than 1 per cent of lead where in contact with the water.

(*b*) **Food**

The food supply for the ordinary household should be subject to scrutiny from the following standpoints: The presence of harmful preservatives introduced either to render bad food preservable or to preserve food which is preserved only with difficulty; the possibility of the presence of specific poisonous material from food containers, wrappers, or utensils used in cooking; danger from food contamination by bacteria and parasites. In order to avoid contamination of foodstuffs by lead from containers used in preserving, from wrappers such as tin foil, or from cooking utensils, metal coming directly in contact with food should contain less than 1 per cent of lead.

The hazards involved in the water and food supply, including milk, are very important to all, and for detailed information on this subject the reader is referred to the large number of publications on these subjects issued by the Department of Agriculture and the Public Health Service.

(*c*) **Liquid Fuels and Gas**

The main risk in using materials of this character as fuels or for dry-cleaning purposes is that due to fire which is considered in another section. Continuous inhalation of gasoline vapors may produce unpleasant results, and it is advisable to use it in the open or in well-ventilated rooms when used for other than fuel purposes. This is an even more important

precaution when wood alcohol or denatured alcohol is used for cleaning or other purposes where the vapors may be breathed or come in contact with the eyes.

Illuminating gas and the products of its incomplete combustion are extremely hazardous when confined in a closed space, and their consideration forms the subject of a section of this circular. This is chiefly due to the poisonous action of carbon monoxide. Air containing 0.06 to 0.08 per cent acts poisonously while as little as 0.1 per cent has caused fatal results.

2. DANGERS FROM MATERIALS MORE RESTRICTED IN USE

(*a*) Paint and Varnish and Other Pigment-Containing Materials

The use and storage of paints and varnishes presents both a fire risk, considered on page 84, and a poison risk. The heavy metal salts, as those of lead and mercury used as pigments, are among the most dangerous materials of this class. Though soluble lead salts in rather large quantity are necessary for acute poisoning, the insoluble pigments containing lead cause chronic poisoning when in contact with the skin for considerable periods of time or introduced into the system in other ways. Though materials of this nature become particularly dangerous in the hands of children, poisoning of this kind most frequently occurs as an occupational disease. Vermillion, a salt of mercury, in not very extensive use as a pigment, is among the most poisonous likely to occur.

Articles of rubber for use by children, such as nipples, teething rings, and similar articles, should be free from salts or oxides of antimony, arsenic, lead, and mercury which are frequently normal and useful constituents of certain types of rubber goods. Examinations by the Public Health Service have shown articles of this character to be free from the latter two metals. Antimony sulphide may occur in black as well as red rubber, and while not dangerous is likely to cause digestive disorders. Similar metallic pigments used in lithographic inks for use in printing picture books may cause trouble in the hands of children.

Methyl alcohol, the main constituent of wood alcohol, is a particularly dangerous substance because of its peculiar paralyzing effect upon the optic nerve, causing temporary and sometimes even permanent blindness. Shellacs and varnishes containing it should never be used except in well-ventilated rooms and preferably in cool weather. The other volatile constituents present chiefly a fire risk.

Linseed and other drying oils used in paints and varnishes present a dangerous fire risk owing to the rapidity with which they

are spontaneously oxidized, causing elevation to ignition temperatures when finely distributed on rags, cotton, or similar material. Silk is the most dangerous of the textiles in this respect, followed by cotton and then wool. Boiled linseed oil containing driers as well as the raw oil is dangerous from this standpoint. Rags soaked with oils of this character should never be left where it is possible for them to ignite other materials.

Metallic pigments similar to those used in paints and metallic salts for fixing dyes on textiles present a certain hazard when used in the coloring of wall papers, tapestries, artificial flowers, and certain types of colored cloth goods. For example, antimony mordants in cloth irritate the skin, and chromium mordants give rise to an occupational disease among dressmakers who continually handle the material. The use of green arsenic pigments in wall paper has practically disappeared, owing to the agitation many years ago against their use. The danger in this case was more acute than with nonarsenic compounds, because of the dust particles containing arsenic and the formation of very poisonous and disagreeable organic arsenic compounds and arsine from the action of yeast and bacteria on the wall paper, especially under damp conditions.

(*b*) **Polishing and Cleansing Materials**

Polishing materials for metals, shoes, floors, etc., as they occur in the household, frequently contain substances the use of which presents a certain risk, and in general articles of this character should be used with precaution as to contact with the hands and particularly the more sensitive portions of the body.

Oxalic acid and certain of its salts used in some kinds of shoe polishes and in ink eradicators are poisonous and corrosive. The former, frequently used for cleaning purposes such as refurbishing straw goods and as a metal polish, is frequently mistaken for the harmless Epsom salts, with very disastrous consequences. Floor polishes and shoe polishes frequently contain small amounts of nitrobenzene to disguise other odors. This material is highly objectionable when inhaled even in small quantities. Benzaldehyde, of much the same odor, can be used for the same purposes and is much less objectionable. Many polishes and dry-cleaning materials contain or consist of inflammable liquids and on this account present the same risks and should be used with the same precautions as gasoline and other similar fuels which are considered in another section. Chloroform and carbon tetrachloride for dry cleaning, used alone or in mixture with gasoline to make the

latter noninflammable, while obviating the fire danger when mixed in the proper proportion, may cause anesthesia. Carbon tetrachloride presents much less danger in this respect.

While potassium cyanide, one of the most deadly poisons, very rarely occurs in metal polishes or cleaners except as they are sometimes used in certain trades, it is a "safe" rule to handle this type of materials with great care. Caustic alkalis, frequently used about the house for removing paint or varnish or making soap from refuse fats, are very irritating to the mucous membranes of the body and present a frequently-occurring and dangerous hazard. Especial care should be taken when opening cans to prevent fine dust from lodging in the eyes or nostrils. Ammonia water as purchased and used for household purposes rarely contains more than 5 per cent of ammonia and as such presents few risks, unless the bottle is heated up and opened in that condition. Considerable pressure may be developed, with the possibility of throwing a spray of the material into the face. While very disagreeable permanent injury is much more likely to occur with caustic alkali, great pain is caused by the action of ammonia on the sensitive membranes of the eyes, nostrils, or mouth. Concentrated ammonia (containing about 25 per cent), to be diluted as used, is much more economical for use about the house, but the attendant hazard is also greater. It should be kept in a cool place and only opened in a well-ventilated place, holding the face well away from the bottle. There is no danger of taking enough of this material internally to do any damage, because of its highly irritating action on the mucous membranes. The stronger acids, which are not in such general use, should be used with similar precautions. The concentrated sulphuric acid used in charging carbon-dioxide fire extinguishers should be handled with extreme care. It is well to remember that acids and alkalis mixed with plenty of water are more or less counteracting in their effects. In case of accidents with alkali, use weak acidic materials, as lemon juice or vinegar, and in case of accidents with acids, use weak ammonia liquor, limewater, or solutions of baking or washing soda, followed by extensive washing with water. This applies to cases where the corrosive material has come in contact with the skin, fabrics, or other materials which may be damaged.

(*c*) **Fumigating and Disinfecting Materials**

Since substances used for fumigation and disinfection—that is, the destruction of insect or germ life—are in general injurious to

health and human life, they may be regarded as the most dangerous type of chemicals used about the house, both from the standpoint of hazard while in use and accidental substitution for harmless substances. Some of the most poisonous chemicals are in common and extensive use for this purpose. Fumigation, which involves the poisonous material as a gas, its most active and dangerous form, and which is used primarily in destroying life as that of fleas, lice, bedbugs, ants, and sometimes rodents, is carried out quite extensively with hydrocyanic-acid gas, sulphur dioxide, and formaldehyde. The first mentioned presents the greatest hazard of all substances used for this purpose, and if not used under expert direction, it should be used only with full observance of the full directions for use as given in Government publications. Fatal accidents have occurred from such a careless thing as going into the room or house being fumigated for a forgotten article. Due attention should be paid to giving adequate publicity to the dangerous operation being carried out. Sulphur dioxide and formaldehyde have very disgreeable temporary effects upon the respiratory organs and the eyes but are not likely to cause serious injury.

Bleaching powder, producing gaseous chlorine which acts as a fumigant, should be used with caution. On the whole, the use of formaldehyde presents the least danger and gives good results as far as its disinfecting power is concerned. Sulphur dioxide and chlorine have a bleaching action and will injure nearly all colored material exposed to them. In addition, they have a corrosive action on metals in the presence of moisture, and all metal articles should be well protected or removed from their sphere of action, if they are expected to retain their metallic luster.

Corrosive sublimate (mercuric chloride), carbolic acid (phenol) and its derivatives, and other substances used for antiseptic purposes on the person, may be used in stronger solution for disinfection or as insecticides. The first two mentioned are in quite general use in the household, and being extremely poisonous and corrosive in their action on the body, many accidents occur, owing to improper use or mistakes in use. Accidental poisoning by mistakes in connection with these two poisons is, perhaps, the most commonly occurring of all fatal hazards in the household. Care in handling and storing can not be too forcefully insisted upon. Materials of this character, no matter for what used, should not be readily accessible to anyone. The bottles should have their stoppers tied or wired in, should be plainly labeled, and should not

be in a place where they may be mistaken for harmless materials. Mistakes of this character most frequently happen in the dark, and judging from the number of accidents of this character, it would be well to insist upon having a special-shaped bottle or one provided with a luminescent radiolite label indicating poison unmistakably. In the case of corrosive sublimate frequently occurring in tablet form, in the interest of safety the tablets are colored blue or given the suggestive shape of a coffin. Solutions are frequently colored blue with copper sulphate so as not to confuse them with other colorless solutions. These measures are all precautionary in nature, and none is likely to be infallible in every case.

(*d*) **Insecticides**

In addition to the materials used for fumigation and disinfection, which may also be used for killing insects and rodents, certain other dangerous chemicals are used as such or as constituents of compounds for specific purposes. White arsenic (arsenious oxide) is used as a poison for flies and rodents. As a constitutent of inferior grades of Paris green, extensively used as an insecticide in vegetable gardens, it presents a considerable hazard to human life. Paris green itself should be handled with considerable care, and vegetables from gardens where it has been used should be thoroughly washed before use. Barium carbonate, also used as a constituent of rodent poison, presents the same sort of a hazard as arsenious oxide but in less degree.

Phosphorus has been used for the same purpose but should be avoided owing to the double hazard of fire and poison. Alkaloids, as strychnine, should not be used for this purpose because of the extreme danger involved in careless or mistaken use. Carbon disulphide, frequently used as a constituent of rubber cement and for destroying ants, though not extremely poisonous is easily inflammable and dangerous because of the fire risk involved.

(*e*) **Cosmetics**

Among the materials used for cosmetic purposes, there are a few which present some hazard. Rouge for cheeks or lips has been the cause of serious mercury poisoning, owing to the presence of vermilion (mercury sulphide). Hair removers are, in general, quite corrosive in character, such as calcium sulphydrate with calcium hydroxide, and sometimes poisonous, as calcium hydroxide with arsenic trisulphide. Dyes used in blackening gray hair generally contain one or more of the salts of silver, lead, copper, iron, or bismuth and can cause serious poisoning when taken internally. It is well to treat all materials of this character as poisons.

(*f*) **Medicines and Drugs**

It is not within the scope of this circular to point out all the dangers incident to the general use of medicines and drugs in the household without expert direction. Their number should be strictly limited, and they should be well segregated so as not to be mistaken for the more commonly used antiseptics and disinfectants. Picric acid in solution, very useful for light burns, is poisonous when taken internally. All medicines and drugs should be provided with accurate and adequate directions as to method of taking and amounts.

(*g*) **Inflammable and Explosive Materials**

The risks involved in the use of materials, or articles made up of materials of this character, such as celluloid and matches, have been considered in another section of this curcular. The more unusual materials, which must be handled with great care when they are occasionally stored or used about the household or farm, are dynamite, gunpowder, and loaded and blank cartridges of all kinds. Matches containing phosphorus in its most dangerous and poisonous form, not only to the public but also to the workers making them, have practically disappeared from the market, so that at this time the main hazard from matches is that due to the possibility of fire. Fulminating caps and detonators sometimes contain the very poisonous material, mercury fulminate, which may be very hazardous.

3. GENERAL PRECAUTIONARY MEASURES

A few of the general principles along the line of which it is possible to reduce to a minimum the large number of accidents and consequent loss of life, health, and property owing to the use of poisons about the house may be stated as follows:

The number of poisons or substances containing poison used or stored about the house should be reduced to a minimum. It is far better to get rid of the surplus of any material of this character that has been in temporary use rather than to have it present in the house as a constant menace. The materials should be plainly and unmistakably labeled and the most dangerous ones should have their stoppers tied in so that an extra effort is required to open the container.

In so far as possible they should be segregated in one place which is inaccessible to children and not too readily accessible to older people. One of the most dangerous hazards arises from having poisons in juxtaposition to patent or prescribed medicines.

The common practice is to have the poisons used for disinfecting and antiseptic purposes in the bathroom. If these can not be kept with convenience along with the poisons and poisonous materials used in other connections, the matter of labeling and rendering inaccessible should demand especial attention.

VII. MISCELLANEOUS HAZARDS IN THE HOME

The preceding sections of this circular have dealt with specific classes of hazards which may arise in the home. Some of these hazards are peculiar to certain groups of people and are entirely foreign to others. Others can be entirely avoided by sufficient precaution. Thus, danger from gas is largely confined to the urban dweller, while danger from fire can be largely avoided by making not only the outer structure of a dwelling fireproof but also using metal window frames, sashes, doors, and interior finish and noncombustible floors. This is so seldom done, however, that it is to be regarded only as a possibility.

There are certain minor miscellaneous hazards which are likely to be present in every house. Some of them can be permanently guarded against to some extent, while only continuous care will suffice to combat others. Attention is called to a number of these in the following paragraphs and suggestions are made for lessening the likelihood of accident.

1. FALLS

Injuries resulting from falls are continually occurring. Some falls are due to reckless practices upon the part of the individuals concerned, while others are due to the lack of proper facilities. Thus, falls down stairs may result from the lack of a baluster or handrail, lack of a gate at the head of the stairs in the case of babies, the presence of sharp turns or narrow treads, all due to defects or omissions in the design or construction of the house. Again, falls may be due to articles left standing on the steps, to the presence of water, slipping on greasy materials on the steps, or to other agencies which are brought into play through the carelessness, negligence, or undesirable habits of certain members of the household. The only cure in this case is the elimination of the objectionable practices.

Falls on stairways and in other obscure places can frequently be avoided by providing adequate illumination, since the falls are often due to the failure to see objects in the way or failure to observe the condition which may favor a fall. In city homes provided with gas or electric service there is little excuse for inadequate lighting, since the condition can be remedied by the installation of a suitable lighting fixture. The lighting unit should be

controlled from the head of the stairs or other point reached before the light is needed. This is easily accomplished by the installation of a wall switch for an electric light, or even by the use of a cord attached to the chain, where a pull-chain socket has been installed. Gaslights can similarly be controlled from a distance by the use of automatic lighters. Where a stairway or dark passage is likely to be approached from more than one direction, a switch should be provided for each point of approach. (In houses where electric or gas service is not available, lamps or candles should be kept handy for use on stairways.)

Another cause of falls arises from slipping on polished floors, either bare or covered with small, loose rugs, slipping on soapy bathtubs, or slipping on wet or icy porches or outside steps. Rubber heels, often intended to avoid slipping, become accessories to such falls when wet, smooth pavements are encountered, unless they are of the antislip type. The high heels, so common on women's shoes, frequently cause sprained ankles when used for rough wear.

Particularly objectionable are small rugs at the top or bottom of stairs, since in such places persons step with considerable horizontal thrust. Danger from loose rugs can be obviated by fastening them to the floor. Where permanent fastening is not desirable temporary means can be used to advantage.

Many persons have been killed by falling in bathtubs, which may become quite slippery when covered with soap. A tub set away from the wall affords a handhold on each side. Where the tub is built in, there should be on the side next to the wall a firm grab rail to help one to get in and out of the tub with minimum risk.

Standing on chairs (especially rockers), on frail boxes, crates, or barrels, and on insecure stepladders is responsible for many falls. Such falls can be entirely avoided by proper care in selecting a mount and seeing that it is steady and secure. Fragile crates and boxes should be avoided, as also should chairs without solid seats. The arm of a chair is a dangerous place upon which to stand, and rocking-chairs should never be used for this purpose.

An upturned barrel makes a precarious stool, as frequently there is nothing to hold the head from being forced inward. Projecting nails on the inside may inflict bad scratches or worse.

Serious and even fatal injuries have resulted from falling only 2 or 3 feet, and the hazard is especially great for elderly persons,

whose bones are brittle and nerves less able to stand sudden shocks.

Many stepladders are of poor design or poor construction, and too much care can not be exercised in purchasing this piece of household equipment. It will usually pay to buy the best ladder available and to keep it in first-class condition. Many stepladders are provided with a folding shelf for holding a bucket of water or other working materials. It is dangerous to stand on this shelf, which has not been designed to hold the weight of a person, and the ladder may be out of balance with such a distribution of weight. Care should be taken to see that the spreaders are in proper position before mounting the ladder.

The straight ladder, utilized more for outdoor than indoor work, must be used with care on smooth floors or pavements, as there is danger from the base slipping out. In such cases it should be blocked or else held steady by an assistant. Climbing a ladder while carrying something in one or both hands involves hazard. The safe way is to carry up a rope (over the shoulder, leaving hands free), and then hoist a basket or other articles up afterwards.

Children frequently experience bad falls by climbing outside of porch railings or upon the ledge of mansard roofs. Where opportunities of this kind invite the venturesome child, cautions should be voiced from time to time, or perhaps, good methods of climbing taught. Similarly, every child should be given some hints on tree climbing. Pole climbing should be discouraged on account of the danger from live wires.

2. CUTS AND BRUISES

A great many unnecessary cuts and contusions are experienced in the home through the careless or improper use or neglect of tools or other objects with sharp or ragged edges. Children are especially prone to use tools improperly when not instructed in proper and safe methods. Knives and other edged tools should have the cutting stroke made in such a direction that a slip will not cause the blade to cut the operator. Especially when the point is being forced through an object is this precaution necessary. The heads of hammers and axes may fly off if not securely fastened. Monkey wrenches with jaws which have been sprung make trouble when a hard pull causes them to let go.

Trash in the form of broken glass and crockery, or old tins with ragged edges, is a frequent cause of bad cuts and scratches. Such articles should be handled carefully and should be placed at once

in appropriate receptacles for disposal. Where such trash is permitted to accumulate on vacant lots, children should never be allowed to run barefoot, as serious cases of blood poisoning have resulted from cuts produced in this way.

Sanitarians condemn the practice of licking envelopes and other gummed articles for the purpose of sealing them. The sharp edge of the paper has sometimes cut the tongue when wiped along the edge of the paper. If the tongue is used for the purpose, a wiping motion should be avoided and the tongue merely pressed against the gum in several places. This avoids the chance of cutting the tongue and also avoids wiping the gum off of the paper. The skin on the more tender parts of the hand is not infrequently cut similarly by being drawn along the edge of stiff paper.

Bruised fingers frequently result from being caught by doors, windows, screens, etc. Children should be warned against this hazard and especially against being caught behind the hinged edges of doors.

Bruises on the head are often the result of insufficient headroom in cellars, on stairways, etc. This is a matter to be considered when building a house. It should especially be remembered that part of the headroom in a basement or cellar will later be utilized by hot-water pipes, electric conduits, etc., and consequently more than the minimum headroom should be left beneath the joists.

Electric batteries for ringing doorbells are frequently placed in very insecure locations, so that a slight pull upon the loose terminal wire may precipitate the battery upon the head of the unwary. Dry cells may now be secured with terminals so arranged that the whole cell screws into a socket, just like an electric incandescent lamp, and any danger from the cell falling off the edge of a shelf is obviated. If ordinary cells are used, they should be placed in a box.

The flooding of a floor by upsetting a vessel of water or from a roof leak frequently results in soaking the plaster of the ceiling below. Such plaster is very likely to fall, and the floor below it should be shunned until the plaster dries again.

Treatment of Bruises

A bruise or contusion is an injury where the tissues beneath the skin have been torn, but the skin itself has not been opened. Blood oozes out of the injured vessels but can not escape as the skin is still intact. The symptoms are swelling, tenderness, and a feeling of soreness or pain. Discoloration of the skin occurs quickly

in superficial contusions and in places where loose tissue abounds, but only after days when the injury is deep-seated. This discoloration is at first red and then successively, purple, black, green, and yellow. This play of colors is due to the changes which take place in the blood while undergoing absorption.

A pad of gauze or soft towel should be tightly bandaged over the injured part to stop hemorrhage, after which cold should be applied except in old or feeble persons or where the contusion is extensive. In the latter cases heat is best, as cold might cause gangrene. Evaporating solutions, such as witchhazel, a 15 per cent solution of alcohol in water, or a saturated solution of Epsom salts, are often found of great benefit. A contusion should not be opened, except in rare cases when it is necessary to stop persistent bleeding. If an opening is made through the skin, germs are liable to enter and cause severe inflammation, resulting in the formation of pus.

3. MACHINERY

All kinds of machines, whether motor-driven or not, present hazards when not properly constructed and properly handled. Too great care can not be exercised when purchasing mechanical equipment to see that all possible protection against accidents has been provided. Thus, all machines which involve gearing should have the gears inclosed so that fingers and clothes are absolutely prevented from getting caught in them. This applies to washing machines, ice-cream freezers, churns, bread mixers, and many other forms of household appliance. Wringers, especially the motor-driven wringers attached to washing machines, should have a guard to prevent the fingers from entering between the rolls and in addition, should have a release device so that extreme pressure upon the rollers will throw them out of gear. Sewing machines should have a guard to prevent the fingers from getting under the needle. Electric fans should always be provided with a guard. Any machines having blades or other sharp parts should be handled with great care. A lawn mower may easily cut off the fingers if turned while being cleaned. Motor-operated saws and farm machinery require similar care. Young children should not have access to such machines, as they do not realize the dangerous possibilities involved in trying to make them work.

4. SWALLOWING SMALL ARTICLES

Pins, tacks, coins, and similar articles having sharp points or edges, or which are small enough to be swallowed, should never be

placed in the mouth. Such articles may cause much trouble if swallowed, and blood poisoning sometimes results from cuts or scratches inside the mouth.

5. SCALDS AND BURNS

The careless handling of hot water may result in painful and even dangerous scalds. The lid of a teakettle should not be lifted while the kettle is held by the handle, as the sudden heat of the steam evolved may burn the hand or cause the grip to be released and the kettle dropped. Boiling pots of water near the edge of the stove may be knocked over or be pulled over by children and produce serious scalds. It is dangerous to carry a child and a kettle of boiling-hot water upstairs at the same time, as tripping may bring the two in contact.

Treatment of Scalds and Burns

The proper treatment of scalds and burns will often lessen the pain which is caused by them, and also result in earlier healing. Much of the following information is from the Medical Handbook of the United States Lighthouse Service.

Burns or scalds are serious and dangerous to life in proportion to the extent and depth of the injury. A burn covering a large area and producing mere reddening and swelling of the skin is as serious as a burn one-half the size in which the skin is destroyed. The danger is from shock, from fever following reaction, from hemorrhage following sloughing, and from congestion and inflammation of internal organs. Burns of slight extent or moderate degree are not so dangerous, and most of the cases commonly met with will recover. But all cases require careful treatment.

The pain from burns will be lessened by keeping the air away from them. Lint or cotton dipped in a solution of baking soda (1 teaspoonful to a pint of water) can be used on burns by means of a bandage. Sweet oil may be used if soda is not available. Cotton should not be used on an open wound, as it will stick to the flesh.

If the burn covers any large portion of the body, a doctor should be immediately sent for, as it is then dangerous to delay having professional help.

The indications for treatment of burns and scalds are virtually the same if the damage is superficial; and this is usually the case, the injuries being only skin-deep. Blisters should be pricked with a needle that has been passed through a flame several times. This allows the water to escape from the blisters, but the skin

raised by the blisters should not be removed. If the burning agent is pitch or tar, and adheres to the skin, it should not be removed; it will come away later with the blistered skin. Any bland oil, such as sweet oil, linseed oil, or vaseline, forms a soothing application. The old "Carron oil," made of linseed oil and limewater, half and half, is excellent, but has an unpleasant odor.

FORMULA FOR LIMEWATER.—If limewater is not at hand, it may be obtained as follows: Quicklime is first slaked by adding to it gradually about 30 times its weight of water. Agitate during one-half hour, allow time to settle, and reject the liquid. Add to the residue of lime about 300 times its weight of water, agitate frequently during the next 24 hours, and allow the lime to settle. The clear water standing above the undissolved lime is limewater.

The parts burned or the entire body, except the head, may be kept immersed in tepid or warm water for days. Cream or white of eggs may be used, but they are apt to become offensive after 24 hours. Kerosene is an old household remedy. One teaspoonful of table salt in a pint of water makes a solution that can be employed. Keep the patient quiet and his bowels active.

If the eye is red from contact with the flames or hot fluid, sweet oil is perhaps the best household remedy to drop in. A bandage lightly applied over the eyes to keep out the light will be soothing.

If the skin or the eye is burned with acid, a solution of baking soda should be used first. If the burning agent is an alkali, such as hartshorn or lye, weak vinegar or lemon juice should be used. Sweet oil should be dropped in the eye after such treatment.

If the patient has breathed the flame or steam, the condition is apt to be a serious one, even though it does not appear so at once. Complete rest and quiet, an ice bag to the chest, the giving of milk and cream, half and half, if swallowing is possible, should be employed.

The scars resulting from burns and scalds always contract, and in severe cases terrible deformities are produced. These may be prevented to some extent by active and passive motion and by splints.

If one is uncertain as to the advisability of applying a particular remedy, the advice of a doctor should be sought before doing something which may result in serious consequences to the patient.

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(For analytical outline, see "Contents," p. 3.)