U. S. DEPARTMENT OF COMMERCE
BUREAU OF STANDARDS

SAFETY FOR THE HOUSEHOLD

CIRCULAR OF THE BUREAU OF STANDARDS, No. 397

U. S. DEPARTMENT OF COMMERCE
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ABSTRACT

This circular considers the hazards which occur in the home and gives suggestions to eliminate them or to cope with them where they can not easily be eliminated. Hazards may be due to physical conditions, to careless habits, or to a combination of both. The former should be dealt with when building the house; the latter are largely a question of housekeeping and hence receive the most attention in this volume.

Nearly 100,000 fatal accidents occur annually in the United States, of which from one-quarter to one-third occur at home. The loss of property by fire is about a half billion dollars, of which $160,000,000 represents residences. The importance of the problem is therefore great, and its attack calls for community organization, which is also the subject of suggestions.

Hazards are classified as mechanical (falls, machinery, cuts, etc.), fire, gas (fire, asphyxiation), electrical (shock, fire), lightning (shock, fire), and miscellaneous (poisons, etc.).

Proper attention to railings, floor coverings, keeping steps clear, lighting, and avoiding substitutes for stepladders will avoid many falls. Power-operated machines require guards.

Fires are started by defective chimneys, combustible roofs, defective heating apparatus, matches, careless smoking, gasoline, rubbish, Christmas decorations, electrical defects, and lightning. Attention is given to fire-retardant treatment of materials and what to do in case of fire.

Gas leaks, proper choice and installation of appliances, and adjustment, operation and care of appliances are fully discussed. Flexible tubing is a hazard. Carbon-monoxide poisoning occurs from running automobile motors in closed garages.

Electrical fuses must be kept intact, standard cords and approved appliances used, and grounding carried out if fires and shocks are to be avoided. Handling of appliances in wet places should be avoided. Do not touch live parts. Do not touch plumbing, etc., while handling appliances. Proper protection from lightning is stated.

Poisons should be labeled and kept out of reach of children. Exercise care in use of alcohol, varnishes, polishing and cleansing materials, disinfectants, fumigants, insecticides, and drugs.

Methods of first aid are given, including resuscitation, treatment of burns, scalds, and bruises.

Suggestions for building a home cover items involving construction and equipment.

CONTENTS

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 of removing causes for alarm. Caution alone is not enough, since many of the dangers are not commonly known. Few know, for example, that under certain conditions a person who turns on an electric lamp while one hand is on a water faucet is in danger of 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. STATISTICS OF ACCIDENTS

It is not generally realized what enormous toll is levied each year by accidents as measured by lives lost and serious injuries inflicted. The number of injuries has been increasing each year in this country, due largely to the automobile, and the total presents a very unfavorable comparison with European countries, when compared on the basis of population. The accidental fatalities have reached an annual total of 100,000, which is far greater than the American lives lost in the World War. Peace-time casualties and their prevention consequently deserve the careful attention of every citizen.

Certain States constituting the so-called registration area require the reporting of all deaths, and these reports are collected by the United States Bureau of the Census. From these, the number of deaths in the entire United States can be estimated on the basis of population. This procedure gives the figures of Table 1.

Table 2 is an estimate for 1930 prepared by the National Safety Council from available reports, mostly from urban communities. They comprise over 2,500 fatalities occurring in the home.

TABLE 1.—*Accidental deaths in the United States*

Year	Number	Year	Number
1925	90,150	1928	95,186
1926	91,804	1929	98,258
1927	92,874	1930	[1] 100,000

[1] Approximate only.

In 1930 the Bureau of Standards cooperated with the North Carolina Federation of Women's Clubs in making a survey of accidents occurring in the homes of club members. A total of 469 accidents were reported, or about 1 in each 13 families. About half of the injured were children. The distribution of these accidents is shown in Table 4. They included 13 fatalities. It has been estimated that, throughout the country, there are at least 200 injuries for each fatal accident.

TABLE 2.—*General classification of accidental deaths in 1930*

Nature	Number	Nature	Number
Motor vehicle	33, 000	Home	30, 000
Other public	20, 000	Industrial [1]	19, 000

[1] Includes 3,000 motor-vehicle accidents.

3. 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 the household and the general public.

The movement for "safety-first" has found expression through industrial establishments, on the railroads, in the schools, through traffic regulations, 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 can be saved and countless accidents avoided each year if the precautions suggested are followed.

4. STANDARDS OF SAFETY

The Bureau of Standards has formulated rules intended to reduce dangers from electricity, and has cooperated with other organizations in the preparation of safety standards for gas service, and for various industrial processes. A list of these publications will be sent upon request.

A part of the National Electrical Safety Code, published separately by the bureau as Handbook No. 7, gives safety rules for the installation and maintenance of electric utilization equipment.

The Code for Protection Against Lightning contains specifications for the installation of lightning rods upon buildings, and instructions for personal safety during lightning storms.

Work on fire prevention and investigation of fire-resistant properties of materials is being carried on by the bureau. A list of publications dealing with these subjects will be sent on request.

The present publication has resulted from the technical work of the bureau dealing with the hazards from electricity, lightning, gas, and fire. It was deemed desirable to present the available information in a form suitable for the guidance and information of the general public, and more especially the householder.

5. STANDARDS FOR THE HOUSEHOLD

While dozens of safety codes and pamphlets dealing with industrial accidents have been published, and while traffic accidents have lately received almost equal attention, little has been done to systematize the attack upon home accidents. There is some literature dealing with this subject, but it is meager. Publications of this bureau bearing upon accident prevention have been mentioned above. Other publications of interest to the householder are Circular No. 55, Measurements for the Household; and Circular No. 70, Materials for the Household.

TABLE 3.—*Classification of fatal accidents in the home*

Nature	Per cent	Nature	Per cent
Falls	43.7	Poisons	8.9
Burns, scalds, and explosions	24.2	Cuts and scratches	1.6
Asphyxiation and suffocation	12.9	Miscellaneous	8.7

TABLE 4.—*North Carolina survey of accidents in the home*

Nature	Per cent	Nature	Per cent
Falls	51	Poisons	3
Cuts and bruises	26	Miscellaneous	5
Burns and scalds	15		

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.

II. MECHANICAL HAZARDS

Hazards of a mechanical nature are the most common in the home as in the factory, and consequently are of the most importance. They are also of a kind which can be most readily dealt with by the householder and can largely be eliminated by personal care and by giving proper attention to the physical conditions. Factory experience has shown that the correction of physical conditions can largely eliminate the accidents due to machinery hazards; whereas, accidents due to handling materials, to falls, and to the movements of persons are much harder to cope with, and their elimination depends largely upon carefulness and the development of good habits.

1. FALLS

Statistics of accidents show that except for traffic accidents falls are the most frequent source of injury. Falls occur from a great variety of conditions which together account for about one-sixth of all accidental fatalities. Some falls are due to reckless practices upon the part of the individuals concerned, while others are due to the lack of proper facilities or to physical conditions. The different classes of falls will be discussed separately.

Stairs.—Falls down stairs may result from the lack of a handrail, lack of a gate at the head of stairs in the case of babies, insufficient illumination, 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 or 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 stairs are so numerous that special attention to this hazard is necessary. There are definite causes for these accidents, and the majority are clearly preventable.

The improper design of stairs is an important factor in causing accidents. Winding stairs are built into small spaces in order to allow more space for closets or rooms. Many falls can be attributed to insufficient space at the landings.

Back stairs, attic stairs, and cellar stairs are the chief offenders in the home.

Cellar stairways are often used to store such things as scrub buckets, brooms, ironing boards, extension table leaves, and whatnot. This condition should not be tolerated, but where it is inevitable great care must be taken while using the stairs.

Handrails assist materially in lessening accidents. A handrail should always be provided for a stair open at the side, as is so common for cellar stairs. Railings should also be provided on porches and verandas, not less than 30 inches high.

Adequate light should be provided, so that all parts of the stairs will be visible to persons going up or down.

Severe accidents have occurred to persons passing through doors that apparently led to other rooms on the same floor level, but which really opened upon inclosed stairways. In cases where the head of a stairway has a door opening directly upon it at the top, the hazard may be reduced in large measure by replacing the door with a gate or a glazed door so that the stairs are visible at all times.

Waxed stair treads and landings, loose rugs, and slippery floor surfaces at the top or bottom of stairways are likely to cause falls, especially among children, aged, and infirm persons. Small rugs near stairways should be avoided. All rugs should be free from wrinkles and curled edges. It is desirable to prevent their sliding by fasteners or by the use of underlays or a special treatment of the under surface.

Gates should be placed at the top of all open stairways and porch steps if babies are allowed to crawl around unobserved, or if children can not be trusted to go up and down steps alone.

Small objects, such as marbles, pencils, and toys, are often left on stairs by children. These objects may cause bad accidents by rolling or sliding when someone happens to step on them. It is bad practice to put small objects on steps even temporarily.

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, a flashlight should be kept handy for use on stairways.

Slipping.—Another cause of falls arises from slipping in soapy bathtubs, 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.

Many persons have been killed by falling in bathtubs, which may become quite slippery when covered with soap, and may not be quite flat. 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 handhold to help one to get in and out of the tub with minimum risk.

Ladders.—Almost every house has a ladder of some kind. It may be a stepladder for indoor use, or a ladder made up with rungs or slats for outdoor use. Ladders require frequent inspection for the sake of safety. Examine your ladder frequently, and give it a shake or two. Many ladders are in daily use that are dangerous and would serve a better purpose as firewood. A sound, sturdy ladder, appropriate to one's needs, is a good investment in both utility and safety.

The use of ladders calls for care. Many accidents have occurred from tools and other objects falling from ladders, and striking persons below. Walking underneath ladders is hazardous, and should be avoided. 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. For wooden floors, metal points or lead-coated bases are recommended; for use on iron floors, carborundum has been found to serve very well. For concrete floors, pivoted lead shoes or carborundum is recommended. For wet floors, recessed rubber bases have given the best satisfaction. A shoe with cork grip, as shown in Figure 1, is satisfactory for general use. The cork is inserted in the steel shoe, and can be renewed when worn out.

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 or attached to belt, leaving hands free), and then hoist a basket or other article up afterwards.

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. Serious injuries have even resulted from falling out of bed.

Climbing.—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.

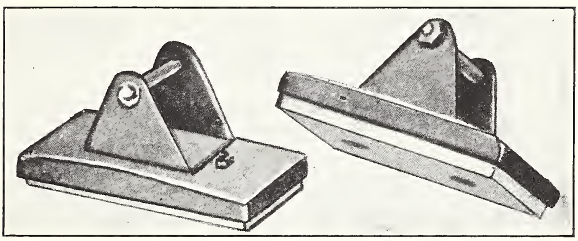

FIGURE 1.—*One type of nonslip base for portable ladder*

2. MACHINERY

All kinds of machines, whether motor-driven or not, present hazards when not properly guarded 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.

3. 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. In using knives and other edged tools the cutting stroke should be 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 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.

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. If ordinary cells are used, they should be placed in a box. It is more satisfactory to operate a bell from a bell-ringing transformer, if electric service is available.

4. MISCELLANEOUS

Handling objects.—Persons frequently injure themselves by attempting to lift or move an object which is too heavy for them to handle. In such cases, assistance should be secured before undertaking the task. When heavy objects are to be lifted there is a knack about applying one's strength which can be better demonstrated than described. A little study will, however, assist anyone to use his strength to the best purpose, as, for instance, by lifting with straight arms and a straight back rather than with elbows bent and leaning over.

Stumbling over objects and bumping into furniture can largely be avoided if upon leaving a room, and especially when putting out lights, care is taken to see that furniture and other objects are in their usual positions and are not in the customary paths between doors.

Falling objects.—If care is taken in stacking objects in closets, in attics, upon shelves, and other storage places so there is no tendency to slide off or fall, many future accidents can be avoided.

In the northern part of the country it is not uncommon for icicles to form along the edges of roofs and similar places, and when the thaw comes these frequently fall in pieces large enough to be hazardous. Before that time arrives it is well to take a broom or some similar object which will reach such icicles and deliberately break them up from a position of vantage. Snow slides from sloping roofs are also sometimes hazardous. This can be prevented by inserting in the roof projections near the edge which prevent the snow from sliding and hold it until it is melted.

When workmen are doing repair work upon a home children should be cautioned from walking or playing beneath the ladders or scaffolds, as tools and other objects are sometimes inadvertently dropped.

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.

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.

III. FIRE HAZARDS

1. LIFE AND PROPERTY LOSSES FROM FIRE

Fire under control is man's best servant and is a fundamental requisite for civilized society. Uncontrolled it can in a short time not only destroy property values that will require years to replace, but also take a toll in lives and cause injuries and damage beyond possibility of valuation or restoration.

Table 5, made up from the mortality statistics of the U. S. Bureau of the Census, summarizes the loss of life for the two general causes pertaining to fire. Reports are compiled from the States having official registration of all deaths, and from these the total for the United States is computed. Under "conflagration" is included deaths from fires in buildings, forests, and similar conditions, and under "burns" those due to ignition of clothing or bodily burns without anything else being necessarily set on fire. For the purpose of the table, those from molten metal and scalds are left out since they have no direct relation to fire. They comprise most of the deaths included under burns not originating directly from fire.

The registration area includes States, the death registration methods of which are judged by the Census Bureau to result in the recording of 90 per cent or more of the deaths actually occurring. Allowing for unreported deaths it is seen that the life loss directly from fire has averaged nearly 7,500 lives per year for the past nine years.

TABLE 5.—*Loss of life from fire and burns (from U. S. Bureau of the Census)*

Year	From conflagration	From burns excluding molten metal and scalds	Total both causes	Population in registration area	Computed from both causes for continental United States
				Per cent	
1921	928	3,944	4,872	82.2	5,927
1922	1,143	4,544	5,687	85.3	6,667
1923	1,445	5,087	6,532	87.6	7,457
1924	1,628	5,506	7,134	88.5	8,061
1925	1,408	5,062	6,470	89.4	7,237
1926	1,558	5,197	6,755	89.8	7,522
1927	1,519	4,832	6,351	91.3	6,956
1928	1,760	5,147	6,907	95.3	7,248
1929	1,710	5,035	6,745	95.7	7,048
Average per year					7,125

The annual loss from fire on all classes of property reported to the acturial bureau of the National Board of Fire Underwriters is given in Table 6. The figures cover the total damage from fire and lightning on all buildings and contents on which a loss was sustained by companies reporting to the acturial bureau. The latter estimates that 25 per cent should be added to these figures to cover losses of which it receives no record.

It is difficult to visualize the extent of the life and property losses from fire. The $500,000,000 annual property loss can be represented by the fire ruins of dwellings placed in a solid row on one side of a highway extending from New York to Chicago, a distance of

TABLE 6.—*Fire loss in continental United States as reported to the actuarial bureau of the National Board of Fire Underwriters*

Year	Estimated population	Fire loss reported		Total loss [1]	
		Amount	Per capita	Amount	Per capita
1920	106, 543, 031	$358, 322, 951	$3. 36	$447, 904, 000	$4. 20
1921	108, 207, 853	396, 324, 810	3. 66	495, 406, 000	4. 58
1922	109, 872, 675	405, 232, 801	3. 69	506, 541, 000	4. 60
1923	111, 537, 497	428, 298, 226	3. 84	535, 373, 000	4. 80
1924	113, 202, 319	439, 249, 699	3. 88	549, 062, 000	4. 85
1925	114, 867, 141	447, 543, 087	3. 90	559, 418, 000	4. 87
1926	116, 531, 963	449, 584, 601	3. 86	561, 981, 000	4. 82
1927	118, 196, 785	378, 347, 175	3. 20	472, 934, 000	4. 00
1928	119, 861, 607	371, 685, 682	3. 10	464, 607, 000	3. 87
1929	121, 526, 429	367, 556, 622	3. 02	459, 446, 000	3. 78
1930	123, 191, 000	399, 791, 338	3. 24	499, 739, 000	4. 06

[1] The actuarial bureau estimates that 25 per cent should be added to cover unreported losses.

about 900 miles. An observer in an automobile would require, perhaps, three days to travel the length of this avenue of desolation. At intervals of 600 feet, or at the rate of three or four per minute, there would be seen the graves of fire victims, mostly women and children, who died from burns, suffocation, panic, or other cause directly attributable to fire.

2. CAUSES OF FIRE LOSSES

A calamity and waste of such proportions as that from fire, calls for careful consideration of the causes concerned in order that preventive measures can be applied that have promise of the greatest effectiveness.

Statistics from 8 States in 1920 showed that there were 56 dwellings burned out of each 10,000 dwellings, or one for each 1,000 population, and the average loss was $632. Considering also the contact with fire outside of dwellings it appears that on the average each adult individual will have one serious experience with fire. Considering, in addition, the contact with fire of those in whose welfare each is intimately concerned, the figures again indicate probability that fire will bring loss, sorrow, or suffering to the average individual more than once in a lifetime. The probability of such occurrence can be decreased as concerns each of us, singly or in groups, only by the exercise of the precautions that have been found effective in preventing origin and spread of fire.

The causes of 1,511 deaths from fire in Illinois in the 5-year period 1912 to 1916 are given in Table 7.

TABLE 7.—*Causes of deaths from fire and burns reported in State of Illinois for 1912 to 1916, inclusive*

Cause	Number	Per cent
Burned in burning buildings	215	14.22
Ignition of clothing by stoves, fireplaces, furnaces, or hot plates	237	15.67
Ignition of clothing by matches	88	5.81
Ignition of clothing by bonfires	164	10.86
Ignition of clothing by kerosene lamps or candles	28	1.85
Ignition of clothing by pipe or smoking in bed	21	1.39
Ignition of clothing by unreported or miscellaneous cause	45	2.98
Playing with fire	17	1.13
Carelessness with matches	60	3.96
Starting fires with kerosene or gasoline	152	10.06
Gasoline explosions	208	13.77
Gas explosions	47	3.12
Dust, dynamite, chemicals, fireworks, or celluloid explosions or fires	45	2.98
Stove-polish explosions	11	.73
Struck by lightning	13	.86
Electrocuted or burned by live wires	15	.99
Cause not reported or miscellaneous	145	9.60
Total reported for the 5-year period	1,511	100.00

Table 8 gives the causes of fires in urban dwellings and on farms as reported to the National Board of Fire Underwriters for the five-year period, 1919 to 1923.

TABLE 8.—*Causes of dwelling and farm fire losses*

Item No.	Causes	Dwellings (chiefly urban)	Farm loss (including farm dwellings)
		Per cent of total loss	*Per cent of total loss*
1	Defective chimneys and flues	11.46	13.42
2	Sparks on roof	9.74	8.10
3	Stoves, furnaces, boilers and their pipes	7.56	4.24
4	Hot ashes, coals, open fires	2.43	1.60
5	Steam and hot-water pipes	.05	.02
6	Gas, natural and artificial	1.33	.15
7	Open lights	1.74	.33
8	Electricity	4.80	.81
9	Petroleum and its products	5.10	4.43
10	Ignition of hot grease, tar, wax, asphalt, etc	.29	.16
11	Matches and smoking	5.94	6.03
12	Rubbish and litter	.30	.07
13	Explosives	.20	.41
14	Sparks from machinery	.03	.46
15	Sparks from combustion	.51	.92
16	Fireworks, firecrackers, etc	.27	.05
17	Incendiarism	.48	.56
18	Miscellaneous known causes	.65	.98
19	Spontaneous combustion	1.39	5.05
20	Lightning	1.95	14.43
21	Exposure, including conflagrations	12.56	2.70
22	Unknown causes	31.22	35.08
	Total	100.00	100.00

The first five items in the table relate to house heating and comprise 31.24 and 27.38 per cent of the total for the urban and farm loss, respectively. The next five items (Nos. 6 to 10) referring mainly to lighting, cooking, and other household operations, total 13.26 per cent of the urban dwelling loss and 5.88 per cent of the farm loss, the difference being probably due to the more limited use of electricity and gas for household purposes on the farm and the fact that fires caused by wood and coal fired stoves of all kinds are included under item 3.

Matches and smoking are responsible for about an equal percentage loss in the two columns, and the miscellaneous causes 12 to 18 total a little higher for the farm loss. As would be expected, spontaneous combustion and lightning cause much higher losses on the farm than on urban dwellings. Most of the loss on the farm from spontaneous combustion is presumably on hay and grain, and would thus not enter into the dwelling loss. The loss from exposure is much larger for the urban areas, communicating fires with farm buildings being limited to those within a group or as caused by grass, brush, and forest fires. On the whole, the table of causes appears to reflect faithfully the difference between urban and rural districts in conditions that affect the fire loss.

3. FIRE-RESISTIVE DETAILS OF DWELLING CONSTRUCTION

The hazard to life and property can be greatly decreased by the incorporation of structural features into the building that will decrease the liability of origin and rapid spread of fire. Fire resistance in the building has the advantage of being independent of the human element on which fire-prevention efforts along other lines must depend. It remains practically unchanged as long as the building is maintained in the condition required for its intended use.

For a full discussion of items of building construction which have to do with the avoidance of fires and accidents, reference may be made to the chapter giving detailed suggestions for building construction. Some of these suggestions can be applied to existing buildings, such as the insertion of fire stops, and the use of plaster boards to protect combustible woodwork. Some of the suggestions may easily be applied when repair work is under way, as, for instance, when a shingle roof needs to be replaced. The typical dwelling will still contain considerable woodwork in the form of joists, flooring, window and door frames, and trim. These with the contents afford plentiful fuel for a serious fire which may gut the building.

4. COMBATING COMMON FIRE HAZARDS

The relative importance of the main causes of fire is indicated by the percentage loss figures in Tables 7 and 8. A consideration of the hazards involved and effective precautions may be helpful.

Chimneys, flues, and fireplaces.—The chimney should be frequently inspected, particularly at the roof line for open masonry joints, and should be cleaned at regular intervals. Wood and soft-coal fuel produce more soot of an inflammable kind than hard coal. Soot fires are not only hard on the chimney, but produce sparks that may ignite combustible roof materials.

Fireplaces should be well screened. Combustible material should be kept away from smoke pipes, ash-pit doors, and similar locations. Hot ashes, when removed from the ash pit of the furnace, should be put in metal containers rather than wood.

Stoves and furnaces.—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 them well away from combustible partitions or woodwork, or, where this can not be done, placing screens to protect the adjacent woodwork; placing sheet metal or other incombustible materials under stoves set on wood floors with the metal extending at least 1 foot beyond the stoves at the front; running stovepipes as far as possible from unprotected walls, floors, and other woodwork; and where necessarily passing through combustible partitions, surrounding them with thimbles which provide air spaces about the pipes; surrounding the stovepipes with suitable flanges where passing into the chimneys; frequently inspecting stovepipes to detect rust holes and open joints, and regularly cleaning the pipes. Fuels should not be kept too near the stove or furnace. Openings in chimneys should be kept covered with metal caps when not in use.

Domestic oil burners.—The past 10 years have witnessed a marked development in the introduction of oil burners for domestic heatiing plants. Usually the burner is designed to operate in the fire box of furnaces designed for coal, although complete installations comprising both burner and furnace are available. The fire and smoke hazards involved must be minimized by proper design and installation of the burner and its fuel supply, together with care in operation.

From the standpoint of design, two general types of burners are in use. In the one type, generally termed " natural draft " or " vaporizing," the oil is spread over the hot surface of a spreader plate and the vapors, suitably mixed with air, are drawn in by natural draft and burned immediately above the plate. The initial heating of the plate and ignition of the gas are accomplished by means of a wick or lighter, the ignition as well as flame control being usually manual. The fuels for burners of this type must generally be more volatile than for the other and hence lighter in specific gravity.

In burners of the second general type, termed " mechanical draft " or " atomizing," an intimate mixture of oil and gas is produced mechanically by means of compressed air, compressed oil, or centrifugal action, obtained with motor-driven fans, pumps, or similar devices. The mixture is ignited with gas or oil flames or electric sparks. In some ignition devices a gas or oil igniting flame is initially ignited by an electric spark. The ignition as well as flame control can be made automatic by means of connections to thermostats set to maintain given room temperatures.

The grade of oil used should be that recommended by the manufacturer of the burner concerned, but no oil used should have a flashpoint below 100° F. on a closed-cup test. Burners of the atomizing type can generally burn a heavier grade of oil than those of the vaporizing type. This is an advantage since the heavier oils present a lower fire hazard and also are less expensive than the ligthter oils.

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The oil supply should preferably be stored in an underground tank located outside of the house with top of tank below the level of the burner. Where the top of the tank is above the level of the burner, provision must be made to prevent siphoning of oil into the basement. Oil storage tanks within the basement are generally limited to 275 gallons capacity. All tanks must be vented to the outside air to relieve pressures from filling or emptying and those produced by fire.

The fuel feed to the burner should preferably be by pump or gravity from a small auxiliary tank. Gravity feed from large tanks must be especially well safeguarded by automatic shut-off valves to prevent overflow of oil. All piping and installation details should be made to conform with recognized standards such as those adopted by the larger cities or those recommended by the National Fire Protection Association.

Reports of fires from domestic oil burners indicate the following as causes, beginning with those of greatest frequency: (1) Absence or failure of automatic shut-off valve, (2) loose connections and leaky piping, (3) defective burner, (4) backfire, (5) carbonization and imperfect combustion, (6) absence or extinguishment of pilot light, and (7) careless operation.

Causes (1) and (2) are concerned mainly with the installation other than the burner, and together caused about 40 per cent of the number of fires. Causes (3) to (7) having to do with the burner itself and its operation were responsible for nearly one-half of the number of fires reported. Carbonization and imperfect combustion may cause damage from smoke and soot rather than fire. Oil burners are generally better suited for hot-water and steam-heating plants than for hot-air furnaces, since the products of combustion, being under greater pressure, are more likely to find their way into the air ducts than those of coal-fired furnaces.

While the above indicates that proper installation and operation are as important from the safety standpoint as the design of the burner mechanism and its accessories, it is essential that these have incorporated in them the necessary safety features. If, as is usually the case, the buyer is not in position to make the examination and tests needed to determine whether these safety requirements are met, he will have to rely on the results of tests and approvals made by others, as evidenced by inspection labels, certifications, or other well-substantiated evidence of satisfactory design or use.

Rubbish and bonfires.—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. (See p. 29.)

Rubbish and waste paper should be burned in containers, which are commonly constructed of open metal work, and placed away from buildings or fences. It should preferably not be done on a windy day.

Dried grass, brush, or leaves should not be permitted near the house or other buildings, particularly where there is danger from grass or brush fires. A clear space of 50 feet will afford reasonable protection where the hazard is not too great. Firing the grass or brush outside of the fire break in the face of an on-coming fire will increase the protection afforded. When a house is exposed to fire in neighboring brush, woods, or buildings, a close watch should be kept to prevent flying brands from igniting combustible roofs. Such roof fires can be easily extinguished in their initial stage with wet brooms or rags, or with water applied from the peak of the roof.

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 or hot.
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.

8. Do not place lamps in warm locations, such as above stoves, since it may cause inflammable vapors to be given off, and the lamp to flare.

9. Do not leave a lamp unattended for a long time after lighting, since temperatures can be built up that in time will cause flaring and possibly explosions.

Gasoline.—The three terms, gasoline, benzine, and naphtha, are applied to liquids that differ only slightly from a fire or explosion standpoint. At ordinary temperatures these liquids readily give off flammable vapors. The main difference between them and kerosene from the fire-hazard standpoint is that the latter does not give off flammable vapor in dangerous amounts at temperatures below 100° F., whereas gasoline, benzine, and light petroleum naphtha give off vapors at all temperatures down to points near 0° F. When any considerable quantity of the vapor becomes mixed with 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.

One gallon of gasoline, entirely vaporized, produces about 30 cubic feet of vapor. If it be liberated in a room so that there is a mixture of from 1.5 to 6.4 per cent gasoline vapor with air, a dangerous explosive mixture is formed. Hence from 1 gallon of gasoline there can be formed as much as 2,000 cubic feet of explosive gasoline-air mixture. 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.

Gasoline should be handled, therefore, 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 or foam-type fire extinguishers be kept handy. It is recommended that dry cleaning of garments be left to experts, but if attempted at home Stoddard solvent should be used in place of ordinary gasoline.

A use of gasoline in the household which has been common is as a fuel in the gasoline stove. The advent of satisfactory blue-flame kerosene stoves and compressed gases has fortunately decreased its use, 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 be no overflow so that vapors of gasoline will be present when the stove is afterwards lighted. Care should be taken to prevent sparks from static charges. 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 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-resistive construction and not in buildings used for other purposes, such as barns.

Running the engine in a small garage with the doors closed results in contaminating the air sufficiently to cause illness and frequent deaths by carbon-monoxide-gas poisoning. (See p. 47.)

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. While filtering funnels are now seldom used for filling automobiles they are frequently used in filling stoves. 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, when 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 or fire may result.

The danger due to the production of charges in both of these ways may be avoided by touching the funnel or nozzle against the metal tank at some distance away from the opening before inserting it 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 operation is completed. Another method is to provide an electrical connection between the tank and funnel by means of a chain or wire before the filling operation begins and maintain it until the funnel is removed.

Grease fires.—The combination in the kitchen of fire to cook food, grease (a very flammable material) and the flimsy garments of the housewife or servant, constitutes one of the most serious life 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. Unfortunately there is no way of preventing such fires except by heeding the time-honored warning, "Be careful." Even with the utmost care grease fires may occur. Water to be effective must be applied in relatively large quantities and care must be taken to avoid burns from the spattering of the burning grease. Such a fire may be allowed to burn itself out under conditions where it will not ignite other materials; or it may be smothered by covering it, or put out with a fire extinguisher. For this purpose the foam, the carbon-dioxide, or the carbon-tetrachloride type is superior, as the water solutions of the soda-acid type tend to scatter the burning grease.

Matches.—Like oil, fireworks, and many other substances highly flammable, matches cause disasters and death through incautious handling. Every year hundreds of children are burned to death because they play with matches, setting fire to their clothing. The varieties of matches in common use are the "strike-anywhere" or parlor match and the "strike-on-box" or safety match. Safety matches are safer than parlor matches, but care must be exercised even 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. When kept in holders, the tip of the match should not be exposed.

Many fires are caused by matches being 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 wastepaper 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 some of these offered for sale have properties which render them undesirable. Among such 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 and these are now generally treated to prevent afterglow. The paper-stem book match is the most dangerous from this standpoint.

Smoking.—The discarded lighted match, cigar, or cigarette is a familiar sight to everybody. The flipping of these articles without regard for flammable material which may be 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 butts create hazards similar to 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, dry grass, and brush, 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 fail to observe such precautions.

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, fiberloid, and viscoloid. Some of these materials are colored and others are nearly transparent. They all belong to the pyroxylin class.

These materials differ from guncotton and similar explosives in degree rather than in kind and under suitable conditions readily burn and may give rise to mild explosions. If heated somewhat above the boiling point of water, decomposition takes place so rapidly that ignition occurs. This low ignition point and rapid rate of burning make it much more hazardous than wood and paper. Also, the products of decomposition contain highly toxic gases (oxide of nitrogen and carbon monoxide) that have caused many deaths. After ignition these materials will frequently continue to burn even though 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 from ignited combs, collars, and other celluloid articles.

Motion-picture, X-ray, and other photographic films on the nitrocellulose base have the same general composition as the materials mentioned above, and municipalities have enacted ordinances to regulate their use so as to minimize the fire hazard.

Acetate-cellulose motion picture and X-ray films present no greater hazard than wood or paper. The same is true of a number of cellulose, acetate-cellulose, and casein-base products, such as cellophane, cellit, cellon (charmoid), transol, erinoid, and karalith.

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. In 1914–15 in Illinois alone, 10 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 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 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 bottle may be dropped and broken. The safe 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.

Christmas trees.—The hazard incident to the illumination of Christmas trees is especially serious and often results in injury and even death. The extreme flammability of the tree constitutes a serious hazard, and 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 flammable 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 continuance of such dangerous practices. Some of the ornaments used may be treated with fire-retardant solutions which will remove much of the attendant hazard.

Lighted candles should never be used on Christmas trees. 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 minutes. If illumination is to be used on the tree, miniature electric lamps are much safer. (See p. 63 for precautions to be observed.)

The electric wiring on trees should be carefully installed by someone familiar with the hazards incurred. The custom of wrapping electric incandescent lamps with cotton or other readily inflammable materials is extremely dangerous.

Fireworks.—The number of deaths and accidents attributable to the use of fireworks on Independence Day totaled as many as 5,000 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 have greatly reduced this number. The number of accidents is still inexcusably large and fireworks 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 strike matches or to smoke in such a room. Little children should not be allowed to play with fireworks. 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, 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.

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.

Spontaneous combustion.—This is a danger against which it is generally considered difficult to guard. However, in most cases it requires only ordinary care and good housekeeping to eliminate this cause of fires. Oily clothing, rags, or waste thrown on the floor may cause a fire from spontaneous combustion.

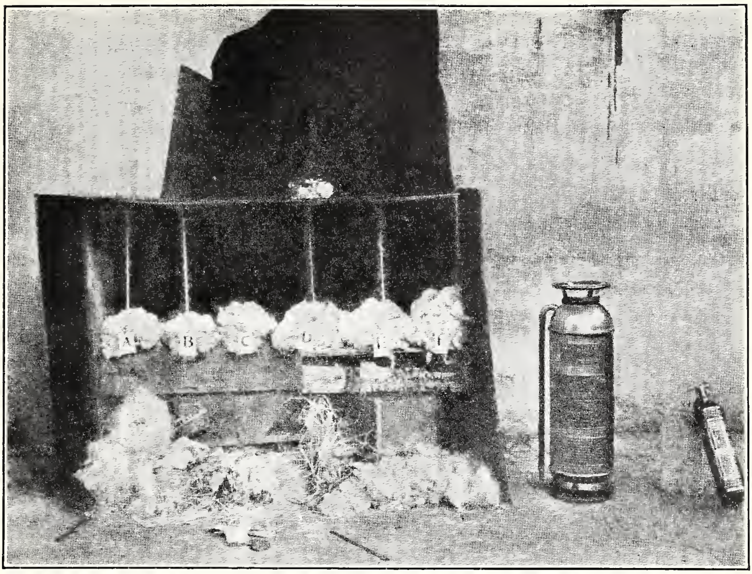

FIGURE 2.—*Floor polishes and paint oils were applied on rags and cotton waste*

One sample was beginning to smoke when photograph was taken.

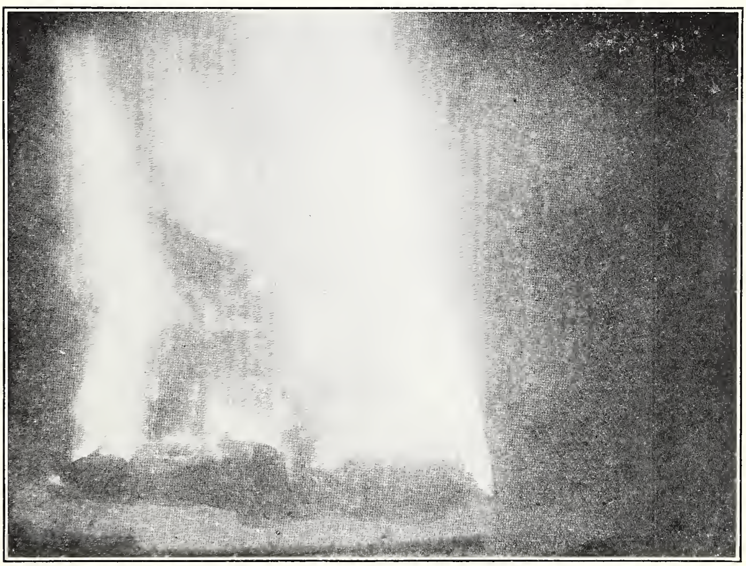

FIGURE 3.—*Showing blaze due to spontaneous ignition of one of the samples*

FIGURE 4.—*Soda-and-acid fire extinguisher held upright until floor is reached*

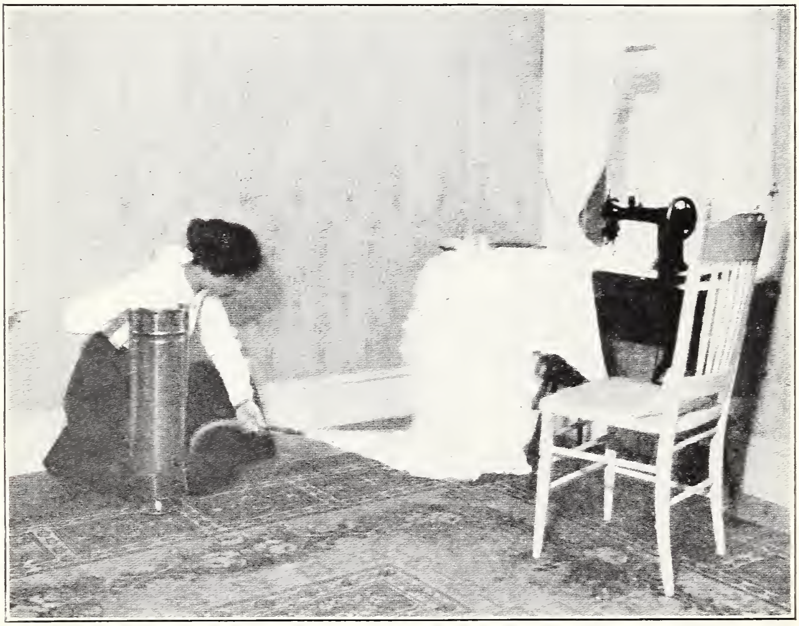

FIGURE 5.—*Soda-and-acid fire extinguisher inverted near the fire and put into operation*

The elimination of unnecessary accumulations would greatly reduce the number of these 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. Animal and vegetable oils are the most likely to cause spontaneous ignition. Mineral oils are almost free from this hazard as they do not oxidize.

Newly mown hay is a frequent cause of fire, and many barns are unnecessarily burned because their owners cut the hay too early or do not cure it properly before putting it in. In the barn more perfect ventilation will often remove heat which otherwise will cause a rise in temperature to the ignition point. Thick layers of hay, just as thick bundles of rags and clothing, are more likely to cause trouble than thin layers, and especially if they have been damp.

5. FIRE-FIGHTING EQUIPMENT

Fire-fighting equipment for the ordinary dwelling will usually be limited, by practical considerations, to portable hand apparatus. Principal reliance for extinguishing fires which have gained any appreciable headway must, of course, be placed upon outside aid. When a fire occurs, the fire department, if one is available, should always be summoned without delay. It is, however, true that most household fires start from a very small beginning and can in the majority of cases be readily extinguished before they have gained headway and before any considerable damage has been done or risk of personal injury has developed, if the proper means is only right at hand and can be promptly applied. The prompt application of a little water or the use of blankets may readily extinguish a small blaze which might later have developed into a disastrous fire. Again, a broom may be effectively used, for example, to bring within reach burning draperies or to beat out a small blaze. An ordinary garden hose with nozzle, kept where it can be quickly attached to a faucet, or permanently attached to a valve in the water piping, is an effective fire-extinguishing device for the area over which its length will permit its application.

There are on the market portable hand extinguishers which are especially designed for first-aid fire protection, the effectiveness of which has been demonstrated by experience of years. They are much more effective than improvised means, as, for example, water thrown from a pail, blankets, or similar expedients, and have the added advantage that since they serve the one purpose only, can be permanently kept in assigned places where they will be available when needed. It is, therefore, distinctly worth while to have one or more good portable fire extinguishers in every household.

There are several types of fire extinguishers available. They may be divided roughly into two groups—those suitable for the general run of ordinary fire risks and those suitable particularly for some special fire risk. Extinguishers for household use, especially if only one extinguisher is provided, should be of the former class. As is shown in Table 8, the great majority of fires occurring in dwellings are of a character for which water is an effective extinguishing agent.

Soda-and-acid fire extinguishers.—The portable fire extinguisher best suited for household use is the 2.5-gallon soda-and-acid type. This is usually in the form of a cylindrical copper tank, about 2 feet high, with a small hose attached near the top. It is put into operation by turning the tank upside down when a stream of water is automatically projected to distances up to 30 or 40 feet. This stream of water is maintained for about a minute. An extinguisher of this kind fully charged weighs about 38 pounds. This type is also available in a half-size unit weighing about 21 pounds.

Extinguishers of the soda-and-acid type must not be exposed to freezing temperature, as the solution will freeze at about the same temperature as water. The extinguisher should be located in some central and readily accessible position, such as a hallway. In case of fire the extinguisher is carried to the vicinity of the fire and then turned upside down. The stream is directed not at the flames but on the burning material. If turned upright, the action of the extinguisher will be stopped.

The construction and operation of the extinguisher is illustrated in Figure 6. Near the top of the tank a glass bottle is supported inside in a suitable cage and covered by a loosely fitting stopple, usually of lead. The tank contains the water in which bicarbonate of soda has been dissolved. The bottle is about half full of sulphuric acid. When the extinguisher is turned upside down the stopple falls partly from the bottle permitting the acid to mix with the soda solution. The resulting chemical reaction produces carbon dioxide gas. The formation of the gas develops sufficient pressure to expel the liquid from the hose. The acid is neutralized before it passes from the extinguisher so that the water stream is free from acid.

Full directions for the care and recharging of the extinguisher appear on a metal plate attached to the copper tank, and they should be strictly followed. Extinguishers should be recharged after use even though only partially discharged. Complete recharges with soda and acid packed in a single carton can be readily purchased.

It is advisable that all members of the household be made familiar with the use of the extinguisher. The extinguisher should be discharged, cleaned, and recharged every year and the dischage furnishes an excellent opportunity for practice and demonstrations with the device.

Foam fire extinguishers.—This type is comparable to the 2.5-gallon soda-and-acid extinguisher for general use and, in addition, is particularly effective on oil and gasoline fires. It is similar in outward appearance and method of operation, but it discharges about 15 gallons of a thick brown foam made up of bubbles filled with carbon-dioxide gas. The foam may be discharged to a distance of about 20 feet for a period of about 50 seconds. The weight of the foam extinguisher fully charged is about 40 pounds. The foam is of particular value in extinguishing oil and gasoline fires because it flows on the surface and forms a heavy blanket of foam which smothers the fire. It is consequently useful around oil-burning furnaces and in garages, where the soda-and-acid type is not so well suited because water spreads such a fire and is not effective.

The use of the foam extinguisher in the living room of a dwelling is open to the objection that the foam, while harmless, is not easily removed from carpets, furniture, etc., after the fire has been extinguished.

This extinguisher, like the previous one, must not be exposed to freezing temperatures. Different foam-forming materials are used by different manufacturers and the procedure in recharging is more elaborate than for extinguishers of the soda-and-acid type.

"*Antifreezing*" *hand fire extinguishers.*—For first-aid protection in locations, such as unheated portions of dwellings or in out-buildings, there are available hand extinguishers designed to be used with solutions of calcium chloride, which freeze at various temperatures below 0° F. according to the strength of the solution. These extinguishers are not automatic in action, but the operator must use a pump which is built into the extinguisher. This is done with one hand while directing the stream with the other.

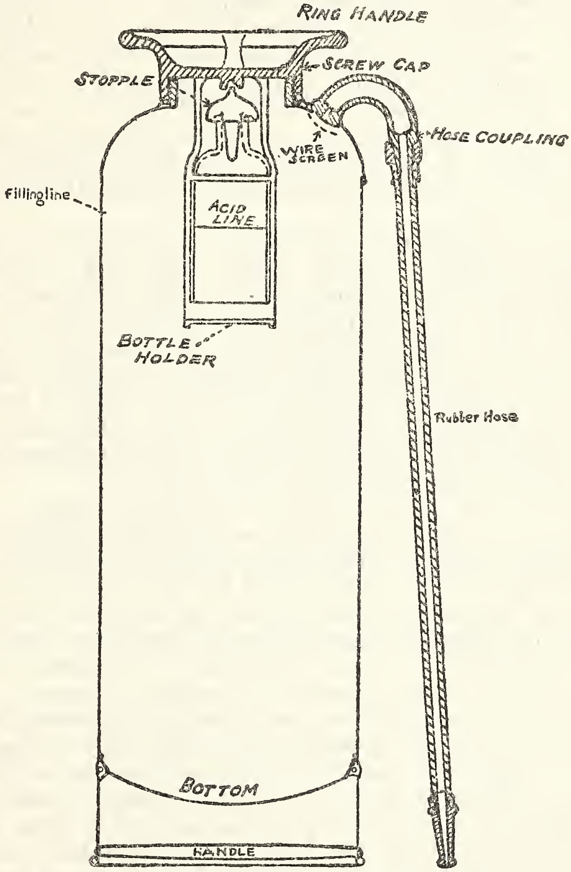

FIGURE 6.—*Sectional view of a soda-and-acid fire extinguisher*

Extinguishers of this type must be particularly constructed to resist the corrosive action of the calcium-chloride solution. Charges of this chemical may be secured from the manufacturer of the extinguisher and is usually supplied in a quantity sufficient to lower the freezing point of the solution to about 40° F. below zero. The extinguisher should be frequently inspected to determine that it is in good working order, since scale might form and interfere with the operation of the pump or plug the nozzle of the hose.

This type of extinguisher is available in the 2.5 and 5 gallon sizes, weighing about 42 and 65 pounds, respectively.

Carbon-tetrachloride fire extinguishers.—This extinguisher is usually in the form of a squirt-gun, consisting of a cylindrical container holding a quart of fluid and a built-in pump. When projected on a fire and raised to a sufficient temperature, carbon tetrachloride is decomposed, forming a heavy gas which smothers the flame. It is especially effective where small quantities of burning gasoline or oil are involved. One particular field of usefulness is around automobiles. It is also suitable for fires in electric motors or other appliances, since it does not injure electrical insulation as water would.

In recharging extinguishers of this type a fluid especially prepared for the purpose should be used. These fluids are carbon tetrachloride which has been purified and to which has been added a freezing-point depressant to reduce the freezing point to about 50° F. below zero. Commercial carbon tertachloride freezes at about 12° F. below zero and often contains impurities which are likely to corrode parts of the extinguisher and render it ineffective.

The fumes generated in extinguishing fire with carbon tetrachloride are irritating and poisonous and may be dangerous to the operator in a confined or poorly ventilated space.

Carbon-dioxide fire extinguishers.—A portable type of extinguisher consists of carbon dioxide in a tank under pressure which may be discharged through a hose and nozzle when a valve is opened. It can be recharged only by returning it to the manufacturer. This extinguisher has special applications, and accomplishes its purpose by smothering the flame and excluding the necessary oxygen from the burning material. It is not considered comparable with the soda-and-acid type of extinguisher for household purposes.

Dry-powder fire extinguishers and hand grenades.—There are sometimes offered for sale so-called dry-powder fire extinguishers, consisting of a metal can about 2 inches in diameter and about 20 inches long, containing a powder (usually ordinary cooking soda with the addition of some inert material to keep it from caking). Another offering consists of hand grenades, filled with chemicals, intended to be hurled at the fire. These devices are of such small effectiveness in comparison with other available first-aid fire appliances as to be relatively worthless, particularly in the hands of inexpert operators.

Securing reliable devices.—In providing first-aid fire-fighting devices for the protection of the household it is of prime importance that the devices purchased be reliable and be designed and constructed in accordance with recognized standards with regard to safety and performance, such as are defined in Federal specifications or those set up by Underwriters' Laboratories. Since it is usually not feasible for the householder to make adequate examination and tests, he will generally have to rely on the results of tests and approvals made by others, as evidenced by inspection labels, certifications, or other form of guaranty. In the case of the Underwriters' Laboratories each extinguisher of a type which has been approved is marked with a distinctive inspection label. This label is usually in the form of a small brass plate attached to the extinguisher near the name plate or forming a part of the name plate itself. It is not intended to state that all fire-fighting devices which do not bear the Underwriters' Laboratories label are improperly designed and constructed, but that the presence of this label provides the purchaser with a simple means of assuring that a given extinguisher has been built in accordance with recognized standards.

6. FIRE-RETARDANT TREATMENTS

The rapid spread of fire in combustible construction, as well as the susceptibility of clothing, curtains, and similar textiles to ignition and rapid burning, can be decreased considerably by the use of treatments, the merits of which will be briefly outlined.

Treatments for wood.—Fire-retardant surface treatments for wood generally have only minor value in preventing ignition from contact with flames, due to the thinness of the film and its rapid destruction in contact with flame. Practically all well-maintained paint coatings have some fire-retardant value in this respect, but none can be considered as affording any considerable protection. As conclusion from a series of tests with different kinds of standard and retardant paints conducted at the Bureau of Standards it was concluded that for inside use about as much fire-retardant effect can be obtained with flat wall paints, whitewash, and sodium silicate as with any proprietary paint.

Sodium-silicate solution is made by diluting 1 volume of commercial water-glass solution (1.39 specific gravity) with 2 volumes of water.

One whitewash solution is made by mixing 10 parts slaked or hydrated lime and 1 part Portland cement with salt water to a thin solution.

The following formulas for whitewash are recommended for surfaces exposed to the weather:[1]

1. Dissolve 12 pounds of salt and 6 ounces of powdered alum in about 4 gallons of hot water. Add 1 quart of molasses. Make a thick cream by thoroughly mixing 50 pounds (1 sack) of hydrated lime with about 7 gallons of hot water. Add the clear solution to the lime, stirring vigorously. Thin to desired consistency. In the foregoing formula, 38 pounds (one-half bushel) of fresh quicklime may be substituted for the hydrated lime. The quicklime must be carefully slaked and screened before use.

2. Soak 5 pounds of casein in about 2 gallons of water (preferably hot) until thoroughly softened (about two hours). Dissolve 3 pounds of trisodium phosphate in about 1 gallon of water and add this solution to the casein. Allow this mixture to dissolve. Prepare a thick cream by mixing 50 pounds (1 sack) of hydrated lime in about 7 gallons of water, stirring vigorously. Dissolve 3 pints of formaldehyde in about 3 gallons of water. When the lime paste

[1] From Bulletin 304B, National Lime Association.

and the casein solution are both thoroughly cool, slowly add the casein solution to the lime, stirring constantly. Just before using, slowly add the formaldehyde to the batch, stirring constantly and vigorously. Care must be taken not to add the formaldehyde too rapidly as that may cause the casein to jell, thus spoiling the batch. The cold lime paste produced by carefully slaking and screening 38 pounds (one-half bushel) of quicklime may be substituted for the hydrated lime if desired. Do not make up more of this formula than can be used in one day.

Several processes have been in use involving the injection of chemicals into wood to make it fire retardant. For interior work, combinations of ammonium phosphate and ammonium sulphate have been much used for this purpose. Other chemicals that have been used or proposed are ammonium chloride, sodium borate, and zinc chloride. Most of these chemicals are soluble and would be washed out where exposed to the weather and possibly when used in floors if the floors are cleaned by washing. Paint coatings would help considerably in preventing this loss in fire-retardant effect.

If a sufficient amount of one of the above chemicals is injected it will make the wood fire retardant in the sense that it will not flame at ordinary temperatures, although at higher temperatures it will char, and the volatiles will distill off and burn.

Flame proofing of fabrics.—For curtains and draperies that do not require frequent washing, and for scenery and decorations, where it is desired to avoid change in color, texture, or gloss of fabrics, dissolve 1 pound of crystallized borax and 13 ounces of boric acid in 2 gallons of water. The salts are soluble and the treatment must be applied after every washing.

For awnings the following treatment is fairly effective, although it probably should be applied once each season. The material is first coated with a solution of 2 pounds ammonium phosphate per gallon of water used, and then with a solution of 3 pounds alum in 2 gallons of water. The aluminum phosphate formed is not as easily washed out as the common flame-proofing salts.

The following flame-proofing method, generally known as the nonflam process, gives good fire-retardant effects and has the further merit that these remain after the material has been subjected to washing or the weather. In tests made by the British Fire Prevention Committee, flannelettes were found to have been little changed in this respect after 20 washings. The process consists in steeping the cloth in a warm solution of 3 pounds sodium stannate per gallon of water. After wringing and drying it is passed through a solution of 1¼ pounds ammonium sulphate per gallon of water used. After wringing and drying it is rinsed several times in cold water and finally dried. The smoothing iron should not be too hot if scorching of the cloth is to be avoided.

This process may affect the luster of a fabric and it may induce slight color change in some fabrics. Whether this will occur can best be determined in a preliminary trial with a small sample.

7. CAUTIONS

The following suggestions have been prepared in the form of 15 fire cautions:

1. Keep matches out of the way of young children. Teach children the dangers of playing with fire.

2. Do not throw away cigars, cigarettes, and matches without first extinguishing them.

3. Do not allow accumulations of combustible waste materials in or near the house. Without them fires from carelessly discarded smoking materials would be less frequent.

4. Keep chimneys and stovepipes clean with all joints and connections tight. Provide separate metal cans for ashes and for rubbish. Never mix.

5. Place substantial fire-resistant guards in front of all woodwork close to sources of heat. The open flames of gas, kerosene, alcohol, and gasoline stoves should be particularly shielded.

6. Keep greasy and oily rags in tightly closed metal cans provided for the purpose.

7. 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.

8. Do not use gasoline, naphtha, or benzine for cleaning. Use some of the safer solutions now obtainable and these, in any considerable quantity, only out of doors and during the day.

9. 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 p. 34.)

10. 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.

11. Avoid toy wax candles. Each year a number of deaths of children due to placing candles on Christmas trees produces a sad ending for an otherwise joyful season.

12. 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. Articles made of the above materials should not be worn in the hair as they may seriously burn the wearer.

13. 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 electrical hazards, p. 55.)

14. Turn the current off of an electrical pressing iron or other electrical appliance before leaving it.

15. Make it a point to know how to get out of every building you enter. This precaution may mean the saving of your life and of others in case of fire.

8. WHAT TO DO IN CASE OF FIRE

Determine as well as can be done whether the fire can be extinguished with the means at hand. Summon help of anyone within calling distance. If not certain that the fire can be controlled without further help, call the fire department.

For fighting fires in draperies, wood, paper, rubbish, etc., use any fire extinguisher available or water from a bucket, pump, or garden hose. Water from a bucket can be best applied with a broom or dipper. Beat down draperies, curtains, or other light burning materials with a wet broom or a pole. Using the bare hands may cause serious burns. A woolen blanket or rag can be used to smother a small fire.

On oil or grease fires use a carbon-tetrachloride, foam, or carbon-dioxide extinguisher or sand, chalk dust, soda, or the earth from flower pots. Water will cause spattering of burning grease.

Saving the lives of the occupants should receive first consideration. Many lives are lost in attempts to put out fires or save personal belongings.

Unless you are very sure that you can control the fire call 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 fire alarm. In many cities it is necessary only to call the fire department on the telephone. In others it is necessary to send an alarm at a corner fire box. In many cities it can be called either by phone or from the street boxes. The methods employed for turning in alarms are often not understood, and as every second counts, 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 telephone. In giving information about a fire over the telephone, one should carefully consider what he is doing. A 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 adequate information be given before hanging up the receiver. If a box is pulled, someone should be in the vicinity of the box or along the route of the responding company to direct it to the fire.

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.

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.

If necessary to go through a room full of smoke, keep close to the floor and hold the breath. It is usually better to crawl on the hands and knees, having covered the mouth and nose with a wet cloth. The drafts and currents cause the smoke to rise and the air nearest the floor is usually the purest.

If you have to retreat and all occupants are out of the building or burning portion thereof, cut off the draft by closing doors and windows.

Do not jump from a high window unless into a life net. To use a rope or life line 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. Getting out from an upper story on a porch roof or veranda has saved many lives. It affords temporary relief from smoke and heat and it attracts rescuers.

9. PERSONS WITH CLOTHING AFIRE

When a person's clothing catches fire, the first consideration is that the flame or hot gases should not be inhaled.

Under usual circumstances, he should take a prone position on the floor or ground (preferably lawn), at the same time endeavoring to smother the flames by wrapping himself in a rug, blanket, portiere, or woolen coat and rolling over while calling for help. If there is nothing to wrap in, beat the flames with the hands. Running makes the condition worse by fanning the fire.

If the article of clothing which is on fire can be easily stripped off, this should, of course, be done. If a shower bath or pail of water is handy, it should be utilized, rolling in the spilled water.

If the clothing of another person takes fire, use similar measures. If excited, it may be necessary to trip him to make him lie down. Then if water or a fire extinguisher is handy, apply it at once, but do not direct the stream on the face.

After the flames are extinguished and the clothing drenched with water, do not remove the clothing from burnt skin until an ointment is available to apply to the burn. Avoid tearing the skin.

10. SCALDS

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. The handle of a saucepan when containing hot liquid should not be left projecting beyond the edge of the table or stove. Tubs or buckets of hot water should not be placed on the floor where small children are at play in the vicinity. 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.

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IV. GAS HAZARDS

1. GENERAL NATURE OF GAS ACCIDENTS

Like many other sources of energy, gas must be used carefully, for in careless hands it is a possible source of great danger. However, nearly 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 gas resulting from 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 first of these hazards, asphyxiation by unburned gas, occurs only when manufactured gas is used; natural gas is not usually poisonous (the gas in some districts contains small amounts of hydrogen sulphide and other poisonous constituents) and is not likely to be breathed in sufficient quantity to cause asphyxiation by depriving one of oxygen. The second hazard, asphyxiation by the products of incomplete combustion, is equally serious in households using either natural or manufactured gas, and is by no means limited to gas-burning appliances. Wherever fuel is burned this hazard may exist. It will, therefore, be discussed with reference to the use of all fuels, liquid and solid as well as gaseous, in the last section of this chapter, which deals with carbon-monoxide poisoning and its treatment.

Many of the precautions given in the following sections are already familiar to nearly every user of gas, but the frequent recurrence of accidents from well-known causes makes it evident that a statement of the warnings is desirable.

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

Many hazards would be avoided if gas users would more frequently seek the advise and assistance which every gas company is glad to render. The employees of a gas company have vastly greater experience with the numerous problems which arise in service than does anyone else likely to be locally available for consultation. Usually the company has special facilities for dealing with every difficulty likely to arise; and it has as great an interest in safety and satisfactory service as have the consumers themselves, for accidents and dissatisfaction seriously affect its business.

In particular, the gas company should be promptly notified in any case of serious trouble and should be consulted before any unusual change is made in the equipment used. No accessory made by one manufacturer for use with an appliance made by another should be purchased without the advice of the gas company.

2. INSTALLATION AND CARE OF GAS PIPING

Accidents from gas may be classified with respect to their origin into those resulting from leakage and those resulting from faulty application.

Much of the danger from leakage may be prevented if the house piping and connections are always maintained in first-class condition. When gas piping is installed see that the best materials are used by a competent workman and that the work is carefully inspected.

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 install appliances 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 liquid could collect and partly shut off the gas. Grounding wires of telephone equipment, electric light circuits, etc., should be connected to cold-water pipes rather than to the gas pipes.

Especially after repairs of leaks have been made, the householder should observe whether the nature of the repair is permanent 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 overnight. 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 appliances. It costs very little more at the start to put in the larger pipe during the construction of the building, whereas later it may be very expensive to substitute the larger size needed to serve 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. Do not place the gas piping under strain by stepping on it; it is even more dangerous to try to change the position of an appliance by forcibly bending the pipe.

Have all cocks and valves so located that there is the least possible danger of opening the wrong one, or of accidentally opening one, as by catching the clothing upon it. Have all connections permanently made with rigid piping, if possible. If flexible tubing must be used, be sure that it is of the best quality and that the connections at the ends are always tight. Never turn the gas off at the outlet end of a piece of flexible rubber or metal tubing, leaving the gas in the tubing under pressure, but rather by a cock in the rigid pipe. Take every reasonable precaution to prevent children turning on or playing with the gas cocks. Several styles of cocks which latch and can not be opened without pressing or turning a release are available and can be obtained through the gas company. These are a valuable protection if children play near an appliance.

A gas cock which is fully opened by a quarter turn of the handle and which can not be turned past the open or closed position is the safest type for general use. Sometimes a cock of this type, through wear or loss of a pin, no longer has a positive stop. See that such a cock is replaced or repaired at once. Cocks should be well lubricated so as to turn smoothly, but should not be loose enough to turn without a distinct pull.

Flammable materials and rubbish should not be placed near the gas meter, since a fire in such material would be likely to melt the soldered seams of the meter or its connections and the flame of the escaping gas might greatly increase the extent of the fire.

The gas meter especially should never be tampered with or subjected to strains. It is generally one of the weakest parts of the piping system because it is usually constructed of light sheet metal and the breaking of its case will cause the escape of gas. The householder should, therefore, allow the company to install the meter where, in its judgment, it will be safe from mechanical strains, falling objects, and other harmful conditions such as excessive heat, cold,

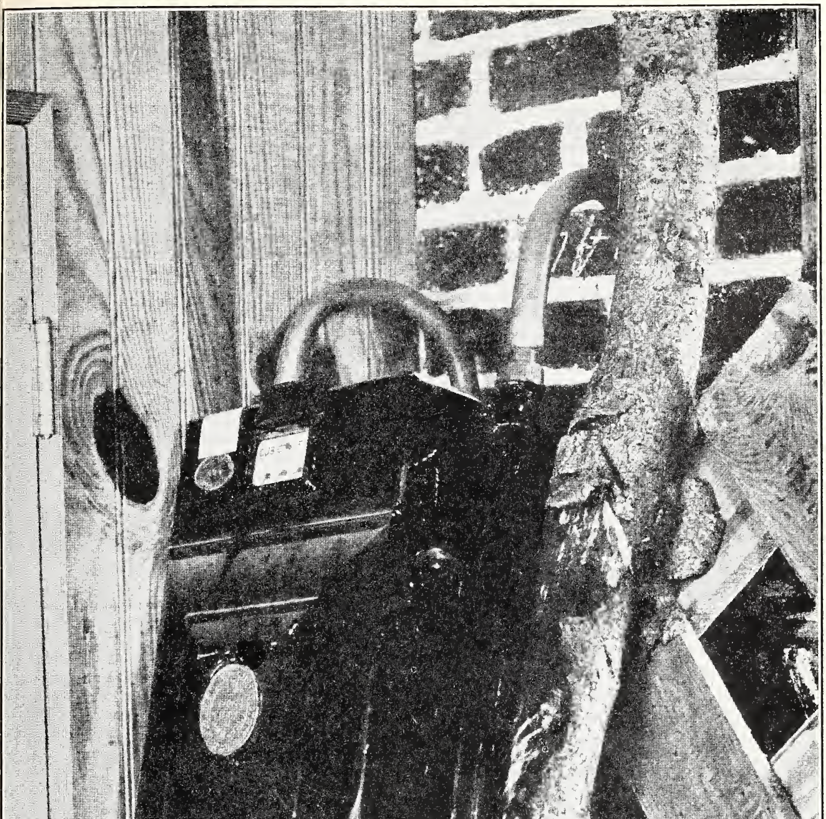


Figure 7.—*A poor gas-meter installation*

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

The installation of so-called house governors or regulators except those installed on the inlet side of the meter by the gas company, or those supplied as a part of the regular equipment of a house-heating furnace or other appliance requiring unusually accurate control, is seldom justified for residential service. The gas company is responsible for the delivery of gas to the user at pressures suitable for the operation of all ordinary appliances, and the obligation is usually met, often with the aid of governors. If the obligation is not met, the remedy lies in an appeal to the company or, if necessary to the proper public authority rather than in the purchase or rental by the householder of controlling devices which may do more harm than good under the circumstances. When expert service is regularly employed for the care of appliances, the use of regulators will, of course, be left to the judgment of the expert. No device intended to modify the character or control the supply of gas, other than a well-made governor, should ever be installed in the supply line without careful investigation and the approval of the gas company.

3. TURNING ON AND TURNING OFF THE GAS

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. 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 been shut off, the gas should not 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's 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, he should not be allowed to turn the gas on.

It is a rule among gas companies that before one of their employees turns on the gas he must first examine every outlet to see that it is closed; after turning it on he must observe the meter to see whether any gas is flowing; he must then light a small burner and observe the meter to make sure that it is registering and would have indicated any flow; and finally he must again visit every outlet to determine that the gas will burn there, and that the outlet is not left open. Equal care, at least, should be taken by less experienced persons when turning on the gas.

One hazard to be particularly guarded against, and which is likely to be overlooked by an inexperienced person, is that of an "air pocket" left in the line, which will extinguish a pilot flame and subsequently permit the release of unburned gas from the main burner which depends upon the pilot flame for ignition.

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

4. 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, it is never possible to be sure of this without a chemical 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.

Leakage of manufactured gas, at least, is usually first detected by odor, which is noticeable when first entering the room, even though the amount of gas present is very small. However, if a person for any reason remains in the room containing gas, he soon loses to some extent the ability to judge by the odor whether or not the air is heavily charged with it. 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. Even at the start it is difficult to judge from the intensity of the odor how much gas is leaking. When the odor of gas, however slight, is noticed it is therefore never safe to disregard it. The very first thing to do is to ventilate the room and then search for the leak, which will usually be at a gas cock or a joint in the connections. If this is quickly located by odor, sound, or by applying soap solution, and 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.

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 spark which will 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 unseen 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.

If the odor of gas seems to permeate the room, and the actual leak 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 flames 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, because the nose loses its sensitiveness when subjected for a while to a gas-contaminated 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 to extinguish lights or to rescue persons sleeping or unconscious, no light should be carried except an electric flashlight which should be turned on and off only outside the room; 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.

Even the slightest odor of gas, the source of which can not be definitely located, should be immediately reported to the gas company. Many of the most serious accidents would have been prevented by attention to this rule. The recent death of two men within a few blocks of the Bureau of Standards was attributed to gas which came from a broken main through porous earth to the basement of the building in which they slept. It was reported that the occupants of neighboring buildings had detected the odor of gas in their basements for several days, and prompt notification of the gas company would certainly have prevented the fatalities.

In a recent case in another city a store was destroyed by explosion and fire, and it was subsequently reported that an odor of gas had been noticed for several days, both in the building in which the explosion occurred and in the adjoining basement.

5. THE SELECTION OF APPLIANCES

The selection of the appliances with which gas is used is much more important than is commonly supposed. While it is true that the danger of getting an unsafe appliance is not very great, as shown by the fact that the number of serious accidents is not great compared with the many millions of appliances in daily use, it ranks in importance with the danger of trouble from accidental leakage and is therefore one of the major hazards in the use of gas.

The American Gas Association, a national organization embracing nearly all the companies distributing gas and most of the important manufacturers of gas-burning equipment, has established a well-equipped laboratory for the purpose of determining whether appliances offered for sale are so designed that they can be used safely and with satisfaction. Specifications called "approval requirements," with which an appliance must comply before it can be regarded as safe, have been adopted. An appliance which receives the approval of the association must pass a number of careful tests of a character such that they can be made only in a specially equipped laboratory. Any appliance, whether manufactured by a member of the association or not, may be submitted for test; and the great majority of models of domestic appliances have been tested. Several thousand models have been approved.

It has been clearly shown in recent years that the cost, reputation, and appearance of appliances have little relation to their safety. The judgment of even the best qualified "experts" regarding the safety of an appliance is not a satisfactory substitute for a careful laboratory test. There is, therefore, little reason for the purchase of an appliance which does not have the approval of the American Gas Association; and at the present time no means is available to the average purchaser for distinguishing a safe appliance except the recognition of such approval.[2]

Usually only one appliance of a given model is tested by the American Gas Association laboratory, and the manufacturer is sure to take care that his appliance is in perfect condition when submitted. Therefore, even among "approved" appliances which are supposed to be duplicates there may be individual differences or defects which can be distinguished by a well-informed purchaser. Consequently, it is desirable before accepting a new appliance to observe it carefully while it is operated under all the conditions likely to exist in service. After studying the discussion of the adjustment and care of appliances which is given later, the purchaser should be able to note any one of several possible indications of unsatisfactory operations which may appear. Mention will be made here only of the uniformity of size and action of the burner "ports," the openings at which the gas burns. All the ports should be clean cut and, unless obviously intended to be different, they should be of uniform size and of regular spacing. Any breaking away, even of the surface, of the original casting around a port should subject the burner to rejection. The gas should ignite without delay at all the ports. The flames at all the ports should be of as nearly uniform size and appearance as the eye can detect. When the air shutter is wide open and the flow of gas is varied as much as possible without extinguishing the flame,

[2] It should not be supposed that all appliances approved by the association are equally good. The association's requirements are minimum standards and the approval of the association indicates only that, in several particulars, the appliance is not worse than the worst appliance that should be installed under any circumstances. An appliance may be much better than this minimum in workmanship, durability, efficiency, appearance, and even in safety. For example, to meet the association's standards a room heater tested when in perfect condition must produce no carbon monoxide when the gas pressure is increased 50 per cent above the normal pressure for which it is correctly adjusted. Some approved heaters barely meet this requirement. If in service they are poorly adjusted or dirty, and some of the parts are slightly displaced, they may produce carbon monoxide at pressures little, if any, above normal. Other appliances will burn the gas completely at pressures four or five times as great as normal, and no trouble is caused by minor changes of adjustment or gas supply.

the flames at the different ports should remain alike in appearance. There should be no noticeable tendency for any flames to flicker, and if the gas rate can be increased until the flames rise from the ports they should all " lift " at about the same rate.

6. THE INSTALLATION OF APPLIANCES

The installation of appliances is a matter which should always 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.

When installing a gas appliance there are five things to be kept in mind: (1) Make sure that the location is suitable for the work intended, (2) make tight and strong gas connections, (3) see that the appliance is so placed that nothing can take fire from it, (4) provide for enough fresh air to completely burn the gas, and (5) provide for the proper disposal of the products of combustion.

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

An appliance should be so located that it is easy to use. When the appliance is awkward or difficult to operate, accidents are more likely to occur. Appliances should be so located that they are not subject to excessive drafts which might extinguish the flame, and that there is no danger of bumping into or stumbling over them or their connections even in the dark. Cocks should not be placed where they could be opened by catching on the clothing, where they can not be easily reached when lighting the gas, nor in such a position that a person turning on the gas is forced to stand too near the burner to be safe in case there is a slight explosion. Cocks controlling different appliances should be placed far apart if possible. If near together, they should be supplied with handles of such different shapes of material that they can be certainly identified by touch.

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. It is considered dangerous practice to put water heaters of any kind in bathrooms or bedrooms, or to heat rooms in which people sleep with appliances which discharge the products of combustion into the room. If a bathroom must be heated by an unvented heater, a window or door should be left partly open for ventilation.

It is desirable, in general, to connect all of the larger appliances to chimneys or other outlets through which a good draft will be assured. Such appliances include " closed-top " gas ranges, the ovens of other ranges, water heaters, and generally all room-heating or house-heating appliances. It is not usually regarded as worth while to vent, by a canopy or otherwise, the " cooking top " or a "grate-top " range, lighting fixtures, or gas refrigerators. It is very doubtful whether the advantage to be gained from venting the oven of an ordinary range justifies the cost of a chimney where one does not exist. Every appliance automatically controlled, and which depends upon a pilot light for ignition should be connected to a flue.

If a chimney is to be built for use with a gas appliance, as much care should be taken in its construction as though it were to be used for any other fuel. If an appliance is to be connected to an existing flue, make sure that the flue is open and in good condition before making the connection.

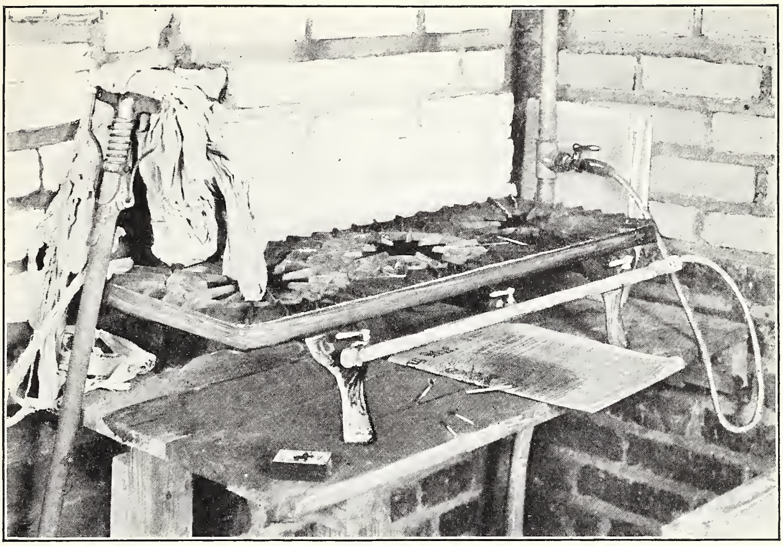
The connection between a gas appliance and the chimney should be short and as free as possible from bends and horizontal portions. A " draft diverter " should be installed in the flue connection of each appliance unless one is unnecessary because of the construction of the appliance itself.

The subject of flues and draft diverters is of such importance as to justify further discussion in order that it may be fully understood.

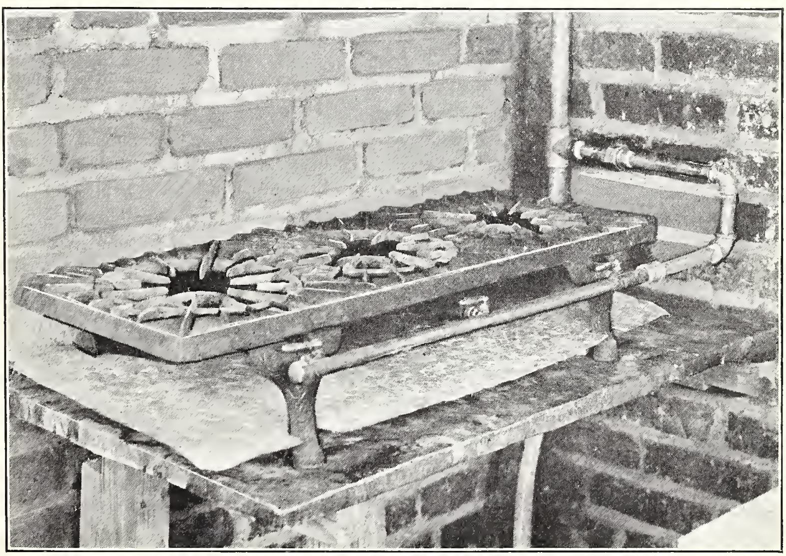
Neither gas nor any other fuel will burn without air. If air does not circulate through a gas appliance in a normal manner, the flame may be extinguished or the gas may be only partially burned, frequently with the production of a large amount of carbon monoxide (in addition to that in the original gas). A gas appliance differs from a stove burning solid fuel in several important respects. If a solid fuel does not burn, it remains harmlessly in the stove; but gas, which is supplied continuously whether it is burning or not, must escape into the surrounding room if not up the chimney. If there is a down draft in a stove burning solid fuel, the stove " smokes " and the odor of the smoke is so disagreeable that the occupants of the room are warned and usually remedy the condition or escape before they are harmed. Dangerous products of incomplete combustion of gas can and sometimes do escape unnoticed. Nearly everyone has had enough experience with smoking fires to realize that the use of gas would be prohibitively dangerous if each case of back draft resulted in the extinction of the flame or otherwise caused the escape of large amounts of carbon monoxide. The necessity for installing appliances in such a way that this will not occur is therefore evident.

Fortunately most gas appliances now on the market are so designed that, when not connected to a flue, enough air circulates through the combustion chamber to permit complete combustion. Trouble results if this circulation is disturbed either by a down draft, as we have seen, or by too strong an up draft. If the flue connection forces a strong up draft, an excessive amount of heat is lost and in some cases a small flame, particularly a pilot flame, may be extinguished. It is the purpose of the " draft diverter " to maintain the same pressure at the outlet of an appliance as at the inlet, in order that the quantity of air necessary for the best service may automatically circulate through the combustion chamber when the appliance is in use. Appliances are sometimes so constructed that there is adequate escape for any down draft through passages other than the combustion chamber. In other words, they have the equivalent of a " built-in " draft diverter. Such appliances need no outside diverter.

In the installation of appliances care must always be taken to avoid incurring any danger of fire. Gas appliances are, in general,



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

FIGURE 8.—*Examples of bad and good gas hot-plate installations*

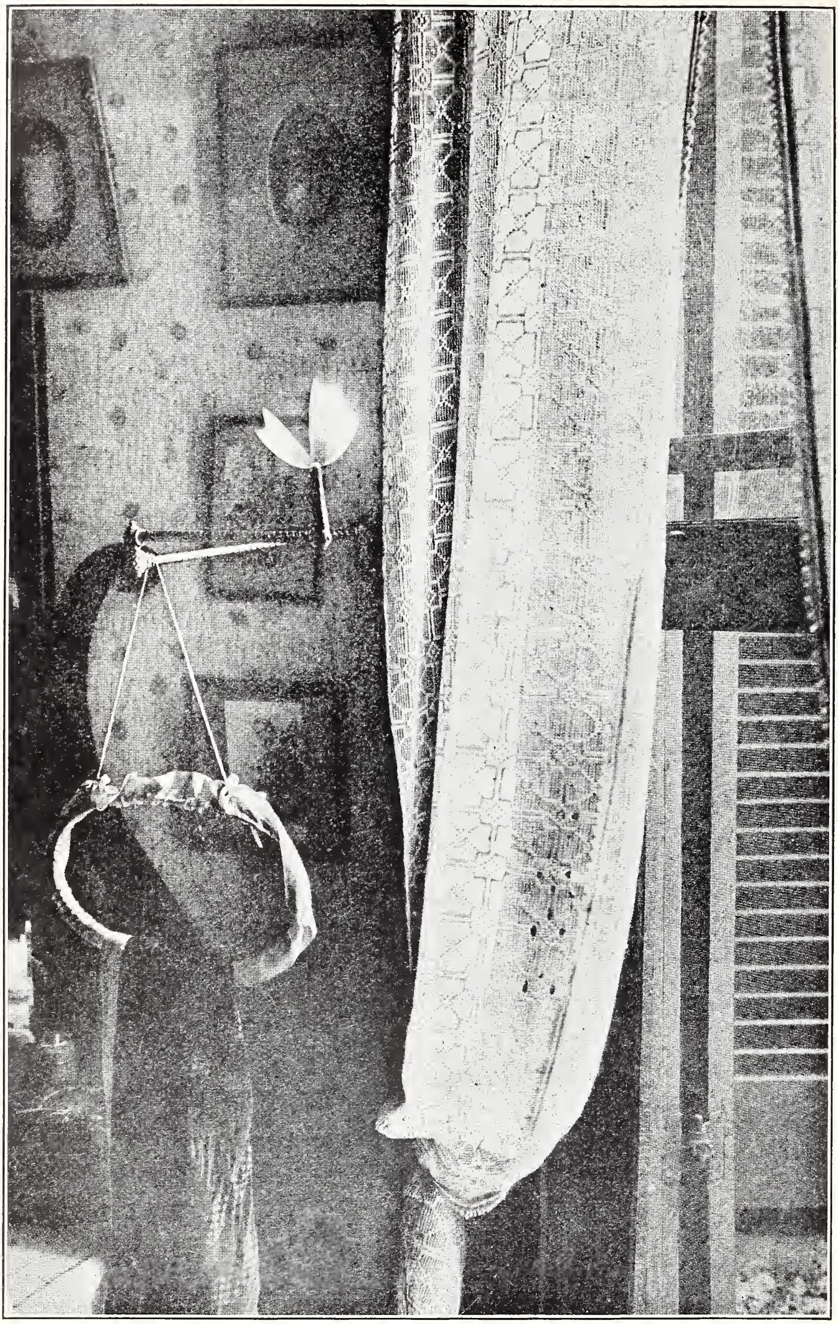
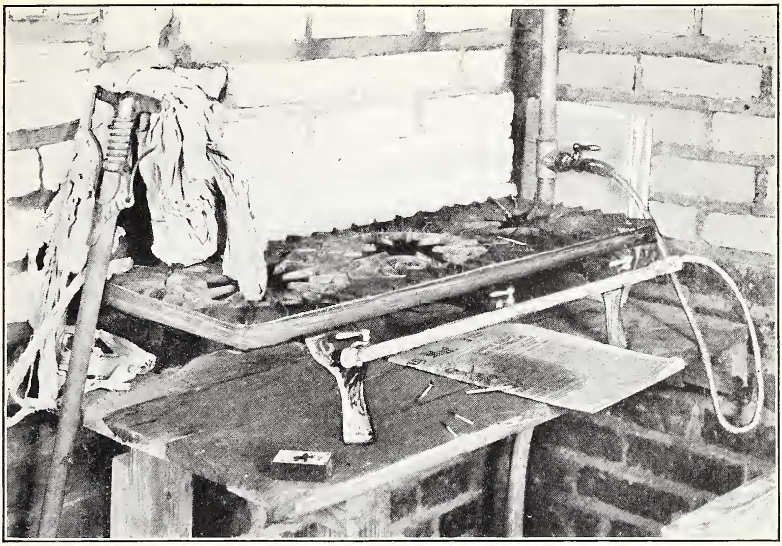


FIGURE 9.—*Gas burner on a swing bracket*

A dangerous type of installation. 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.



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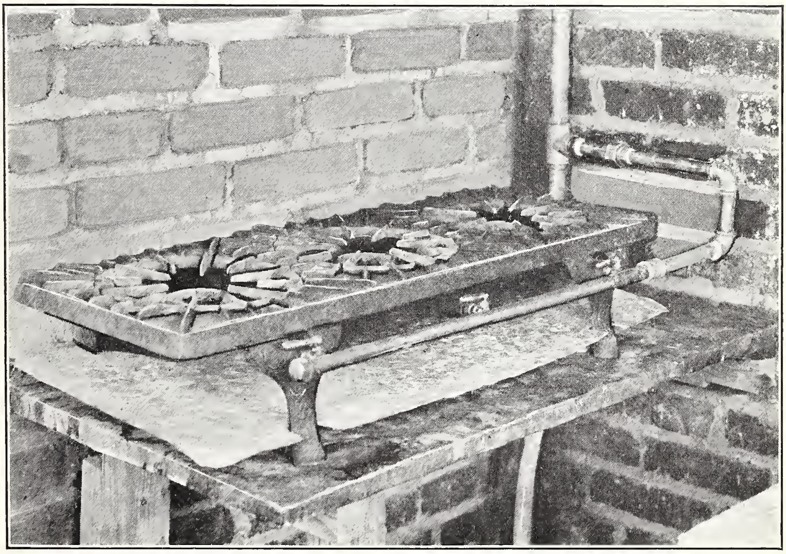

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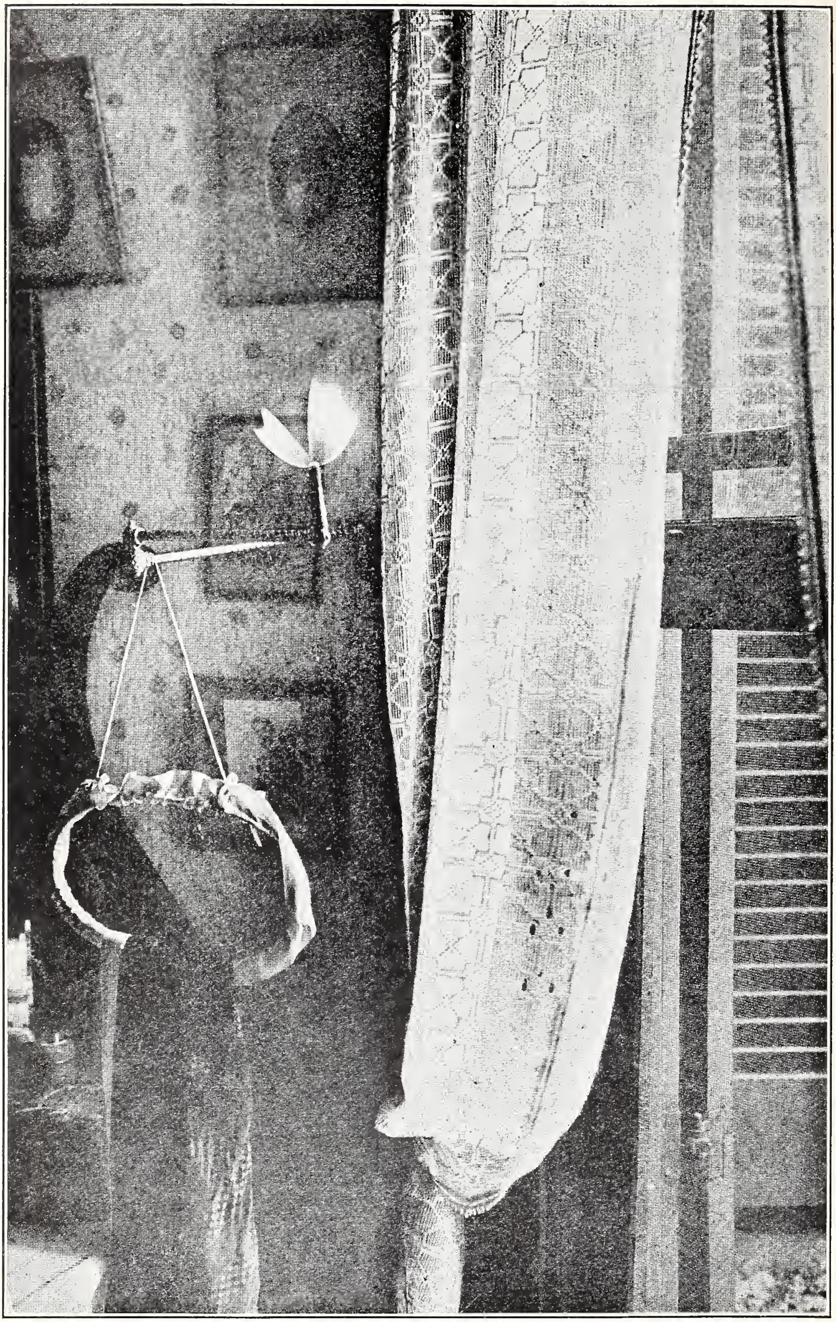

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much more easily installed properly to safeguard wood floors and walls, and other parts of the house or its furnishings than are coal or wood-burning stoves; and this has led to a carelessness with gas appliances that is often serious. The householder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

The preceding chapter of this circular describes the various methods of covering or protecting combustible materials that may be subjected to a dangerously high temperature. These methods apply to gas appliances as well as others.

With gas ranges, water heaters, and other common domestic appliances it is rarely necessary to install a fireproofing material, for by proper spacing between the device and the wall or floor all danger is eliminated. Appliances which receive the approval of the American Gas Association must pass a test which demonstrates that, when they are set 6 inches from a wooden wall the wall will not be heated to an unsafe temperature. Not all appliances in use have been subjected to this test, however, and some responsibility for making sure that the insulation between appliance and flammable material is adequate still rests with the owner. An air space through which there is free circulation is more effective and usually cheaper and more convenient than any other form of insulation; but 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 hand, 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.

Shelves should not be placed above a stove or heater; but if this is unavoidable 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, have been a very frequent cause of fires.

In 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 be set afire.

7. ADJUSTMENT OF APPLIANCES

The possible liberation of carbon monoxide from an appliance in which gas is burning presents a problem distinct from that of raw gas which leaks from pipes or burners unburned. In a gas flame to which there is an unrestricted access of fresh air and no sudden chilling, the carbon monoxide is completely burned. When the flame is partially inclosed and brought into contact with an object which takes away some of the heat, the carbon monoxide may be completely burned or it may not.

It is not always easy to tell when an appliance is liberating carbon monoxide through incomplete combustion, but certain things may well be regarded as warnings. Any odor (which does not come from grease, varnish, or other material about the flame to which the odor can be definitely ascribed) is a cause for suspicion. Of course, carbon monoxide has no odor; but when any odorous substance is liberated from the flame it is pretty safe to assume that carbon monoxide is liberated too. The usual odor accompanying the liberation of carbon monoxide is slightly irritating to the membranes of the nose but is not particularly unpleasant when not too strong. Many people will identify the odor at once as that given off by a plumber's or tinner's gasoline torch. It has no resemblance to the odor of the unburned gas. The absence of any odor is unfortunately not a positive indication that carbon monoxide is not being liberated, even in dangerous quantity.

Another valuable indication is the appearance of the flames. When a flame has a sufficient supply of fresh air its outlines are sharply defined. When, however, the burning gas is surrounded by an atmosphere from which most of the oxygen has already been used, the outlines of the flames are very faint and indefinite and have a wavering or ragged appearance even in the absence of any noticeable air currents. Most appliances, when correctly adjusted, have flames with distinct greenish "inner cones," the size of which may be a valuable guide to an adjuster familiar with the particular model with which he is concerned; but the inner cones are of little significance, in general, in judging whether combustion is complete, for carbon monoxide may be liberated in dangerous quantities, under certain conditions, from flames with bright, well-formed inner cones; while flames without perceptible inner cones may burn the gas completely. It is the size, form, steadiness, and continuity of the pale blue outer boundary of the visible flame which give valuable indications of the safe or unsafe condition of the appliance.

A flame which is depositing carbon (soot) is not necessarily liberating carbon monoxide, but it is to be regarded with suspicion. When the flame flashes back—that is, when the gas burns inside the ports of the burner—carbon monoxide is almost always liberated in dangerous quantity. This condition is usually recognized at once by a roaring noise and a disagreeable odor. Usually there is a distinct pop when flash back begins.

Whenever any indication of unsatisfactory combustion is observed, notify the gas company, as in a case of leakage. Many gas companies give free service in correcting conditions of this kind; any of them will perform the service at reasonable cost, since failure to insure satisfactory and safe utilization of gas always results in a loss of business.

All manufacturers of appliances endeavor so to construct their products that they will completely burn all the gas that may be needed for the best service; nearly all of them place on the name plate a rating in B. t. u. per hour.[3] In the case of ranges the rating of each burner is usually standard and is understood by adjusters although it does not appear on the name plate. This rating is either the greatest rate at which heat should be supplied to give good service, or it is the maximum amount of heat for which it is safe to adjust the appliance, probable changes in the pressure of the gas supply and in the condition of the appliance being allowed for. Usually the safety consideration determines the rating. All appliances have

[3] B. t. u. is the abbreviation for British thermal unit and means the amount of heat which will raise the temperature of 1 pound of water 1° F.

means for changing the size of the opening, called the orifice, through which the gas flows from the supply piping into the burner. This may be done either by means of a threaded part, turning which opens or closes the orifice, or by replacing the small block of metal in which the orifice is drilled with another block which is drilled with an opening of a different size. The orifice should be adjusted to give the manufacturer's rating when all cocks and valves are wide open, and when the pressure is the maximum which commonly occurs. Suppose, for example, the appliance is rated at 12,000 B. t. u. per hour and is connected to a gas supply of 500 B. t. u. per cubic foot (a common value for many manufactured gas supplies) in a locality where the pressure varies daily from about 4 to about 6 inches of water pressure with occasional minima of 3 and maxima of 7 inches. The orifice should then be so adjusted that 24 cubic feet of gas ($24 \times 500 = 12,000$) will flow through the orifice per hour when the pressure back of the orifice is 6 inches of water. This adjustment, and in some cases that of the shutter which controls the amount of air admitted to the burner, can safely be made only by a man who is entirely familiar both with the operation of appliances and with the conditions of gas supply.

If an appliance is moved from one community to another, or if the character of the gas supply is materially changed, for example, from manufactured to natural or the reverse, it is particularly important that the appliance be adjusted for the new conditions by an experienced man who is entirely familiar with the local situation.

After the adjustment is set, it is dangerous to change it, particularly to enlarge the orifice at a time of low pressure. If service is unsatisfactory because not enough heat is supplied, the trouble may be caused by a partial clogging of the house piping, the service pipe connecting with the street main, or the cock controlling the appliance itself; it may be caused by mechanical difficulty in the meter; or it may be the result of a temporary condition which causes low pressure in the mains which supply the neighborhood.

In none of these cases is the enlargement of the orifice a correct or safe method of remedying the trouble. The only safe course is therefore to notify the gas company and permit it to locate and remove the cause of the difficulty.

Although a change of orifice should never be attempted by the average user of gas, an adjustment of the air shutter may usually be made with safety in the case of ranges, water heaters, and some other appliances, but the adjustment of room heaters not directly connected to flues should be left to an expert. Generally the small flame at each orifice on the burner should be distinct, free from yellow, 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, to permit flashing back of the flame when turned down as much as it is likely ever to be in use, or to cause any tendency for the flames to "lift" away from the ports.

8. OPERATION AND CARE OF APPLIANCES

In lighting an oven, a water heater, or other appliances in which a large amount of gas is burned in a partially inclosed space, a few simple precautions should be taken to assure safety. The doors to the burner box and oven, or to whatever large space communicates with the combustion chamber, 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 main burners are actually lighted before turning off the pilot. In case the main burners flash back when turned on, the gas should be shut off at once and then turned on again before the pilot is extinguished. If this flashing back occurs frequently, or if a blue flame burns about the pilot flame but will not "settle" on the burner, 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 burner on full and applying the match flame immediately. If, as sometimes happens, there is so much delay in igniting the gas that it escapes from the pipe unburned for several seconds, the main burners should be turned off, time allowed for the appliance to become free from gas, and the condition which resulted in delayed lighting remedied, if possible, before lighting is again attempted. Especially in case of an automatic heater this precaution is very necessary, 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.

It sometimes happens that the gas does not light at every port of a burner and unburned gas escapes from those at which there is no flame. Oven burners are especially subject to this trouble. When the gas is lighted see that there is a flame at every port. If much difficulty is encountered in getting all the ports of the burner to light, something is wrong. Usually the burner needs cleaning, but if cleaning does not remedy the trouble, the burner must be repaired or replaced by an experienced appliance adjuster.

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 with a match and therefore removes the hazard.

Various forms of catalytic[4] or friction lighters intended as a substitute for matches are on the market and their use has been recommended, in a former edition of this circular and elsewhere, as a safety measure. This recommendation needs revision. With such lighters ignition is usually delayed longer than with a match, frequently much longer. Hence gas may accumulate before ignition to the extent of causing a dangerous flame. The type of friction lighter

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[4] Catalytic lighters are those which become red hot when held in the unlighted mixture of gas and air.

in which a wheel, rotated by a spring, definitely directs a shower of sparks forward in a narrow stream is the best of these devices and can usually be relied upon. It is probably as safe as, or safer than, matches; but the use of many other forms of mechanical or catalytic lighters introduces a distinct hazard.

Appliances should always be kept clean and in good condition. If any part of the appliance appears to be broken, bent, or out of position, you should have an experienced man correct the condition unless the part can be simply replaced, as in the case of glassware and mantles of lighting fixtures, and glowers or radiants of radiant heaters.

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 or any other appliance showing such carbon deposits should be cleaned and adjusted. Mantles should be replaced as soon as the slightest break appears, because the uneven heating resulting from a broken mantle is the usual cause of broken glassware; it is uneconomical as well as unsafe to neglect broken mantles.

In all cases safe combustion requires clean burners and unobstructed flue passages. Obstructions in the burner ports or air shutters and accumulations of dirt or soot in the burners modify the design, interfere with the proper mixture of air and gas, and create dangerous conditions. Burners can be easily cleaned by washing in boiling water and soda; they should be dried before using. After cleaning a burner or displacing it for any other reason, it must be carefully restored to exactly its original position.

Nothing is more dangerous than to close the vent of an appliance either by carelessly placing something over it or by deliberately obstructing it, as is sometimes done by ignorant people, for the purpose of saving heat.

The proper way to save heat is to burn the gas only when needed and then at the lowest rate that will accomplish the desired work. A vessel containing a liquid should be closely watched as boiling begins because the liquid may run over the edge of the utensil, extinguish the flame, and permit unburned gas to escape. The boiling over of cooking foods is the most common cause of clogged burners. As soon as liquids start to boil the gas should be turned down until boiling continues only very gently. There is nothing to be gained by violent boiling, for the temperature of a liquid can not be raised above the boiling point, and the high flame simply wastes the gas and increases the risk.

When it is desired simply to keep the contents of a utensil hot, it is better to place the vessel over a moderate flame from a small burner than over a low flame from a large burner. It is best always 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 flammable materials away from the gas range. For example the range should not be used to dry clothing or other articles if this can be avoided. If it is 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. Paraffin may be safely and conveniently melted in a utensil immersed in or supported above boiling water.

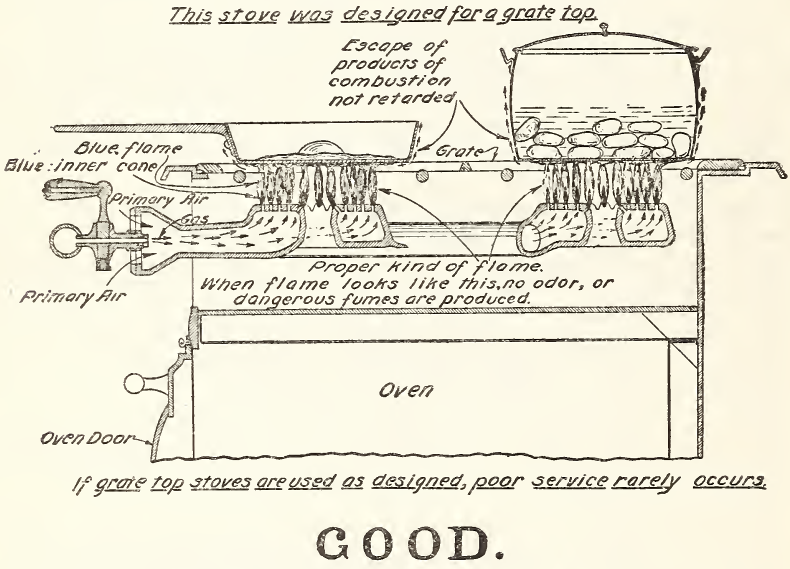

FIGURE 10.—*Appearance of flames when stove is equipped with a grid top*
This represents a safe condition.

9. ACCESSORIES FOR USE WITH APPLIANCES

Accessories that may alter the character and size of the flame, or the access of air to the burner and the escape of products of combustion from it should never be purchased. Particularly to be avoided are the "solid tops" or plates to be placed on a stove designed for the use of a grate top, and the miscellaneous devices sold from house to house and alleged to save gas when placed on other appliances. Meritorious solid-top stoves, built as such, are available, but they must be particularly well designed to be safe and reasonably economical. Placing a solid cover on a range not designed for it interferes with the admission of air around the flame, and with the escape of the products of combustion through the open grates as intended by the designer.

One manufacturer of an attachable solid top, to whose attention the extremely dangerous character of his product had been called, endeavored to eliminate the hazard by cutting outlets for products of combustion at the back and along the edges of the top. The top so modified was tested repeatedly, the outlets being enlarged after each test. Although this process was carried to such an extent that the top was hardly recognizable as a solid top, and any advantages of appearance, convenience, or protection to the burners it may have originally possessed had been sacrificed, it still prevented the burners from operating properly. Its use would render dangerous a grid-top stove which previously was only upon the verge of becoming unsafe.

If the various devices alleged to save gas when installed on range burners were really valuable, they probably would have been incorporated by the manufacturer of the original appliance. These devices do not, in general, correct any fault which may exist in the

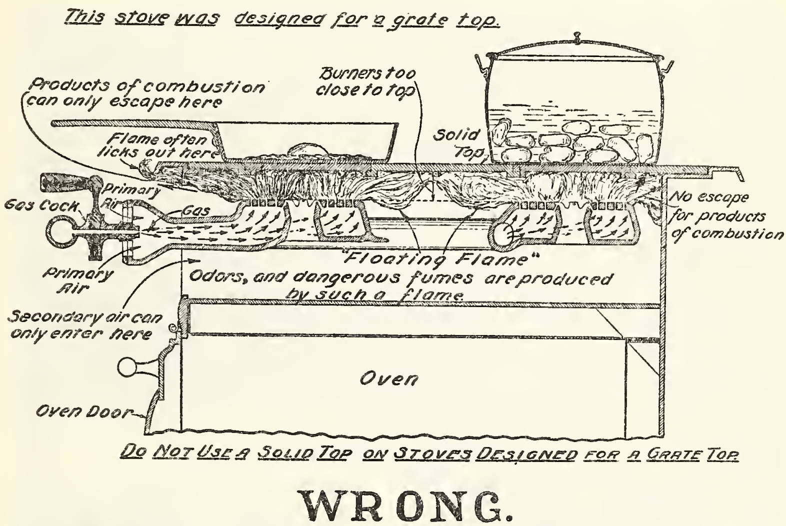

FIGURE 11.—*Appearance of flames when a stove does not have a grid top—is equipped with a solid top*

This represents a dangerous condition.

consumer's appliance, except that of a burner placed too far below the top of the stove, a condition which is now rarely found. They occupy much of the space between burner and utensil, interfering with the access of air to the flame and the escape of products of combustion.

The effect on the flame of a typical device of this kind is shown in Figure 12. On the left is pictured a top burner with all the flames of the same height. When a utensil is placed the proper distance above such a burner the heat is distributed uniformly over the bottom of the utensil. Such a condition results in efficient heating of the utensil, causes no local overheating, and allows the gas to burn completely. Placing a "gas saver" above such a burner produces the effect shown on the right. A utensil placed over this burner is enveloped in flame, the individual cones are no longer distinct as in the preceding case, and it is impossible for the air necessary for completing the combustion to reach all portions of the flame. The result is the formation of considerable quantities of carbon monoxide.

An attachment of another type which should be strictly avoided is one alleged to filter or purify the gases escaping into the room from an oven or space heater and installed on the vent of the appliance. An open elbow turned away from the wall, or other deflector equivalent to an elbow, is useful to prevent the streaking of the wall behind an appliance, and may prevent local overheating; but the householder should never allow steel wool or other metallic shavings, perforated plates, or porous material of any kind to be introduced into the vent or flue passages of an appliance.

10. FLEXIBLE TUBING

Among useful items of gas equipment flexible tubing is by far the most dangerous, for, considering its limited importance and application, it has without doubt been the cause of a greater number of serious accidents than anything else for which there is legitimate use in connection with the burning of gas. Several types of accidents have been common: (1) Cracking or breaking of the tubing itself, allowing gas to escape; (2) the pulling off of the tubing from the appliance or the gas outlet to which it is connected; (3) the separation of the tubing itself from the connectors which attach it to gas outlet or appliance; (4) the momentary kinking or collapsing of the tubing (when stepped on, for example) which extinguishes the flame or causes it to flash back; and (5) the overheating of the tube or its connectors which results in leakage. Burners at which backfiring has occurred usually get extremely hot, and the rubber connectors sometimes melt or burn off. Even the flexible metal tubing with metal connectors usually depend for tightness upon a thread of rubber packing, and will leak if overheated.

The best precaution against the dangers of flexible tubing is to avoid its use whenever possible. Hot plates, radiant heaters installed in fireplaces, and all other appliances which are to be used in one location for a considerable period of time should always be connected with rigid and permanent piping. There is little difference in cost, considering the fact that the flexible connection may have to be replaced repeatedly during the life of the appliance.

If flexible connections must be used, as in the case of a gas iron, the best tubing obtainable should always be secured. In this case as in that of appliances, the best available evidence that the tubing is safe is the approval of the American Gas Association, which subjects tubing to a series of rigorous tests to determine its safety from each of the more common hazards. Tubing should always have the connectors at both ends permanently attached at the factory.

Always take the utmost care in connecting the tubing. See that the ends are as tight as they can be made and that they will not loosen with a strong pull. See that no part of the tubing is left in a position in which it may become overheated. The gas should always be shut off the appliance at the inlet end of the tubing, never

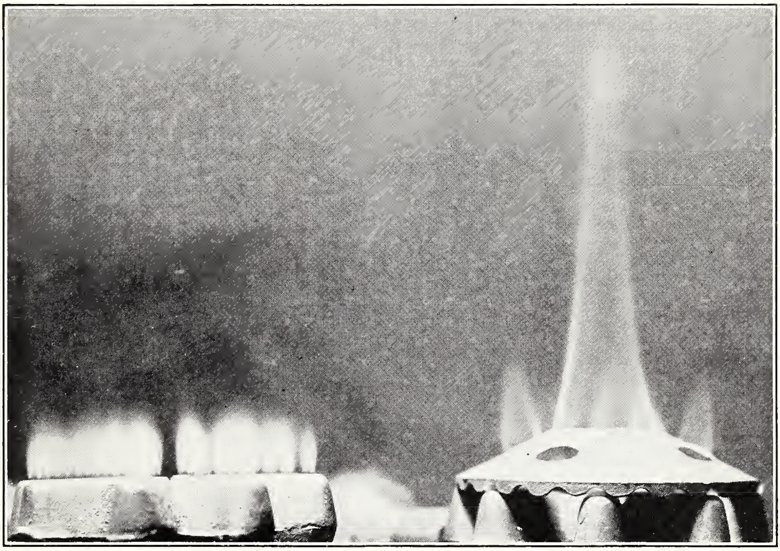

FIGURE 12.—*Effect of "gas saver" on flame*

at the appliance. For this reason it is unsafe even to make a flexible connection to an appliance which has a shut-off.

When tubing which has been in use shows the first sign of leakage or other serious deterioration, throw the piece away and get a new length. Successful repairs are almost impossible to make. The very best repairs lengthen the life of the tubing so little that the saving effected is negligible; and many deaths have resulted from attempted repairs of this kind.

11. LIQUEFIED PETROLEUM (BOTTLED) GASES

The use of liquefied hydrocarbon gases, mainly propane, though sold under many trade names, for houses beyond the reach of city gas mains has recently reached extensive proportions. These gases are supplied in liquid form in steel cylinders which are usually placed in cabinets outside the house. Propane evaporates to a gas at all temperatures likely to be encountered and its pressure is controlled by regulators at the cylinders so that only gas at moderate pressure enters the house piping.

In some cases butane or other gases not sufficiently volatile in cold weather to evaporate out of doors at a satisfactory working pressure are supplied. In such a case the house piping contains a liquid fuel similar to a very volatile gasoline which may evaporate only at the burner and which is usually at a higher pressure than is employed when only gas enters the house piping. The hazard of leakage from a system in which liquid is conveyed to the burner is much greater than from one employing only gas-filled piping, especially if effective means are not provided to automatically cut off the flow of liquid in case it becomes much greater than is required for the normal operation of the appliances supplied.

With any bottled gas system the same precautions are to be taken as in the case of a supply of natural gas. The only additional precaution that need receive attention is for the householder to assure himself that the pressure regulators, valves, etc., are the best available, are properly installed, and are maintained in good condition. Probably the best assurance of these facts is to be obtained by securing the supply of fuel only from a reliable company and using only equipment furnished and maintained by it.

Nothing except rigid piping to all appliances should be considered in the case of bottled gas systems. Flexible tubing should never be used.

12. CARBON-MONOXIDE POISONING AND ITS TREATMENT

The active constituent of gas which causes death when breathed is carbon monoxide. This gas is so active a poison that as little as 1 or 2 parts in 1,000 parts of the air, if breathed continuously for several hours, may cause death. It is not present in natural gas, and varies in amount in manufactured gas from 5 or 6 per cent to about 30 per cent, depending upon the method of manufacture. If either natural or manufactured gas is burned under unfavorable conditions, carbon monoxide is produced in the appliance. It is possible, under the worst conditions, such as those which may result from closing the vent of an appliance with a damper or cap, to convert practically the entire carbon content of the gas into carbon monoxide. If this is done, the volume of carbon monoxide liberated is actually greater than the volume of gas burned in the case of some natural gases, and almost as great in the case of manufactured gases.

Fortunately, one who has breathed air containing carbon monoxide, even to the extent of losing consciousness, will, if still breathing, rapidly recover when removed to fresh air and will generally suffer no permanent injury. Ill health may, however, be caused by the continued or frequently repeated breathing of small amounts of gas.

Carbon monoxide is a constituent of all manufactured illuminating or fuel gas. It is formed and then burned during the combustion of all fuels, coal, wood, oil, or gas. A blue flame is, to a large extent, burning carbon monoxide; that is, carbon monoxide in the process of uniting with the oxygen of the air to form the harmless gas, carbon dioxide.

If two requirements only are met, carbon monoxide burns readily and completely. These two requirements are that the gas have access to enough air to supply the necessary oxygen, and that it be hot enough for the chemical combination of the carbon monoxide and the oxygen to take place.

In the cylinder of an automobile it is possible that neither condition will be met. The oxygen present is limited to that drawn in with the "charge," and the water-cooled cylinder walls may cool the gases before their combination is complete. Hence, an automobile is a well-recognized source of possible carbon-monoxide poisoning, and it is never safe to run an automobile engine in a small closed garage. When it is necessary to run the engine in the garage for even a few minutes, every precaution should be taken to ventilate it, and help should be near at hand if needed.

Stoves and furnaces of all kinds are possible sources of carbon monoxide. Hot-air heating systems, in which leaks have developed between the flue passages and the hot-air ducts are the most dangerous of the coal-burning appliances. Any odor of coal gas, especially if it persists day after day, should be traced to its source and its cause eliminated. Appliances burning gasoline or oil are to be regarded with at least as much suspicion as the most nearly equivalent gas-burning appliances. Usually there is no danger of carbon monoxide from a stove or fireplace burning wood because, although the gas is produced under some conditions, it is always accompanied by so much irritating smoke that no one is likely to breathe a dangerous amount of it.

Symtoms of rapid carbon-monoxide poisoning are lassitude and weakness followed by dizziness and, perhaps, nausea and headache. If such symptoms are noticed in a room in which a gas appliance is burning or in which any odor of gas has been detected, get into fresh air at once.

In cases in which there is a rapid liberation of carbon monoxide, such as a considerable leakage of raw gas, or the operation of an automobile in a closed garage, loss of consciousness may occur so suddenly that the victim is aware of no warning, except the initial odor of gas, until it is too late to escape. If there is any reason for suspecting that carbon monoxide may be present, the only safe course is, therefore, to escape from the contaminated atmosphere with as little delay as possible, even though no effects may yet have been noticed. Headache practically always follows some time after breathing even so small an amount of the gas that there is no other noticeable effect. Frequent or persistent headaches of no great severity for which there is no other known cause are likely to be the first indication of chronic carbon-monoxide poisoning, and when such headaches occur it would be well to consider their possible relation to probable sources of this gas.

When anyone is found helpless, and carbon monoxide is suspected as a possible cause, do the following things: First, provide the patient with fresh air, either by carrying him outdoors or to another part of the house or by thoroughly ventilating the room in which he is found, breaking open doors and windows is necessary. Whichever means will most quickly accomplish the result should be used. Second, call a physician and, if in a city, notify the fire department and the gas company. Many city fire and police departments have special equipment for, and men, the so-called rescue squad, trained in the resuscitation of partially asphyxiated persons. Telephone calls always go through to them instantly, and there is a minimum of delay in their arrival. Every second is precious. The gas company likewise has trained men and special equipment for dealing with these cases. Until the doctor comes, keep the patient warm and at rest. If breathing has ceased, artificial respiration is to be applied as in cases of drowning or electrical shock (see p. 89). If you do not know how to apply the prone-pressure method of artificial respiration, call the nearest boy scout or girl scout, as they have usually been trained. Forced respiration should be continued without interruption, for many hours if necessary, until natural breathing is restored or the physician declares that rigor mortis, a certain indication of death, has set in. If breathing begins and artificial respiration is discontinued, watch the patient carefully; he may stop breathing again. In that case apply artificial respiration again and continue until the patient is out of danger.

In all cases of severe poisoning the most effective immediate treatment is the breathing of oxygen, preferably containing 5 per cent of carbon dioxide to stimulate respiration. When oxygen is available, from the fire department or otherwise, its use should be commenced as soon as possible. Its discontinuance and the subsequent treatment of the patient should be determined by the physician.

Do not give any liquid by mouth until the patient is fully conscious and then only under the direction of the doctor. Never give alcoholic beverages.

When the patient revives, keep him quiet and lying down. It is dangerous to allow him to sit up or stand. Let the physician decide when it is safe for him to move.

V. ELECTRICAL HAZARDS

1. SAFETY OF PROPER APPLICATION OF ELECTRICITY

Electricity is one of the most convenient forms of energy for household use. It serves not only to illuminate the home but to supply power to various motor-driven appliances and to supply heat for cooking, for radiant heaters, and other heating appliances. In addition to its convenience, electricity when properly used is safer than many other means for rendering similar service, such as oil lamps and gasoline for lighting, power, and cooking. It does away with the use of matches and the need for such substances as kerosene and gasoline, which involve a certain fire hazard if even stored within the home.

When not properly safeguarded and used, there are, nevertheless, certain hazards to both life and property involved in the use of electricity. Fires may be started and persons may be shocked if conditions are not right. It is desirable that every user of electricity should understand the hazards and how to avoid them.

2. HAZARDS OF ELECTRICAL INSTALLATIONS

Accidents of electrical origin may be classified in three groups—shocks to persons, burning of persons, and burning of property.

Shock.—Electrical shock results when electric current of appreciable magnitude flows through the human body. If the current is very small it may produce only a slight tingling sensation. If larger, it may produce involuntary muscular contractions which, in extreme cases, become decidedly painful. If the current is large enough it may be fatal. Severe shocks may cause muscular contractions which may throw a person to the floor or against adjacent objects, thus causing bruises or fractured bones. A severe electrical shock frequently interrupts the process of breathing, and if breathing is not started again promptly the shock may be fatal. In such cases artificial respiration should be immediately brought into action. The method of accomplishing this is described in detail later.

The amount of current which flows through the body and the consequent severity of the shock depends upon several conditions, the most important of which is the electrical resistance of the skin at the point of contact with the electrical circuit. Dry, thick skin offers a high resistance to electrical current, whereas this resistance is small if the skin is thin and moist. Persons with delicate skin are consequently more susceptible to shock than others, and any person is more likely to receive a shock when the skin is wet from perspiration or otherwise. Other factors affecting the severity of the shock are the voltage applied to the body, the area of the contact surface, and the conditions for making a closed electrical circuit.

Most electrical circuits installed in residences have one of the conductors grounded and consequently a shock may be received by touching a single conductor when in electrical contact with the ground. This contact with the ground may be direct as when standing upon soil, wet concrete, etc., or the ground connection may be made by touching pipes, radiators, water faucets, and other metal objects which have a direct connection to ground. It may also result from standing upon a wet floor. It is commonly found in consequence that many of the worst electrical accidents, and especially the fatalities at low voltage, occur to persons who make contact with the electrical circuit under wet conditions.

In a report presented to the National Safety Congress in 1930 by the committee on low-voltage electrical hazards accounts were given of 68 fatal accidents which had occurred in domestic locations. Of these, 23 were connected with the use of the bathtub and 22 others occurred to persons making contact with the earth or with the wet floor of a basement. It is thus seen that about two-thirds of the fatal accidents occurring on ordinary lighting circuits in the home involve a good connection to ground and this frequently occurs on account of some wet condition. It is the unusual case when the shock occurs on account of making contact with both sides of the electrical circuit.

Burns.—If the current passing through the body is large enough it may actually sear the tissue, especially at the point of contact with the skin. This seldom happens except on circuits of higher voltage. It is most likely to happen when the voltage is high enough for the electricity to spark or arc to the skin before actual contact is made with the electrical conductor.

Burns are also caused at times from immediate proximity to an electric arc which has formed between two conductors so that the current does not flow through the body of the subject. Such arcs may be due to a short-circuit or may be caused when an electrical circuit through which current is flowing is broken at the switch or fuse.

Fires.—The fire hazards of electricity arise largely in the same way as the burns just discussed. They may be due to the overheating of an electrical conductor which carries too large a current, or to the production of an electric arc in the presence of combustible materials. If the arcing is long continued, molten metal or burning insulation may fall upon combustible materials which were not very close to the electrical conductor.

The overheating of electrical conductors may be brought about by trying to operate lamps, motors, or appliances which are too large or take too much current for the circuit to which they are connected. This may arise from connecting too many appliances to one circuit or it may arise from some fault in the insulation which causes an abnormal current to flow. Precautions are ordinarily taken in electrical installations to prevent excessive currents from flowing and thus creating a fire hazard.

When an electrical installation includes loose or improperly made joints in wires or connections to devices, such as switches and sockets, dangerous heating or sparking may occur at these connections, even when the currents are not excessive. It is accordingly important from a fire-prevention standpoint that all joints and connections in electrical circuits be tight and permanent; and to prevent trouble when they are not, it is best that joints be made inside a metallic inclosure, such as an outlet box or switch box.

Prevention of hazards.—In order to prevent the hazards just discussed from arising, the design of electrical circuits should be, and usually is, such as to make it improbable that these hazards will exist in buildings of residential occupancy. To avoid contact with live parts, electrical conductors are covered with insulating material and are so disposed that they normally are not exposed to contact. To prevent excessive foreign voltages from occurring due to the possible contact outdoors of the wires supplying the premises with other high-voltage wires, one of the wires of the house circuit is usually grounded. To prevent the exposed metal covers of electrical equipment and the metal coverings of wires from presenting a hazard in case of insulation failure so that they become connected to the electrical conductors, these metal parts should also be grounded, and this is commonly done when the electrical equipment is installed.

To avoid receiving shocks in wet places, such as a basement, laundry, or bathroom, it is desirable to avoid the use of portable appliances in such locations. If the use of portable appliances in such locations seems to be unavoidable, then care should be taken not to handle the appliances when the hands are wet, not to touch them when standing upon a wet floor or when also in contact with a water faucet, radiator, or other grounded metal object. Such appliances as must necessarily be handled with wet hands, such as an electric washing machine, should have the frame and other metal parts definitely grounded by connecting a wire to the frame and to a cold-water pipe. Insulation is especially subject to breakdown when exposed to moisture, and the current may consequently in such cases leak from the electrical conductors or the motor to the frame of the washing machine. Grounding the frame of the machine will prevent such leakage from giving a shock to the operator.

To avoid overloading the electrical wires with excessive currents a device known as a fuse is connected in the circuit. The fuse is so selected that there is no interference with service so long as the current does not exceed the proper value for the particular circuit in question, but if for any reason the current becomes too large, a piece of metal in the fuse will be melted and the circuit will thus be interrupted. Fuses are very carefully rated for different values of current, and the appropriate size of fuse is installed in the circuit. The usual branch circuit in a residence is designed to carry not more than 15 amperes and is consequently connected up with a 15-ampere fuse in circuit. If too many lamps or appliances are connected in one circuit, or if accidentally a contact is made between the two conductors of the circuit, producing what is called a short-circuit, the excessive current will cause the fuse to blow and interrupt the circuit. It is thus that the wires of the circuit are prevented from being overheated and setting fire to the house.

To prevent the electric arcs which may be produced on opening a circuit from doing any damage, the fuses, switches, and any other devices which may be used to open circuits should always be in-

FIGURE 13.—*Illustrating danger from shock when in contact with an electrical fixture having exposed metal 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.

closed in metal boxes. This will prevent any arcs which may be formed from setting fire to neighboring objects or from burning the hand of the person who may manipulate the switch.

One substitute for a fuse which is coming into more extensive use is known as a circuit-breaker. This device also interrupts the circuit when the current reaches an excessive value, but it does so by a mechanical action similar to that of the switch instead of by melting a portion of the conducting metal.

The use of such protective devices as fuses or circuit-breakers, as well as switches, in all electrical circuits, is required by the National Electrical Safety Code of the Bureau of Standards,[5] and by the National Electrical (Fire) Code of the National Board of Fire Underwriters. These codes are recognized standards of the electrical industry and their requirements are very largely incorporated in the local regulations enforced by the electrical inspection departments of most large cities and some States.

In order that fuses may give the intended protection, it is necessary that their integrity be rigidly maintained. The blowing of a fuse is a warning that some fault has occurred or that a circuit is overloaded. Before the fuse is replaced, the reason should be ascertained and the fault remedied. A fuse of the proper size may then be inserted in place of the blown fuse. To replace a blown fuse by one of a size too large for the circuit or to replace the fuse by other metal which will not give the intended protection is to remove a very necessary safeguard to the use of electrical energy and it may have very sad consequences. The fuse is to the electrical installation what the safety valve is to a steam boiler, and to render a fuse inoperative is taking a chance with life and property which is similar to tying down the safety valve of a steam boiler.

In order that plug fuses suitable for ordinary branch circuits may be easily distinguished from larger sizes, they are designated by a hexagonal shape. This may take the form of a hexagonal opening in the cap through which the window of mica or other material shows; or of a hexagonal-shaped recess in the cap; or of a hexagonal impression raised or depressed on the (metal) cap. Fuses of sizes larger than 15 amperes do not carry such a hexagonal design.

3. INTERIOR WIRING

The electrical wiring of residences is usually designed for use at 110 or 120 volts on the branch circuits but frequently twice this value of the voltage is supplied over the service conductors entering the premises. There is an economy in the supply of double voltage over three conductors which need not be gone into here, but which makes this a common method of supply. These service conductors are derived frequently and wherever alternating current is utilized from an outdoor transformer. The transformer is a piece of apparatus which can be supplied by the high-voltage wires constituting the street mains and transforms this high voltage to a value suitable for bringing into the premises. Since it occasionally happens that the insulation of a transformer may fail or that the high-voltage wires in the street may come in contact with the low-voltage wires entering

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[5] Handbook No. 3 of the Bureau of Standards.

the building, it is necessary to protect the occupants of the building from the high voltage. This is done by connecting one of the low-voltage circuit wires to the ground. Where water pipes are available, the grounding of the conductor is carried out by making a connection to the water pipe. In localities where there are no water supply pipes, a connection to ground is usually made by driving a pipe or rod into the soil and connecting the wire to it.

In cities which are supplied with direct current, the ground connection is not made upon the consumer's premises but is made at the power station where the current is generated. The requirements for the proper method of making grounding connections are given in both the National Electrical Safety Code and the National Electrical (Fire) Code.

The wires used for electrical circuits in buildings are provided with an insulating covering in order to confine the current to its proper course. In some methods of wiring, the insulated wire is led around the building inside of a metal inclosure which may take the form of rigid conduit, flexible conduit, armored cable, metal molding, or metallic tubing. In other cases the wires are incorporated in the form of a cable which has a covering of material which provides mechanical protection and electrical insulation. In still other cases the wires are provided with no further mechanical protection, but are carefully mounted upon insulators which may either be exposed or may be concealed in the wall spaces but which are intended to keep the conductors out of contact with other materials.

House-wiring installations of recent date will have the circuits made up of white wires and black wires. The grounding connection is made to the white wire which is thus identified so that its polarity may be maintained throughout the installation past joints, switches, lamp sockets, etc., since it is important that single-pole switches be inserted in the black wire and that the shells of sockets be connected to the white wire. Fuses are not inserted in a grounded white wire.

The conductors which run around the building are connected to the service conductors through a main switch and fuses, and each branch circuit has, in addition, its individual fuse. The switches for operating lamps, motors, and other appliances are usually provided at the point of use.

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 when, perhaps, only one circuit out of many needs attention. A more convenient arrangement is to have each fuse arranged with a separate switch, whose operation will disconnect it. Devices are now generally available which will accomplish the purposes 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. It is especially desirable that cabinets including fuses have no live conductors or parts of the fuse holders exposed to accidental contact when changing fuses.

Hazards of switches.—Next to portable appliances, switches are the most handled portion of the electrical equipment, and the live parts should consequently not be exposed to contact. In modern installations this is accomplished by the inclosure of switches under the flush plates of metal wall boxes with only handles or push buttons projecting, or by the use of snap switches 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 to fail under damp conditions as is a fiber lining. Knife switches should always be mounted in cabinets and should be selected only when operation will be infrequent. Switches operable by a handle protruding outside of the inclosure are recommended.

Switches should be placed in convenient locations. This is especially true of the main or service switch which is installed for the purpose of cutting off the building wiring from the source of electrical supply. When a house is to be left unoccupied for long periods, it is well to open this switch.

Making repairs and changes.—It may be 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. Later changes or additions to the wiring should be discouraged unless made by thoroughly competent persons, and the practice of householders unacquainted with proper electrical construction methods making such changes is to be strongly condemned. Additions to the circuits may overload them seriously and involve the use of larger fuses than are safe. 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.

4. HOUSEHOLD ELECTRICAL APPLIANCES

Use of portable cords.—Portable cords to lamps, pressing irons, fans, and other electrical appliances 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 cords is more subject to deterioration by mechanical injury and moisture than fixed wires. Portable cords in general impose a greater shock hazard than other parts of the electrical installation. It is partly on account of such wires that the grounding of circuits as above mentioned is so necessary and that the use of low voltages for interior wiring is essential. The manufacture of portable appliances for domestic use operating at more than 120 volts has been abandoned except for appliances rated at more than 1,650 watts. A satisfactory degree of protection is provided by the use of heavy fibrous or tough-rubber 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.

The deterioration of such cords, varying with the moisture, oil, heat, 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 condition 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 braid, 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, unless connected to heating appliances, for which a special type is supplied. 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.

Use of lamps and appliances.—The same general considerations that apply to the use of portable cords in various locations apply to portable appliances 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.

The use of portable appliances 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 the skin is wet and a large surface of the body may be in contact with the conducting water. Accidents under these circumstances frequently prove fatal.

Of course, where such appliances 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.

In nearly all cases where an electrical accident has occurred in the bathroom, the victim's body was wet. In most cases the person was in a bathtub. Under this condition he may have attempted to turn the switch of an electric light or appliance. In these instances the part of the switch, appliance, or socket that he touched

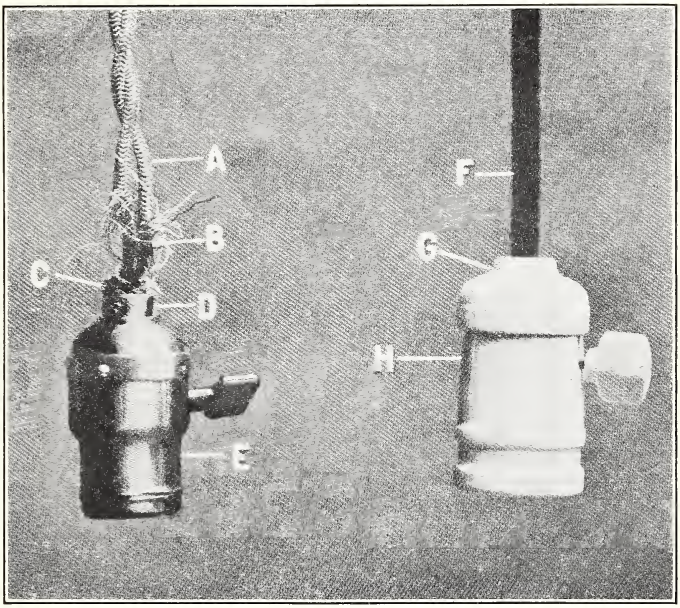


FIGURE 14.—*Examples of bad and good types of sockets on pendent cords*

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 also to the user.

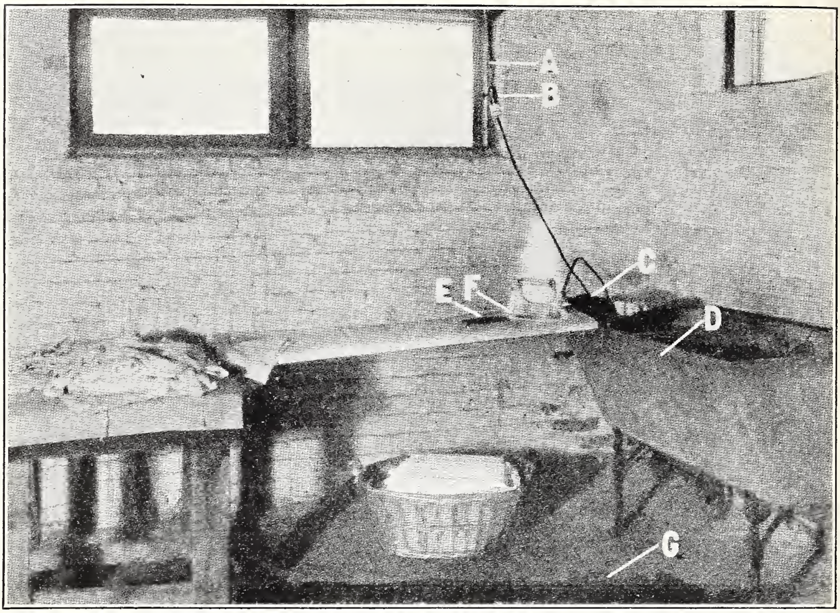


FIGURE 15.—*An improperly equipped and inadequately protected arrangement*

Note the metal-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 one of the most frequent causes of electrical fires.

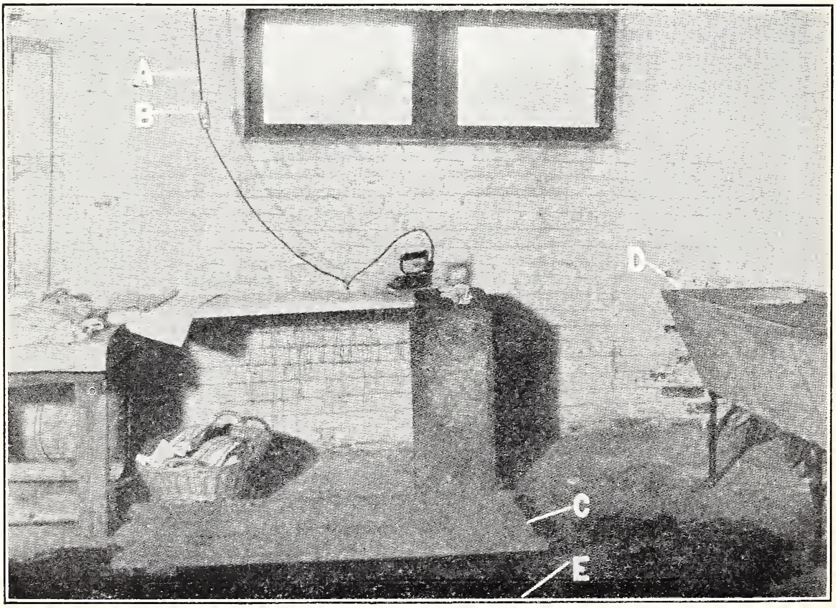


FIGURE 16.—*A properly equipped and adequately protected arrangement*

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*.

was uninsulated and in contact with the ungrounded part of the electric circuit.

Electric fixtures in the bathroom should be controlled by a wall switch near the entrance door. No key sockets should be used. Ceiling fixtures are best. No electrical appliances which require handling should be used in the bathroom. To permit accessibility for aid in case of accident, it is well not to lock bathroom doors where this can be avoided.

Brass-shell sockets should not be installed in the basement or other places liable to have damp floors, if key sockets are used. There are many homes where this hazardous condition exists. Only porcelain or composition sockets should be employed under such circumstances.

Portable extension lamps are often put together by inexperienced persons, and records show them to be frequently involved in severe accidents or fires. Extension lamps should not be made up of twisted lamp cord and brass-shell sockets. They should be equipped with a socket of nonabsorptive insulating material and the insulated conductors should be inclosed within an outer protective covering.

Electric-lamp bulbs become very hot when free ventilation 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 basket guards is essential. Such guards also protect the bulbs against breakage. Paper or cloth articles should never be placed in contact with lamp bulbs, and such materials should be used for lamp shades only if very liberal ventilating space is left between the shade and the lamp bulb.

In general, the insulation and protection from mechanical injury of conductors in portable appliances, including the portable cord, is less than that of the fixed wiring. Accordingly, it is as a general rule undesirable to leave portable appliances attached to receptacles when not using them.

Where it is necessary to make use of portable lamps or appliances in such places as a garage having a cement or earth floor, it is worth while to make use of a special type of portable cord which contains an additional wire used for the purpose of grounding the frame or case of the appliance. A special type of plug and a special type of receptacle are necessary for the use of this cord which interferes with its use by attachment to the more ordinary type of receptacle. The appliance or lamp may, therefore, be used only where the special receptacles are installed. Such receptacles are not usually installed in residences but are becoming common for use in factories. In some States they are now required for certain industrial installations.

A rather common hazard is the overloading of lighting fixtures by the attachment of portable appliances. Large numbers of electrical 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 lamps, but not large enough safely to supply some of the larger appliances or several of the smaller ones. A single lamp 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 appliance, and it will be advisable to attach such appliances to entirely separate outlets. It would be still more safe to provide special appliance 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 wires of these lighting circuits.

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

Then, too, many devices are safe while in 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 of electrical fires, by burning slowly through any combustible material beneath. This hazard is greatly lessened by the type of iron having automatic temperature control. A thermostat disconnects the electric current when the iron reaches a predetermined temperature, and reconnects it when the temperature falls too low.

Teakettles, chafing dishes, and other appliances for boiling liquids become overheated and dangerous if left connected to the circuit after the liquid has boiled away.

Choice of appliances.—Many household electrical appliances are purchased after the wiring and fixtures have been inspected, and in the selection of such appliances care should be taken to see that they are suitable for the purpose intended, and where appliances have been submitted to examination and test by a competent authority and found to comply with the requirements of the National Electrical Safety Code, the National Electrical (Fire) Code, and other recognized standards, such appliances should be given the preference. Cords and appliances 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 inadequate braids are too frequently seen, as well as portable lamps loosely put together and having rough edges over which the portable cord must pass. Electrical stoves have been seen with insulation to their frames so poor and with frames so close to 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. The screw-plug type is obsolete. 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 local authority before using new devices.

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 of a heated sleeping room. They present 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 not so important. 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. Both pads and quilts afford a shock hazard when wet.

Inspection departments have reported fires and injuries from the use of these appliances, and insurance companies discourage their use. Underwriters' Laboratories (Inc.) do not approve such appliances.

Water heaters.—Portable immersion water heaters have been offered for sale in which the current-carrying parts and the water to be heated come in contact. Under common conditions part of the current will flow through the water to the containing vessel and offers opportunity of shock to anyone touching the latter. The use of such types of water heater is not recommended.

To get quick results in heating water, a larger current is usually needed than can be supplied by the ordinary branch circuit. Water heaters intended to be plugged in on such circuits should consequently be viewed with suspicion, and if rated at more than 15 amperes, should not be employed. Any appliance which does not have the rated current and voltage plainly marked should be condemned.

Satisfactory water heaters of both the storage and instantaneous types are available for permanent installation, and will usually require a separate circuit on account of the high value of current employed.

Refrigerators.—Each year an increased number of mechanically operated refrigerators is coming into use by the householder and most of these are electrically driven. The electrical hazards are no different from those associated with other motor-driven appliances, but new hazards may be introduced by the refrigerant used. The chief refrigerating substances used for domestic refrigeration are methyl chloride, ethyl chloride, sulphur dioxide, ammonia, and isobutane. These substances are of such a nature as to be poisonous or at least corrosive to the delicate tissues of the body if they escape into the air. Leaks are not common but they sometimes occur, and should any refrigerant escape into the room, windows should be raised and care taken not to breathe the fumes. The hazards will be minimized if the following simple precautions are followed:

1. Before buying a mechanical refrigerator make sure that it has been approved by a competent disinterested organization, such as the Underwriters' Laboratories (Inc.), or The Good Housekeeping Institute. Make sure that it uses a refrigerant having a pronounced odor, so that a leak will be promptly detected.
2. When buying a machine keep in mind the desirability of the local company for servicing that particular make of machine.
3. Have the machine installed by a competent and reliable person so that proper connections will be made.
4. In case repair or adjustment is necessary, call service man. Never tamper with the machine.
5. If a leak of refrigerant is detected, give the room plenty of ventilation, shut off the machine, and call the service man to make necessary repairs.

Radio receiving equipment.—With the development of radiobroadcasting and the popular use of so-called socket-power broadcast receivers, certain precautions are necessary to combat a very real hazard.

Voltages ranging from 1.5 to 1,000 volts are necessary to the successful operation of modern radio receivers, and it is necessary to be careful in handling the set and its live conductors, especially when the voltages exceed 50 volts. For voltages higher than 120 volts, as used in amplifying tubes, the conductors should be carefully guarded and so located that persons are not likely to come in contact with them.

Antennas may present both electrical and mechanical hazards and they should be carefully installed. Poles and towers should be guyed in such a manner that they can not fall in any direction even if the antenna wire should be accidentally broken. The results of such an accident may be dangerous to passers-by. The following situations should be avoided in erecting antennas and guy wires: (*a*) Attachments to electric power, light, telephone, or telegraph poles; (*b*) crossings over railroad tracks or public highways; and (*c*) crossings over or under electric power, light, telephone, or telegraph wires. Erection of antenna wires over electric-power conductors has been a much too frequent source of serious accident. Contact between the antenna wires and power conductors has often caused a fatal shock.

During lightning storms it is a good plan to disconnect outdoor antennas from the radio set and connect them to ground. This is usually accomplished by a double-throw switch. It is always necessary to have a lightning arrester connected to the lead-in wire from an outside antenna.

The local electrical inspection bureau should be consulted if additional house wiring is necessary to connect the set.

Radio transmitting stations.—Installations of amateur transmitting stations should be made only by thoroughly competent electricians familiar with all the rules applying to such installations, as given in the National Electrical Safety Code. Of course, as therein required, every such sending system should be kept disconnected from the aerial wires when not in use and the antenna effectively grounded at such times. This can be done by use of a double-throw, single-pole switch outside the building. The aerial should not be attached to the radio apparatus inside the house during severe lightning 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.

Antennas used for transmitting should be erected with the same precautions as for receiving sets and, in addition, the wires should be run at right angles to any neighboring light, power, and telephone wires in order that interference between the two systems be avoided.

Transmitting stations are required to be licensed by the Federal Government, and information can be secured from the Department of Commerce radio supervisor in charge of the district in which the proposed radio station is located.

Laundry appliances.—Electrical appliances and machinery used in laundry work, such as washing machines, involve a special hazard, owing to the likelihood of the work being done in a damp place, such as a basement. Even when the laundry room is not permanently damp, water is likely to be spilled on the floor. A person standing upon a damp floor is especially liable to a severe electrical shock from contact with a live wire or machine frame, because a good conducting path to ground is thereby provided.

It is obvious that in laundries and places equally subject to dampness, exposed metal parts of motors or machines should not be permitted to become alive through any failure of insulation. There is an easy way to prevent this, and it is by making a positive connection to ground. Motors permanently installed are regularly grounded, but with portable machines it is not customary. It is easily done by fastening one end of a wire (No. 10 or larger) to the frame of the motor or machine, and the other end to the nearest cold-water pipe. A ground clamp is used for this purpose.

A motor-operated wringer should be equipped with a guard or with a device which will stop the motor or release the wringer in case one's hand gets caught in the wringer.

Electrical toys.—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 or direct current.

If alternating-current service is supplied, selection should be made of a transformer which is entirely inclosed in an iron or insulating 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 receptacles. The transformer arrangement should be such that the high-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 electrical inspector 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 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 metallic objects getting across them with the possibility of burns or fires. It is also advisable that the current from the low-voltage winding be limited by fuses which will prevent excessive current in the toys used or in transformer.

Certain precautions which follow should 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 produced, 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. 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 may 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 resistors with direct-current service, like that of the transformer with alternating current, is to produce the top operating voltage of 15 volts or so in place of the 110 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 the resistor is connected directly to the ungrounded conductor of the house circuit. If the grounded conductor is not distinguishable from the ungrounded conductor, two resistors may be 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 resistor it is well to avoid touching or standing on water or steam pipes, radiators, stoves, or other conducting surfaces. It is, of course, somewhat problematical whether children may be depended upon to observe this precaution.

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 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 some of the Christmas-tree lighting outfits now on the market, 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 and are listed by Underwriters' Laboratories.

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 high temperature 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. Because of these hazards, it is highly desirable that such decorations be placed at a sufficient distance away from electrical wiring and fixtures. If the electrical decorations are at all extensive, it may be advisable to have the installation inspected.

5. OUTDOOR ELECTRICAL HAZARDS

Electrical wiring outside of buildings is either placed underground or is mounted upon overhead structures, such as wood poles or steel towers.

The voltages ordinarily used in the transmission and distribution of electrical energy require the careful isolation of the circuits. This involves for overhead lines suitable elevation above highways; suitable clearances from buildings, trees, and other structures; and suitable separations of the several conductors.

Every householder can assist in increasing the safety of the community by reporting to the electric-light company, or other proper authority, any wires which have fallen in the street or which have broken or sagged down so as to be within reach of pedestrians or vehicles. Contacts of conductors with trees are not so serious but even this should not be permitted to continue. Broken or sagging wires are most likely to be observed after heavy storms.

The reduction in the safe clearances of overhead wires constitutes the only danger to the public from such wires. They are responsible for a considerable number of fatalities annually. These occur from contact with fallen or broken wires, from unauthorized climbing of poles, from contact of other wires with the electric-power wires, and occasionally from some tall object, such as a derrick being moved in the street where there is insufficient clearance.

It should be understood that the covering of high-voltage wires can not be depended upon to supply sufficient insulation for safety, and no one should touch a high-voltage wire even though it is covered with such insulation.

The flying of kites near overhead wires has been responsible for a number of accidents, particularly where wire has been used as a kite string or where cotton string has become wet. Children should be instructed not to fly kites near overhead wires and not to throw strings or pieces of wire over the power wires. They should also be warned against the climbing of poles or trees near which electric wires pass.

Another frequent cause of injury has been the attempt to erect radio-antenna conductors in locations where it was necessary to carry them over electric light or power wires. Contact with the power wire of an antenna wire held in the hand subjects the victim to a severe electrical shock. Antenna wires should never be erected in the immediate vicinity of electric light or power wires.

Electric light companies usually trim trees near which their wires pass so as to avoid contact. With later growth of the trees such contacts frequently develop, and it is desirable that trees be kept trimmed so as to avoid these contacts. Such a contact may rub the insulating covering of a wire until it is bare, and the wet surface of a tree during a rainstorm may be sufficiently conducting so that it becomes hazardous to touch the tree at any point.

Persons should also avoid touching wet poles that carry electric light or power wires. Such wires are usually mounted upon insulators, but during a storm the wire may come in contact with the pole or cross arm and if the pole is wet the current may be conducted to a person touching it near the ground.

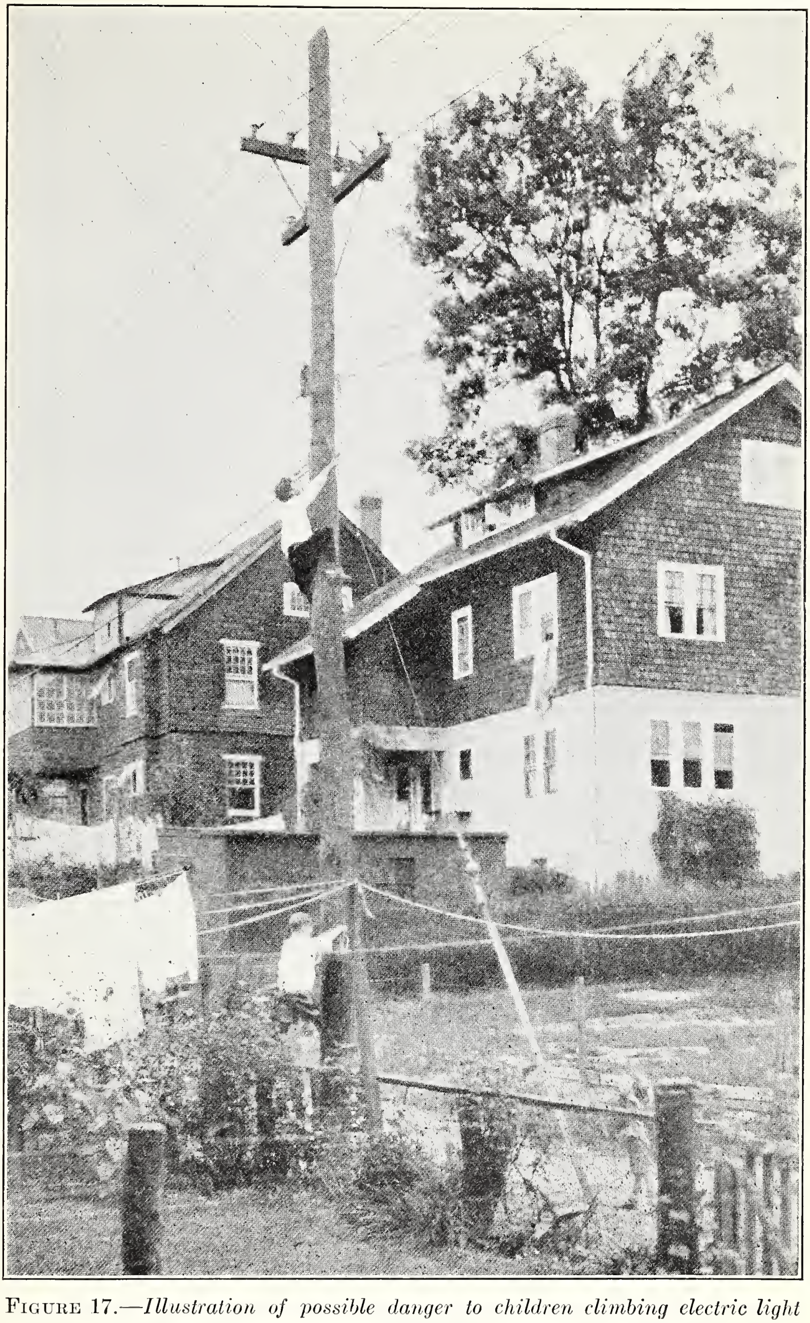


FIGURE 17.—*Illustration of possible danger to children climbing electric light poles*

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.

FIGURE 18.—*The fallen wire serves as an object of curiosity, especially where dangerous voltages cause flashing at the contacts with the earth*

Contact with the guy wires which support poles should also be avoided, since live wires might also sag against them during a storm.

Third rails.—Where third rails on the rights of way of electric railways are not provided with protective guards, approach to them is dangerous, and children in particular should be instructed to keep away. This is particularly true because of their harmless appearance and similarity to ordinary rails.

6. TYPICAL ACCIDENTS AND GENERAL PRECAUTIONS

The reality of electrical hazards, and the manner in which accidents occur practically, may be more forcibly visualized by the brief recital of a few dozen actual cases which have been recorded in the files of the Bureau of Standards. Some of these are due to contact with high-voltage conductors outdoors. Others have occurred in the use of electricity at the ordinary indoor lighting voltage of 110 volts, which many persons erroneously believe to be harmless. Numerous similar cases are on file in the offices of the National Safety Council and the National Electric Light Association.

1. 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. 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 power wire. He was killed.

3. 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. 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. An attempt to remove a discarded radio antenna caused the death of a man and his wife while neighbors looked helplessly on. The antenna wire had been tossed aside by carpenters reshingling a roof. One end had caught on an overhead electrical supply wire. As the man returned from work he found his wife attempting to remove the sputtering antenna wire with a mop handle. He took the mop handle from her, but in maneuvering the wire it dangled from the mop handle and came in contact with his arm. He fell to the ground still in contact with the wire. His wife took hold of him and also instantly fell to the ground. Physicians called in did not arrive soon enough to resuscitate the couple, although they worked in vain for two hours.

6. Two boys planned to extend a radio antenna. One of the boys tied an insulator to the end of the antenna wire and threw it over electric power wires. The boy immediately fell. In falling he twisted the wire about himself and was horribly burned, and killed. A woman seeing the accident rushed to the yard and as she neared the boy touched a wire fence that had become alive. She was severely

burned and thrown to the ground apparently lifeless. Neighbors came, among them one who understood first-aid service. Both victims were disengaged from the live wires and the woman resuscitated by artificial respiration and sent to the hospital to be treated for severe burns.

7. A boy in eastern New York climbed a tree to rob a bird's nest. He was killed by contact with a live wire while in the tree.

8. A 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.

9. 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.

10. 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.

11. A man in a western city 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.

12. 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.

13. A man in eastern Pennsylvania 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.

14. 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 $2,000.

15. In a western city an incandescent electric lamp left burning in a clothes closet set fire to some of the clothing and caused considerable damage.

16. A man in a small city of Utah 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.

17. 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.

18. 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.

19. A laundress in Illinois, 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.

20. 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.

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. 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.

23. A young man in Illinois 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.

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

25. A plumber in Baltimore, Md., was electrocuted while standing in a puddle of water in a cellar and holding a cord to a portable electric lamp.

26. A man in Midland, Md., was electrocuted in a garage when he placed a knife blade in a socket while attempting to adjust an electric lamp.

27. A man in Murfreesboro, Tenn., was carrying an extension cord for an electric lamp when he touched a water pipe and was accidentally killed.

28. A student at a university in California was found dead on his bed. He was wearing a bath robe which had a network of wires and was connected to an electric socket.

29. A man in Watertown, S. Dak., was electrocuted when he attempted to turn off an electric light while standing in a bathtub.

30. A 9-months old baby was burned to death in Rochester, N. Y., by an electric bed warmer which became short-circuited.

31. A man at Leaksville, N. C., was killed while holding an extension light to make repairs to his automobile. His hands were wet and the ground was wet.

32. A woman in Omaha, Nebr., was electrocuted in the bathtub by an electric heater.

33. In July, 1925, a man in Washington, D. C., was killed while holding a defective extension cord and standing on the wet floor of his garage.

34. In Richmond, Va., a colored woman touched a telephone at the same time that she pulled the chain to light a lamp. She was instantly killed.

35. A man and his wife were killed and two other persons were severely injured by electric shock while operating a washing machine on water-soaked ground on a farm in Virginia.

To obviate such accidents as are listed above, and to prevent fires of electrical origin, it is recommended that the following precautions be observed by all members of the household.

(a) SUMMARY OF PRECAUTIONS

1. 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.

2. 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 a lamp socket, fixture, or other electrical device, since it may accidentally be alive. While in a bathtub never touch any part of an electric cord or fixture, even if it is a nonconductor.

3. When using the telephone, avoid touching stoves, radiators, lamp fixtures, electrical appliances, water faucets, etc.

4. Avoid touching bare or abraded spots on flexible cords attached to electric lamps, pressing irons, or other portable appliances. Handle all cords carefully in order to avoid injury to their insulation. Do not hang them on nails or over fixed wires. Always have them replaced when any injury to insulation is observed. Where toasters, fans, pressing irons, or other appliances are moved about so that 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 appliance, inquire whether it has been inspected and approved by the proper authority.

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

6. If combustible materials are used for lamp shades, be sure they are not in contact with the bulb. Provide portable hand lamps with substantial wire guards.

7. Disconnect fuses (by opening a switch) before replacing them, and see that all lighting circuits are protected by fuses not larger than 15 amperes.

8. Do not touch a wire which has fallen in the street, but warn others to keep away, and notify the city electrical department, the power company, telephone company, or other owner. Overhead wires with a protective covering should be treated like bare wires, since the covering soon deteriorates.

9. 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.

10. 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. Warn children against climbing poles or standing on pole steps. Never throw strings, sticks, or pieces of wire over the electric wires. Also, never fly kites near overhead wires, nor throw sticks or stones at insulators.

11. 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 from him. Never use metal or any moist object.

12. 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. Use the method of prone-pressure resuscitation explained on page 89.

7. PRIVATE ELECTRIC-LIGHTING PLANTS

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 may be 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 electrical switches used with a power plant. If a private plant is placed in the home or other main building, the character, amount, and storage 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. 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. Where batteries are provided for stand-by service it will be necessary to run the plant only at intervals in order to have current available at all times. Frequently storage batteries are used only as a means of starting the engine.

Where storage batteries are used 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 all cells inclosed were it not for the fact shown by experience that when inclosed they do not receive the proper attention.

110-Volt systems.—When a 110-volt power plant is used, the wiring will not be different from that ordinarily installed for use of 110-volt public utility service. This will especially include an identified wiring system; that is, one white wire and one black wire in each circuit. The white wires will all be of one polarity and the black wires of the other. When connected to the terminals of devices, such as sockets that have identified terminals, the white wire will be connected to the white-metal terminal and the black wire to the copper or brass-colored terminal.

When receiving the electrical supply from a public utility the white wire of the circuit is always connected to ground near where the service wires enter the building. It is, however, not important to connect one wire of a private electric lighting plant to ground. If this is done, it should be the negative lead from the generator that is connected to ground.

If the circuit wire is connected to ground, a good ground connection of low electrical resistance should be provided. A good ground connection may be afforded by a metallic underground water-piping system of considerable extent. If a water-piping system is not available, a ground connection consisting of driven pipe, driven rod, or buried metal plate may be used. Where such grounds are used they must be imbedded in the soil below permanent moisture level, and each pipe or plate should present not less than 2 square feet of surface to the soil. One driven pipe or rod usually does not provide a ground connection of sufficiently low resistance, and it is advisable to use two or more driven pipes or rods spaced not less than 6 feet apart.

If one terminal of the generator is connected to ground, the white wire of the house wiring should be connected to it. The white wire throughout the premises, therefore, will be at ground potential. It should, nevertheless, be insulated from ground and other objects like the black wire except at the point where the ground connection is made.

Where the circuit wires are inclosed in a metal covering, such as afforded by rigid conduit, armored cable, or metal raceways, the metallic covering should be grounded near the group of switches and fuses called the distribution panel. Also the outside metal of the engine and generator, and the outside metal frames of motors and exposed metallic frames or casings of other electrical appliances should be connected to ground. These noncurrent-carrying exposed metal parts of electrical equipment should be connected to ground as a safety measure whether or not one wire of the circuit is connected to ground. This ground connection should be independent of the ground connection for the generator and white wire.

The frames of motors and the metal parts of other appliances will be satisfactorily connected to ground if connected to iron conduit or the armor of armored cable that affords an electrical path from the frame to the point where the conduit or cable armor is itself connected to ground.

If the metallic frames and other exposed metal parts of electrical appliances are not connected to ground by means of conduit or cable armor, they should be connected to ground by means of a wire to a ground connection such as described above for grounding the circuit.

Live parts of electrical equipment, such as generator terminals, switch blades, etc., should be inclosed, isolated, or insulated so as to make accidental contact by anyone with the live parts unlikely. As an exception, the careful guarding of live parts will not be necessary if a person would not be likely to touch both sides of the circuit at the same time, or would not be likely to touch one side of the circuit while standing on damp floors or touching at the same time some metallic object, such as plumbing or machinery.

Most electrical apparatus will need occasional maintenance work. A working space of from 1½ to 2½ feet wide should be provided for this. Electrical appliances that will require repair or maintenance work on them should be provided with a switch or disconnecting plug, so that they can be disconnected from the electrical circuit to make repair or maintenance work safe.

The provision of a way to disconnect fuses from the electrical circuit while examining or replacing them is particularly important. One way is to have fuses in a cabinet and so arranged that opening the cabinet to get at the fuses automatically disconnects them from the source of current. If the fuses are not arranged so that they can not be touched without disconnecting them from the circuit, switches should be placed ahead of the fuses so that opening the switches will disconnect the fuses from all sources of electric current, and thus permit their safe examination or replacement.

30–volt systems.—It is common, however, for small lighting plants to operate 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 three and a half to four times as many cells of storage battery, the individual cell of which, however, would be of smaller capacity. By using a smaller number of larger cells the plates in the battery can be made more sturdy, 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 rural owner 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 conductors 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 little or 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 appliances, 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 supplemented by inspection.

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.

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 appliances, 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 appliances 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 appliance. 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 fire hazard if appliances are connected to the fixtures.

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. This 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 vicinity, such service may be utilized without any change in the lamps or in heating appliances 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 farm houses 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.

8. LIGHTING THE HOME

Whether lighting the home should properly be considered in connection with safety may be a question, since the results of poor lighting are a health hazard rather than an accident hazard. It should be pointed out here, however, that poor lighting may have a permanent deleterious effect upon the eyes, especially the eyes of children. It has been found that the majority of the homes in this country are not provided with adequate artificial lighting. Use of the eyes under poor conditions of lighting leads to fatigue; continued application of the eyes under fatigue conditions leads to eye strain; repeated eye strain leads to permanent injury to the eyes; and faulty eyesight leads to other troubles.

This subject can not be gone into extensively here, but the essentials of good lighting will be pointed out. These consist of a sufficient intensity of illumination, a suitable distribution of the light, and freedom from glare. A sufficient intensity of illumination will be provided in the case of electric lighting by properly relating the size and number of lamps used to the premises to be lighted. A proper distribution of the light will be determined by the location of the lamps and the reflecting character of walls and ceiling. To avoid glare it is essential that no bare lamps be used, and especially that lamp filaments be not exposed in the direct field of vision. The best way to obviate glare is to provide lamps with suitable diffusing shades. Glare is sometimes caused also by the use of glossy paper, polished desk tops, and similar reflecting surfaces. Children should be cautioned against working where direct reflections are thrown into the eye from such causes.

Details of the planning of electric light installations can not be gone into here. Suggestions as to proper design may be found in the Transactions of the Illuminating Engineering Society and in the publications which may be secured from the principal manufacturers of incandescent lamps. Valuable advice may be secured from the Home Equipment Primer which has been issued by the General Federation of Women's Clubs.

VI. LIGHTNING

1. EXTENT OF HAZARD FROM LIGHTNING

Lightning leads to relatively few deaths and injuries as compared with other causes. In the United States approximately 500 persons were killed annually and about 1,300 persons injured. Approximately nine-tenths of these casualties occur in rural districts. The lightning hazard is greatest among persons whose occupations keep them out of doors.

Of the total number of fires in the United States, at least 3 per cent are due to lighting. The property losses from such fires average more than $20,000,000 annually. In addition to this there is the destruction of livestock and the 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 that to protect all buildings would lead to excessive expense. Most of the fires, however, occur in a few classes of buildings, and if these were protected 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, about four times as many barns as houses are fired.

2. SAFEGUARDING LIFE

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 underground, 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 near the walls on the interior of the house, 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 livestock, may afford a better path for lightning and should be regarded as dangerous.

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.

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 in another chapter.

It may be stated that if those who have been struck by lightning and eventually given up for dead 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.

3. PROTECTION OF BUILDINGS

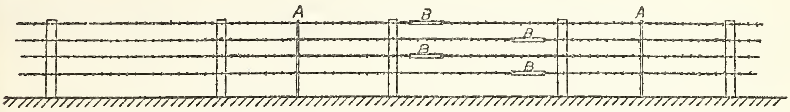
A means of protection against lightning is provided in the lightning rod invented in 1752 by Benjamin Franklin and which, after 180 years of use, is admirably fulfilling its function. If due care is given to its installation a lightning rod may be expected to function perfectly in ninety-nine cases out of a hundred on barns and similar buildings where very little metal enters into the construction; and to protect nearly as well houses and other buildings where there are chimneys and metallic masses which may make protection more difficult. Where one wishes to provide protection against lightning, therefore, lightning rods should be installed.

Protection should be provided on exposed buildings which are of themselves inflammable or have inflammable contents or in which large numbers of persons are likely to be congregated 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 occur very infrequently, and here a lightning rod may be considered unnecessary.

A few principles to be observed in the installation of lightning rods are given in the chapter on "Suggestions for building a home." Standard specifications should be followed when planning an installation.

4. PROTECTION OF LIVESTOCK

To protect livestock from lightning discharges received through wire fences, the fence should be grounded at intervals of 150 to 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 should also be broken up at intervals of 1,000 feet by cutting the wires and inserting short lengths of seasoned wood or other insulating material. (See fig. 19.)



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.

FIGURE 19.—*Method of protecting livestock against lightning from barbed-wire fences by grounding and sectionalizing the wires*

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VII. MISCELLANEOUS HAZARDS

The health hazards involved in the use of water, milk, and other foods are important, and for detailed information the reader is referred to the publications of the United States Public Health Service and the Department of Agriculture. Lists of such publications can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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.

1. PAINTS AND VARNISHES

The use and storage of paints and varnishes present both a fire risk (considered on p. 21) 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. Vermilion, a salt of mercury, in not very extensive use as a pigment, is among the most poisonous likely to occur.

Methyl alcohol, also called methanol, 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. While undiluted methyl alcohol is seldom used in shellac and other spirit varnishes, such varnishes should never be used except in well-ventilated rooms. 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. Rags used for applying furniture polishes and for other similar purposes should be kept in tightly closed metal boxes.

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 non-arsenic 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.

2. 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. The utterly misleading name, "salts of lemon," is sometimes applied to one of the common oxalates. Because of the name, people have thought it could be used for making synthetic lemonade. 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 flammable 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 a previous chapter. Carbon tetrachloride for dry cleaning, used alone or in mixture with gasoline to make the latter nonflammable, while obviating the fire danger when mixed in the proper proportion, may cause anesthesia.

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, commonly called concentrated lye, 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. Concentrated lye quickly absorbs moisture from the air, and unless the can is tightly closed, some solution may be produced and may spatter into the face when the can is opened. When used for drains, care should also be taken that the face is not spattered when lye is first mixed with water.

Lye should be kept well out of the way of children, as it is known from experience that many of them get it and eat it. Lye is very corrosive to animal tissue, and the children's departments of many hospitals have cases where the vocal apparatus of the child has been permanently destroyed and the windpipe has been constricted to such an extent as to create a complete stoppage of air. In these cases, the windpipe had to be tapped at the neck. The reason that many children mistake lye for sugar or bread crumbs is because it immediately paralyzes the sense of taste.

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 soda-acid 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.

If a strong acid, alkali, or other poisonous or corrosive substance is swallowed, vomiting should be induced at once by drinking a large volume of warm water in which common salt has been dissolved. Then consult a physician.

3. OTHER CHEMICAL POISONS

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 use of the poisonous material as a gas, its most active and dangerous form, and which is used primarily in destroying life 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 should be used only under expert direction, and with full observance of the instructions given in Government publications. Fatal accidents have occurred from such a careless thing as going into a room or house for a forgotten article while the place was being fumigated. Due atttention should be paid to giving adequate warning while the dangerous process is being carried on.

Sulphur dioxide and formaldehyde have very disagreeable 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 (bichloride of mercury), 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 common in the household. Care in handling and storing can not be too forcefully insisted upon. It is recommended that corrosive sublimate be abandoned as a general household antiseptic in favor of less dangerous antiseptics such as some of the carbolic derivatives. Materials of this character, no matter for what used, should not be too readily accessible. 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.

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 constitutents of compounds for specific purposes. White arsenic (arsenious oxide) is used as a poison for flies and rodents. It is an essential constitutent of Paris green and of London purple, which are extensively used as insecticides in vegetable gardens. These insecticides also contain copper, which is poisonous. They should be handled with considerable care. Vegetables from gardens where it has been used should be thoroughly washed, even though neither insecticide has been applied directly to them.

The Department of Agriculture has studied the hazard involved in eating apples and other fruit which has been sprayed with poisonous insecticides and fungicides, such as Bordeaux mixture. Barium carbonate, also used as a constitutent 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, is not extremely poisonous but its use involves a great fire hazard; its vapor may be ignited by contact with a steam pipe or other object at a temperature far below red heat.

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 vermillion (mercury sulphide). Hair removers are, in, general, quite corrosive in character, such as calcium hydrosulphide 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 if taken internally. It is well to treat all materials of this character as poisons.

VIII. WHAT CAN BE DONE ABOUT IT?

The recital of the hazards frequently found in the typical American residence and a statement of some of the national statistics on this subject which have been given, naturally lead to the question of what remedial steps can be taken. Some suggestions along this line will now be given.

There are a number of hazards existing in many residences which involve the construction of the building itself and which it is not easy to remedy after the home has been built. Some of these, however, may receive attention when repairs are being made or when new electric or gas service is being introduced. In other cases the hazard itself can not be removed but often precautionary measures can be taken to mitigate the hazard. In the following chapter some suggestions are given to the home builder regarding items which are involved in the construction of the building itself.

1. HOUSEKEEPING

Many of the hazards which exist in the home are dependent not upon the building, but upon its contents or upon the practices and habits of the occupants. The elimination of these hazards becomes a matter of good housekeeping. The question of safety in the household consequently comes to depend very largely upon the knowledge of the housewife as to what may be done to eliminate hazards and upon putting this knowledge into effect in actual practice. Many hazards are of a very transient nature. Many cuts result from the presence of broken glass, upturned nails and similar conditions which would never exist if broken glass were immediately swept up and placed in the proper receptacle, and boards containing upturned nails were not allowed to lie around on the premises. The consistent disposal of rubbish would dispose of many fire hazards. Care and watchfulness will prevent children from playing with matches, and from pulling pots of scalding water off of the stove. The cultivation of good habits will eliminate the practice of leaving obstructions on the stairway, or permitting children's toys to be scattered around on the floor, and various other careless practices. Sharp tools and poisons, as well as matches, should be kept out of the reach of children. Rugs which show a disposition to slip under the foot may have their location changed or may be provided with antislip unlerlays or a coating of antislip solution. Another alternative is to fasten them to the floor.

Many a fall will be saved if prompt attention is given to the presence of ice upon outdoor steps and walks. A very thin layer can often be disposed of by a pot of hot water. In other cases, salt, sand, or ashes may be applied.

2. INSTRUCTION OF CHILDREN

It has already been suggested that physical conditions be made such that children are not invited to incur active hazards. While matches, poisons, and sharp tools should not be put in the way of children, sole dependence should not be placed upon the inaccessibility of such objects. All children should be instructed as to the proper handling of objects and materials which are dangerous, and the child should be aided to cultivate good habits, in taking the proper precautions, and in keeping hazardous materials where they belong. Carefulness and tidiness are twin virtues which will usually be found in company.

If the child can be made hazard-conscious during the growing years, he will probably remain so in later life and will not take unnecessary chances or tolerate unnecessary hazardous conditions in his home or elsewhere.

Instruction in school reaches more children than individual instruction at home can hope to do. It is therefore a hopeful sign that so many schools have concerned themselves with safety during the last 10 years. The results are already becoming apparent. Each year since 1924 there has been a decrease in the number of children killed by accidents in the United States, whereas the same period has witnessed for adults a 21 per cent increase. Prior to 1924 there were increases each year for both adults and children. Communities which have not yet started this work in the schools are subjected to a serious disadvantage.

Not only the children of the family but the adults as well should have their attention called to existing hazards and cooperation sought in either eliminating them or in using the care necessary to prevent the possible accident. In case fire should occur, every member of the household should understand how to send in a fire alarm in those communities where a fire company is maintained. Small children should be instructed to get out immediately and avoid smoke.

3. ORGANIZED SAFETY

Since the conditions in the household appear to be determined largely by the attitude and practices of the housewife, it is natural that activities to organize safety should be taken up by the women's clubs. In many communities the women's club has constituted a safety committee to look into the conditions in the community and to take steps to diminish the present enormous tolls which are being levied by fires and accidents. Parent-teacher associations can perform a similar service.

The advantage of organized safety is found partly in the interest which can be developed in a cooperative movement, partly in the additional accomplishments which can be brought about in a community by organized activity, and partly in the community standards which can be created by organized action.

As the subject of accident prevention is taken up in the club, it is possible to have discussions which will serve to enlighten those who do not get such information by reading; it serves to create an enthusiasm for the subject which the lonely advocate will lack. It serves to sustain interest; it may result in a community survey which will bring to light the prevailing hazards of the neighborhood, and, as stated above, it may result in community accomplishments which no housewife could bring about unassisted. It is consequently suggested that this subject is an appropriate one to be taken up by every local club of women devoted to civic and community interests. The subject is one which has already been considered by the General Federation of Women's Clubs and is an active project in many of the State federations.

One of the instruments for eliciting interest and at the same time securing information as to local conditions, is to have all club members report to the committee handling the subject accidents which have occurred to members of their own household, and in this way any conditions which may be typical of the individual community will be brought to light.

Another activity of such a committee may be to inaugurate a series of home inspections, leaving it to each club member to report the conditions found in her own household; or in some cases a committee can make a visit to each of the premises concerned and prepare its own report. As an aid in making such an inspection the following questionnaire has been prepared, with the thought that answers to these questions will give a good idea of conditions existing in the particular premises concerned.

Survey of accident hazards in the home

Name: ------------------------------------ Address: ------------------

1. Are all stairs provided with rails?
2. Is there sufficient headroom on all stairs?
3. Are stairs adequately lighted?
4. Are there any loose rugs at foot of stairs or at places where sharp turns are frequently made?
5. Are floors or steps too highly waxed and polished?
6. Are steps cluttered with loose material or articles?
7. Is bathtub provided with handhold?
8. Are porches provided with railings?
9. Are chairs or other unsafe substitutes used in place of ladders?
10. Are sharp tools left where children may handle them?
11. Is there a fire extinguisher in the home? What kind?
12. What type of matches are used?
13. Are children permitted to play with matches?
14. Are incombustible ash trays provided for smokers?
15. Is kerosene ever used to light fires?
16. Are kerosene lamps ever filled while lighted?
17. Is gasoline used in the home?
18. Is stove polish used? What kind?
19. Are combustible materials kept away from stoves and out of contact with stove pipes?
20. Is there a screen for the open fireplace?
21. What disposition is made of waste paper?
22. Is rubbish allowed to accumulate in attic, basement, or elsewhere?
23. Is gas piping or fixtures used to support clothes lines, clothing, or utensils?
24. Are gas cocks adjusted to turn smoothly but not too easily?
25. Are gas connections made with tubing? Does it leak?
26. Where are poisonous drugs kept? Are all bottles properly labeled?
27. Are any of the electrical circuits improperly fused?
28. Is the frame of the electrical washing machine grounded?
29. Is portable cord for electrical appliances or lamps badly worn?
30. Is portable cord of an approved type?
31. Is a stand provided for the electric iron?

32. Are there any metal pull-chains without insulating links?
33. Are electric lights in bathroom controlled by wall switch?
34. Are portable electric heaters or other portable appliances used in the bathroom?
35. Is the outdoor radio antenna equipped with a lightning arrester?
36. Is the automobile engine ever run in the closed garage?
37. Are first-aid materials at hand?

The above list of 37 questions covers a great many of the more common hazards which occur in the home. If a more brief list is desired, questions Nos. 5, 14, 32, and 35 may be omitted as of less importance, and certain of the questions will not be pertinent in particular cases. Thus if a community does not have electric service or gas service, the particular groups of questions involving electricity and gas may be omitted. On the other hand, if electric service is general in the community, a question such as No. 16 may be irrelevant.

In addition to the self-examination of their own homes and their own practices which may be inaugurated by a women's club, it may well start an effort to bring about some attention to this subject in the local schools. It is becoming more and more common for the schools to take up the matter of instruction in accident prevention, and where this has been done definite results are being reported in the statistics dealing with local accidents.

Both the women's club and the school may well take up the subject of accident prevention in other places than the home. The matter of highway safety is a very important one for the present generation, owing to the rapidly growing number of automobile accidents. Safety patrols are now common in the schools to insure the safety of the children going to and from the school building. The establishment of public playgrounds will assist in keeping children off the street.

When the interest of the school authorities has been elicited in the matter of accident prevention, definite assistance may be secured through application to the education division of the National Safety Council, 1 Park Avenue, New York, N. Y. This organization issues a monthly magazine devoted to this subject, under the title of Safety Education.

4. FIRST AID

Primary attention has been given to the elimination of accident hazards, and in cases where the hazard can not be eliminated, to the cultivation of carefulness in order that injuries due to accidents may be prevented. When injuries occur, however, there should be a readiness to do something for the injured person in order that the severity of the results of an accident may be lessened. This suggests the subject of first aid.

Methods of first aid for various types of injuries can be considered here only briefly, but it is well for the housewife to secure instruction in such matters whenever an opportunity may offer. There are some items of first aid which should be familiar to every householder.

The slightest abrasion of the skin may have serious results if an infection sets in, as it may lead to blood poisoning. Wounds of a penetrating or perforating character are particularly dangerous on account of their liability to develop tetanus infection. Consequently, no cut or scratch should go without some attention. Of equal or greater importance than any of the commonly used antiseptic solutions is thorough mechanical cleaning of the injury with warm water and soap. This is always available and frequently omitted. It is a common misconception that the use of antiseptics is sufficient and can be entirely relied on. After thoroughly cleaning the place of injury, an antiseptic may be applied to skin abrasions. The most commonly used and most valuable is a 3.5 per cent solution of iodine in alcohol (tincture of iodine) which can be secured at any drug store. Too intensive a use of this drug may lead to blistering.

Almost any severe injury is accompanied by a greater or less degree of shock. The degree of shock is not always proportional to the extent of injury. Except in cases where profuse hemorrhage exists, shock should be treated first and the injury second. The symptoms of this condition in general are a weak and rapid pulse, and pallor of the skin, which is cold and clammy and covered with perspiration. Usually the patient is sufficiently conscious to answer questions in an indifferent way, though complete unconsciousness may exist. Respiration is rapid and shallow and usually irregular. Treatment consists in placing the patient in a recumbent position with the head low. While plenty of fresh air should be admitted, the body should be kept thoroughly warm by wrapping in woolen blankets and by the application of hot-water bottles. The medical treatment consists in the use of stimulants, the most readily obtainable of which is black coffee or spirits of ammonia (a teaspoonful in a small quantity of water). It should be remembered that an unconscious patient or a semiconscious patient is not able to take fluid by mouth without danger of strangling.

(a) TREATMENT OF SCALDS AND BURNS

The proper treatment of scalds and burns will often lessen the pain caused by them and will also result in early healing. Burns and scalds may be followed by shock and the treatment in these cases is similar to that given above.

Burns and scalds are serious and dangerous to life in proportion to the extent and depth of the injury. A burn covering a large area, though quite superficial, is as serious or more so than a much deeper burn in which a smaller skin area has been involved. Large or deep burns are not cases for household remedies, but slight or moderately severe burns and scalds, such as are commonly met with, may be handled by simple methods.

Among the remedies usually found in the household, ordinary baking soda is perhaps the most efficient. This should be made into a strong solution with water and applied to the burned area. The surface should not be permitted to dry but should be kept moistened with water. Sweet oil may be used if soda is not available. Absorbent cotton should never be used as a dressing—steriled gauze is preferable.

Dressings saturated with 1 per cent aqueous solution of picric acid afford marked relief from the pain caused by superficial burns, promote rapid healing, and minimize the danger of secondary infection. This simple and efficient remedy should be, together with tincture of iodine, in every family medicine cabinet. The simple blistering that follows minor first-degree burns is best treated by opening the blister, permitting the inclosed serous fluid to escape. The skin should not, however, 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.

A first treatment for extensive burns is the drinking of large quantities of warm water mixed with a pinch of salt if desired.

The best method of handling minor burns about the eye, which have not involved the eyeball proper, consists in the application of dressings kept moist with boric-acid or with picric-acid solution. Any burn which actually results in destruction of any portion of the cornea is, of course, a case for expert treatment.

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 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 treatment by a physician may prevent terrible deformities.

(b) 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 if 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 lessen bleeding, after which cold should be applied except in old or feeble persons or where the contusion is sufficiently severe to cause shock. In the latter case the shock should be treated first and the contusion after all danger is over. In old, greatly debilitated, or acutely ill persons, heat is preferable, as cold might cause gangrene. It is often of benefit to use a saturated solution of Epsom salts, or evaporating solutions, such as witchhazel, or a 15 per cent solution of alcohol in water. 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 or perhaps blood poisoning.

First-aid kits containing an assortment of bandaging material and other articles needed for minor injuries are generally available, and

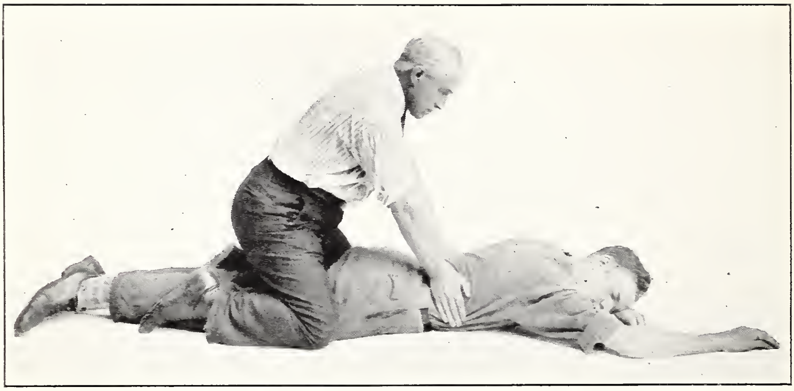

Figure 20.—*Initial position for resuscitation*

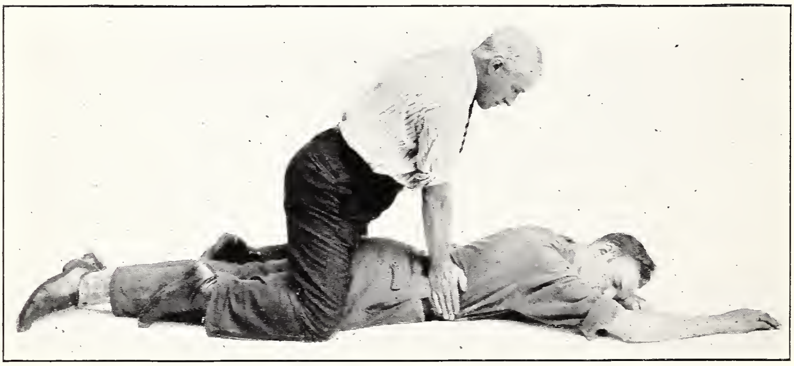

Figure 21.—*Second position for resuscitation*

something of the kind should not only be kept in the house but may well be carried in the automobile.

Another example of first aid with which it would be advantageous for every householder to be familiar is the method of artifical respiration generally known as the Schaeffer prone-pressure method of resuscitation. When breathing has ceased in any human being, due to electrical shock, asphyxiation, a stroke of lightning, or drowning, immediate effort should be made to start breathing again. This process is designated as resuscitation. The time element here is of utmost importance and artificial respiration should invariably be commenced immediately without losing time in transporting the patient from one point to another, or in waiting for a physician. Many lives have been saved by the prompt efforts of those who knew how to apply this method, and many have been lost because there was no one present with such knowledge.

Boy scouts and girl scouts are now generally trained in this method and their services may be called upon when there is no adult present familiar with the method. It is something, however, with which every head of the household should familiarize himself or herself. The following directions for the application of this method are those which have been prepared by a committee consisting of representatives of the United States Public Health Service, the American Red Cross, the National Safety Council, the Bureau of Mines, the Bureau of Standards, and other interested organizations.

5. HOW TO GIVE ARTIFICIAL RESPIRATION BY THE PRONE-PRESSURE METHOD

1. Lay the patient on his belly, one arm extended directly overhead, the other arm bent at elbow and with the face turned outward and resting on hand or forearm so that the nose and mouth are free for breathing.

2. Kneel straddling the patient's thighs with your knees placed at such a distance from the hip bones as will allow you to assume the position shown in Figure 20.

Place the palms of the hands on the small of the back with fingers resting on the ribs, the little finger just touching the lowest rib, with the thumb and fingers in a natural position, and the tips of the fingers just out of sight.

3. With arms held straight, swing forward slowly so that the weight of your body is gradually brought to bear upon the patient. The shoulder should be directly over the heel of the hand at the end of the forward swing. (See fig. 21.) Do not bend your elbows. This operation should take about two seconds.

4. Now immediately swing backward so as to completely remove the pressure, thus returning to the position in Figure 20.

5. After two seconds, swing forward again. Thus repeat deliberately 12 to 15 times a minute the double movement of compression and release, a complete respiration in four or five seconds.

6. Continue artificial respiration without interruption four hours or longer until natural breathing is restored.

7. As soon as this artificial respiration has been started and while it is being continued, an assistant should loosen any tight clothing

about the patient's neck, chest, or waist. *Keep the patient warm.* Do not give any liquids whatever by mouth until the patient is fully conscious.

8. To avoid strain on the heart when the patient revives, he should be kept lying down and not allowed to stand or sit up. If the doctor has not arrived by the time the patient has revived, he should be given some stimulant, such as one teaspoonful of aromatic spirits of ammonia in a small glass of water or a hot drink of coffee or tea, etc. The patient should be kept warm.

9. Resuscitation should be carried on at the nearest possible point to where the patient received his injuries. He should not be moved from this point until he is breathing normally of his own volition and then moved only in a lying position. Should it be necessary, due to extreme weather conditions, etc., to move the patient before he is breathing normally, resuscitation should be carried on during the time that he is being moved.

10. A brief return of natural respiration is not a certain indication for stopping the resuscitation. Not infrequently the patient, after a temporary recovery of respiration, stops breathing again. The patient must be watched and if natural breathing stops, artificial respiration should be resumed at once.

11. In carrying out resuscitation it may be necessary to change the operator. This change must be made without losing the rhythm of respiration. By this procedure no confusion results at the time of change of operator and a regular rhythm is kept up.

IX. SUGGESTIONS FOR BUILDING A HOME

Many of the hazards which are found in residences are the type which can best be eliminated when the building is being designed and constructed, and it is often difficult to remove such hazards after the construction is complete. It is consequently thought to be of some value to collect here some suggestions having relation to the prevention of fire and accident hazards which might be inherent in a building if consideration was not given to these points in the design of the building and the preparation of specifications. Many useful suggestions in the design of a home will be found in bureau publication BH–1, Recommended Minimum Requirements for Small Dwelling Construction; BH–6, Recommended Minimum Requirements for Masonry Wall Construction; BH–13, Recommended Minimum Requirements for Plumbing; and BH–14, Recommended MinimumRequirements for Fire Resistance in Buildings.

1. FIRE-RESISTIVE CONSTRUCTION

From the standpoint of fire hazards, the best construction of a building is to make its exterior walls, floors, roofs, and interior partitions of incombustible material. With modern building materials this is an entirely feasible proposition as the walls and floors may be constructed of concrete reinforced with steel, or of hollow clay tile, and various suitable materials are available for interior partitions and roofs. These are mentioned later. It has been so customary, however, to make use of lumber for joists, flooring, and the studs of partitions that due consideration is not usually given to the use of incombustible materials for these purposes. We are accustomed to think of steel-frame buildings and reinforced-concrete construction with respect to office buildings, apartment houses, and other large structures. It should be realized, however, that it is entirely feasible to build a small dwelling of incombustible materials without prohibitive expense.

Exterior structural elements.—The roof and outside walls or finish of a house are required to resist brands and other modes of fire attack from the outside, and in built-up localities it is desirable that they confine a fire within the building to such extent that a complete burning out will not be unduly hazardous to near-by buildings. Almost all of the incombustible types of roofing, such as slate, clay, and concrete tile, cement asbestos, metal sheets, and metal shingles, have sufficient fire resistance to prevent ignition of the boards supporting them from chimney brands or brands from an adjacent burning building. The protection afforded by the metal roofings can be increased by placing asbestos felt between the roofings and the boards. Prepared asphalt-saturated rag-felt roofings afford fair resistance against brands, the effectiveness depending mainly on the thickness of the roofing and the amount of mineral surfacing present. Wood shingles are less resistive to brands and when burning may give off flying brands that can set other combustible construction on fire. Weathered wood shingles are particularly subject to attack from brands.

As coverings for outside walls, we have a range in fire resistance beginning with board finish followed in order by stucco on wood lath, stucco on metal lath (both over wood framing and boards), masonry veneer over wood frame, and load-bearing masonry walls. Well-maintained paint coatings will slightly increase the fire resistance of a board finish against an exterior exposed fire. Masonry walls 8 inches or more in thickness will generally give adequate protection against outside fires in residential districts.

Interior construction.—Since the greater number of fires originate within buildings emphasis should be given to the importance of interior structural provisions that will aid in preventing origin and spread. Interior fire origins range from sparks and match flames to rapid burning of quantities of flammable liquids.

The basement, if housing the heating plant and fuel and other storage, gives rise to many fires, and a smoke-tight and fire-resistive separation from the upper stories is desirable. Plaster board, asbestos board, and plaster on metal or wire lath applied on the basement ceiling joists are effective. A double first floor with incombustible felt between the two board layers adds appreciably to fire resistance and smoke tightness. Protecting the floor members for a space of several feet above and around the furnace will help to prevent fires resulting from overheating and defective or fallen smoke pipes. Complete fire separation by means of a fire-resistive and incombustible first-floor construction is advantageous even where the rest of the house is of ordinary construction.

The interior partitions, floor, and roof constructions determine the main fire-resistive characteristics of the building. The wall, ceiling, and floor finish are the first to receive the attack of fire from interior origins. Wood and combustible fiber-board finishes can be made a little less flammable by application of paint, whitewash, or calcimine. Well-applied whitewash coatings are as effective as any ordinary or fire-retardant paint. Plaster boards, plaster on wood lath, plaster on plaster board, and plaster on metal or wire lath give greater protection, the effectiveness being approximately in the order given. For interior work, gypsum plaster has been found to be very effective, as it is not likely to fall off during the fire exposure and high temperatures do not penetrate it rapidly. Where walls and ceilings are protected against moderate fire attack, the fire may burn through the wood floors almost universally used with wood framing and spread into the hollow spaces back of the finish, particularly where no fire stopping is present.

Fully fire-resistive interior construction for dwellings can now be obtained in a number of forms, including for floors several forms of light steel protected framing, hollow clay, or gypsum tile between reinforced-concrete ribs or protected steel beams, and reinforced-concrete slabs and beams.

Nonbearing partitions can be of steel studs covered with plaster on plaster board or on metal or wire lath, of hollow-clay tile, gypsum or concrete blocks. Load-bearing partitions can be of heavy steel studs protected by plaster on metal or wire lath or of suitable thickness of hollow clay tile, concrete block, poured concrete, or brick.

Fire stopping.—Where the framing involves hollow spaces with combustible framing members or finishes, the spread of fire can be retarded by closure of the hollow spaces at the floor, wall, and roof lines. Well-fitted board or plank stops can serve as temporary checks, but somewhat better results can be obtained with incombustible materials fully filling the spaces in walls and partitions opposite hollow spaces in floors and for 4 inches or more above them. Board stops at the mid-height of walls and partitions are also desirable. With outside masonry walls without hollow furring spaces, fire stopping need be applied only at intersections of hollow interior partitions with floor and roof constructions and at the exterior roof lines. Among incombustible materials suitable for fire stopping

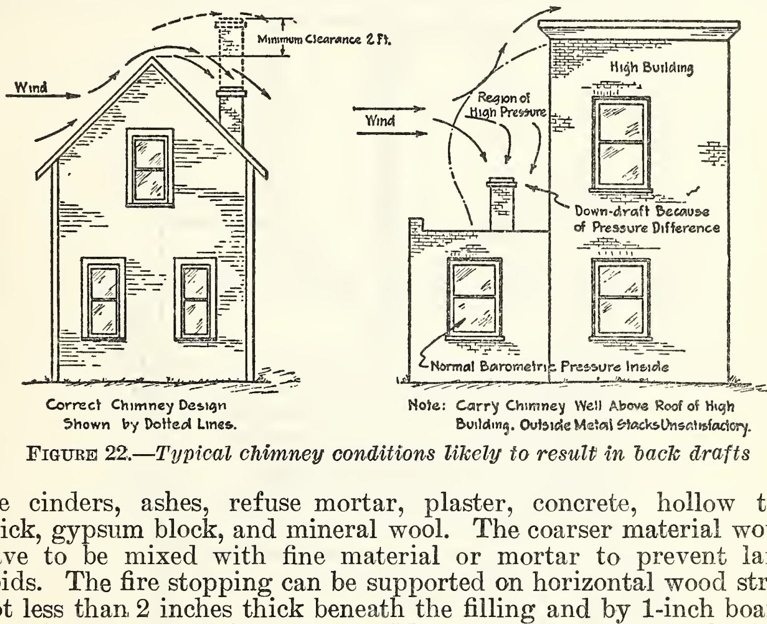

FIGURE 22.—*Typical chimney conditions likely to result in back drafts*

are cinders, ashes, refuse mortar, plaster, concrete, hollow tile, brick, gypsum block, and mineral wool. The coarser material would have to be mixed with fine material or mortar to prevent large voids. The fire stopping can be supported on horizontal wood strips not less than 2 inches thick beneath the filling and by 1-inch boards opposite the hollow floor spaces. Metal or wire mesh has also been used for these purposes. Generally, considerable care and expense are required to obtain a good job of fire-stopping.

Chimney construction.—Some form of flue lining inside of the brickwork is desirable where the latter is not more than 4 inches in thickness. If the space between the lining and the brickwork is filled with Portland cement or cement-lime mortar for the full length of the chimney, the lining will be likely to remain in place even if cracked and to function almost as well as if it were intact.

Wood beams, joists, or partition members should be placed at least 2 inches away from the chimney walls and the intervening spaces filled with mortar. The ends of floor boards can come nearer, but it is desirable to leave a mortar-filled space around the chimney not less in thickness than the plaster. Chimneys should be high enough to avoid back drafts. (See fig. 22.)

Doors.—For ordinary interior construction there is little object in providing more protection for openings between rooms than is afforded by wood doors and frames of the ordinary designs. With well-protected basement ceilings or a fire-resistive first-floor construction a heavier wood door or the lighter type of metal or metal-clad door leading to the basement would be in accord with the conditions, considering that in this location the door is normally closed. For interior wood framing protected by the more effective methods previously outlined, and for full fire-resistive construction, doors heavier than the usual thin-paneled type should be used.

2. LIGHTNING RODS

Considerations which will determine the advisability of equipping a residence with lightning rods can not be fully stated here.

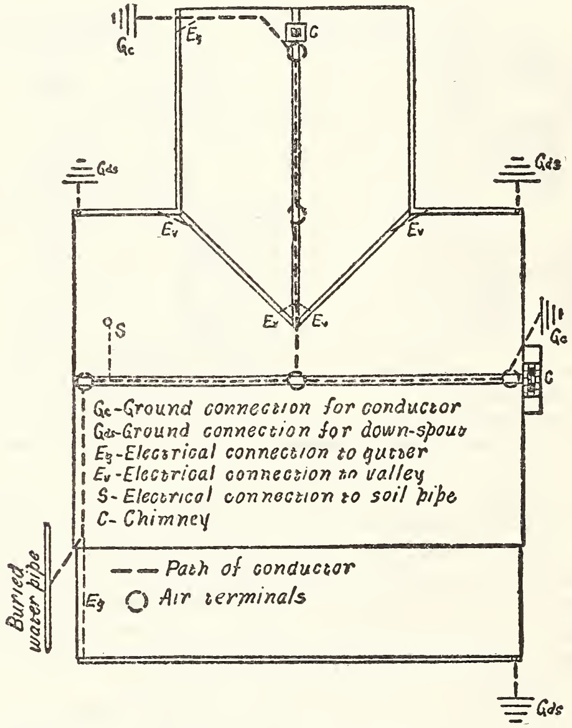

FIGURE 23.—*Roof plan of house, showing installation of lightning rods with connections to gutters and valleys and ground connections for downspouts*

These considerations are discussed in Miscellaneous Publication No. 92 of the Bureau of Standards, entitled "Code for Protection Against Lightning." This publication contains detailed specifications for the construction and installation of lightning rods. There is less likelihood of a dwelling being set on fire by lightning than a barn, on account of the nature of the contents, but for the protection of the family it will frequently be desirable in those locations where the dwelling is particularly exposed to lightning storms. The following is a very brief summary of principles which should be followed in designing lightning-rod protection.

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.

Rods.—Rods are usually of copper in the form of either solid conductor or cable. It should weigh not less than 3 ounces per linear foot.

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.

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 eleva-

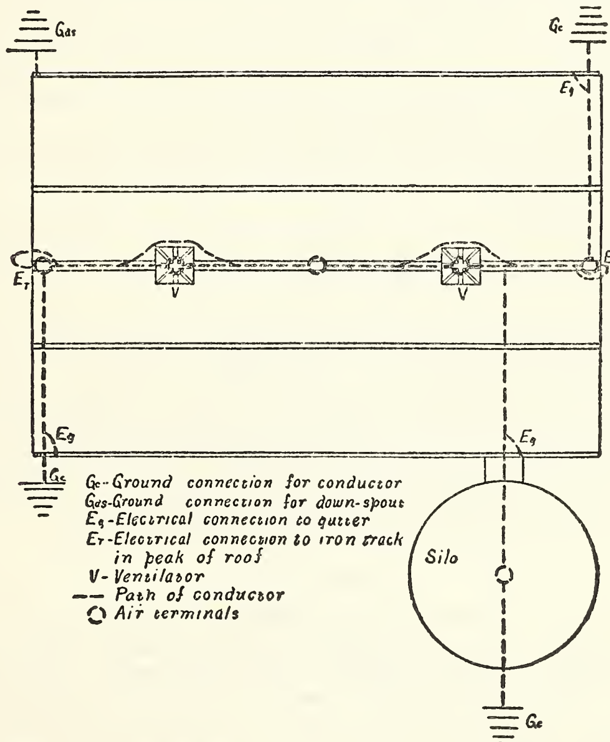

FIGURE 24.—*Roof plan of a rectangular barn with shingled roof, showing course of lightning rods and location of air terminals*

tion rods should be such as to place the point at least 12 inches above the object being protected. Joints between sections of rods should be secure, both electrically and mechanically.

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.

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

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 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. 23 and 24.)

Interconnection of metal.—Every metal part of appreciable size on the exterior of a building should be made a part of the lighting-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.

Figures 23 and 24 show the course of lightning rods and the location of air terminals on the roof plans of two buildings of common types of construction. The roof plan shows the building as one would see it when looking down directly upon it. Wherever a ground connection is shown it is supposed that the conductor is run around the eaves and down the side of the building into the earth.

3. STAIRWAYS

Attention was directed early in this publication to the fact that falls are the main cause of accidental injuries in the home and that a large number of falls take place upon stairways. The design of stairways should consequently receive detailed consideration.

To begin with, a stairway should not be made too steep and a proper proportion should be maintained between the dimensions of riser and tread. Satisfactory values are 7 or 7½ inches for the riser and 10 or 11 inches for the tread. In any case these values should meet the condition that the sum of the tread and twice the riser equals 25 inches, and the angle of slope is between 30° and 38°.

It is desirable to provide every flight of stairs with a handrail, and even if this is not done where the stairway is inclosed on both sides by solid walls, it should at least be done where there is a possibility of falling over the side of the stairs as is commonly the case on cellar stairways. Winding stairways are to be avoided where possible, as they particularly invite falls. If a doorway is placed at the head of a flight of stairs, which has merit from the standpoint of preventing the spread of fire, the door should either have a glazed window so that one may see through it or there should be a landing at least 30 inches wide on the stair side of the door. Accidents have occurred from persons stepping through a doorway without realizing that the door was at the head of a stairway.

Provision should be made for the adequate lighting of stairways and this is most readily accomplished where electric lights are installed. The lighting unit should be so placed that all treads are illuminated. It is desirable to have the control switches located at both bottom and top landings.

Where space is at a premium it frequently occurs that insufficient headroom is left over stairs. This results in tall persons frequently bumping their heads when starting down the stairs. This is poor economy, and stairway design should always include generous headroom. The same is true of basements where water pipes, electrical conduits, etc., may be run below the joists.

Consideration of exits from burning buildings indicates that it is desirable to have two stairways in different portions of the building, with full inclosure for at least one of them. In small dwellings this may not be considered warranted in every case, but where only one stairway is provided there should be windows in the upper stories that open out onto verandas or the roofs of porches so that a means of exit is provided in case the stairway is obstructed by fire.

4. MECHANICAL HAZARDS

Items contributing to mechanical hazards in the home have been mentioned in an earlier chapter, but those involved in the building construction will be mentioned here. Porches, balconies, etc., should be provided with railings to prevent the possibility of falling off the edge. Such falls may cause serious accidents even when the height is not more than 2 or 3 feet. An acceptable substitute for the railing along the edge of a porch is a set of flower boxes which extend the complete length of the porch.

Low window sills should be avoided, especially at stairway landings. Where they already exist, the windows should have one or more cross bars to prevent children from falling out. Built-in window screens have advantage, from the accident-prevention viewpoint as well as others, over portable types.

In designing the bathroom, especially where built-in tubs are installed in tiled rooms, provision should be made for a hand grip built into the wall.

In the north, sloping roofs which end over steps or walks should be equipped with snow guards to prevent heavy weights of snow from sliding on the head of the passer-by.

5. GAS EQUIPMENT

The hazards involved in the use of manufactured or natural gas in the home have been dealt with in a previous chapter. It is sufficient to repeat here that gas piping should be installed only by skilled workmen, and the suggestions already given should be carefully followed. Piping should be of generous size and there should be no low points which may act as traps through condensation of the less volatile components of the gas. It is better not to run piping in outside walls for the same reason. The gas meter should never be installed near a furnace, since a leak in the meter or its connections might lead to fire or explosion. It should preferably not be within 3 feet of the electric meter or other electrical apparatus.

Gas appliances which utilize large quantities of gas should be connected with a flue for removing the products of combustion. This will apply to ovens, water heaters, and large space heaters.

6. ELECTRICAL EQUIPMENT

The electrical installation in the home should be made only with standard materials installed by skilled workmen. The specifications should require compliance with the rules of the National Electrical Code and the National Electrical Safety Code. These specifications will secure an installation properly grounded, equipped with fuses and equipped to comply with a number of precautions, such as the use of porcelain sockets in basements and an inclosed main switch. Since these codes contain only the minimum requirements for eliminating the most obvious hazards, such specification will not provide the highest degree of safety which may be desired by the household.

At distribution points, if panel boards are used they should have no live parts exposed (dead-front type) and there should be not only a switch ahead of every fuse, but a main switch to disconnect the conductors which feed the panel boards. Wall switches are a convenience in every room, but should invariably be supplied in the bathroom or other rooms where the hands may be wet. In the bathroom it is desirable to have no receptacles for connecting portable appliances so that there will be no temptation to use such appliances in that room. If the use of an electric air heater is contemplated between seasons when the room may not be otherwise heated, it is far preferable to make a permanent installation of such heater and equip it with a wall switch. Fatal accidents have been all too frequent from the handling of electrical heaters in bathrooms.

It is convenient to have a wall switch at the point of usual entrance to the room which it controls. If a large room is frequently entered from more than one door it is convenient to have control switches at both entrances and this can easily be accomplished. Similar dual control is desirable for the electric lights on stairways, one point being at the foot of the stairs and the other upon the upper floor.

A modern convenience is provided in the form of small-capacity circuit-breakers which may be used in place of both switch and fuse to control branch electric circuits, including both lighting circuits and those to appliances, such as the washing machine. A circuit-breaker is a type of switch which will automatically open the circuit whenever it is overloaded or a short-circuit occurs. It thus takes the place of a fuse and at the same time it can be closed and opened by hand like any other switch.

In planning the electrical installation, separate circuits should be provided for any apparatus taking more than six amperes. Such apparatus will include an electric range and electric water heater and the group of appliances used in the laundry.

For rural dwellings which are supplied through overhead conductors, it is desirable to protect against the possibility of a lightning surge coming in over the wires and either shocking the inmates or setting the building on fire. This is not likely to happen if the wires enter the building through conduit, but if the wires enter separately the one which is not grounded should be equipped with a simple form of lightning arrester whose other terminal is connected to ground. This arrester may be of the form commonly used to protect against similar surges on radio antennas, and should not be in proximity to flammable material.

Lighting fixtures should be chosen with the idea of providing adequate illumination without producing the glare which results from exposed lamp filaments or surfaces of high intrinsic brilliance. General lighting can be best accomplished by ceiling units. Wall lights should be installed for ornamental purposes only and should be shaded to avoid glare. Local lighting can be provided by well-shaded table lamps and floor lamps.

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