Dwelling Houses

A Code of Suggestions

FOR

Construction and Fire Protection

RECOMMENDED BY

THE NATIONAL BOARD OF FIRE UNDERWRITERS

NEW YORK

TO SAFEGUARD HOMES AND LIVES
AGAINST THE RAVAGES OF FIRE

SECOND EDITION

1920

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Foreword

TO FIRST EDITION
1915

THE National Board of Fire Underwriters has received many requests for construction specifications which will properly protect dwelling houses against fire. This pamphlet has been prepared in response to such inquiries, and is addressed directly to owners of dwellings and to carpenters and builders who erect them.

The majority of dwellings are outside the control of building ordinances, and those within the jurisdiction of such laws usually have but few restrictions; hence the field for use of this information is broad.

The few specifications governing dwelling house construction in a Building Code are usually so scattered through the ordinance it is difficult for a person unfamiliar with such laws to ascertain exactly what is required. That fact further justifies codification of these well established principles for the protection of such structures.

The pamphlet is distinctly educational in character, since naturally there is no authority to enforce its provisions. Many of the more important suggestions were extracted bodily from our Recommended Building Code, and still retain the imperative form of expression "shall" as indicating in our opinion the strict necessity for the requirements. Although other parts may be expressed less positively, it should not be inferred that they are unimportant.

The principal idea in the preparation of the pamphlet has been to indicate so plainly the structural features necessary to make any house reasonably fire-resistive, that even a layman could understand them. It is hoped that home builders may be sufficiently impressed with the logic of the requirements to voluntarily adopt them.

Aside from the personal satisfaction and peace of mind resulting from owning a home that is known to be as safe as care and forethought can make it, there are other benefits in prospect. Underwriters are considering plans for a scientific classification of cities according to their fire hazard and a grading of buildings based upon their location and construction. When this is accomplished, buildings of good construction will receive a deserved recognition which has hitherto been impossible.

The endeavor has been to recommend the most efficient and practical methods of fire protection, to warn against unsafe construction customs, and to urge best structural practice generally.

That the pamphlet may fulfill these functions satisfactorily, the Committee asks co-operation from those receiving it in making it as reliable and beneficial as possible to the general public.

With this end in view the readers of the pamphlet are requested to send the Committee any suggestions or criticisms which they think would contribute to its betterment. All such communications will be given careful consideration in the preparation of a new edition.

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Committee on Construction of Buildings
National Board of Fire Underwriters.

Foreword

TO SECOND EDITION

DURING the four years since this volume was first issued over 15,000 copies have been distributed by the National Board of Fire Underwriters, nearly all upon request. By permission it has been reprinted in full in several fire protection journals and has also been largely copied in a number of publications issued by national, state, and private agencies. It is a classroom reference book in a number of schools and colleges and in fact has become a recognized standard for dwelling house construction.

The steadily increasing demand for the book indicates that its popularity is growing and it is hoped that the wide publicity given to its recommendations, particularly those relating to chimney construction and fire-stopping, may eventually be reflected in much safer general practice in such particulars than was prevalent before its advent.

The purpose of the volume is fully explained in the Foreword to the First Edition, and the Second Edition is not essentially different from the first in character. Complete statistics on dwelling house fires are given in Part I, Section 4, in place of the rather incomplete and fragmentary data originally published which was the best available at that time. Loss data for 1919 is not yet compiled, but it will be noted that the average annual fire loss in dwellings for the four previous years is nearly $56,000,000, and that it is increasing.

This enormous waste of property coupled with the distressing loss of life should be sufficient incentive to produce a public demand for safer construction.

Part VI on Chimney Construction has been completely re-written to harmonize with the requirements of the new Chimney Ordinance which we recently issued, and numerous small changes have been made throughout the book which will tend to increase its usefulness.

Committee on Construction of Buildings,
National Board of Fire Underwriters.

E. T. CAIRNS, *Chairman.*

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The Code was drafted for the Committee by its Consulting Engineer, to whom correspondence in reference to same should be sent.

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PART I.

GENERAL DISCUSSION OF DEFECTIVE CONSTRUCTION IN DWELLINGS, AND ITS RELATION TO THEIR FIRE HAZARD.

Section 1. Definition and Scope of Suggestions.

1. In municipal building laws, the term *Dwelling* has been defined as, *"A residence building, designed for or used as the home or residence of not more than two separate and distinct families."* It is to such buildings that this pamphlet refers. Its principal purpose is to issue warnings against prevalent dwelling house fire hazards and to indicate how they may be avoided. It deals only with construction which influences the spread of fire. The subjects of design, costs, and suitability of materials, are avoided, except so far as they are necessary incidents to the discussion of general fire-resistive features and good construction. Some of the suggestions are suited only for certain types of high class buildings, but the majority are applicable to dwellings of all grades from the modest cottage to the ostentatious palace as commonly constructed. It is believed their greatest field of usefulness is in connection with the vast number of unpretentious dwellings which house our population outside of municipal limits.

2. Many of the suggestions also apply with equal force to multiple family houses, that is buildings harboring three or more families; but as these come under the classification of Tenements, and the construction of such buildings is usually specified by State Law, they are not included here.

Section 2. Dwelling Construction Under Slight Control.

1. Municipal Building Codes place little restriction upon the construction of dwellings. Within the fire limits, which commonly comprise a small congested portion of a city's area, frame dwellings are usually excluded; wooden shingle roofs prohibited; regulations regarding chimneys, heating appliances, and lighting are enforced; and in most codes some provisions for fire-stopping walls and partitions are made, but not sufficiently explicit usually to be of much real service. Outside the fire limits, any type of construction is permitted, and the enforcement of other regulations is generally lax. There are some pleasing exceptions to this statement, but ordinarily it is true.

2. Beyond the boundary lines of cities and towns which have building ordinances, there are hundreds of suburban real estate developments and villages which have little or no building regulations, and also vast numbers of dwellings scattered over the country which are under no restrictions whatever. Every builder is a law unto himself.

3. Dwellings have the least protection of any class of buildings. This results from a combination of careless construction, a lack of appreciation of the fire hazard which always exists, and isolation of the structures. The majority are absolutely devoid of fire-resistive features. Many have little or no protection from public fire fighting equipment, and very few have private fire extinguishing devices.

4. For people in moderate circumstances the home often represents a large proportion of the family capital, and in all conditions of life it usually shelters things which are cherished because of tender associations and hallowed memories; things so treasured that their value could not be measured in gold, or so rare that money could not replace them. Therefore the prevalent neglect of structurally safeguarding the home is surprising from a purely economic viewpoint. No honest person can have his house burn without suffering serious financial loss, even though supposed to be fully insured. However, the indifference to protection of property is not a tenth part so astonishing as the fact that not one private house in a thousand is constructed with any serious thought regarding the safe escape of the occupants in case of fire, although the annual loss of life due to dwelling house fires is appalling. This apathy is strange, for one would naturally suppose that a man's first thoughts would be for the safety of his family and the protection of the home which is so essential to his comfort and happiness.

5. When we consider that our millions of homes shelter the lives of all those held most dear—the old and feeble, the sick and infirm, the young and incompetent—many of whom would be absolutely helpless if trapped in an upper story by a fire, the situation is well nigh incomprehensible. The only explanation for this condition must be a lack of appreciation of the hazard which exists, and the ease with which it can be either entirely removed or greatly reduced. Even with a wooden house a few simple precautions at time of erection will practically eliminate the life hazard from a fire, and reduce the danger of a fire spreading from the point of origin to all parts of a building before aid can be secured to extinguish it.

Section 3. Life Hazard.

Accurate statistics on the life loss due to dwelling house fires are not available, but it is known that the total is large. Scarcely a week passes that the daily papers do not record several deaths due to this cause.

The best data obtainable indicates a probable total loss of over 20,000 lives per year in the United States due to fire. It is certain that a large percentage of these result from fires in dwellings.

Section 4. Fire Loss Statistics for Dwellings.

1. The following statistics, furnished by the Actuarial Bureau of the National Board of Fire Underwriters, are compiled from true loss values upon the properties involved, as reported by the insurance companies which are members of it.

2. The term "dwelling" as used in the statistics is not restricted to the definition of the word employed in this pamphlet, but includes tenements and apartments, except those which have portions of the building devoted to commercial purposes which are classified elsewhere. In the majority of States the proportion of the tenement class of residence buildings would be relatively small, so the figures given probably indicate fairly well the losses on ordinary dwellings. The figures cover both buildings and contents, and no distinction is here made between buildings protected by public fire service and those unprotected.

The term "brick" includes all buildings having masonry walls and wooden interior construction. The term "frame" includes with wooden buildings, buildings with wooden frames covered with stucco, brick veneer, or metal.

3. The compilers believe the values given represent over 90 per cent. of the total losses upon which insurance was carried. They do not by any means represent the actual losses to property owners, for large values not protected by insurance are destroyed in every State annually. The Fire Marshals who have studied this subject, and who have some data upon which to base an opinion, estimate that the actual property loss would be an increase of 25 to 33 per cent. upon the losses recorded.

4. TABLE I.

Average Fire Losses per Year on Dwellings and Contents for the Years 1915 to 1918, both inclusive.

State	Frame	Brick
Alabama	$1,168,806	$11,587
Arizona	142,731	17,768
Arkansas	725,759	17,129
California	2,689,501	21,102
Colorado	303,711	85,959
Connecticut	734,713	139,941
Delaware	47,978	23,259
District of Columbia	21,410	28,697
Florida	767,616	5,600
Georgia	2,760,212	126,931
Idaho	324,951	5,618
Illinois	3,844,677	716,969
Indiana	1,781,237	40,081
Iowa	1,738,528	45,737
Kansas	1,125,330	20,809
Kentucky	1,152,831	82,763
Louisiana	886,471	13,363
Maine	682,048	8,928
Maryland	612,886	154,024
Massachusetts	2,492,142	237,973
Michigan	1,731,926	94,985
Minnesota	2,277,917	172,862
Mississippi	1,048,805	11,688
Missouri	2,041,748	431,534
Montana	441,474	3,919
Nebraska	703,052	19,023
Nevada	33,945	258
New Hampshire	397,454	11,337
New Jersey	1,835,318	113,357
New Mexico	75,126	47,852
New York	4,199,925	978,896
North Carolina	522,832	6,509
North Dakota	409,489	1,418
Ohio	2,320,605	162,254
Oklahoma	851,434	9,056
Oregon	455,704	1,296
Pennsylvania	2,292,066	521,442
Rhode Island	758,787	24,775
South Carolina	145,543	6,768
South Dakota	170,135	1,835
Tennessee	1,425,244	186,174
Texas	2,752,113	94,115
Utah	86,874	32,384
Vermont	123,407	2,939
Virginia	871,230	124,868
Washington	1,000,497	4,001
West Virginia	504,066	8,587
Wisconsin	818,347	31,729
Wyoming	55,226	1,188
Yearly Average	$50,880,787	$4,814,609

5. The four leading known causes of fire in dwellings in nearly every State were defective chimneys and flues, exposure, lightning, and stoves, furnaces, boilers and their pipes. The average losses for three years due to each cause are given in Table II. The table also includes losses from unknown causes, for it is probable that a large percentage of fires charged to "unknown causes" should be distributed among the four principal causes.

TABLE II

Average Losses Due to the Four Leading Causes of Fires in Dwellings for the years 1916, 1917 and 1918.

	Type of Building	
	Frame	Brick
Defective Chimneys and Flues	$7,941,479	$332,174
Exposure	4,490,904	115,904
Lightning	4,900,629	446,061
Stoves, Furnaces, Boilers and their Pipes	4,128,745	417,050
Unknown	12,595,234	1,286,557

Although accidental causes in some years have reversed the order in which the hazards operated or gave unusual prominence to a minor cause, the general statement is correct and in accord with fire statistics gathered from other sources. The necessity for special precautions to counteract these devastating influences is plainly indicated.

6. Table III gives general average losses for four years. It is apparent that these are steadily increasing in spite of all efforts to reduce them. It is evident that more drastic action of some kind must be taken to stem this rising tide of needless waste.

TABLE III

Fire Losses on Dwellings Due to All Causes.

	Frame	Brick
1915	$40,573,661	$3,912,093
1916	47,328,487	4,396,643
1917	57,203,691	5,245,110
1918	58,417,308	5,704,589
Total	$203,523,147	$19,258,435
4 year average	$50,880,787	$4,814,609

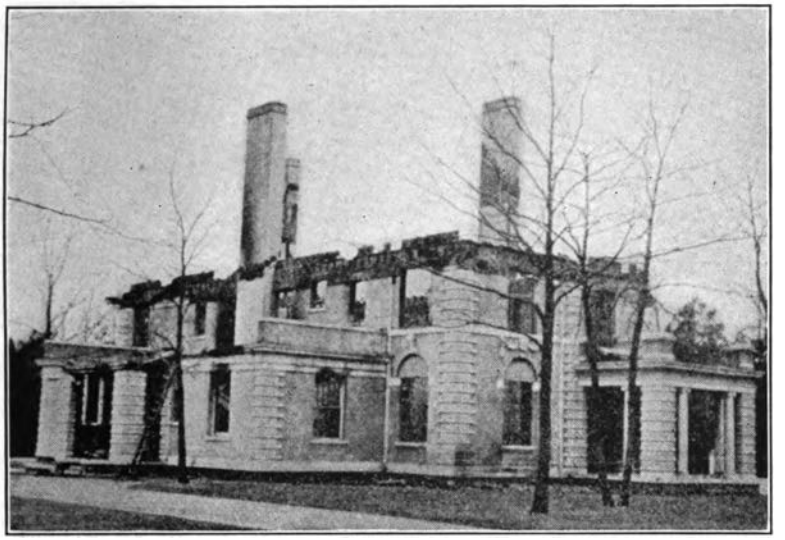
Total Average Yearly Loss, $55,695,396.
Total Loss for Year 1918, $64,121,897.

Section 5. Cost of Dwellings No Measure of Fire Resistance.

As a general proposition, the cost of a dwelling bears little relation to its fire-resistive ability. The effects of a fire are practically the same whether a house costs $3,000 or $300,000. The same defective construction exists in both, and unless the fire is controlled by outside agencies, the destruction is swift and complete. In recent years there have been a large number of very costly suburban and country houses burned in different parts of the country with an aggregate loss of many millions of dollars. The majority of these beautiful buildings could doubtless have been saved in whole or in part, if they had been built in accordance with the principles advocated in this pamphlet. It is a practical certainty that the owners of these buildings would have gladly incurred the additional expense necessary to have made them in some degree fire-resistive, if their architects had called attention to the simplicity of such precautions and the resulting decreased hazard. Ordinary business prudence should insure that such costly residences be made as fire-resistive as possible, particularly when remotely situated from public fire protection.

Section 6. Reasons Why Dwellings Burn Freely, and the Remedy.

1. The proportion of dwellings which catch fire and are a total loss, or which have building and contents ruined, is very high. The reasons are plain. First, in cities such buildings are usually located in outer areas more or less remote from fire fighting apparatus. Many are situated outside of city limits, or in villages or suburban developments where fire protection appliances are meagre and unreliable. Then there are vast numbers scattered all over the country which are entirely unprotected. Second, dwellings are generally small and low, so that a fire well started before discovery is likely to envelop all portions before outside assistance can become effective. Third, the majority of dwellings are of very combustible construction, with open stairways lined with varnished or painted woodwork connecting all stories, and with no provisions for arresting the spread of fire from floor to floor or from room to room. The cellar, where the heating appliance is usually located, often contains much combustible material, a combination which is dangerous. Moreover, the cellar is more or less directly connected by open channels with all parts of the house, including the garret. This results from lack of proper protection around water, gas and steam pipes, hot air pipes, dumb waiter shafts and open spaces through walls and partitions. Fourth, the nature of the occupancy is such that much of the time there are not enough able-bodied occupants present to do effective fire fighting from within.



Courtesy of Safety Engineering.

Costly dwellings, as usually constructed, burn as freely as inexpensive ones.

Courtesy of Safety Engineering.

Thousands of dwellings in this country, many of them palatial, burn each year. This should be prevented.

The spectators have saved what they could and now gaze at the swift destruction with helpless awe. Such scenes in varying forms are being enacted in a hundred places throughout the United States every day. Sometimes it is the dwelling of the rich which goes, but more often it is the home of those who can ill afford the loss. At least 40% of such fires are strictly preventable. Why not prevent?

Another American Palace "Going Up In Smoke."

2. These four conditions combined result in the enormous annual property fire loss, and the sacrifice of many lives. The lamentable feature of the situation is that a large part of this loss could be prevented by reasonable precaution in construction and careful observance of the ordinary rules of fire protection. The cost of the former would be comparatively small; the only expenditure for the latter would be a little thoughtful vigilance.

3. The cost of structural fire barriers necessary for reasonable protection to a dwelling house amounts to but a small percentage of the total cost of a building. For this reason it is hoped that architects and owners will adopt them once their attention is directed to the reduced hazard resulting from a little intelligent thought and care. Speculative builders who erect houses to sell, and build them as cheaply as possible with slight regard to utility, will perhaps be disinclined to adopt alterations which will *add anything* to the cost. However, even these should be convinced of the advantage gained as an advertising medium by the introduction of such structural safety features. It is reasonable to assume that a prospective home purchaser would be very favorably impressed with the idea of buying a house in which all precautions had been taken against the spread of fire.

Section 7. Classification According to Construction.

1. Dwellings in this country consist essentially of four types as regards their method of construction.

Type I. Buildings fully protected, properly called "fireproof," or fire-resistive, in which all structural parts, including doors, windows and trim, are of incombustible construction. Some buildings which belong in this class have minor doors and windows of combusitble construction, but where these do not serve as important cut-offs, or are not likely to be subject to serious fire exposure, their presence in the building would probably not materially increase the hazard.

NOTE.—All varieties of interior trim are now made of sheet steel and so beautifully finished they are difficult to distinguish from handsome wooden trim. Metal trim costs more than wood, and requires a skilled artisan to install it, but *it will not burn*, and this is a compensating advantage that should be seriously considered by those who can afford to buy it. Wooden trim treated by some process to render it fire-resistive would be entirely suitable for use in a house where the owner desired an incombustible trim, but wished to preserve the artistic effect of wood color and grain. There are companies which make a commercial business of treating lumber for such purpose, but of course it increases the cost. Still it is used quite extensively where necessity or a desire for a nonflammable trim justifies the extra expense. See Note to par. 6, Section 56.

Type II. Buildings with partial protection; commonly (though improperly) called "fireproof." The term "semi-fireproof" would properly be applicable. Such buildings have walls,

LIBRARY.

Courtesy of N. F. P. A. Quarterly.

MAIN STAIRWAY.

This beautiful modern dwelling, luxuriously furnished, was in a city block under complete metropolitan fire protection and was commonly accepted as "fireproof." Views show conditions after a fire originating in the first story from an electric heating device left with current on. Despite fireproof floor, partition, and stair construction throughout, the fire spread rapidly to all stories because of open stairway and abundance of wooden trim. The lesson is obvious.

floors, roofs, and partitions of incombustible construction, but with wooden floor finish, wooden trim, and ordinary wooden doors and windows.

Buildings of this type usually have masonry walls with steel beams filled between with fire-resistive material for floor and roof construction, and partitions of hollow tile, gypsum, metal lath and plaster or other equivalent material; or they are of reinforced concrete construction throughout; or any other combination of the foregoing materials. Some moderate priced dwellings of this type have recently been erected with a light steel framework covered with metal lath with stucco and plaster finish on walls and partitions, and having concrete floors.

Type III. Buildings with walls of incombustible construction, but having all interior construction, including the roof, of wood, the roof covering being either wooden shingles, or some type of fire-resistive material. The walls of such buildings are either masonry, brick veneer or cement stucco. Usually generous wooden piazzas are attached.

With stucco construction on wooden studs it is recommended that the stucco be back-plastered between the studs. The back-plastering makes board sheathing unnecessary and provides a stronger wall than when sheathing is used. At the same time it greatly increases the fire-resistance and prevents corrosion of the lath.

In all exterior stucco construction on wooden framework it is important that the metal lath be furred off from the studs by ¼-inch steel rods or by ½-inch metal furring.

NOTE.—The object of the furring is to prevent cracking and to provide additional thickness of stucco protection over the stud surface. If the lath is attached directly to the studs the thickness of the stucco is decreased over the wood and the keying of the stucco is liable to be defective.

Type IV. Buildings constructed entirely of wood, either with or without fire-resistive roof covering.

2. Except for precautions against open stairways, or other passageways through a house, very few of the recommendations of this pamphlet apply to dwellings of Type I. Such buildings are in a sense ideal; and although an increasing number is being erected each year, the total is still very small.

3. The same is essentially true in reference to buildings of Type II. They are not subject to spread of fire through concealed spaces, which is the worst constructional defect in dwellings; nevertheless, they are liable to destruction due to fire communicating from one portion of the house to another through open stairways, aided by the free use of wooden trim, doors, and win-

dows. Many houses of this type have been built in late years, some being costly and others medium priced buildings erected in groups for workingmen's houses in connection with industrial plants. Unfortunately their occupants are taught to have a feeling of security which often does not really exist. Experience has shown that because of faulty design, even expensive structures of this class frequently suffer a complete burn-out from an interior fire when outside aid is not promptly rendered.

With a little thoughtful care in the design of such buildings, and the exercise of prudence in selecting materials for trim, particularly where they are used in the planes of fire barriers, this class of residence can be made exceedingly safe. There are several methods of constructing non-combustible dwellings of this type which cost but little more than a frame building.

There is a prevailing belief that incombustible dwellings are impracticable because of excessive cost; as a matter of fact this opinion is not justified, for numerous dwellings of this class are being erected in different parts of the country at costs not exceeding 10 to 15 per cent over that of first class combustible construction. Reputable contractors claim that in some localities the difference in cost is less than this. If properly designed, such buildings not only furnish complete safety to the occupants, but reduce to a minimum the danger of a complete burn-out from an interior fire, and greatly lessen the hazard of ignition from burning of neighboring buildings. They are also rat and mouse proof, as well as having increased sanitary advantages.

4. As regards the last two types of dwelling there is little to be said in defense of their fire-resisting properties. Their weakness is well recognized. So far as the exterior fire hazard is concerned, Type III—that is buildings with incombustible walls—has a marked advantage. When an interior fire occurs, the chances of a complete burn-out in either type are more nearly even. All the recommendations of this pamphlet are applicable to these two types. It is hoped that the publicity given to the many prevalent defects in the construction of these two particular types of dwellings, together with the suggestions for correcting same, may serve to materially lessen the danger which such careless methods create.

5. It should be borne in mind, that many of the fire prevention measures recommended in this pamphlet can be put into a house at the time it is built with practically no extra expense, if specified in the plans before being submitted to contractors for bids.

Section 8. Definitions.

The following terms when used in this book shall be understood to have the meaning here given them:

1. *Approved.* The term "approved" refers to a device, material, or construction which has been approved by the Underwriters' Laboratories; or an approval issued by some recognized authority based upon satisfactory evidence of competent and impartial tests or investigations.

2. *Bearing Wall.* A wall which supports any load other than its own weight.

3. *Fireproof.* Refers to materials or construction not combustible in the temperatures of ordinary fires, and which will withstand such fires without serious impairment of their usefulness for at least one hour.

NOTE.—It is recognized that the term "fireproof" is misleading and should be abandoned for the more correct term "fire-resistive"; but until the latter term has been authoritatively defined in a manner expressive of its elastic interpretation, it seems advisable to continue the use of the more common though objectionable word.

4. *Fire Door.* A door, frame, and sill which will successfully resist a fire for one hour in accordance with test specifications of the Underwriters' Laboratories, and has been approved upon such test.

(a) A self-closing fire door is one which is normally kept in a closed position by some mechanical device.

(b) An automatic fire door is one which is arranged to close when released by the action of heat.

5. *Fire Wall.* A wall subdividing a building to restrict the spread of fire.

6. *Fire Window.* A window frame, sash and glazing, which will successfully resist a fire for one hour in accordance with test specifications of the Underwriters' Laboratories, and has been approved upon such test. No single pane in a fire window shall exceed 720 square inches.

7. *Incombustible.* Materials or construction which will not ignite and burn when subjected to fire.

8. *Non-bearing Wall.* One which supports no load other than its own weight.

9. *Parapet Wall.* That portion of any wall which extends above the roof line and bears no load except as it may serve to support a tank.

10. *Party Wall.* A wall used or adapted for joint service between two buildings.

11. *Wired Glass.* Glass not less than ¼ inch thick enclosing a layer of wire fabric reinforcement having a mesh not larger than ⅞ inch, and the size of wire not smaller than No. 24 B. and S gauge.

PART II.

QUALITY OF MATERIALS SUITABLE FOR CONSTRUCTION WORK.

Section 9. Brick.

All bricks used in buildings, except those used for fire-stopping, should be sound, hard burned, or other approved brick of regular shape. Second-hand brick shall be thoroughly cleaned before being used. Not more than 15 per cent shall be bats or broken brick.

Section 10. Sand.

The sand used for building construction shall be a sharp, clean, coarse quartz.

NOTE.—The sand should not soil the hand when rubbed in the palm, and should have a gritty sound. Bank sand is generally better than river or lake sand, the two latter usually having well rounded grains which are objectionable.

Section 11. Lime.

1. Slaked lime (lime putty) shall be made from well-burned quick lime, free from ashes, clinker, and other foreign material.

2. Dry hydrated lime shall be the finely divided product resulting from mechanically slaking pure quick lime at the place of manufacture.

Section 12. Lime Mortar.

Lime mortar shall be made of one part by volume of slaked (limed putty) or dry hydrated lime, and not more than four parts by volume of sand.

Section 13. Cement.

1. Only first quality cement should be used. Caked or lumpy cement should never be used; having once hardened, its binding value is gone.

2. Natural cement is somewhat cheaper than Portland cement, and is suitable for plain mass concrete or mortar in footings, cellar bottoms, or other work of lesser importance. Portland cement is better, and must be used for reinforced concrete, for concrete subject to heat, or for plain concrete where the best strength and tenacity are desired.

3. The quality of cement is very important. The specifica-

tions of the American Society for Testing Materials for testing cement are standard throughout the United States where purchases are made in quantity. These specifications are elaborate and exacting. Purchase should be made under specification wherever possible, but where small quantities are needed, the purchaser must generally depend upon the reliability of the dealer. The two varieties of cement should not be mixed, neither should mortar made from them be used in the same wall.

A fair estimate of the setting qualities of cement or a cement mortar may be obtained by making small pats, about 2 inches in diameter and ½ inch thick. Place these on a piece of glass, cover them to exclude the air, and note the rate of hardening by occasional pressure of the thumb. When the thumb nail fails to indent the surface, the cement paste or the mortar may be considered to have reached its final set.

Section 14. Cement Mortar.

1. Cement mortar shall be made of cement and sand in the proportions of 1 part of cement and not more than 3 parts of sand by volume.

2. Dry hydrated lime may be added in amount not exceeding 15 per cent of the cement by volume. The lime and cement shall be thoroughly mixed before the addition of water. The mortar shall be used immediately after water is added.

NOTE 1.—Cement mortar is improved by the addition of a small proportion of hydrated lime. It makes it work more smoothly under a trowel, and increases its waterproofness. Its strength is not decreased within the percentage of lime herein permitted.

NOTE 2.—If dry hydrated lime is not available, well slaked lime putty may be used, but care must be taken to insure a uniform mixture. Except for footings, a mortar for ordinary rubble stone work may be composed of cement and sand in proportion of 1 to 4, and will be much stronger than lime mortar.

Section 15. Gypsum Mortar or Plaster.

Gypsum mortar (recommended for setting gypsum blocks) should be composed of 1 part retarded gypsum, and not more than 3 parts sand, with binding material when necessary.

Section 16. Building Blocks.

1. Terra cotta or hollow tile blocks for bearing walls shall be dense, and hard-burned or vitreous.

Portland cement only shall be used in the manufacture of concrete blocks, and the coarse aggregate shall be of suitable material graded in size, but in no case shall the maximum dimension exceed one-half the thickness of the thinnest shell or web of the finished block.

2. The mixture for concrete blocks should be 1 part of Portland cement to not more than 7½ parts of suitable clean aggregate, fine and coarse.

NOTE.—While the above proportions are recommended as being as lean a mixture as should be used in general practice, it should not preclude the use of a block of any mixture which will meet the test specifications given in this section.

3. The following test specifications for hollow building blocks are those recommended by the National Board of Fire Underwriters. They are given here to indicate what requirements first class blocks should meet—the term "block" meaning any shape of block, brick, or tile, which forms a hollow or cellular wall.

(a) Tests shall be made to establish the working stresses to govern the use of blocks of each particular mark or brand. A series of ten full size blocks shall be selected from average quality stock, either at the factory, or from stock delivered for use at a building, and shall be tested for compression.

(b) Concrete blocks shall be not more than 36 days old when tested.

(c) The compressive strength of building blocks shall in all cases be calculated upon the gross sectional area of the bedding faces including the cellular spaces.

All blocks submitted to test shall be bedded in plaster of paris or cement to secure an even bearing.

Two-piece blocks shall be tested in pairs as set to form the two faces of the wall. The strength requirement shall be the same as for hollow blocks, and it shall be calculated upon the gross sectional wall area which would be formed by the two blocks and the space between them.

(d) The average ultimate compressive strength for hollow tile blocks designed to be normally laid with the cells vertical, and which are tested with the cells in that position, shall be not less than 1,200 pounds per square inch. The allowable working stress on such blocks shall not exceed 120 pounds per square inch.

(e) The average compressive strength of hollow tile blocks which are designed to be normally laid with the cells vertical, but are tested with the cells horizontal, shall be not less than 300 pounds per square inch, and no block of the set shall test less than 200 pounds per square inch. The allowable working stress on such blocks, when laid with the cells horizontal, shall not exceed 30 pounds per square inch.

(f) The average ultimate compressive strength for hollow tile blocks designed to be normally laid with the cells horizontal, and which are tested with the cells in that position, shall be not less than 800 pounds per square inch. The allowable working stress on such blocks shall not exceed 80 pounds per square inch.

(g) The average compressive strength for concrete blocks, when tested with the cells vertical, shall be not less than 800 pounds per square inch; and 300 pounds per square inch, with no block testing at less than 200 pounds per square inch, if tested with the cells horizontal. The allowable working stress for such blocks shall not exceed 80 pounds and 30 pounds per square inch respectively.

(h) The absorption of building blocks used for bearing walls, determined by taking the average test of three blocks, shall not exceed 10 per cent in 48 hours, and shall not exceed 15 per cent in any case.

Section 17. Concrete.

1. The sand and cement used in concrete shall be of quality specified in Sections 10 and 13, and the coarse aggregate shall be clean and free from all deleterious material.

NOTE.—The quality of the sand used in concrete is as important as the quality of the cement. Failure to recognize this fact has produced many disastrous results.

2. Gravel shall be free from clay or loam except such as naturally adheres to the particles. If clay or loam is in such quantities that it cannot be readily removed by dipping in water or brushing lightly with the hand, the gravel should be washed. When bank-run gravel is used, the best results will be obtained if it be screened from the sand and remixed in the proper proportion for fine and coarse aggregate.

NOTE.—See note in Section 68, paragraph 2, on poor fire resistance of quartz gravel concrete.

3. The size of the coarse aggregate will vary with the use, and shall always be graded from small to large. For ordinary mass concrete the maximum size should not exceed 2 inches. For reinforced concrete the maximum size should not exceed 1¼ inches, and the minimum size ¼ inch.

4. Good concrete should develop a strength of 2,000 pounds per square inch, when tested in 6-inch cubes or in cylinders 8 inches in diameter by 16 inches high, after having been kept in a damp place for 28 days. If the cement and aggregates are good, and the concrete is properly proportioned, mixed and placed, the strength can be considered satisfactory for any ordinary work. See Sections 61 and 63 for proportions and mixing.

PART III.

WALLS.

Section 18. Necessity for Rigid Specifications.

Substantial walls are the most important structural feature in every building. They must not only render satisfactory service as regards carrying capacity and resistance to weather, but they should also be efficient in case of fire, which means that they shall be rigid enough to withstand the expansive force of continued severe heat. Since walls are fundamentally a vital constructional part of a building, and the necessity for specifications which will insure their being well built is so imperative, the subject is treated in considerable detail. Special attention has been given to requirements for hollow block walls, because of their growing use in dwelling house construction, and the numerous complaints which have followed the use of inferior blocks.

Section 19. Bearing Capacity of Soils.

In the absence of tests, the safe bearing capacity of different soils used to sustain walls should not exceed the values given in the following table:

Character of Soil.	*Tons per Square Foot.*
Soft clay	1
Firm clay, fine sand, or layers of sand and clay, wet	2
Clay or fine sand, firm and dry	3
Hard clay, coarse sand, gravel	4
Hard pan	8 to 15
Rock	15 to 72

Section 20. Footings.

1. The footings for foundation walls, piers and columns, of masonry buildings should be constructed of plain or reinforced concrete. Stone laid in cement mortar may be used for footings for frame buildings, but good concrete is better.

2. Concrete for footings should be made of at least 1 part of Portland cement, and not more than 2½ parts of sand, and 5 parts of broken stone or gravel.

3. Where mass concrete is used for footings or foundations, the stone or gravel shall be of such size as will pass through a two-inch ring. Sufficient smaller aggregate shall be added to secure density.

NOTE.—Under some conditions it is permissible to embed large stones in mass concrete, it then being called "rubble concrete."

4. The quality of the aggregates and cement, and character of the mixture shall be as specified in Section 17.

5. Concrete footings for dwellings with masonry walls should be not less than 12 inches thick. Footings for foundation walls of frame dwellings exceeding 15 feet in height shall be not less than 8 inches vertical thickness.

6. The bottom of footings shall rest upon solid ground at a depth at least equal to the frost line below the surface, unless solid rock occurs above this point; or they may rest upon piles or ranging timbers of wood where necessary. If wooden footings are used they should be entirely below the level of low water.

7. Footings should be so designed that the loads they sustain shall be uniformly distributed.

8. The dead loads carried by the footings shall include the actual weight of the superstructure and foundations down to the bottom of the footing. All tanks or other receptacles for liquids shall be figured as being full. The live load in a dwelling is sometimes considerable when account is taken of pianos, bookcases, heavy furniture, rugs, etc., as well as crowded assemblages of people. It should be taken as not less than 50 pounds per square foot for the ground floors, and 30 pounds per square foot for upper floors.

NOTE.—It is poor economy to skimp footings. If they are insufficient for the load they carry settlement is sure to come in time, producing ugly wall cracks, misfitting doors, openings which will let in ground water, and other defects, which plague the occupants as long as the house exists. The settlement of foundations is also liable to produce chimney cracks, and so cause a fire hazard.

9. All footings shall extend at least 4½ inches outward from each side of the bottom of the foundation walls which rest upon them. In no case shall the load per square foot under any portion of any footing due to the combined dead, live, and wind loads exceed the safe sustaining power of the soil upon which the footing rests.

10. Footings and foundation walls shall be laid in cement mortar.

Section 21. Foundation Walls.

1. Foundation walls are construed to include all walls and piers built below the curb level, or nearest tier of beams to the curb, or to the average level of the ground adjoining the walls, to serve as supports for walls, piers, columns, girders, posts or beams.

2. For dwellings with masonry walls the foundation walls, if built of rubble stone, should be at least 8 inches thicker than the wall next above them. If built of brick or plain concrete and sup-

porting walls over 30 feet in height, they should be at least 4 inches thicker than the wall next above them. In buildings not exceeding 30 feet in height, the foundation walls may be in most cases the same thickness as the walls above.

3. The foundation walls of frame structures exceeding 15 feet in height, if of stone, shall be not less than 16 inches thick, and if of brick or concrete not less than 12 inches to the grade and 8 inches to the under side of the sill. If the foundation and first story walls are constructed of brick or concrete, the foundation walls shall be not less than 12 inches thick to the first tier of beams and 8 inches thick from the first to the second tier of beams; or if these walls are constructed of stone, they shall be not less than 18 inches for the foundation walls and 16 inches for the first story wall.

4. Hollow blocks may be used for the foundation walls of buildings not exceeding three stories or 40 feet in height, provided said walls are not less than the thickness required for foundation walls of brick or plain concrete, but in no case less than 12 inches. All blocks shall be laid to line and level, and carefully bonded. When blocks are laid with cells vertical the stability of the walls and their resistance to water may be increased somewhat by being filled solidly with wet concrete. Such foundations shall not be stressed beyond the limits allowed in Section 16, taken over combined area of blocks and fill. See Section 26, par. 2.

NOTE.—Attention is called to the fact that foundation walls of hollow building blocks, even when filled with concrete are sometimes not efficient in resisting moisture. It is recommended that such walls be thoroughly waterproofed on the outside.

It is safer to waterproof all walls located in soil that is liable to be watersoaked at times. Damp walls are always a source of much trouble and expense.

Section 22. Brick Walls in General.

1. The thickness of bearing walls for brick dwellings not exceeding three stories in height, should be not less than 12 inches. When the height exceeds three stories, the walls of the upper three stories should be 12 inches thick and the lower stories 16 inches.

NOTE.—Although the use of 8 inch walls for dwellings is common practice in many localities, the National Board of Fire Underwriters advocates a minimum thickness of 12 inches. They are dryer, more stable, and much less liable to be ruined by expansion due to heat in case of fire.

2. The masonry walls and piers of every building shall be properly and solidly bonded with mortar joints. They shall be built to a line and carried up plumb and straight. All walls shall be securely anchored and bonded at points where they intersect.

The walls of each story shall be built up the full thickness to the top of the beams above.

NOTE.—It is exceedingly important that all masonry joints in every wall be completely filled with mortar, but it is especially imperative for bearing and fire walls. Permit no porous or unfilled mortar joints. There should be a uniform coating of mortar on every course of brick or other solid masonry which will fill all spaces resulting from broken brick or other causes. Each succeeding course of brick or other material should be well bedded into the mortar and all vertical joints absolutely filled.

Brick is porous and unless properly encased in mortar on all adjacent sides the walls will be watersoaked by heavy rains, with consequent interior damage. Unfilled joints in brickwork separating wooden beams in a wall are most pernicious. Many buildings have been burned by fire passing through defective walls.

3. All brick shall be thoroughly wet just previous to being laid, except in freezing weather when they shall be thoroughly dry. No mason work of any description shall be built when the temperature is below 28 degrees Fahrenheit on a rising temperature, or 32 degrees on a falling temperature at the point where the work is in progress. No frozen materials shall be built upon, but shall be removed.

4. The walls and beams of every building during erection or alteration shall be securely braced wherever required until the building is enclosed.

5. In brick walls every sixth course shall be a heading course, except where walls are faced with brick in Flemish bond, in which case the headers of every third course shall be full brick and bonded into the backing. Where running bond is used, it shall be bonded into the backing by cutting the corners of every brick of every sixth course of the face brick and putting in a row of diagonal headers behind the same; suitable metal anchors shall also be used in the bonding course at intervals not exceeding 3 feet. Where face brick is used of a different thickness from the brick used for backing, the course of the exterior and interior brickwork shall be brought to a level bed at intervals of not more than eight courses in height of the face brick, and the face brick shall be properly tied to the backing by a full heading course or other approved method.

6. Face brick shall be laid at the same time as the backing, and shall in no case be laid after the backing is in place.

7. No timber, except inside lintels as described in paragraph 10, and nailing blocks not over 8 inches in length, shall be placed in any masonry wall.

8. Openings for doors and windows shall have arches or lintels of masonry or metal which shall have a bearing at each end of not less than 5 inches on the wall. Bearing plates shall be provided for lintels resting on walls where the span is more than 6 feet.

9. The maximum percentage of openings in exterior walls should not exceed 40 per cent of its superficial area per story.

10. On the inside of openings less than 4 feet in width in walls of non-fireproof buildings in which lintels or arches may be less than the thickness of the wall to be supported, timber lintels may be permitted which shall rest at each end not more than 2 inches on any wall, and be chamfered or cut to serve as center for a rowlock or keyed arch.

11. Party or division walls between brick dwellings built in rows should extend through the roof with a parapet not less than 2 feet high. Parapets should be laid in cement mortar and be the full thickness of the top story wall.

NOTE.—The object of such parapet is, in case of a house burning, to prevent the flames lapping over and igniting the roof of an adjoining house.

12. For division walls between frame dwellings built in rows, see Section 60.

Section 23. Stone Walls.

1. Stone walls should have one header extending through the wall in every 2 feet in height and every 3 feet in length. The headers should be good flat stones, not less than 12 inches wide and 8 inches thick.

2. All stones should be laid on their natural bed. Stones shall be firmly bedded in mortar with all spaces and joints thoroughly filled.

3. Walls built of squared stone with dressed level beds, shall have a thickness not less than that required for brick walls under similar conditions. Rubble stone walls shall be at least 4 inches thicker than required for brick walls.

Section 24. Piers.

Stone posts shall not be used for the support of columns, girders, or walls, and stone bond or cap stones should not be used in interior brick piers.

NOTE.—The reason for these restrictions is that such stone will split and spall when attacked by heat and are liable to cause a collapse of the building in the early stages of a fire. If brick piers are built with Portland cement, as they should be, bond and cap stones are unnecessary, but if a bond or cap is desired, let it be of cast iron or steel.

Section 25. Fire Walls.

1. The great value of solid walls in restricting the spread of fire is so well known, argument should be unnecessary to insure their use wherever suitable. They have generally been re-

stricted to commercial and public buildings, and while not adapted for small or moderate sized dwellings, ordinary prudence should require that they be a structural feature of every dwelling having a large ground floor area, such as is common upon handsome country estates and at fashionable resorts. Fire walls are particularly applicable to palatial dwellings where the architectural design is such as to form natural vertical planes of separation between different portions. For example, a building with large wings should have fire walls placed on the line of division between sections. The design of many handsome mansions would readily permit separation into three parts by the use of two fire walls. The additional expense of such cut-offs is slight, and neither the architectural effects nor the utility of the building need be affected by their introduction. Necessary openings in such walls can be efficiently protected by fire doors as artistic in finish as ordinary doors. The effect of the walls would be to form fire barriers between the separate portions of the building, so that one might burn with reasonable assurance that the adjoining portions could be saved.

2. Fire walls in dwellings should be built of brickwork not less than 12 inches in thickness, or of reinforced concrete not less than 8 inches thick; hollow blocks or tiles are not suitable. For brick fire walls, Portland cement mortar only should be used. The walls should start from the cellar or lowest story, be continuous through all stories, and project as a parapet at least 3 feet above the roof. If the whole roof construction be of fireproof material the wall need only extend to the roof, but should make close connection with it. The parapet will not only prevent flames lapping over on to the adjoining roof, but forms an effective bulwark to protect firemen in fighting a fire in either portion of the building.

3. The number of openings should be as few as possible, and ought to be limited to one in each story, usually in the hallway. Such openings must be protected by approved fire doors, either self-closing or automatic, the former being the best because always normally closed. Self-closing swinging doors are adaptable to openings not exceeding 45 square feet in area when used in pairs. When an opening exceeds that of an ordinary size swinging door, a pair of doors should be employed, one of which is held stationary by suitable bolts, and the other made self-closing. By this arrangement a large opening in a hallway is available when needed, and the opening is protected at all times. Many approved doors of this type are as attractive in appearance as the finest wooden doors.

4. Where it is desirable to preserve a large opening passageway through such a wall as might be necessary on the ground floor, the opening should be protected by automatic sliding fire

doors on each side of the wall. Such doors can be arranged to be entirely hidden in pockets on the sides of the wall, and thus not interfere with interior decorations in any way. To secure a maximum of protection, it is recommended that an automatic sliding fire door be installed on the opposite side of the wall at openings where self-closing swinging doors are placed, the automatic door to be stored out of sight in a pocket, and would only come into use in case of a fire. The object of two fire doors, one on each side of the wall, is to give the opening the best protection possible. At best it can scarcely be equal to the solid wall. Automatic sliding doors do not fit the wall face snugly enough to prevent smoke and some flame passing around the edges, hence the second door is a strict necessity. Properly hung self-closing doors are tight fitting enough to entirely exclude smoke as well as flame, for a limited time. However, they are likely to warp when attacked by severe heat for a considerable period of time, and it is therefore safer to have the auxiliary automatic door as a safeguard in case of such severe emergency. Automatic doors should be controlled by an automatic door release on each side of the wall, thus insuring quick closure, whichever side is attacked by fire.

5. Aside from the value of a fire wall as protection to property, it also provides the easiest and safest of emergency exits to protect life. By simply passing through the wall at any floor level and closing the fire doors, a person would be perfectly safe in case of fire. This means of escape is known as a "horizontal exit." Some means of descent from the upper floors must of course be provided in the portion of the building to which refuge is taken.

Section 26. Walls of Hollow Building Blocks.

1. Dwelling house walls built of hollow tile blocks or hollow concrete blocks are common in all parts of the country. Generally they have proved strong enough to support the weight imposed upon them in such construction; however, their use has developed other defects, upon some of which there is conflicting testimony, but all of which should be recognized and understood by the house builder. In the Southwest where severe winds of a tornado character are prevalent, hollow block walls have been severely criticized because of their lack of stability and their porosity; such walls having been thrown down when similar brick walls remained standing, and driving storms frequently making the inside of hollow block walls wet.

2. Hollow building blocks may be filled solidly with cement concrete or cement mortar to increase the stability and to aid in

distributing the load, but the allowable working stress on such blocks shall not be greater than that permitted for unfilled blocks.

NOTE.—Tests have demonstrated that the strength of hollow tile blocks is not increased by being filled with concrete, the reason being the difference in strength and elasticity of the two materials. Similar tests thus far available upon concrete blocks indicate some gain in strength by filling, but not sufficient to warrant recognition.

3. The defect of porous walls is everywhere prevalent, though it is not confined to hollow block walls. Moisture on the interior surface of a wall not only ruins the decorations but renders the house unhealthful and uncomfortable. The results are much the same whether caused by water penetrating the wall or condensing upon it. The latter trouble is more common on concrete block walls. To insure block walls being dry they should either be veneered with brick, stone or tile, or covered with stucco; or the walls should be furred on the inside. As concrete block walls are rarely covered on the outside they should always be furred on the interior, unless the builder knows from experience that the particular block used or method of construction will insure dry walls. This danger can be largely avoided if blocks of proper density are chosen and are properly laid in cement mortar.

NOTE.—Occasionally records are given of concrete block walls plastered directly on the blocks which have proved satisfactory, but they are the exception, not the rule.

4. Walls built of inferior concrete blocks are almost sure to be a total loss when subjected to fire, failure usually resulting from the webs splitting in the middle of the blocks due to unequal expansion of the walls, also to a general disintegration of the low grade concrete. First class blocks are not subject to this criticism.

5. No block or tile should be used for bearing wall construction unless the manufacturer can show a complete certificate of test from some testing laboratory of recognized standing, showing that the product has successfully met standard test requirements, and the purchaser should have satisfactory assurance that the product delivered has the quality of that which was tested. The test requirements are particularly necessary for concrete blocks, for the reason that such a large proportion of them are manufactured by irresponsible or unskilled workmen. A thoroughly reliable concrete block can be made, but it requires plenty of good cement, a clean aggregate with proper proportions of fine and coarse to secure density, sufficient water to make a wet mixture, and then should be kept damp while curing. All these requirements are necessary to produce a first class product. Unfortunately, under the ordinary conditions of manufacture, several and sometimes all of these essentials are ignored. The result is an inferior and unsatisfactory material. See Section 16 for test specifications.

Section 27. Thickness and Construction of Hollow Block Walls.

1. The minimum thickness of hollow block walls shall be the same as for brick walls.

NOTE.—The practice of building hollow block walls 10 and 8 inches thick should not be encouraged. While they are probably strong enough to carry the loads imposed, they have little surplus stability and like thin brick walls are weak when attacked by fire. Their only justification is where they are substituted for frame buildings, and even then the advantages of the thicker wall warrant the small additional expense if it can be borne. See Note to Section 22, par. 1.

2. All hollow block walls shall be laid in Portland cement mortar.

3. Building blocks shall be so laid that the shells and webs shall be superposed upon the shells or webs of the adjacent block or blocks below.

4. If a wall be built of blocks laid with the cells horizontal, which were designed to be normally laid with the cells vertical, or if band courses of such blocks with cells horizontal be laid in a wall otherwise built of the same blocks with the cells vertical, the carrying capacity of such walls shall be calculated from the strength of the blocks tested with their cells horizontal.

5. When hollow block walls, laid with cells vertical, are decreased in thickness, the blocks in the top course of the thicker wall shall be filled solidly with concrete, or the exposed openings in such top course may be covered with slabs of hard burned terra cotta, or concrete at least 1 inch in thickness. Terra cotta, concrete, or metal slabs or templates of approved size and thickness, shall be placed under all floor beams and girders as bearing plates in order that the allowable working stresses shall not be exceeded.

6. Hollow blocks when used to form lintels, which are not keyed arches, shall be reinforced with steel rods and be filled solidly with concrete.

7. When walls of hollow blocks are veneered, the facing shall be bonded to the backing with a row of headers every 16 inches, or be attached to the backing with approved metal wall ties bedded in the mortar joints. Such ties shall not be spaced further apart on centers than one foot vertically and 2 feet horizontally. This veneering shall not be considered a part of the required thickness of the wall. Brick facing or veneering may, however, be considered as part of a hollow terra cotta or concrete wall (or vice versa), provided the veneering is bonded at

least 4 inches into the wall at intervals not exceeding six courses of brick. When veneering is used special care shall be taken to fill all joints flush with mortar around wall openings.

NOTE.—Ordinary hollow building blocks are not suited for this latter bonding requirement; blocks of special size must be used to insure a proper spacing of the joints.

PART IV.

FLOOR AND ROOF CONSTRUCTION.

Section 28. Wooden Joists or Floor Beams.

1. Wooden joists for buildings with masonry walls should be 3 inches thick (commercial size). Most Building Codes specify that thickness, and it is recommended for reasons explained in Section 59, paragraph 1, which is applicable to all types of dwellings where wooden joists are used. For fireproof first floor construction see Section 38, par. 2, 3, and 4.

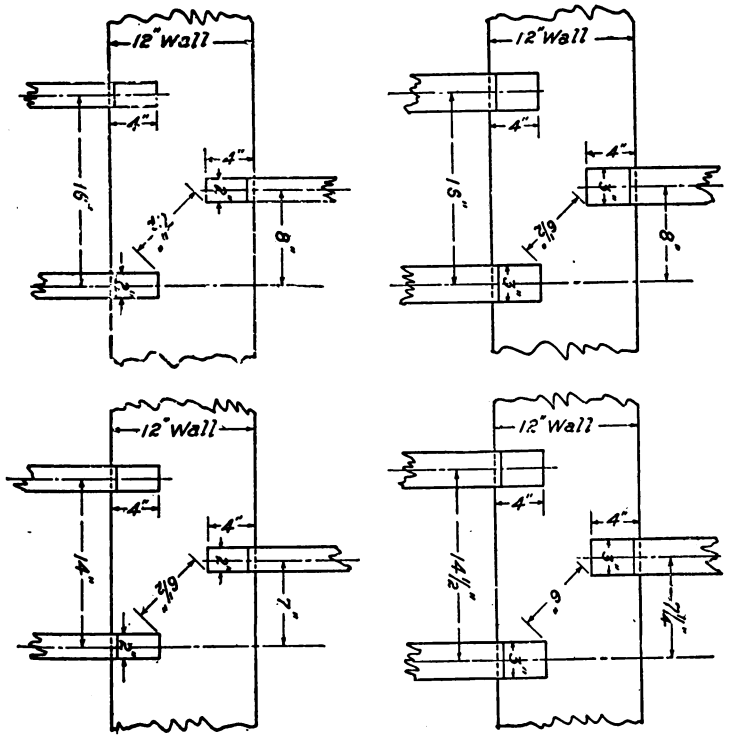


PLATE I.

Diagram showing placing of floor beams in a wall to secure a separation of at least 6 inches between ends.

2. Every wooden beam which rests in a party or fire wall shall be separated from any other beam in the wall by at least 6 inches of solid masonry. Such separation may be obtained by staggering the beams, corbeling the wall, or by use of steel wall hangers arranged to make the beams self-releasing. No wall shall be corbeled more than 2 inches for this purpose. If the beam ends are opposite each other in the wall the separation shall be not less than 8 inches. Plate I indicates spacing and arrangement of beams of different thickness in a 12-inch wall which will meet the requirement of this section. The spacing could be reduced if the walls under the beams were corbeled. Figure 1 in Plates VI and VII shows how a proper separation of beam ends may be obtained around a fireplace or chimney. Offsets in the masonry work can be avoided by use of steel wall hangers.

NOTE.—Staggering the beams distinctly lessens the danger of transmission of fire through a wall, because the fire or highly heated air must travel through two joints at right angles to each other to pass from one beam to the other. The probability of two right angle joints being open is much less than in the case of one straight connecting joint. See Note to Section 22, par. 2, on mortar joints.

3. Trimmer and header beams over 4 feet in length shall be hung in approved metal stirrups or hangers.

4. Every wooden beam, except header and tail beams, shall have bearings of at least 4 inches.

NOTE.—In designing wooden floor constructions to carry heavy loads, it is important to take into account the resistance of wood to crushing perpendicular to the grain. Frequently the area allowed for support of the ends of wooden beams is so small that crushing occurs while other proportions are ample for the load. The allowable load on yellow pine and Douglas fir should not exceed 325 pounds per square inch, and on spruce and hemlock not in excess of 250 pounds per square inch.

5. The ends of all wooden floor and roof beams which rest in walls shall be cut to a bevel of ¾ inch for each 3 inches in depth, but need not exceed a total of 3 inches.

NOTE.—This is to make the beams self-releasing in case they should collapse from fire or other cause, and so avoid throwing down the walls.

6. All wooden floor and roof beams shall be properly braced with cross bridging. The distance between bridging or between bridging and bearing should not exceed 8 feet.

7. Each tier of beams running parallel to enclosing walls shall have approved 4-inch anchor strips dovetailed into the beams diagonally, crossing at least four beams.

Section 29. Wooden Flooring.

1. Wooden flooring should always be double, and it is recommended that a layer of heavy asbestos or other incombustible

floor felt be placed between the rough under flooring and the upper finish flooring.

NOTE.—The felt will not only make the floor warmer, and assist as a sound deadener, but it will aid somewhat in resisting the passage of fire through the floor.

2. Where wooden flooring is laid over a fireproof construction, the space between the wooden sleepers should always be filled level with underside of flooring with cinders or other dry porous incombustible filling. This avoids air spaces through which a fire might travel.

NOTE.—It is important that timber used for interior construction be thoroughly seasoned, especially if it is to be encased in a manner to prevent free circulation of air about it. Otherwise, there is danger of dry rot attacking the timber, and causing great expense for its replacement within a few years. Dry rot also increases the fire hazard, as rotted wood is more combustible than sound wood. Furthermore the shrinking of green woodwork in a building always produces ugly disfigurations. Another advantage of using seasoned timber is that shakes and checks will have reached their ultimate development. Consequently, there will not be the danger that a joist or beam selected green will develop dangerous checks and shakes in seasoning.

Sapwood is very susceptible to dry rot, and should be avoided in locations where the timber is liable to be subjected to dampness. In timbers used in such locations, if the species used shows a marked difference in color between heartwood and sapwood, it is a good rule to specify that three-quarters heart shall show at any part of the narrow faces of joists or posts. From a strength standpoint alone, sapwood is no defect.

Very wide-ringed wood of the conifers (popularly known as "softwoods") is likely to be considerably weaker than that which is intermediate. It is well to avoid the use of joists and posts of coniferous wood in which the yearly growth rings are fewer than six to the inch.

In southern yellow pine and Douglas fir each annual growth ring is composed of a dense, dark and heavy band of summerwood, and a lighter and softer band of springwood. In these two species the greater the proportion of summerwood in the ring the greater is the dry weight and strength of the timber. The proportion of summerwood in timbers of either species ought not to average less than one-fourth the total width of the ring. If the summerwood in a piece of southern pine or Douglas fir grades off gradually into the springwood, this piece should not be used, unless the proportion of summerwood is considerably over one-third.

In other species, such as spruce, hemlock and Norway pine, if timbers are exceptionally light when dry they should not be used as they are not strong, hence not so reliable.

The number, character, and location of defects in timber has much to do with its strength. Checks and shakes in joists are most harmful in the middle half of the height; that is, in the portion showing white between the shaded areas of the beam indicated in Plate II. The best place to judge such defects is on the ends of the timber. The measurement, out to out, of a ring-shake, measured parallel to the width of the timber, should not exceed one-half that width. Shakes and checks need not be considered in selecting a post or column.

The weakening effect of knots likewise depends upon their position, as well as upon their soundness, tightness, and the amount they distort the grain of the wood from a straight line. A comparatively small

knot near the lower edge of a beam at its middle is far more harmful than a large knot near the same edge but close to the end. The size of sound knots (those securely attached to the surrounding wood) when located in the portions of a beam indicated by the shaded areas in Plate II, should not be greater in diameter than one-half the width of the face on which they show, and should never exceed 3 inches.

If the knot is loose or surrounded by pitch or bark its diameter should not be greater than one-fourth the width of the face on which it shows, and should never exceed 1½ inches.

No timber with a rotten knot however small, should be used, since the interior of such a timber is likely to become badly decayed.

Cross-grain timber should be avoided when the cross-grain occurs in the lower of the two shaded areas shown in Plate II.

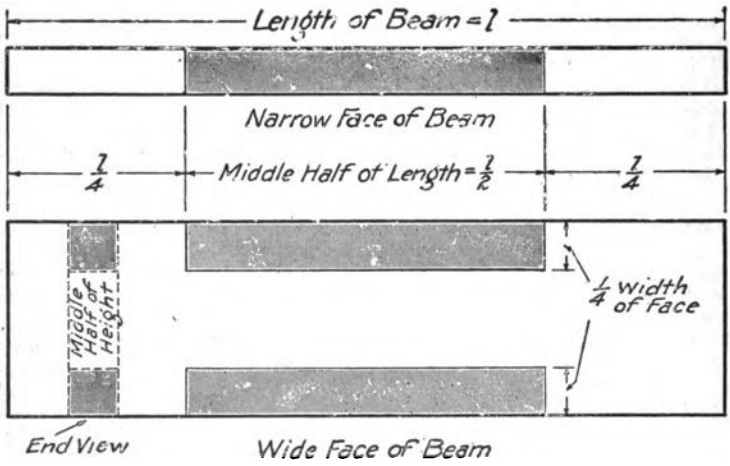


PLATE II.

Plan and elevation of wooden beam, with shaded areas indicating portions in which certain defects should be excluded.

Section 30. Approved Roofings.

1. Whenever possible use a fire-resistive roof covering. The safety which it offers is well worth the additional expense. There is a variety of approved roofings on the market which will afford satisfactory protection and service; a number of them are but little more expensive than first class wooden shingles. The first cost of a roofing material must be averaged with the years of service it will render in order to ascertain the real expense of maintaining the construction. The life of the best fire-resistive roofings is considerably longer than that of the wooden shingle, and this fact should be considered in selecting. Among the recommended roofings are tile, tin, slate, asbestos shingles, and other

composition shingles and prepared roofings which have been tested and approved for fire-resistance and durability.

2. The fire-resistance of ordinary roofs can be considerably increased by covering the rafters on the underside with metal lath and plaster, asbestos mill board, or asbestos building lumber, gypsum plaster board or any other incombustible heat insulating material. Such coverings add much to the comfort of the house by making the attic cooler in summer and warmer in winter. The insulation can be further improved by a 2-inch layer of mineral wool placed between the rafters and supported by any of the board materials above mentioned. Gypsum plaster blocks could also be employed for this purpose. Such construction owing to its resistance to heat and cold, is particularly advantageous when sleeping rooms are located in the attic.

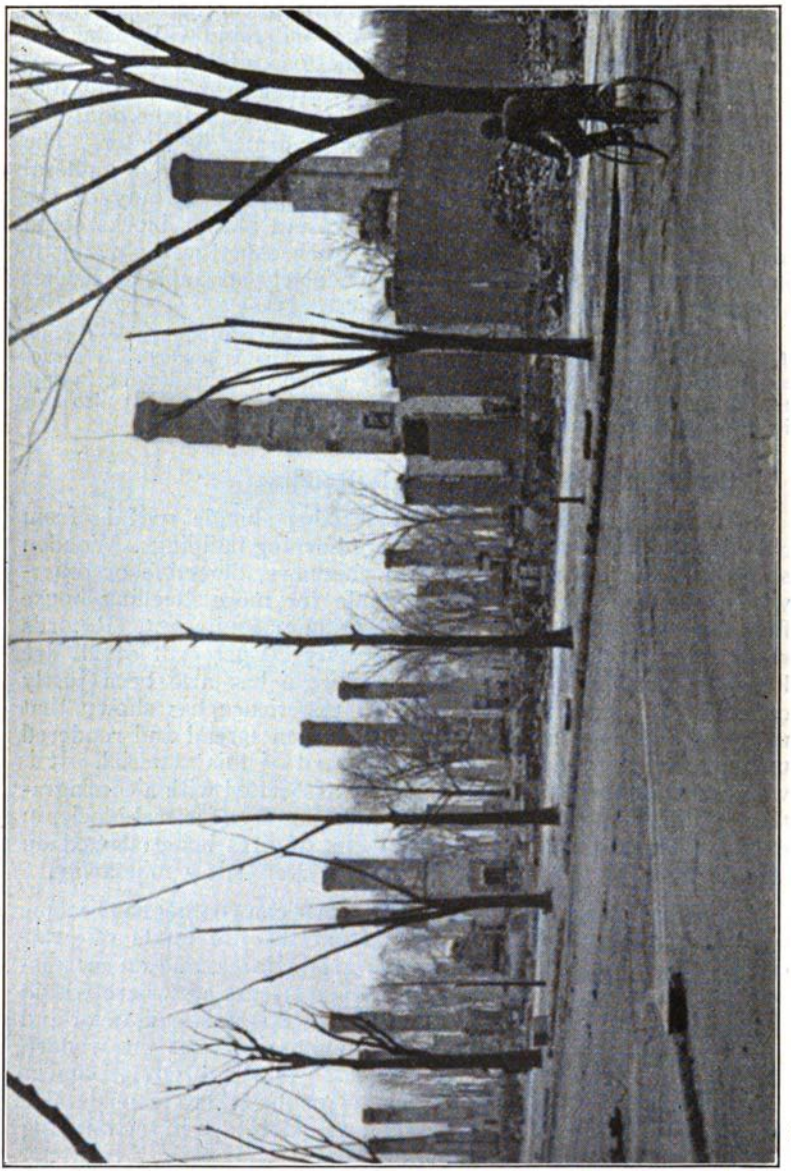
NOTE.—It is recommended that a layer of non-flammable roofing felt be laid on the roof decking before tin roofing is applied. It serves as an insulator and would prevent ready ignition of the decking in case the tin were subjected to fire brands or severe radiant heat. It also aids in keeping the attic cool in hot weather.

Section 31. Wooden Shingle Roofing.

1. The great danger of the wooden shingle roof is from chimney sparks, or flying brands from burning buildings. Wooden shingle roofs in combination with chimneys, defective or otherwise, have probably been accountable for more dwelling house fires than any other defect in construction or equipment. Records show that they are responsible for over 20 per cent of all fire losses in dwellings. The wooden shingle has also been justly called a "conflagration breeder" for experience has shown that many of our large conflagrations have been spread and rendered uncontrollable by the flying brand hazard of this material. It is well known that the high wind usually associated with a conflagration will distribute blazing shingles over an area several blocks in extent. There are numerous incidents of fires being started on shingle roofs by the burning of another over half a mile away.

2. The hazard of this typically American roofing has become so well recognized it is excluded from the fire limits of practically all cities where building laws are in force, and an increasing number are enacting laws forbidding its use anywhere within the corporate limits. However, in spite of this public disfavor and its "criminal record," it is an unfortunate fact that the wooden shingle roof is still extensively used for isolated dwellings, and in many towns and real estate developments where considerable building congestion but no building laws exist; also in the outlying areas of the majority of our cities.

3. The reasons for the continuance of this evil are several, first of which is habit. It is easier and more natural to do the



A once beautiful street in Augusta, Georgia, as it appeared after the conflagration of 1916—a graveyard of handsome houses. Behold a sacrifice to the wooden shingle!

thing we are accustomed to do, than to start something new. The second primary cause is low first cost of wooden shingles; third, the ease of application—skilled labor not being required; and fourth, the general distribution of the product—they being on sale in practically every town in the country. There are other reasons for their use, but all their advantages are overshadowed by their one great discrediting feature—their fire hazard. This menace is always present, and no sophistry or argument can remove it. Therefore the National Board of Fire Underwriters urges that wooden shingles shall not be used where a safer roofing can be secured.

Courtesy of N. F. P. A. Quarterly.

Typical result of sparks falling on a wooden shingle roof. Danger increases with the age of the roof.

4. When wooden shingles are used, their fire hazard should be recognized, and every precaution taken to make them as safe and efficient as possible. The life of the shingles can be considerably increased by treating them with preservative compounds. This can be done at the building, or treated shingles can be purchased in the market. Most of such compounds are in the nature of stains, which do not directly increase fire-resistance. However, indirectly they assist the shingles to resist fire in this way: A newly shingled roof offers much better protection from fire than an old one, because the shingles lie closely together and

present a smooth, hard surface upon which sparks or embers are not likely to lodge permanently, but will roll or be blown off. On an old roof where the shingles are badly weather-worn and have curled and broken edges, the chances of sparks being held and igniting the roof are very greatly increased; therefore any treatment which will preserve the shingles and prolong their existence as a smooth roof surface will incidentally improve its fire-resistance.

5. Various methods of fireproofing wooden shingles have been proposed, and the U. S. Forestry Service and the Underwriters' Laboratories are making systematic investigations of their merits and adaptability. It is hoped that some practical process may be evolved which will remove this serious drawback to an otherwise exceedingly useful material.

If it is desired to collect rainwater for household purposes from roofs, it will be necessary to choose treated shingles which will not contaminate the water. Some preservatives have this objection.

6 A well known fire prevention expert in New England has expressed his faith in a plan to protect a wooden shingle roof from conflagration hazard by installing a dry pipe along the ridge pole with perforations so placed as to spray the whole roof when water is turned on from a service pipe with which it would be connected. This would undoubtedly protect the roof from sparks or embers from any source, or extinguish an incipient blaze provided the occupants knew of the danger and turned on the water.

Section 32. Skylights.

All skylights should have metal frames and sash and be glazed with wired glass, or be protected above by heavy wire screens.

NOTE 1.—The purpose of this requirement is to prevent possibility of fire brands carried by the wind from some burning building breaking through a skylight and setting fire to the interior of the house.

NOTE 2.—Building Codes usually require that a skylight over any shaft passing through a building directly to the roof, such as elevator, stairway, vent and light shafts, shall be glazed with thin glass. The idea being that if a fire occurred in the building and worked into the shaft, the heat would break out the thin ordinary glass, and so give vent to the heat and smoke. This would prevent the fire being forced sidewise through other portions of the building and at the same time give firemen a chance to control it. Such construction would scarcely apply to dwellings except those having considerable size and height, and presumably within the radius of public fire protection.

Section 33. Roof Structures.

All structures built above the roof surface, such as bulkheads, scuttles, tank houses, etc., should either be of fireproof construction or be covered with incombustible material.

NOTE.—Such structures are liable to be forgotten in the confusion during the burning of some nearby building. If they are not protected and the wind is in the right direction, the danger of their ignition from radiant heat and consequent firing of the upper story of the house before discovery is well known. The fact that such a fire would be in the most inaccessible place to fight increases the risk. A prudent person will make all the roof surfaces of his house at least non-flammable, and economize elsewhere if necessary.

PART V.

MAJOR STRUCTURAL REQUIREMENTS TO PROTECT LIFE AND PREVENT SPREAD OF FIRE.

Section 34. Structural Features Which Every Dwelling Should Possess.

1. There are three fundamental structural features that should be incorporated into every dwelling in order to safeguard properly the lives of the occupants, and to resist destruction of the building by fire. These are:

(a) Proper protection of stairways and other vertical openings.

(b) Introduction of a secondary means of exit from upper stories.

(c) Providing a fire-resistive horizontal cut-off between the cellar or basement and the story above.

2. These three requirements are so inter-related, the accomplishment of one to a certain extent removes the hazard of the others. Whether they are given in the order of their relative importance is difficult to say, and is really immaterial. They will be discussed in the order here given.

Section 35. Danger from Open Stairways.

1. Even in fire-resistive houses of good construction there is always danger of intense fires due to burning contents. Furniture, hangings, bric-a-brac, and floor coverings, are always present sufficient to make a hot blaze if well ignited. The danger is that the smoke, heat and sparks from such a fire in any lower story room may be carried upward through the house by an open stairway, and thus imperil lives and property on the floors above. Once the gases and air surrounding a fire attain the combustion temperature of wood and fabrics, they become very dangerous

because they will ignite everything inflammable they touch. Under such circumstances a fire will jump from floor to floor through an open stairway with incredible rapidity, even though the latter be quite free of combustible material.

2. It is for this reason that stairs and stair hallways should, wherever practicable, be separated from the balance of the house by incombustible partitions and fire doors.

3. Complete enclosure of stairs and hallways is the ideal method of protection against vertical spread of fire, but it is recognized that such separation of rooms from entrance hallway upon the first floor would be in some cases an objectionable interference with architectural effect and artistic furnishing. As fires are less likely to originate in the reception and living rooms than in other portions of a house, there would doubtless be occasional justification for open connection between such rooms and the entrance hallway, provided they are cut off from the kitchen, dining-room and other more hazardous parts of the house by incombustible partitions. It is very essential that all other portions of the house be separated from the main hallway by substantial fire-resistive partitions and doors.

4. Dwelling house fires most dangerous to life are those which occur in the cellar, basement, or first story. The smoke and heat ascend through all possible channels and always concentrate in the stairway if it is accessible. When such a fire happens at night and the occupants are asleep, the danger of the stairway being clogged with smoke or filled with flames before discovery is very great. When this occurs, if other means of exit from the upper floors is not provided, the only possible escape is by jumping from the windows. Many lives are lost in dwelling house fires annually from this cause and too much stress cannot be laid upon the extremity of the hazard and the necessity for removing it.

NOTE.—Experience has shown that people compelled to jump from a third or higher story of a building are almost invariably killed or dangerously injured. Death has frequently resulted from a jump from even a second story window, and serious injury, such as broken limbs are very likely to be received. Stone pavements and frozen ground are especially perilous.

5. This logically leads to a consideration of the second fundamental structural safety requirement, which will be discussed before methods of construction to overcome these defects are described.

Section 36. Necessity for Secondary Exits.

1. It must be recognized that the protection herein indicated for main stairways could not be efficient under all circumstances

and at all times. There would always be the possibility of fire within the stair hallway itself or in rooms not isolated from it, also in rooms supposed to be properly separated from the stairway but temporarily connected with it through a doorway accidentally left open. *For these reasons it is absolutely necessary that at least one additional means of safe exit be provided from the upper stories of every dwelling. In very large houses more than one may be necessary.*

2. The character of such exits is immaterial provided they will afford safe egress in an emergency. For most dwellings, the logical and natural solution of the problem is the introduction of an additional stairway. Such stairway is a great convenience in every house, and is especially desirable where servants are employed. Many houses have such back stairways, but when arranged as they frequently are, to connect on an upper landing with the entrance stairway and therefore are contained in the same hallway space, they have no value as emergency exits. A fire that rendered the entrance stairway useless would involve the rear stairway at the same time, and vice versa. Furthermore, rear stairways as ordinarily constructed and connected with the kitchen or other rear rooms where fire is liable to occur, constitute a distinct menace in that they afford a direct passageway for smoke and fire to all upper floors and the front stairway.

3. The remedy for these defects is to place the rear stairway in a separate fire-resistive enclosure, with doorway connection to the front stairway or hallway in each story above the first, and connect as many of the upper story rooms as possible with the rear stairway so that entrance to it could be gained without passing through the front stair hallway. This is the simplest and most desirable method of securing safe emergency exit, as it furnishes egress for the occupants of the upper story rooms by either stairway. It is important that such secondary stairway be provided with a door at the bottom.

Under some circumstances it would be acceptable to place the secondary stairway outside the building, but there are objections. If the stairway is of wood it adds to the outside exposure hazard; if of incombustible construction it is more or less expensive, and in either case it would not be ornamental. Such stairways should be enclosed, otherwise they might be dangerous to use in winter weather. Steel fire escapes consisting of balconies connected by steps may in some cases be permissible on existing buildings, but they are treacherous in bad weather and at no time suitable for the use of young children or infirm persons. They are also liable to be rendered useless by fire issuing from the window of a lower story. Outside stairways or fire escapes are also objectionable as offering possible entrance to un-

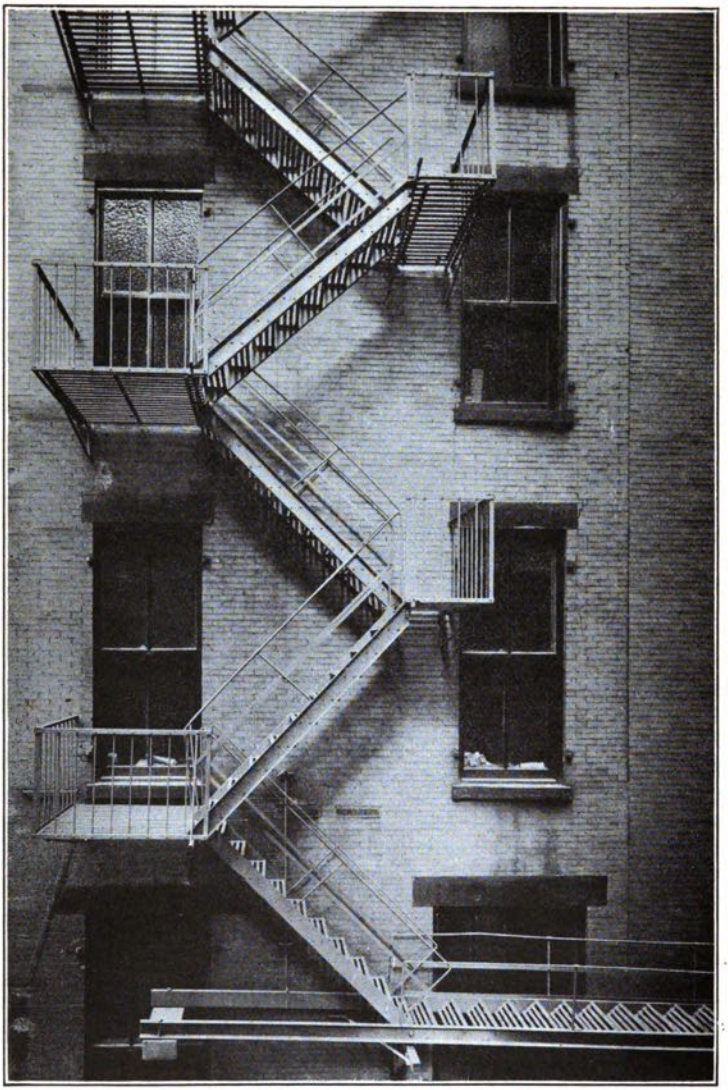


PLATE III.

A simple type of outside fireproof exit stairway or fire escape entirely supported by brackets, and suitable for either a new or an existing building. The balanced flight of stairs at the bottom could be replaced by a fixed flight if desired. An enclosed stairway would be better. The windows are wired glass in metal frames.

desirable callers. However, with all their faults outside stairways or fire escapes are a thousand times better than having no secondary means of egress. See Plate III.

4. Every dwelling over one story high, either new or old, and irrespective of size, should be provided with some second means of exit from the upper stories. It is particularly important where attic rooms are occupied. This is a matter for serious consideration. Think it over and adopt some plan to accomplish it.

5. In connection with the subject of safe egress from a dwelling it is proper to call attention to the "horizontal exit" as a means of escape from fire. This is described in Section 25, par. 5, in connection with fire walls. Another form of such exit may be used where dwellings are built in a row. Windows of upper stories of adjoining houses can be connected by a balcony which affords an excellent emergency exit around the party wall, but the obvious objections to such connection between houses occupied by different families would in most cases prevent its use.

Section 37. Structural Requirements for Protecting Stairways and Shafts.

1. Enclosure partitions for stairways in dwellings of Types I and II, as defined in Part I, should be entirely of fireproof construction.

Materials suitable for such construction would be brick, hollow tile, solid concrete, or concrete tile, gypsum blocks, cinder plaster blocks, solid metal lath and plaster, or hollow metal lath and plaster on steel studding, or any incombustible material or combination of incombustible materials forming a rigid partition and having fire-resistive qualities equivalent to those named. The thickness of such partitions should be not less than 3 inches. While in some cases a slightly less thickness might suffice, we consider that the additional stability and fire-resistance secured by the thicker material well warrant the small additional expense. All doors in such partitions should be of metal or metal covered, and in set frames of like material. It is highly desirable that such doors should be made self-closing, to insure their being always shut. In any case doors connecting the two stairways, or doors at the bottom of stairways, should always be shut at night.

It is also recommended that fire doors be used to protect entrances to the art gallery or valuable library which frequently is found in high class residences.

NOTE.—The Underwriters' Laboratories have tested and approved a wide variety of fire doors, many of which are as artistic in appearance as wooden doors. Lists of such doors can be obtained upon application.

2. In buildings of Types III and IV the stairway enclosure partitions should preferably be the same as for Types I and II, except that in some cases the weight of such construction might be objectionable. For this reason, and the fact that the wooden construction of these two types would offer less resistance to a fire, the thickness of the stair enclosure partitions in unpretentious dwellings might be reduced to 2 inches, though 3 inches is better and is advisable in elaborate dwellings. When such reduced thickness is used in tile or block construction, care must be exercised to insure perfect mortar joints; the corners should be held by metal clips or anchors, and the whole construction properly secured to floor and ceiling. It would also be permissible in such buildings to construct the partitions of wooden studding with metal lath and plaster, or its equivalent on each side. Under no circumstances should wooden lath be used. Such partitions carefully built will resist a hot fire for a considerable time, and the additional expense of the construction would be small. When hollow partitions are used, they should be fire-stopped at each floor level as prescribed in Part VIII, and the whole surface of the wall on each side from floor to ceiling should be plastered before the base-board or other trim is applied. Incombustible lath is recommended in all parts of wooden constructed buildings when the extra expense can be afforded.

3. In moderate priced dwellings of Types III and IV, where the additional expense of approved fire doors in the stair enclosure partitions would prevent their use, substantial wooden doors without sunken panels may be substituted. A panel effect on such doors is obtained by application of surface mouldings. The doors should be selected for the purpose, be extra heavy and especially well made. Such wooden doors will of course burn, and therefore are not the equivalent of fire doors, but they would prevent the passage of flame and smoke for a short time, and therefore protect life and property for a limited period. The same precautions regarding closing the doors should be observed as specified in paragraph 1. Such doors if open at time of a fire would add fuel to the blaze instead of retarding it.

4. So far as possible windows or fan lights in stair enclosure partitions should be excluded. If glass is really necessary it should be wired in fixed metal frames and sash, or ¼-inch plate glass will serve.

NOTE.—Fixed frames and sash are necessary to prevent possibility of the window being open at time of a fire and so nullify its value.

Ordinary glass either thick or thin, breaks and falls from the sash very quickly when attacked by fire. It is self-evident that if openings were thus formed in such a partition its value would immediately be lost. Wired glass or plate glass in metal frames will stay in place until the glass melts, and it requires a severe fire to do that.

Wired glass will also stay in place even though water be thrown upon it while hot, but will not withstand the full force of a fire engine stream. Plate glass is likely to fall out if sprayed by water when hot. Neither glass will prevent heat being radiated through it, hence there is always danger that combustible material, even though some distance away from the opposite side of the glass may be ignited from this cause.

5. Stairways leading to cellar or basement should be completely enclosed in such story the same as in the upper stories, and should be protected by a fire door at the bottom. This is very important, for there is always great danger of a fire starting in the lower story and passing to the upper stories by this channel. Cellar fires are always difficult to subdue because of their inaccessibility, therefore every precaution should be taken to confine them there. Avoid glass in a partition enclosing the stairway, or in the fire door. If a window is necessary for light, put it in the outside wall if the stairway follows the wall, otherwise use wired glass in fixed metal frame.

If a stairway leading directly from the cellar into the house can be avoided it is safer. This is often accomplished by making a side enclosure or entry surrounding the kitchen door, utilizing one end for the refrigerator and the other for a stairway leading to the cellar. It is a convenient arrangement and permits entrance to the cellar without going out of doors.

6. Passenger elevators, if placed in dwellings, should be enclosed with the same construction as required for stairway enclosures, including the doors. Dumbwaiter shafts should also be similarly enclosed and have self-closing fire doors at all openings. In buildings not exceeding three stories in height the thickness of the enclosing material may with propriety be reduced to 2 inches. The same precaution should be taken regarding joints and corners as specified in paragraph 2. Shafts which extend into a cellar or basement should be enclosed in that story with walls not less than 3 inches thick, and have substantial self-closing fire doors. This is a seat of danger, and great care should be exercised to prevent a fire being distributed upward through the house by the shaft serving as a flue. For this reason masonry walls are usually specified in building codes for enclosing shafts in such locations, and are to be recommended.

7. Care must be taken to protect in like manner any other shafts or chutes connecting different floors, such as linen chutes, elevator fuel supply boxes, and similar devices. They should be avoided so far as possible, for unless very carefully protected by fire-resistive material, they are sure to act as flues for the quick distribution of a fire.

NOTE.—Such devices can be made safe, but it is somewhat expensive to do so; as a matter of fact they very seldom are safe. It is better to omit them.

Section 38. Horizontal Cut-Off for Cellars.

1. As the heating equipment of most dwellings is located in the cellar or basement, where subject only to occasional supervision; and as that space is also usually a storeroom for fuel and all sorts of combustible material, the chances of a fire are evident. There is also the additional hazard of defective lighting appliances in such location, either from improperly protected fixtures or in the use of lamps, candles or matches. Be the cause what it may, whether an overheated furnace which being "out of sight is out of mind"; or carelessness in handling lights or matches; or possibly spontaneous combustion in rubbish; the fact remains that records show an excessive number of cellar fires. As such fires frequently attain considerable headway before discovery, they are liable to involve the whole house by working upward through all open connections, and the many small hidden channels due to ignorant design or defective workmanship, whose existence are unknown to the occupants. The remedy is to confine such fires at the place of origin by a cut-off between the cellar and the story above by making the separating floor as fire-resistive as possible consistent with the type of construction, and to properly protect all openings through same as herein provided.

2. The best possible cut-off is a fireproof floor. Such floors are a requisite for dwellings of Types I and II. They are equally applicable to dwellings of Type III, and to the highest grade buildings of Type IV, such as are often seen in city suburbs and on country estates. They should be used wherever possible, for they constitute a distinct safeguard. Such floors may be constructed of steel I beams with stone or cinder concrete, hollow tile, or other approved fireproofing between them with suitable protection for the bottom of the beams; or steel beams may be omitted, and the floor be constructed entirely of reinforced concrete: or a composite construction of reinforced concrete beams filled between with hollow tile, or metal or plaster forms with a concrete covering may be employed.

3. In buildings where steel beams are not otherwise used, it is probable that some variety of concrete floor construction would be the simplest and most economical. The forms could be easily supported, no hoisting of concrete would be necessary, and as the floor would be laid before the rest of the builidng was erected, all the form lumber could be used again for other purposes. In order to reduce the span and thickness of the floor slab, and thereby lessen the expense, the floor could be divided into panels by having beam supports at one or more intervals. A steel beam would be best suited to the purpose, but even a heavy wooden girder resting on brick piers, pipe-concrete columns, or substantial wooden posts, might be permissible if necessary.

4. Reliable building constructors state that such concrete floors can be built in most localities at practically the same price as first class wooden construction. Owing to the fact that the fireprcof floor is also waterproof, vermin proof, and thoroughly rigid, it would justify increased cost. If desired, a wooden finish flooring may be laid over the concrete. See Section 29, par. 2. The supporting beams under the floor, whether steel or wood, must be protected; the former by 2 inches of fireproofing, and the latter by at least ½ inch of metal lath and plaster, plaster board, or ¼ inch asbestos mill board.

NOTE 1.—An unprotected steel beam when attacked by fire is not as reliable as a wooden beam. The reason is that steel loses its strength very rapidly when heated in excess of 500 to 600 degrees F., and such temperatures are easily attained in an ordinary fire. On the other hand a wooden beam of large cross section would burn fiercely over its whole surface, but the actual rate of penetration would be slow, consequently considerable time would be required for the beam to burn sufficiently to produce collapse even in a hot fire. This fact indicates the necessity for protecting steel beams, but does not warrant the substitution of wooden beams for steel. Other considerations may at times justify the use of timber construction instead of steel work, but unless protected by sprinklers, or covered with some non-flammable material it adds to the fire hazard in the room in which it is exposed. If necessary to use a heavy wooden beam in a cellar as above suggested, it is recommended that if not protected by sprinklers, it be covered with metal lath and plaster, or with asbestos or plaster board. For sprinkler suggestions see Section 74.

NOTE 2.—For the reason herein explained, it is necessary that all metal structural members used in dwelling house construction should be fully encased in fireproof material the same as would be required in other buildings.

5. In dwellings of Type III, where it may be impossible to secure the high degree of protection afforded by a fireproof floor for a cellar cut-off—also in frame dwellings of a grade which would not warrant the expense of such a floor—it is still very essential that efficient temporary protection be provided, and that every precaution be taken to prevent a cellar fire spreading to floors above, at least long enough to afford reasonable time to subdue it. This can be accomplished by protecting all communicating openings as elsewhere provided, and by covering the ceiling with fire-resistive material.

6. A high grade fire-resistive ceiling construction is one with about 2 inches of mineral wool, gypsum block, magnesia block, or other non-combustible fibrous material securely attached to the joists for sound deadening or heat insulating purposes before the application of metal lath and plaster. There are firms which specialize in such construction.

In pretentious dwellings, where large boilers are necessary in the heating plant, substantial hanging ceilings are sometimes employed to insulate the floor above and prevent its becoming unpleasantly warm. An efficient type of such ceiling is a light

steel framework supporting magnesia blocks about 1½ inches thick and covered with a layer of metal lath and plaster. Such construction under a wooden floor is a superior fire-barrier, provided no openings communicate with the air space between the hanging ceiling and the floor joists. If such space were not thoroughly cut off, a fire would get in and burn behind the ceiling, and the construction would be a distinct disadvantage. No woodwork should be allowed in the construction of the hanging ceiling.

NOTE.—A floor deadened with incombustible material placed between the rough and finished flooring as is frequently done, is of little value as a fire-stop. Even though the deadening material is 2 inches thick as sometimes specified, it would leave the joists and under flooring free to burn, and would offer no opposition to the fire until the under flooring were burned through.

7. An excellent ceiling protection is obtained by first applying double layers of ¼ inch fibrous asbestos mill board securely nailed to the joists, and laid with broken joints; then cover this with metal lath and a coat of asbestos plaster which will give a smooth, attractive surface. Instead of metal lath and plaster, a covering of sheet metal over the mill board would give good fire-resistance, except that any wooden furring strips would be objectionable. If the lath and plaster or metal covering be omitted, the ceiling protection will still be quite satisfactory, though not so strong nor so pleasing in appearance. In this case all joints should be filled with asbestos cement.

NOTE.—Use large nails (not less than 2 inches long) to attach the mill board to the joists. The reason for this is explained in paragraph 8. Screws would be far superior to nails for the outside layer, though their use would increase the labor somewhat. The screws should be 1½ inches long and spaced on about 8 inch centers.

8. The minimum ceiling protection is a galvanized metal lath not less than No. 24 gauge, covered with ¾ inch asbestos or cement plaster; or the joists may be covered with strong plaster board not less than ½ inch thick (fibre plaster board preferred), and coated with ¼ inch of gypsum plaster; or the plaster board may be covered with sheet metal. If sheet metal covering be used, the joints between the sheets of plaster board must be first filled with plaster to form a smooth surface with no wood exposed. If the joist spacing is such that the sheet metal can be laid parallel to direction of joists and lap upon them, it is advisable to do so. For convenience in nailing, the location of joists should be marked on the plaster board as it is laid. Heavy nails, not less than 2 inches long, should be used to attach the metal, with a spacing not exceeding 4 inches. When it is neces-

sary to place furring strips on the plaster board to support the sheet metal, it would be useless to use nails longer than would penetrate the strips, but care should be taken to use heavy nails wherever possible to hit a joist. Warping of the metal when attacked by fire, and charring of the wood around the red hot nails, will cause small nails to pull out and allow the metal to fall. For the same reasons metal lath should be attached with long heavy staples or nails. Metal ceilings are not advised in cellars or basements, which are liable to be damp when the heating equipment is out of commission. Corrosion may make them worthless in time.

NOTE.—A metal ceiling without plaster board or other non-conducting backing is not suitable for any place where considerable fire-resistance is desired. The sheet metal alone, when attacked by fire quickly becomes red hot and will ignite woodwork to which it is attached. It is for this reason that combustible furring strips should be omitted wherever possible between plaster board or other backing and the metal covering.

Section 39. Window Protection.

1. When two portions of a dwelling are placed at right angles to each other, the windows in the angle should be kept as far apart as possible to avoid a fire jumping through them from one wing to the other.

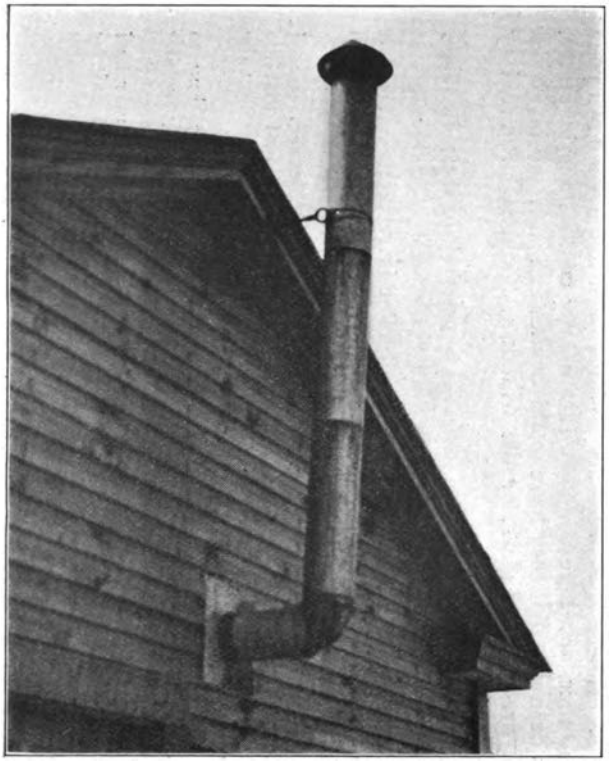
2. Where it is necessary to have such angle windows near each other, or where windows face nearby combustible buildings, it is desirable that they have metal frames and sash and be glazed with fire-resisting glass, or the windows should be protected by fire-shutters.

NOTE.—Such construction might not be practical for cheap dwellings, but the extra cost would be quite justified in expensive dwellings.

3. In dwellings of Types I and II it is recommended that all exterior window openings be protected by metal frames and sash, of which the upper half shall be glazed with wired glass.

NOTE 1.—Such glass can be had in polished plate if desired. Wired glass in the lower sash is sometimes objected to on the ground that the wire interferes with vision, but experience does not appear to sustain the criticism.

NOTE 2.—There is always a tendency for a fire in a building to travel upward from story to story by way of the windows. By making the frame and sash incombustible, and providing wired glass in the upper half, flames in a room, even though they caused collapse of the lower half window, would mushroom against the ceiling and could only get exit by passing downward through the lower sash. This would separate them from the windows above and add materially to the protection.



Two forms of cheap chimney construction frequently seen. When in use, each flue in a constant fire menance. Burning of the house in Fig. 2 would seriously endanger its numerous nearby neighbors, and possibly start a conflagration. These examples were found in well-known Eastern cities. There should be a severe penalty for such carelessness.

Unpardonable Substitutes for Chimneys.

PART VI.

CHIMNEYS, FLUES, SMOKEPIPES AND FIREPLACES.

Section 40. Defective Chimneys.

1. The worst single cause of fires in every State in the Union is the defective chimney, including flues and stovepipe connections. The combination of defective chimney flues and wooden shingle roofs is the most prolific of all known causes of fires. Statistics show that on an average over one-fifth of all dwelling house fire losses are due to these causes, and in some States the ratio is as high as one-third. For reasons explained in Section 6, a large proportion of dwelling house fires approximate a total loss. *Proper chimney construction is therefore the one most important structural feature in reducing the chances of fire.*

2. The reasons why chimneys are such a fruitful source of fires are numerous; the following are the principal ones:

(a) Use of terra cotta sewer pipe, or other unprotected tile or hollow blocks, for a chimney.

(b) Construction of chimneys with brick laid on edge.

(c) Chimney walls built with brick flatwise, but only one brick thick and flues unlined.

(d) Supporting chimney on the timber construction of a building, or brackets; or insufficient masonry foundation when the chimney rests on the ground.

(e) Two or more connections to a single flue.

(f) Building woodwork into the wall of chimney, or placing it in contact with the exterior surface.

(g) Smokepipes arranged to enter chimney in vertical run.

(h) Carelessness in sealing connection between smokepipe and chimney, and failure to anchor pipe to chimney.

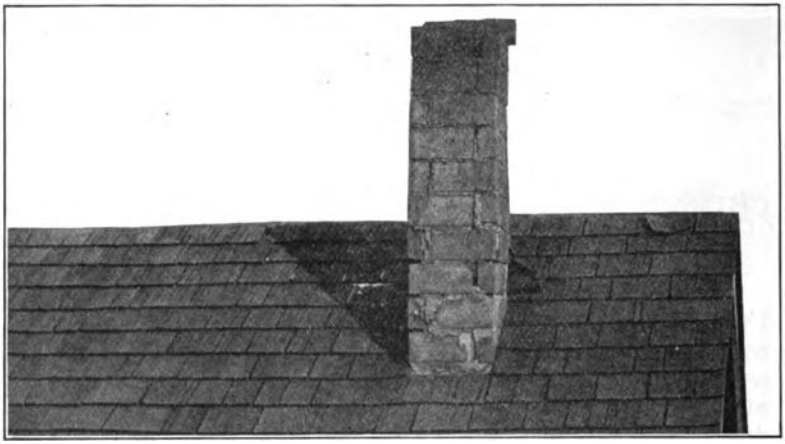
(i) Carelessness in not renewing smokepipe which has rusted out where it connects with chimney, also in allowing combustible material too near the pipe.

(j) Carelessness in not keeping chimney clean and joints in brickwork properly pointed.

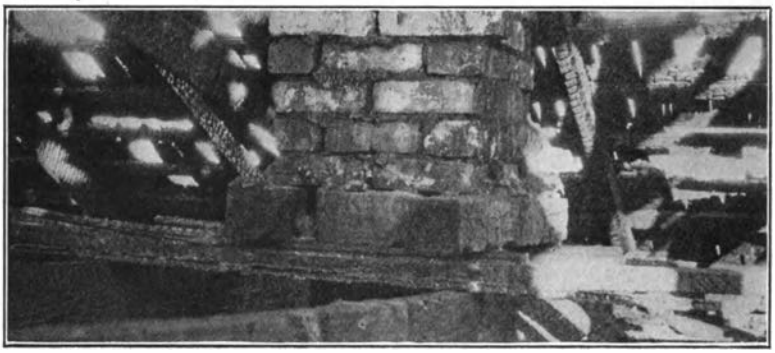
3. A considerable part of the chimney hazard is due to carelessness, and the balance to bad construction; nevertheless, if chimneys are properly built, nearly the whole hazard would disappear. Therefore the importance of proper construction and maintenance of chimneys cannot be emphasized too strongly.

Section 41. Construction of Chimneys and Flues.

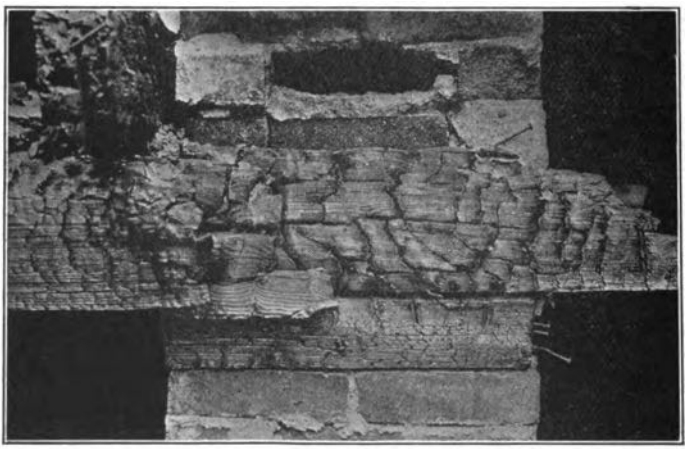
1. The use of sewer tile or other clay or concrete tubes for a chimney is dangerous in the extreme. They are very liable



Chimney built with brick-on-edge and unlined. Roof in contact. Cracks in chimney under the roof, same as appear above it. The hazard is apparent.



Chimney on wooden supports in a garret space. Walls one brick thick unlined. White spots are caused by sunlight through holes in the partially burned roof.



Courtesy of N. F. P. A. Quarterly.

Chimney one brick thick unlined. Floor construction built into chimney wall. Floor timbers also in contact with it. Vibration loosened brick and caused fire.

Three Object Lessons in Dangerous Chimney Construction.

to crack due to unequal expansion, thus permitting the escape of sparks and hot gases, which will ignite woodwork or other combustible material near them.

2. Building chimneys with brick on edge is a practice all too common in some parts of the South and Middle West. It is very little if any better than the unprotected tile chimney, and is vigorously condemned.

3. The walls of chimneys used for stoves, ranges, fireplaces, heating furnaces, or other heating appliances, whether the fuel used be wood, coal, oil or gas, shall be built of brick, concrete, stone, or hollow tile of such thickness and construction as is hereafter specified. All chimneys, irrespective of which materials the walls are built, shall be lined with fire clay flue lining or with fire brick. The lining shall be made for the purpose and adapted to withstand high temperatures and the resultant gases from burning fuel. Other varieties are liable to crack and have pieces fall into the chimney, thus opening the possibility of exposing defective mortar joints in the brickwork with consequent danger.

NOTE.—The lining of chimney flues is very important, for it prevents the disintegration of mortar and bricks due to flue gases and temperature expansion. The omission of lining is a serious defect in old chimneys, and the cause of numberless fires.

4. Solid brick or concrete chimney walls shall be not less than 4 inches thick exclusive of flue linings. A standard size brick laid flatwise shall be deemed to fulfill this requirement for brick.

NOTE.—For exterior chimneys, or chimneys having any wall exposed to the weather, it is recommended that all such exposed walls be not less than 8 inches thick. This additional thickness will produce a more uniform temperature in the flue, thereby greatly improving the draft, which will result in fuel economy and a lessening of smoke annoyance.

5. Concrete chimneys cast in place shall be reinforced vertically and horizontally to avoid cracks liable to occur from temperature stresses or unequal settlement of foundations. The metal shall be thoroughly embedded in the concrete.

6. Concrete blocks should not be used for chimney construction unless they contain substantial steel reinforcement running continuously around the blocks with the shell of the blocks not less than 4 inches thick, and the chimney continuously lined with best quality flue lining the same as a brick chimney.

NOTE.—The use of ordinary concrete blocks in chimney construction is not recommended. While it is recognized that blocks suitable for this use are made by some manufacturers, it is also an unfortunate fact that the majority of this product used in construction of chimneys is unsuited to the purpose. Such blocks are liable to be carelessly made; often have defective mixture; frequently the materials are poor; and usually the curing is improperly done.

Aside from these defects of manufacture, the blocks are generally less than the minimum 4 inch thickness. In view of these well known facts, extreme care should be exercised in the selection and use of concrete blocks for chimney building. Owing to the large size of each block, especially if there be more than one flue in a chimney, the danger of cracking due to uneven settlement of foundation is increased even though the blocks be of good quality. This justifies the requirement for reinforcement.

7. Stone chimneys shall be at least 4 inches thicker than required for corresponding brick or reinforced concrete chimneys, and shall have flue linings the same as for brick chimneys. Rubble stone chimney walls shall be not less than 12 inches thick.

8. Hollow tile shall not be used for the walls of isolated or independent chimneys, but it may be used for chimneys built in connection with exterior hollow tile walls of buildings not exceeding three stories in height, in which case the chimney walls shall be not less than 8 inches thick. The outer 8 inches of a building wall may serve as the outside wall of the chimney, but the remaining chimney walls shall be constructed of two layers of 4-inch tile set with broken joints; or they may be built of 4 inches of solid brickwork. The side walls of the chimney shall be securely bonded into the wall of the building. No chimney shall be corbeled from a hollow tile wall.

9. A chimney shall never rest upon or be carried by wooden floors, beams, or brackets, or hung from wooden rafters. In frame buildings chimneys shall always be built from the ground up, or rest on basement walls.

NOTE.—Wooden construction is certain to shrink, and beams carrying heavy loads always deflect in time even though they may support the load without sign of distress when first applied. Settlement is sure to occur, and such movement not only injures the wall and ceilings of the house, but is very liable to crack the chimney and render it dangerous. Such chimneys are always several feet in height above the roof, thus offering considerable surface exposure, and owing to their unstable support they will sway in a heavy wind. This also tends to produce open joints at the roof line, which is a most hazardous place for sparks to issue as they come directly in contact with the woodwork.

10. Do not support chimneys on iron brackets or stirrups attached to wooden construction however carefully devised. This practice is not uncommon, but is hazardous for reasons explained above. Furthermore, a small fire around the base, from any cause, may drop the chimney and form a draft for rapid spread of fire.

NOTE.—It is well known that steel begins to lose its strength at about 500 degrees Fahr., and at 1,000 degrees Fahr. approximately 50 to 70 per cent. of its strength is gone. Such temperatures are produced in an ordinary fire, and if maintained even for a short time are almost sure to produce collapse of exposed steel structural members.

11. When a chimney is to be cut off below, in whole or in part, it should be wholly supported by brick or stone work, or steel construction, properly erected from the ground up.

Piers which support chimneys shall start from the foundation on the same line with the chimney breast. They shall be not less than 12 inches on the face and shall be properly bonded into the walls.

12. Chimneys shall be built upon concrete or masonry foundations properly proportioned to carry the weight imposed without danger of settlement or cracking. Foundations shall be at least 12 inches wider on all sides than the area of the chimney. The foundation for an exterior chimney shall start below the frost line.

13. The walls of brick buildings may form part of a chimney, but the side walls of the chimney shall be securely bonded into the walls of the building.

No walls less than 12 inches thick shall be used to support a corbeled chimney; such corbeling shall not project more than 6 inches from the face of the wall, and in all such cases the corbeling shall consist of at least five courses of brick. Flues in party walls shall not extend beyond the center of the walls, and their location shall be permanently indicated on the exposed side of the wall.

14. All mortar used in chimney construction, except as specified for fire brick in paragraph 20, shall be cement mortar proportioned as follows: Two bags of Portland cement, 200 pounds, and one bag of dry hydrated lime, 50 pounds, thoroughly mixed dry. To this mixture shall be added three times its volume of clean sharp sand with sufficient water to produce proper consistency. When dry hydrated lime is not available 1 cubic foot of completely slaked lime putty may be substituted for 50 pounds of dry hydrate. In case of such substitution, the mixing of lime and cement shall be very thorough. Dry hydrate should always be used in preference to putty.

NOTE.—Portland cement mortar as above specified is superior to lime mortar in resisting the action of heat and flue gases. The latter disintegrates in time, and is liable to fall out of the joints, thus producing a hole which will lessen the draft, and through which a fire is liable to originate. Some building laws specify that cement mortar need only be used for the foundation of a chimney and the portion exposed to the weather above the roof. This is unwise; for reasons stated above, the whole chimney should be built with cement mortar. Cement is much cheaper to-day than when such specifications were originally written, and considering the small amount of mortar necessary to build a chimney, the difference in cost between cement mortar and ordinary lime mortar is of small account compared with the superiority of the former.

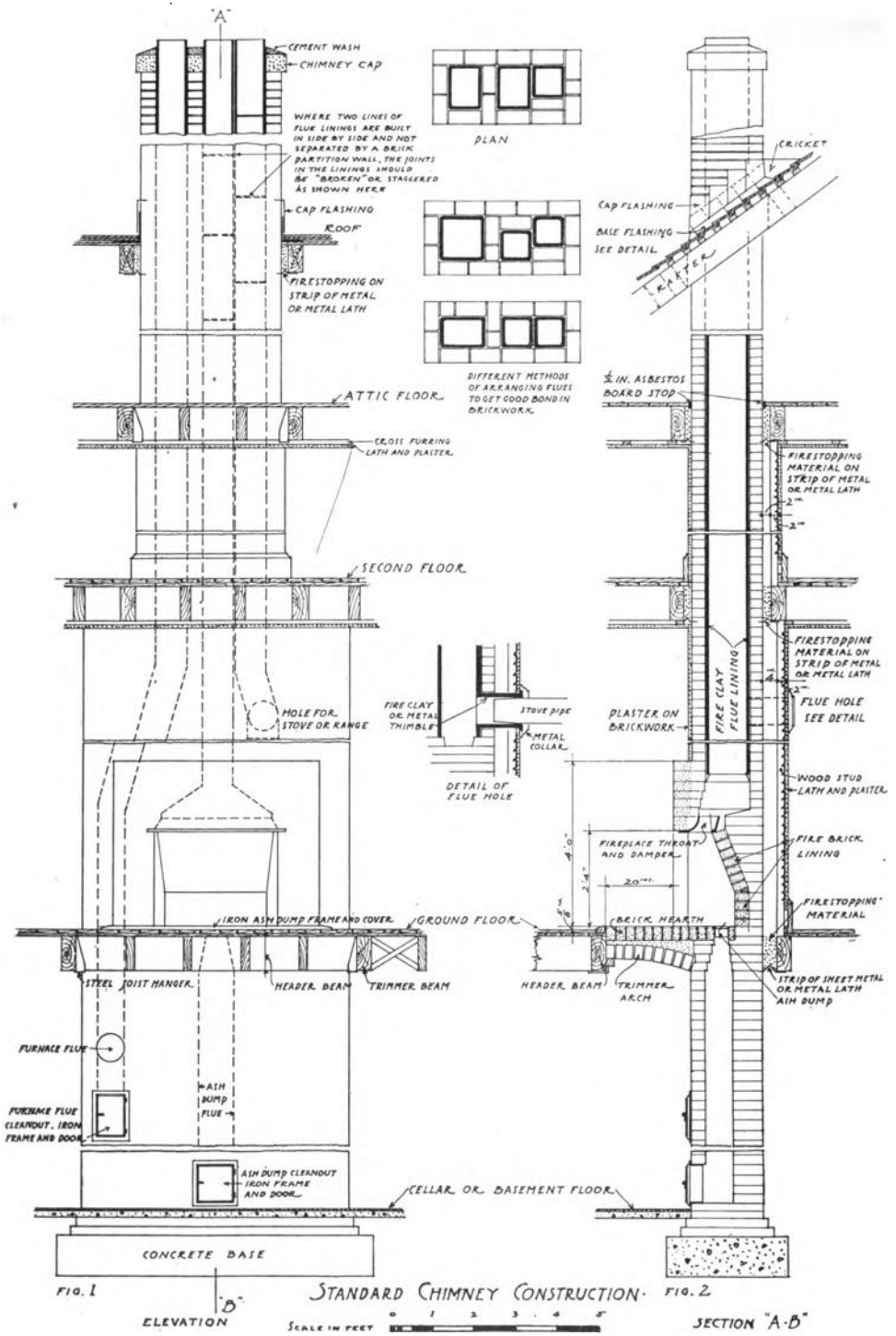


PLATE IV.

Elevation and section of an interior independent chimney showing recommended construction. Extra flues can be added as desired.

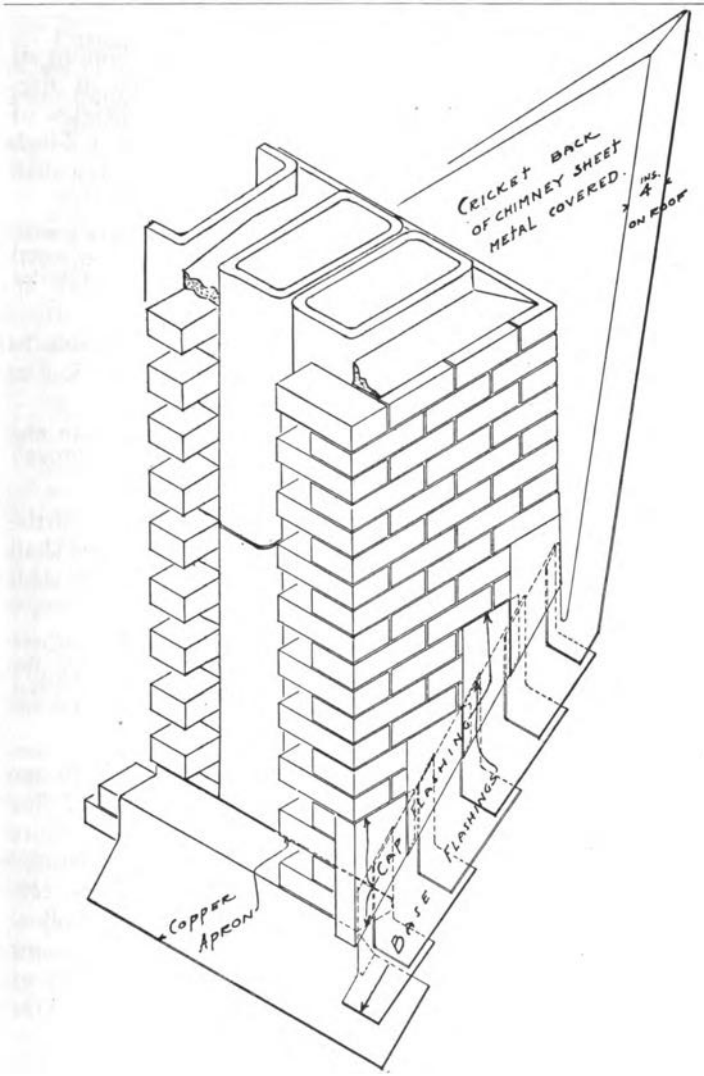


PLATE V.

Details of chimney construction showing method of flashing at roof surface. See Plate IV.

15. Fire clay flue linings shall be of standard commercial thickness, but not less than ¾-inch, and without collars. The flue sections shall be set in mortar of quality above specified and shall have the joints struck smooth on the inside. The masonry shall be built around each section of lining as it is placed, and all spaces between masonry and linings shall be filled with mortar.

Flue linings shall start at least 4 inches below the bottom of the smoke pipe intakes of flues, or from the throats of fireplaces and shall be carried up continuously the entire heights of the flues, and 4 inches above top cappings to allow for a 2-inch wash and a 2-inch projection of lining. The wash or splay shall be formed of a rich cement mortar. See Plates IV and V.

NOTE.—Rectangular linings fill the flue space better and make it easy to fill voids with mortar, thus producing a strong chimney; but a round flue is somewhat easier to clean, and some claim that it gives a better draft. However, the rectangular form is commonly used.

16. Flues should be built as nearly vertical as possible to secure the best draft, and there should be but one connection to a flue.

NOTE.—Fires are constantly occurring from having more than one connection to the same flue, the sparks passing from one opening through another.

17. Where flues change direction, the abutting linings at the angle joints shall be chipped to fit closely, and at no point shall the cross section area be reduced. No broken flue lining shall be used.

NOTE.—Masons are often careless about lining the flue even where the specifications call for it, and are apt to omit it until they get to the straight part of the flue. This makes the flue dangerous at its hottest point. Watch chimney construction carefully, and see that details recommended are not ignored by the mason.

18. Not more than two flues shall be permitted in the same chimney space, and the joints of any two adjoining sets of flue linings shall be offset at least 7 inches. When there are more than two flues in a chimney, each third flue shall be separated from the others by a withe or division wall of brick or concrete at least 4 inches thick and bonded into the sidewalls. In hollow tile chimneys, the withe may be of tile. A withe is necessary to insure stability of the chimney. It also prevents possibility of a fire in one flue involving both the others. See Plate IV for details of proper chimney construction.

It is recommended that the flue intended for the heating plant, or other large flue connected to a fireplace, be separated from other flues by a 4-inch withe. This will assist in securing a uniform temperature in the flue which greatly promotes good draft.

19. When coal, wood or oil is used for fuel the minimum area inside of flue lining for furnaces or fireplaces should be not less than 75 square inches; for stoves and ranges 49 square inches, and for small gas stoves or heaters 10 square inches.

Furnace and fireplace flues should be not less than 96 square inches in area, and for the latter 144 square inches would be a better minimum; greater areas are often necessary.

NOTE.—A generous sized chimney produces a better draft; a poor draft is a great annoyance and is difficult to remedy after a chimney is built.

20. When any single flue area within chimney walls exceeds 200 square inches, the walls shall be built not less than 8 inches thick and shall have fire clay flue lining as previously specified, but when flues become so large as to render it impractical to secure fire clay flue lining, they shall be lined with fire brick for a distance of at least 25 feet from the point of intake. The fire brick shall be laid in fire clay mortar with joints struck smooth.

No parging mortar or plaster should be permitted on the inside of chimneys.

NOTE.—The plastering is liable to fall under the influence of heat and weather, and not only choke the flue, but tear out the mortar between the joints of the bricks.

21. Build all chimneys to a point at least 4 feet above flat roofs, and 3 feet above the ridge of peak roofs, and provide a proper capping of stone, terra cotta, concrete or cast iron.

22. Under no circumstances shall the brickwork of the chimney be extended out over the roof by the projection of the course of brick nearest to it.

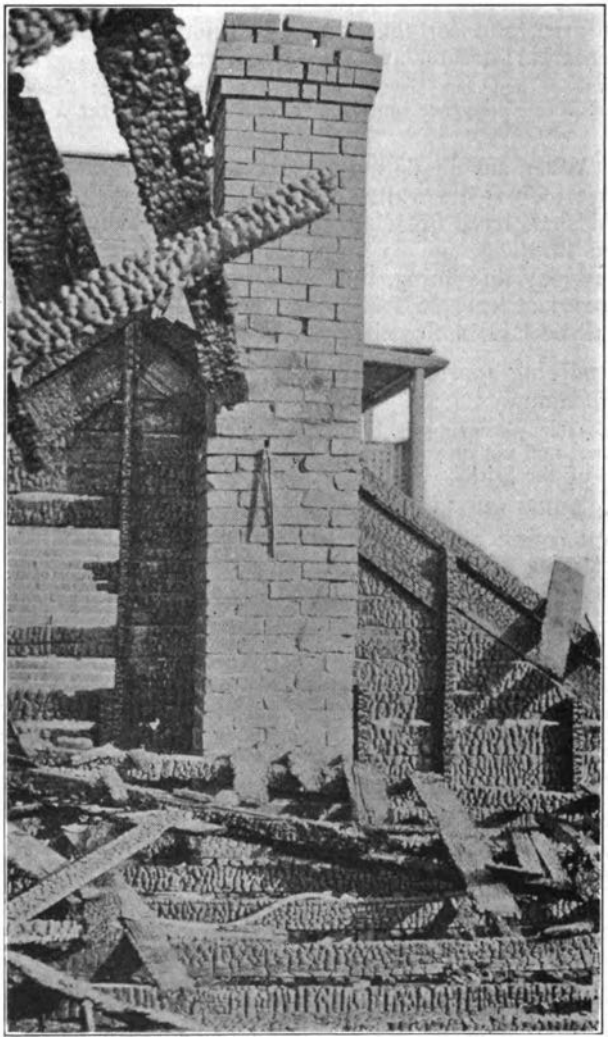
NOTE.—Such overhanging projection or shoulder will inevitably cause cracks in the chimney in case the chimney settles; the roof in such event lifting the upper portion of the chimney by means of the overhang or shoulder and causing a crack at the most dangerous of all places.

23. Any increase in the wall thicknesses of chimneys should be made at least 12 inches below the rafters, and not be made above the roofs except for cappings.

24. Connection between chimney and roof shall be made with sheet metal flashing, arranged to overlap and allow for movement that may occur between chimney and roof. See Plates IV and V.

NOTE.—Copper is the best metal to use. It costs but little more than tin or sheet iron, and will be permanent, whereas the latter will rust out and it is difficult to replace a flashing after it has failed. Zinc resists corrosion well, but melts easily, so in case of fire it would quickly disappear leaving a draft opening around the chimney, thus contributing to the spread of the fire. For the same reason lead should not be used.

25. Smokepipe intakes to flues shall always enter the chimney through the side and shall be made of fire clay or metal thimbles securely set in the chimney wall with mortar, or be cast in concrete. Such openings should be at least 18 inches below wooden lath and plaster or other combustible ceilings, or open joists. See detail sketch, Plate IV.



The fire probably started from sparks through the open mortar joint near the roof line indicated by the camera tripod. Note the open joints at the top, also that the wooden roof construction was in contact with the chimney—no metal flashing having been used.

There are hundreds of thousands of such chimneys in the United States. Is it any wonder they produce over 20,000 fires per year?

A Typical Unlined Defective Chimney.

A beautiful house with brick walls, properly constructed chimneys, and attractive but dangerous wooden shingle roof.
A Very Unwise Combination.

26. All flues leading from cellars or basements shall have proper cleanout doors below the smoke intakes.

27. After a chimney has been completed, all flues shall be thoroughly cleaned and left smooth on the inside.

28. All chimney flues should be subjected to a smoke test before acceptance, but the test shall not be made until the mortar is thoroughly hardened. The method of test is to build a small smudge fire of damp wood or other dense smoke-producing material in the base of the chimney or in the furnace, fireplace, or other heating appliance attached to the flue under test, and after the smoke is flowing freely from the flue close it tightly at the top. Escape of smoke into other flues or through the chimney walls indicates openings which shall be made tight before the chimney is accepted. Each flue should be separately tested.

NOTE 1.—Be sure there is water in a steam or hot water heating boiler before you start any fire under it.

NOTE 2.—For methods of repairing old chimneys, see Section 71.

Section 42. Woodwork Around Chimney.

1. No wooden beams, joists, or rafters shall be placed within 2 inches of the outside face of chimneys, whether the same be for smoke, air or any other purpose. No woodwork shall be placed within 4 inches of the back wall of any fireplace. See Plate VI, Fig. 2, and Plate VII, Fig. 4.

2. All spaces between chimneys and wooden joists or beams shall be filled with loose cinders, loose mortar refuse, gypsum block or other porous incombustible materials to form a fire-stop. See Plates IV, VI and VII.

The incombustible material shall be supported by strips of sheet metal or metal lath set into the brickwork and nailed to the wooden beams, forming a buckled flexible joint between, as indicated in Plate IV; or flat metal nailed to the woodwork with the inner edge close to the chimney will serve the purpose. See Plate VIII.

NOTE 1.—If the ceiling below is not to be plastered, and metal lath is used to support the filling, it is best to cover the lath with a layer of mortar before filling. This will prevent annoyance from possible sifting, and at same time improve the fire-stop.

NOTE 2.—The filling of dead air spaces around a chimney before the flooring is laid, is to form a fire-stop, and prevent an accumulation of shavings and other combustible material in them; also to avoid the danger of mice building nests there. The filling material should be porous, thus preserving the heat insulating advantage of the air cells; consequently brickwork, mortar, or solid concrete, should not be used.

3. The header joist or beam, carrying the tail joists of a floor and supporting a trimmer arch in front of a fireplace, shall be not less than 20 inches from the chimney breast.

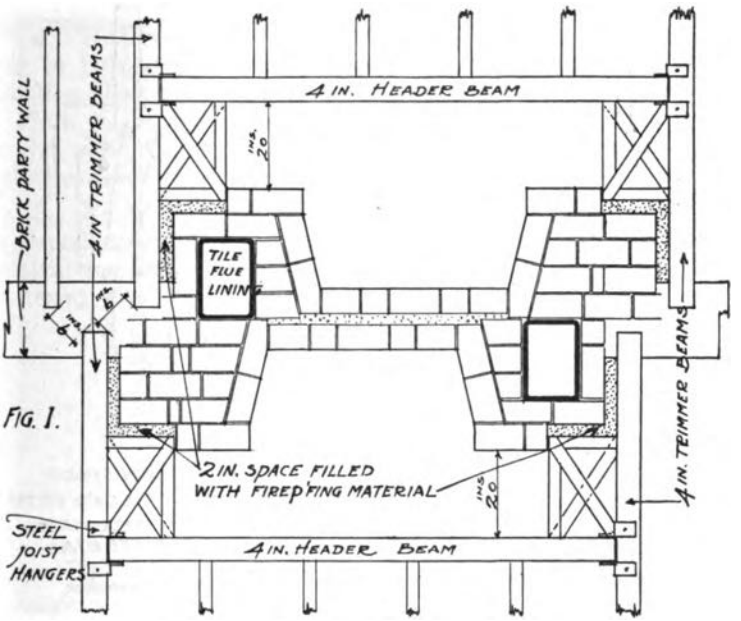


FIG. 1.

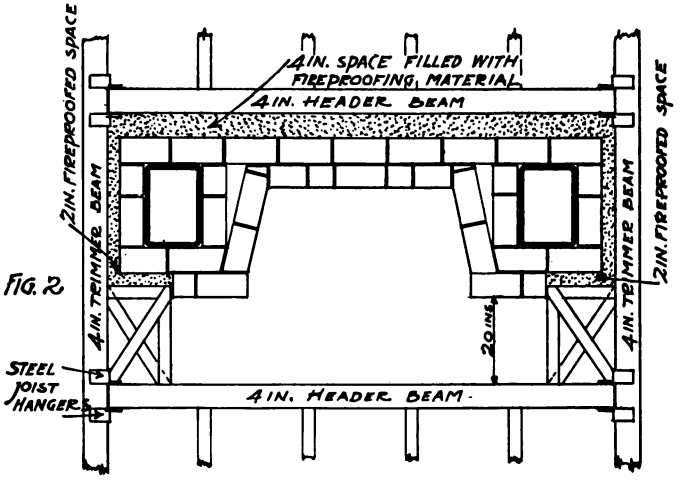


FIG. 2.

PLATE VI.

Fig. 1.—Method for building two fireplaces back-to-back in a brick party wall to secure proper spacing between ends of floor joists.

Fig. 2.—Floor framing around a single fireplace. Note filling between framing and brickwork, which serves both as insulator and fire-stop.

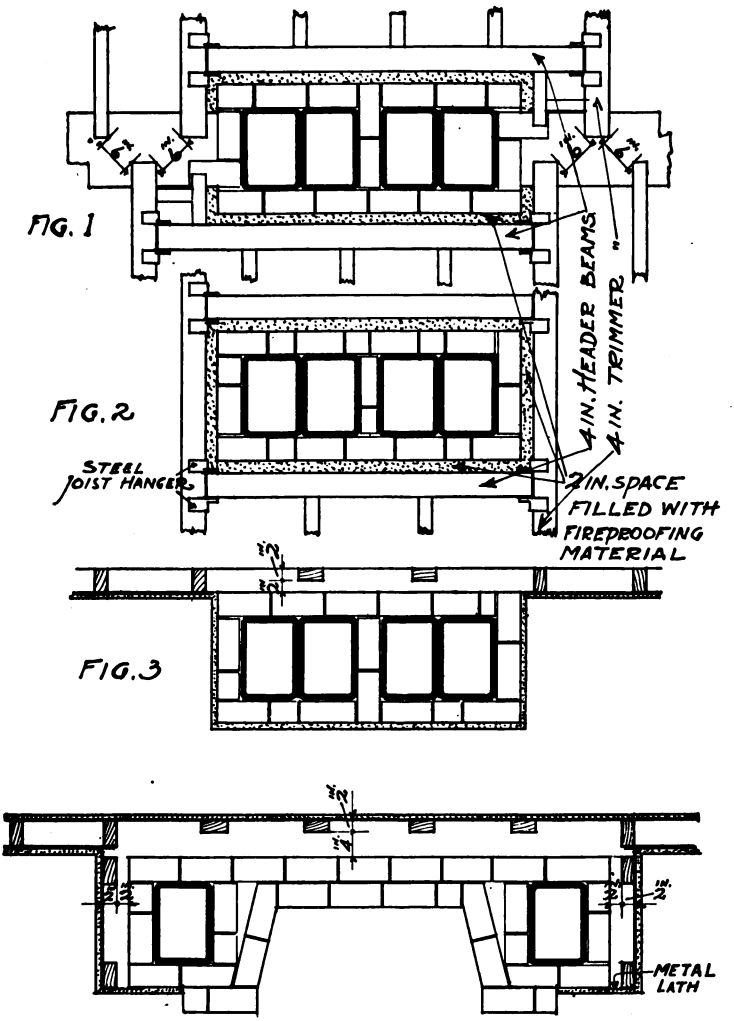


PLATE VII.

Fig. 1.—Floor framing around chimney in a party wall, to secure proper space between ends of floor joists.

Fig. 2.—Ordinary floor framing around a chimney. All timbers 2 inches clear of brickwork and space filled with fireproofing material.

Fig. 3.—Stud partition across back of a chimney showing proper method of arranging studs.

Fig. 4.—Stud partition across back of a fireplace and around the ends of the chimney breast, showing proper arrangement of studs. Method of fire-stopping this space is shown on chimney section, Plate IV, also in Fig. 2, Plate VI.

4. Under no circumstances shall wooden studding, furring, or lathing be placed against any chimney; the wooden construction shall either be set back from the chimney as indicated in Plate VII, Figs. 3 and 4, or the plastering shall be directly on the masonry, or on metal lathing, or incombustible furring material which affords a surface for plastering.

5. No wooden studding, furring, lathing, or plugging shall be placed against any chimney, or in the joints thereof. Wooden construction shall either be set away from the chimneys, or the plastering shall be directly on the masonry or on metal lathing

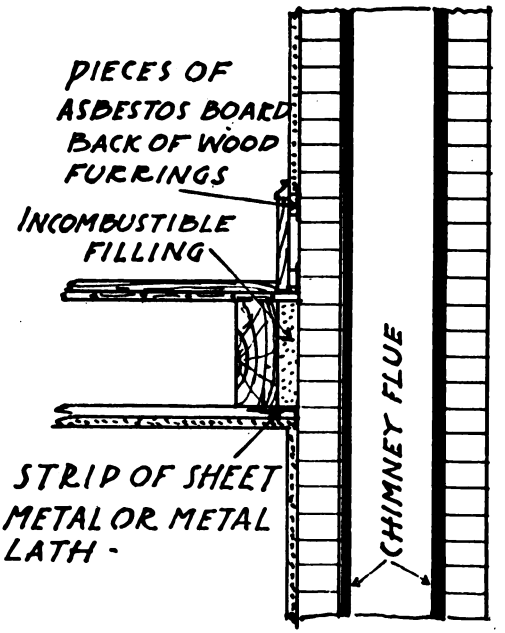


PLATE VIII.

Detail showing support for fire-stopping around chimney, and protection for woodwork placed next to plaster on chimney brickwork.

or on incombustible furring material. Wood furring strips placed around chimneys to support base or other trim shall be insulated from the masonry by asbestos paper, at least ⅛-inch thick, and metal wall plugs shall be used for nailing. See Plate VIII.

NOTE 1.—The practice of inserting wooden joists in the wall of a chimney, or of placing studding, furring, or other woodwork in contact with the wall is very risky, and should not be permitted under any circumstances.

NOTE 2.—When necessary to attach metal lath, either with or without metal furring strips, to a chimney wall, it is recommended that wire

loops be embedded in the mortar joints at intervals as the chimney is being built. The lath can be easily and rigidly attached to these loops. Nails should never be driven into a chimney wall less than 8 inches thick; they are liable to break out the mortar on the inside and render the chimney defective.

Section 43. Smokepipes.

1. Next in importance to correct construction of a chimney, is proper installation and maintenance of smokepipes. Thousands of fires occur annually from defective smokepipes—usually the direct result of carelessness.

2. Smokepipes should always enter the chimney horizontally, and the connection through the chimney wall to the flue should be made with round tile or metal thimbles securely set in the chimney with cement mortar. In concrete chimneys the connection should be cast with the chimney.

NOTE.—The practice prevalent in some parts of the country, of running a smokepipe vertically into the bottom of a chimney, is condemned together with the chimney carried on wooden supports with which it is usually associated. Even though the chimney has incombustible supports, the practice is bad. The pipe is exposed to rain falling in the chimney thus aiding corrosion. It is more difficult to make a spark tight connection between pipe and flue, and in case of a flue-fire the sparks will fall directly into the pipe igniting the soot there, thus producing a dangerous condition.

3. The connecting thimble should be of such size that the smokepipe will fit it closely, and a snug fitting metal collar should surround the pipe and be securely fastened to the chimney. See "Detail" in Plate IV.

NOTE.—A round thimble connection that is too large, is nearly as dangerous as a square hole in the brickwork without a thimble. The open space around the smokepipe in either case is liable to be left improperly stopped. If such openings are not securely sealed with cement or plaster, they will permit the passage of sparks if the chimney burns out, and so are dangerous. Many fires start at this point.

4. Flue holes when not in use shall be closed with tight fitting metal covers. Pasting paper over them is a very pernicious practice.

5. No smokepipe should be within 9 inches of any woodwork, or any wooden lath and plaster partition or ceiling.

NOTE.—When wood or coal are used as fuel, it is better to provide a greater distance than 9 inches if possible. When only that space can be given between a smokepipe and exposed woodwork, such as a ceiling, it is safer to provide a sheet metal shield between the pipe and woodwork. A smokepipe occasionally gets red hot when wood is used for fuel, or even when it is used to start a coal fire. When a pipe is in this condition it is particularly dangerous, especially when woodwork near it contains pitch, or is oiled or varnished. These substances ignite very easily, and burn fiercely. Many fires occur from this cause when occupants are temporarily absent from a room.

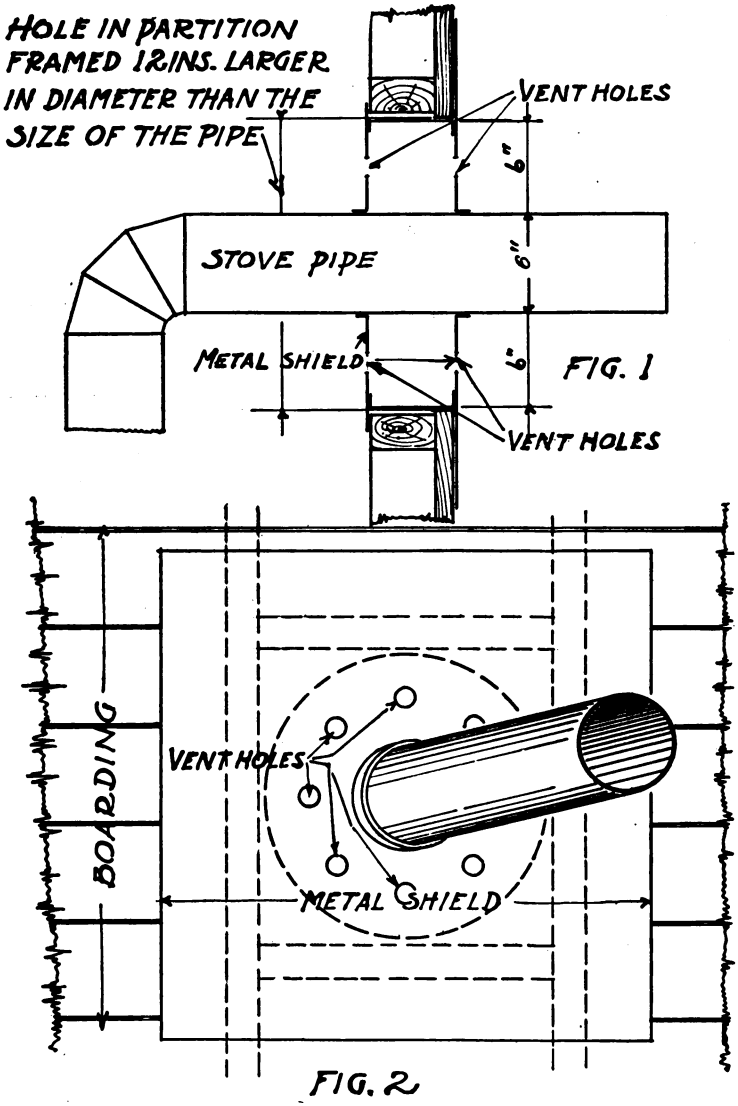


PLATE IX.

Fig. 1.—Section view of protection around a stovepipe passing through a wooden partition.

Fig. 2.—Elevation of same protection device.

6. Smokepipes for large cooking ranges, hot air furnaces, low pressure steam or hot water boilers, shall be not less than 18 inches below any wood lath and plaster or other combustible ceiling, unless at least the upper half of such smokepipe is properly protected by 1 inch or more of asbestos covering or its equivalent, or by a metal casing spaced 2 inches from the upper half of the pipe. If so protected such smokepipes shall be not less than 9 inches from any wood lath and plaster construction, or 12 inches from unprotected woodwork or other combustible material.

NOTE 1.—In all cases where metal is used to protect wood, there should be an air-space between the metal and the woodwork of at least 1 inch. For method of doing this, see Plate X, Figs. 1 and 2.

NOTE 2.—The cellar is always liable to be a storeroom for wood fuel, wooden boxes and barrels, excelsior, paper and combustible trash of all sorts. Ordinary prudence ought to prevent the placing of such material under or near a furnace smokepipe. It is a strange fact that such precautions are often ignored.

7. Where a smokepipe passes through a wooden lath and plaster partition, a section of the partition shall be removed and the pipe shall be protected from the woodwork of the partition by a galvanized iron, double walled, ventilated thimble having a diameter not less than 12 inches larger than the pipe; or by at least 4 inches of brickwork or other incombustible material. See Plate IX.

8. Smokepipes should not be permitted to pass through floors, nor through closets or other concealed spaces.

NOTE.—The hazard of a smokepipe passing through a floor is no greater than through a partition, so far as the construction is concerned, provided it is surrounded with suitable ventilated thimble. However, experience has shown that smokepipes through floors create a real danger due to the liability of combustible material getting in contact with the pipe in the upper story. Furniture or clothing are likely to be placed too near the pipe when it is cold, and later when it gets hot are ignited. An open window may cause paper or other combustible material to be blown against the pipe, and the hazard is always increased when there are children in the house.

If it is really necessary to have a smokepipe pass through a floor, it is recommended that it be encased with a 3 inch ventilated galvanized iron thimble of sufficient length to pass through the floor and project about a foot up into the room above. This will prevent dust and refuse falling into the thimble, also serve as a guard to keep combustible material away from the pipe. However, a hazard will still exist.

9. A smokepipe shall never pass through a roof having wooden framework or covering.

10. A smokepipe shall never enter a chimney in the attic or garret.

NOTE.—Smokepipes in garrets have always been prolific fire breeders. Such spaces are frequently storerooms for combustible material, and in non-fireproof houses the garret is lined with unprotected woodwork as inflammable as tinder.

Any defect in the smokepipe that would permit the passage of sparks, such as falling apart at joints or at chimney connection; or if the soot should burn in the pipe thus making it red hot, is almost sure to start a fire. Owing to the secluded location, such fires usually involve the whole garret space before discovery.

11. Every smokepipe should be thoroughly cleaned at least once each year, and if in practically continuous service, they should be cleaned twice a year.

12. Smokepipes should be securely anchored in position by tightly drawn wires. This is very important.

Section 44. Fireplaces.

1. The walls of fireplaces should never be less than 8 inches thick, and if built of stone the minimum thickness should be 12 inches.

2. It is advisable that the backs of all fireplaces be lined with firebrick or cast iron. When a grate for burning coal or coke is set in a fireplace, it is imperative that a lining of firebrick at least 2 inches in thickness shall be added to the fireback; or soapstone, tile or cast iron may be used, if solidly backed with brick or concrete. For area of fireplace flues, see Section 41, par. 19. For lining of fireplace flues, see Section 41, par. 15.

3. All fireplaces and chimney breasts where mantels are placed, shall have trimmer arches or other approved fireproof construction supporting hearths. The arches and hearths shall be at least 20 inches in width measured from the face of the chimney breast. The arches shall be of brick, stone, terra cotta, or reinforced concrete, not less than 4 inches in thickness. A flat stone may be used to carry the hearth instead of an arch, if it be properly supported and a suitable fill be provided between it and the hearth. The length of the trimmer arch and of the hearth shall be not less than 24 inches longer than the fireplace opening. The hearth shall be of brick, stone, tile, or concrete. False fireplaces should only be permitted against unfurred masonry walls.

Wood centering under trimmer arches shall be removed before plastering the ceiling underneath.

4. No coal burning heater shall be placed in a fireplace which does not conform to the foregoing requirements and have an incombustible mantel. No wood mantel or other woodwork shall be placed within 8 inches of the side nor within 12 inches of the top of any open fireplace. No combustible summer piece or fireboard shall be used in connection with any open fireplace.

Provide a substantial spark screen for all wood-burning fireplaces. For construction of fireplaces and flues, see Plates IV and VI.

PART VII.

HEATING AND LIGHTING EQUIPMENT.

Section 45. Protection of Boilers, Furnaces and Ranges.

1. Low pressure heating boilers, hot air furnaces, laundry stoves and coal ranges, without legs, and similar appliances where hot fires are used, shall rest upon incombustible foundations wherever possible. When necessary to be placed upon wooden floors, the floors shall be protected by sheet metal or a 1/8 inch layer of asbestos board or building lumber, covered with not less than 4 inches of masonry set in cement mortar. Such masonry shall consist of one course of 4 inch hollow tile, or of two courses of brick or terra cotta, at least one of which shall be hollow and be laid to preserve a free circulation of air throughout the whole course. Concrete may be substituted for a course of solid brick if desired. The masonry shall be covered by sheet metal of not less than No. 26 gauge, so arranged as not to obstruct the ventilating passages beneath; or the heating appliances may rest upon 6 inch foundations built of incombustible materials supported within the thickness of the floor framing. Such hearths shall extend at least 12 inches on the sides, back and front of the furnace, range, or similar heating appliance; if solid fuel is used the front extension shall be at least 24 inches.

NOTE.—Solid brickwork will conduct heat quite freely. There are records of fires starting by the ignition of wooden flooring underneath single layers of brick, which supported furnaces or ranges. Hence the necessity for the double layer and air space.

2. Any woodwork or wooden lath and plaster partition within 4 feet of the sides or back, or 6 feet from the front of any such boiler, furnace, or heating appliance, shall be covered with metal shields or other approved incombustible material to a height of at least 4 feet above the floor. This covering shall extend the full length of the boiler, furnace, or heating appliance, and to at least 5 feet in front of it. Metal shields shall be so attached as to preserve an air space behind them. See Plate X, Figs. 1 and 2. Combustible construction when properly protected shall be not nearer than 2 feet to the sides or back of the heating appliance, or 5 feet to the front of same.

NOTE.—The protective coverings mentioned in paragraph 3 as suitable for use over a furnace, would be satisfactory for protecting woodwork around the sides.

3. Heating boilers shall be encased on sides and top by incombustible protective covering not less than 1 inch thick, and at least the tops of all hot air furnaces shall be covered in the

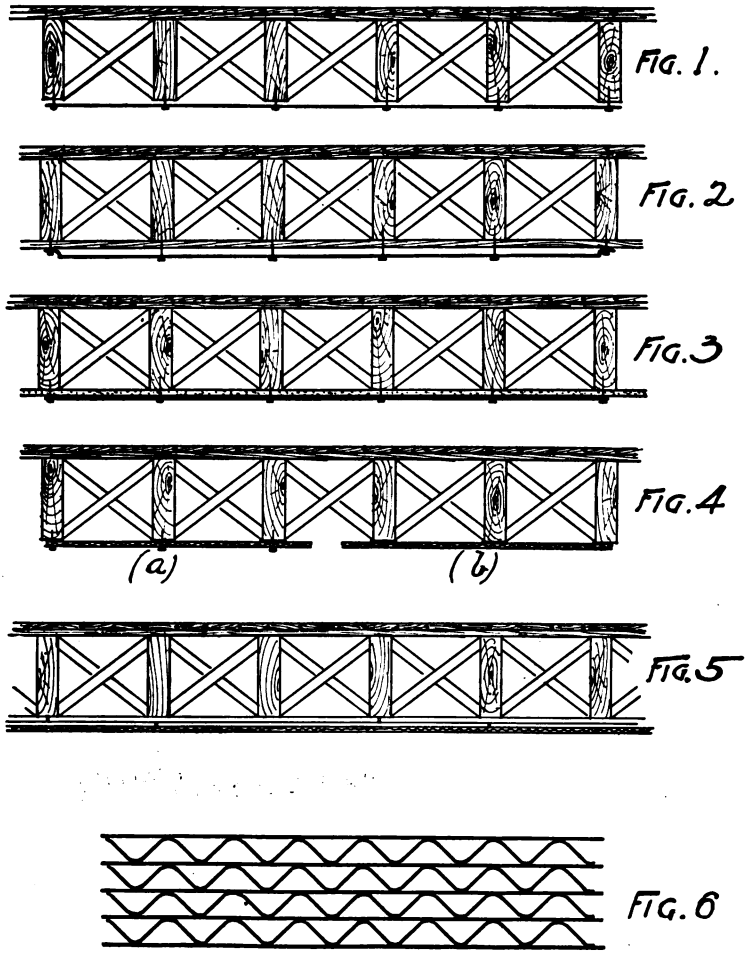


PLATE X.

RECOMMENDED METHODS FOR PROTECTING WOODEN CEILINGS OVER A FURNACE.

For descriptions, see Section 45, par. 3.

Figs. 1 and 2.—Sheet metal. Note how air space is obtained.

Fig. 3.—Layer of plaster board covering with metal.

Fig. 4.—(*a*) Cellular asbestos. (*b*) Metal lath and plaster.

Fig. 5.—Two layers asbestos mill board covered with metal lath and plaster.

Fig. 6.—Detail showing a section of asbestos cellular board.

same manner. The overhead clearance of such covered boilers and hot air furnaces shall be not less than 15 inches. Any woodwork within 2 feet of the top of such boiler or furnace shall at least be protected by a loose fitting metal shield arranged to preserve an air space between the metal and the wood. If tin be used for this purpose it should have locked joints; soldered joints are not reliable. A much better protection can be obtained by the use of some heat insulating material, such as a double layer of ¾ inch asbestos board covered with metal lath and a coat of cement or asbestos plaster; this makes an excellent protection. Instead of the lath and plaster a covering of sheet metal might be used, but would not be quite so efficient and would be subject to rust. A ½ inch layer of plaster board covered with sheet metal is also a satisfactory covering, and metal lath and a ¾ inch coat of cement plaster will give good protection. Another excellent material suitable for such use is 1 inch cellular asbestos sheets. The air cells in this material make it a high grade heat insulator; it is particularly suited for use where desired to prevent the furnace heat making the floor above uncomfortably warm, but it will not stand mechanical abuse as well as the other forms of protection. Plate X illustrates all these forms.

NOTE 1.—It must not be assumed that this minimum protection over a furnace is satisfactory fire protection from the hazard of a heating equipment. It is by no means a substitute for a complete covering of the cellar ceiling as specified in Section 38, paragraphs 7, 8 and 9, or of the entire isolation of the heating plant in a fireproof room as recommended in Section 46.

NOTE 2.—The saving in fuel by completely encasing hot air furnaces in protective covering, well warrants the moderate expense aside from the advantage of increased safety. Cellular asbestos covering ½ inch thick especially adapted to this purpose can be purchased at moderate prices. Brick set furnaces should have a layer of 3 inches of sand on top if other covering is not provided.

Section 46. Isolation of Heating Equipment.

In dwellings of a character to warrant the additional expense, it is strongly urged that all heating, ventilating or other service equipment should be separated from other portions of the building by 8 inch brick or 5 inch concrete walls or their equivalent, and that all interior openings in same be provided with fire doors in incombustible frames. The ceiling also should be of fireproof construction.

Section 47. Stoves and Ranges.

1. No furnace, boiler, kitchen range, stove, or other heating appliance shall be placed less than 3 feet from any woodwork or wooden lath and plaster partition, unless the woodwork or partition is properly protected by metal shields, in which case

the distance shall be not less than 18 inches. Metal shields shall be so attached as to preserve an air space behind them. See Plate X, Figs. 1 and 2.

2. All stoves or ranges with legs shall be set on sheet metal or other incombustible material which shall extend at least 24 inches in front when solid fuel is used.

Section 48. Hot Air Pipes and Registers.

1. All stone or brick hot air flues shall be lined with tin or other suitable sheet metal or burnt clay pipe.

2. Horizontal hot air furnace pipes shall be placed at least 6 inches below wooden floor beams or wooden lath and plaster ceiling; if the floor beams or ceiling are protected by metal lath and plaster, or covered with loose fitting tin, or the pipe be covered with at least ½ inch of corrugated asbestos, the distance from the woodwork may be reduced to not less than 3 inches.

NOTE.—It is important that the hot air pipes be covered as here specified. See Note to par. 15, Section 55.

3. Cold air ducts for hot air furnaces shall be made of incombustible material.

Cross-section Through Stud Partition Showing Hot Air Pipe

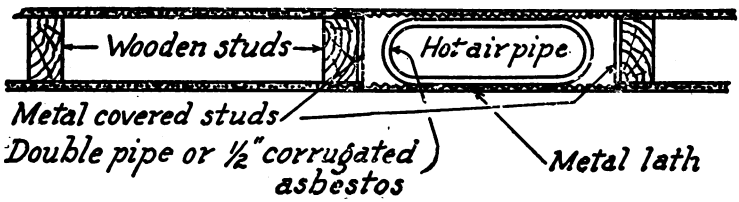


PLATE XI.

Protection of hot air pipe in wooden stud partition.

4. Hot air pipes where passing through combustible partitions or floors, shall be doubled tin pipes with 1 inch air space between them. No woodwork shall be within 1 inch of the outer pipe.

5. Hot air pipes contained in combustible partitions shall be placed inside another pipe arranged to maintain ½ inch air space between the two on all sides, or be securely covered with ½ inch of corrugated asbestos. Neither the outer pipe nor the covering shall be within 1 inch of wooden studding, and no wooden lath shall be used to cover the portion of the partition in

which the hot air pipe is located, Plate XI. Hot air pipes in closets shall be double, with a space of at least 1 inch between them on all sides. The air space between pipes shall be open at bottom and closed at top.

6. A hot air pipe placed in a wooden partition and protected as specified in paragraph 5, should be not less than 5 feet horizontal distance from the furnace.

NOTE.—A greater distance than 5 feet should be obtained where practical; many building ordinances require 8 feet. There is always possibility of the furnace becoming overheated, or a break occurring in the furnace dome, thus permitting direct connection between the fire and the hot air pipes.

7. To prevent overheating, every hot air furnace shall have at least one register without valve or louvres.

8. A register located over a brick furnace shall be supported by a brick shaft built up from the cover of the hot air chamber; said shaft shall be lined with a metal pipe, and no woodwork shall be within 2 inches of the outer face of the shaft.

A register box placed in the floor over a portable furnace shall have a space around it of not less than 4 inches on all sides. When the distance between joists is not sufficient to furnish the space here specified, special framing should be done to secure it. The woodwork shall have a metal casing.

Hot air registers placed in any woodwork or combustible floors shall be surrounded with borders of incombustible material not less than 2 inches wide securely set in place. Soapstone borders are much superior to metal.

Register boxes shall be of metal, and where set in wooden construction, shall be surrounded by a metal casing attached to the woodwork and having its edge turned under the register border. The distance between the register box and the casing should never be less than 2 inches. Some building laws require 4 inches, and that distance is recommended, at least for floor registers. For fire-stopping around registers, see Section 54, par. 15.

Section 49. Steam and Hot Water Pipes.

1. No steam or hot water pipe shall be within 1 inch of any woodwork. Every steam or hot water pipe passing through combustible floors or ceilings, or wooden lath and plaster partitions, shall be protected by a metal tube 1 inch larger in diameter than the pipe and be provided with a close-fitting metal cap on each side of the floor or partition. Plate XVIII. All wooden boxes or casings enclosing steam or hot water heating pipes, or wooden covers to recesses in walls in which steam or hot

water heating pipes are placed, shall be lined with metal, and the pipes shall be kept at least 1 inch away from the walls of the box. Steam and hot water pipe coverings shall be of incombustible material.

2. Where steam or hot water pipes run horizontally parallel to joists and between floor and ceiling, they shall have metal supports, and the under side of the floor and the sides of the joists shall have metal protection; or the pipes shall be covered with incombustible pipe covering ¾ inch thick.

NOTE 1.—There are two reasons for requiring the metal protectors for pipe above specified. First, to prevent fire following a pipe through a partition or wall. When a fire has heated the air and gases in a room to the temperature of combustion, they will pass through a very small opening and ignite any combustible material they touch. If such gases are under pressure as is usually the case in a fire the danger is increased. It must be understood that air or gases heated to the point of ignition of wood—which is less than 1,000 degrees F.—even though they carry no flame and are invisible, will set fire instantly to practically everything combustible with which they come in contact. Second, the metal sleeves protect woodwork from the heat of the pipes themselves. Steam pipes, even from low pressure boilers, will in time char wood in contact with them, and are liable to start a fire under favorable conditions. Cold water or other pipes should be sealed solidly into floors through which they pass.

NOTE 2.—Where waterproof floors are provided, metal sleeves which encase steam pipes should extend a little above the floor level and be capped. This provides a dam to prevent water flowing to stories below, if from any cause the floor should become flooded.

Section 50. Installation of Gas Pipes and Gas Appliances.

1. Each gas supply pipe leading from a street main shall be provided with a heavy brass straight-way stopcock or valve placed in the sidewalk at or near the curb, and arranged to permit shutting off at that point.

NOTE.—This provision is important. In case of fire the gas should be immediately shut off from the whole house, otherwise the melting of connection or fixtures permits the gas to escape freely and increases the difficulty of extinguishing the flames. The gas supply should also be shut off in instances of damaged mains, and in case of repairs.

2. The opening around supply pipes where they pass through exterior walls of a building, should be solidly filled with cement mortar to prevent any escaping gas in the outlying system following the pipes into the building.

3. All outlets and risers shall be left capped until covered by fixtures.

4. No unions or running threads shall be permitted. Where necessary to cut out for repair of leaks, or making extensions, pipe shall be again put together with right and left couplings.

5. All gas burners shall be placed at least 3 feet below any wood lath and plaster ceiling or woodwork, unless the same is

properly protected by a shield, in which case the distance shall be not less than 18 inches.

6. No swinging or folding gas bracket shall be placed against or near any stud partition or woodwork.

7. No gas bracket on any wood lath and plaster partition or woodwork shall be less than 6 inches in length, measured from the burner to the plaster surface or woodwork.

8. Gaslights placed near window curtains or any other combustible material shall be guarded by globes or wire cages.

9. Gas connections to stoves and similar heating devices shall be made by rigid metal pipes. For small portable gas heating devices and lamps, flexible metal or rubber tubing may be used when there is no valve or other shut-off on the device. In no case should a rubber tube exceed 6 feet in length.

NOTE.—Safety requires that the shut-off be always made in the rigid metal pipe. Gas should never be left turned into a flexible tube when not in use.

10. All gas, gasoline, oil, or charcoal burning stoves or heating devices shall be placed on iron stands at least 6 inches above combustible supports, unless the burners are at least 5 inches above the base with metal guard plates 4 inches below the burners.

NOTE.—The practice prevalent in some localities of placing a natural gas heater in the floor, with a register over the open flame is dangerous to both life and property. It should never be permitted.

11. Gas stoves, ranges, and heaters, should be vented to a regular masonry chimney flue the same as similar heating devices using other fuel. The size of such flues should be not less than 10 square inches. See Sec. 41, par. 19.

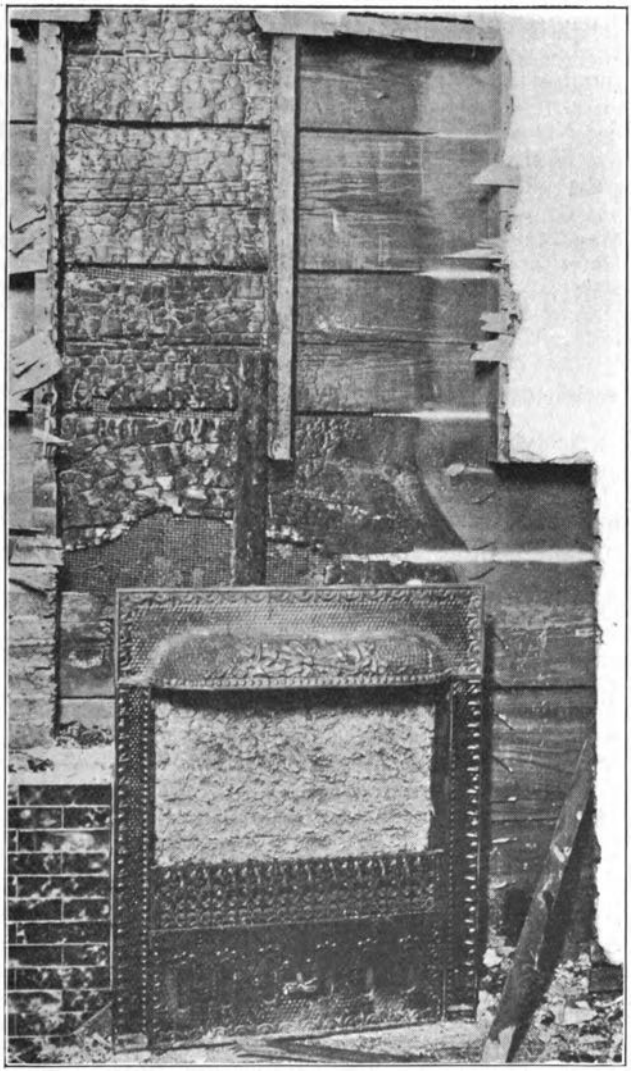
NOTE.—Gas appliances without flue connections when burning properly in a room produce an unpleasant and unhealthful atmosphere because they burn up the oxygen as well as discharge their products of combustion into the air.

On the other hand it is a well known fact that such devices frequently burn improperly, and they then discharge the deadly carbon monoxide into the atmosphere. This gas is inodorous and so insidious in its effect that persons breathing it may not be aware of their danger until they have become helpless. Many lives have been lost due to this cause, and frequently the victims were awake when attacked by the poison.

Another reason for venting such devices, is that the unburned gas itself is poisonous and if for any cause the gas flame should be extinguished without cutting off the gas supply, it will soon make the atmosphere very dangerous to life, as well as invite an explosion if any source of ignition is present. Many persons annually lose their lives due to this kind of poisoning.

Such accidents usually occur when the victims are sleeping, for the escaping gas would be detected by the smell if people were awake.

12. After all piping is installed and all outlets capped, there shall be applied by the plumber in the presence of an inspector



An open gas heater. Note vent pipe placed inside of a wooden partition. The natural consequence of such folly is apparent.

of the Department of Buildings, a test with air to a pressure equal to a column of mercury 6 inches in height, the same to stand for five minutes; only a mercury gauge shall be used. No piping shall be covered, nor shall any fixture, gas heater or range be connected thereto until a card showing the approval of this test has been issued by the Superintendent.

13. No meter shall be set by any gas company until a certificate is filed with them from the Department of Buildings certifying that the gas pipes and fixtures comply with the foregoing rules.

NOTE.—If the building is not under the jurisdiction of a Department of Buildings paragraph 12 does not, of course, apply, but even under such circumstances some competent person should inspect the installation and test it out to insure that it is entirely safe, and in accord with good practice.

Section 51. Acetylene Gas Lighting.

1. Acetylene gas is highly explosive when mixed with the right proportion of air. Fortunately its presence is usually discovered by its characteristic garlic odor before a mixture rich enough to explode has been reached. The ease with which an acetylene gas lighting system can be installed, and the brilliancy of the light it affords, has made it a favorite in many country dwellings remote from light distributing systems. Unfortunately numerous serious fire disasters have resulted from careless operation or improper installation of such systems.

2. Only systems and devices which have been tested and approved by the Underwriters' Laboratories shall be used. The installation and operation of such systems or devices should be in accord with the recommendations of the National Board of Fire Underwriters.

Generators not in use the entire year, should be thoroughly cleaned at the end of the season of service.

A regular time during daylight hours should be designated for charging the generator, and this should be scrupulously adhered to.

3. The same general precautions as regards fixtures, location of burners, defective piping, etc., as specified for ordinary gas should be observed.

4. Portable lamps shall be of approved types only.

NOTE.—For complete details of construction, installation and operation of acetylene gas machines and equipment, see "Regulations for the Installation and Operation of Acetylene Equipment," by the National Board of Fire Underwriters. Such details and instructions should be carefully studied and rigidly observed.

Section 52. Gasoline Vapor Lighting.

1. Gasoline vapor lighting, like acetylene lighting, is most frequently used in isolated localities, where ordinary gas or electric lighting is not available. There are several different methods of using gasoline for lighting, but under the best conditions there is always a distinct hazard, whether it is employed in a distribution system or in an individual device, such as a lamp. No such system or device should be used unless it has been approved by the Underwriters' Laboratories. The installation and operation of gasoline lighting systems shall be only in accord with the recommendations of the National Board of Fire Underwriters.

NOTE.—For complete details of installation and operation of gasoline lighting equipment, see "Installation, Maintenance and Use of Gasoline Vapor Gas Lighting Machines, Lamps and Systems." The details and instructions should be carefully studied and rigidly observed.

Some States prohibit by law the use of gasoline for lighting purposes.

Section 53. Electrical Installations.

1. Fires originating from defective electric wiring are frequent and insidious, for they usually occur in hidden places where not likely to be discovered until beyond control. It is therefore most important that all electrical wiring, apparatus, or appliances for furnishing light, heat, or power, shall be in accordance with the "National Electrical Code," and no installation of electrical equipment shall be made, except in conformity thereto.

NOTE.—The National Electrical Code may be obtained by application to the National Board of Fire Underwriters.

2. Electrical installations made by inexperienced persons are liable to be dangerous. All electrical work should be rigidly inspected by an experienced person before it is put into use.

PART VIII.

FIRE-STOPPING.

Section 54. The Necessity for Fire-Stopping, and Suitable Materials to Use.

1. No one feature of house construction will contribute more to its safety in case of fire than efficient well placed fire-stops. Their purpose is to delay the spread of fire and so assist in confining it to the story in which it starts. This protects life, and affords a better chance of extinguishing the fire.

2. Fire stops are principally applicable to non-fire-proof buildings, such as Types III and IV, though they should be used

in any type of building where openings exist which would act as flues to distribute heated air or gases from a fire in one part of a building to other portions where they might ignite combustible material. The added cost of such protection is very slight, and yet its value is so little appreciated, the ordinary dwelling either has no fire-stopping at all, or else the work is so indifferently done as to be practically worthless. Because such work does not show when a building is completed, and because its importance is usually entirely underestimated, it is common to delegate it to a boy, or some careless incompetent person. The result is that the fire-stop is so in name only; it being merely a delusive imitation which if called upon to fulfill its purpose, fails completely. Such work does not require any high degree of mechanical skill, but it is absolutely necessary that it be done by an intelligent conscientious workman if it is to be efficient.

3. The danger resulting from careless workmanship is greater in the construction of wooden fire-stops than when incombustible material is used. The reason for this is, that as the spaces between studs and joists vary somewhat, and as odd ends of timber are used for the purpose, it often happens that the opening supposed to be filled is really not completely closed. There will be a space of ¼ to ½ inch due to a stop-piece happening to be that much short of the correct length, but which is considered "good enough" for the purpose. Another cause for openings at the ends, is that if the end of a stop-piece is not square, a careless person will consider it too much trouble to saw it to fit; or a stud or joist may be warped, or not set squarely, and unless the stop-piece is carefully fitted an opening will be left. The same defects exist at the sides of the stop-pieces, and as all such joints are sure to widen somewhat due to shrinkage, it is extremely important that such fire-stopping be snugly fitted. If wooden fire-stopping be used for walls or partitions, an intermediate stop shall be placed between the studs midway between floor and ceiling.

4. The above mentioned defects of wooden fire-stopping can be greatly decreased by covering the stops with a layer of loose incombustible material such as broken up refuse mortar, plaster, fine concrete, gypsum blocks, or loose cinders, mineral wool, coarse sand or a mixture of sand and gravel. Some of these materials are nearly always found as waste products about a new building; their use involves no expense, except for labor, and the disposal of refuse is an advantage.

A lack of sufficient refuse material around a building for the fire-stopping is no excuse for omitting it. In such a case suitable material should be secured elsewhere.

The necessity for having tight joints is to prevent the passage of air or gases which have been heated to the point of combustion. See Note 1, Section 49, par. 2.

5. Strips of metal lath or sheet metal nailed to the studs are superior to wooden boards as supports for the fire-stopping material. They are incombustible and easily installed because no accurate cutting at the ends is necessary, they being merely bent up and nailed. They will also adapt themselves to shrinkage of the studs. To prevent sifting of the loose material through the lath, a layer of mortar is recommended on the lath before filling in the loose material.

6. For reasons already explained, it is urged that incombustible fire-stopping materials be employed wherever possible. Their use not only lessens the chances of defective workmanship, but as they are unburnable themselves, the possibility of a fire getting by them is considerably decreased. There are places, however, where wooden fire-stopping is permissible. These will be discussed later.

7. The loose filling should be 3 or 4 inches deep and should contain sufficient fine material to form a compact mass. Such loose material has a tendency to expand and fill in spaces that may be formed by shrinkage of the timber. This is a distinct advantage.

8. Fire-stopping for walls and partitions is frequently made of brickwork and for this purpose almost any sort of bricks will serve, such as second-hand, under-burned, chipped, broken, or other defectives, providing sufficient mortar be used to fill all joints and interstices.

NOTE.—As wooden studs are only about 3⅝ inches wide, the spaces between them are not wide enough for ordinary brick to be laid flatwise. Therefore in fire-stopping a stud wall it will be necessary to lay the brick on edge on the inner line of the fire-stop and fill the space between the brick and the sheathing with mortar; or use some other incombustible material. When fire-stopping a partition resting on a girder or the cap of a partition below, the bricks can be laid flatwise up nearly to the floor level, and then be laid edgewise with sufficient mortar on the side or sides to fill the space in the partition.

9. When mineral wool is used for fire-stopping it should be packed into the space between the studs at least a foot deep, for even with that thickness it will settle in time to a thin layer. Mineral wool is especially adapted for places where it is necessary for the stopping to yield as the timbers shrink, as over the top of a brick partition or wall which supports a floor, also in places where its light weight is advantageous.

10. Solid gypsum blocks are excellent for fire-stopping in dry locations. They can be purchased the correct size to fit between studs, or ordinary partition blocks can easily be sawed to fit any space. It is important that any open joints in such material should be filled with mortar. Such blocks will also yield similar to mineral wool when timber shrinks and throws pressure upon them.

NOTE.—Gypsum products, such as gypsum blocks, or so-called "plaster blocks" or "cinder plaster blocks," also plaster board, absorb moisture freely, and when wet they lose considerable of their strength. They should not be used in contact with wet surfaces, or where likely to become water soaked. Fire-stopping which remains damp is liable to induce dry rot in adjoining woodwork. Gypsum products are also liable to deteriorate when subjected to temperatures in excess of 200 degrees Fahr. for considerable periods of time. They should not be used where such unusual temperatures prevail.

11. Asbestos mill board, gypsum plaster board, or metal lath and plaster, are useful fire-stopping materials where considerable areas must be covered, such as a cellar ceiling or as the lining of the pocket for a sliding door. Because of the fragile character of the boards they are not recommended for the ordinary stopping of walls or partitions.

12. Aside from its great value in resisting the spread of fire, incombustible fire-stopping serves the very useful purpose of preventing the travel of rats or mice through a house, and aids in resisting the transmission of sounds.

Section 55. Construction of Fire-Stopping.

1. Fire-stopping shall be arranged to cut off all concealed draft openings, and form an effectual horizontal fire barrier between stories. Open passages in frame walls or partitions are a prolific cause for rapid spread of fire to all parts of a structure. If fire occurs in the cellar or basement, they act as flues to carry it to the attic. If the fire starts in the attic the sparks fall down the hollow spaces. Results are disastrous in either case.

2. *Furred Walls.* For all walls furred with wood the masonry between the ends of wooden beams shall project the thickness of the furring beyond the inner face of the wall for the full depth of the beams; or a double course of bricks or other masonry above and below the beams shall project beyond the face of the wall the full thickness of the furring. Plate XII. Such fire-stopping in hollow block walls is usually obtained by using 1 inch slabs of the same material, the slabs serving also as the bearing course for the floor joists. Where floor beams are parallel to a wall furred with wood, there shall be a space of not less than 2½ inches between such wall and the nearest beam. This space shall be filled in solidly with brickwork or concrete for the full depth of the floor beams, or be equivalently fire-stopped.

NOTE.—Two courses of bricks, tile slabs, or other masonry, are required to cut off a furring space, for mortar joints may drop out of a single course and render it useless.

Incombustible furring is excellent since it entirely prevents a fire creeping along a wall from one story to another behind the

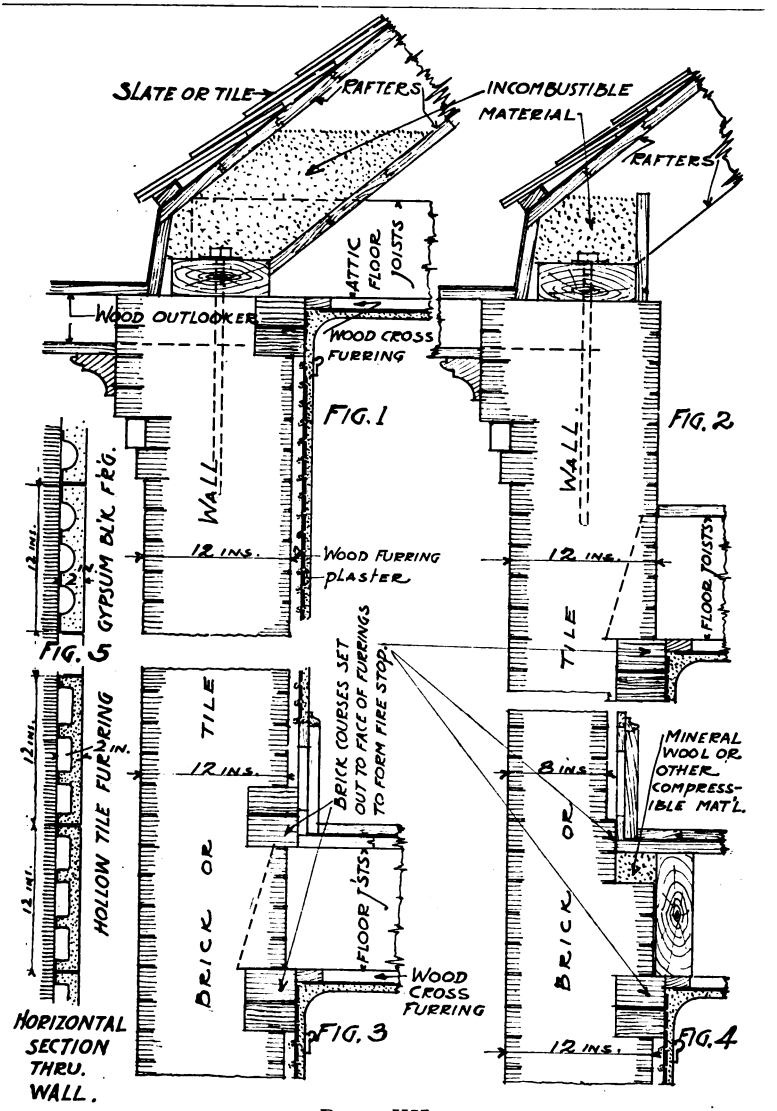


PLATE XII.

DWELLINGS WITH WALLS OF BRICK OR OTHER MASONRY.

Fig. 1.—Method of fire-stopping at eaves when attic floor joists are level with plate.

Fig. 2.—Same as Fig. 1, except that attic floor joists are any distance below the plate and built into the wall. Support for fire-stopping might be same as in Fig. 1 if more convenient.

Fig. 3.—In this and the other figures of this plate note fire-stopping of wooden furring by two courses of brickwork being set out to face of furring above and below floor joists all around the building. Other types of masonry walls should be built out in the same manner.

Fig. 4.—Fire-stopping at a floor level when the wall is thinner above the floor than below.

Fig. 5.—Terra cotta and gypsum block wall furring.

NOTE.—The first course above each floor shall either be solid blocks or the hollow spaces be filled with mortar.

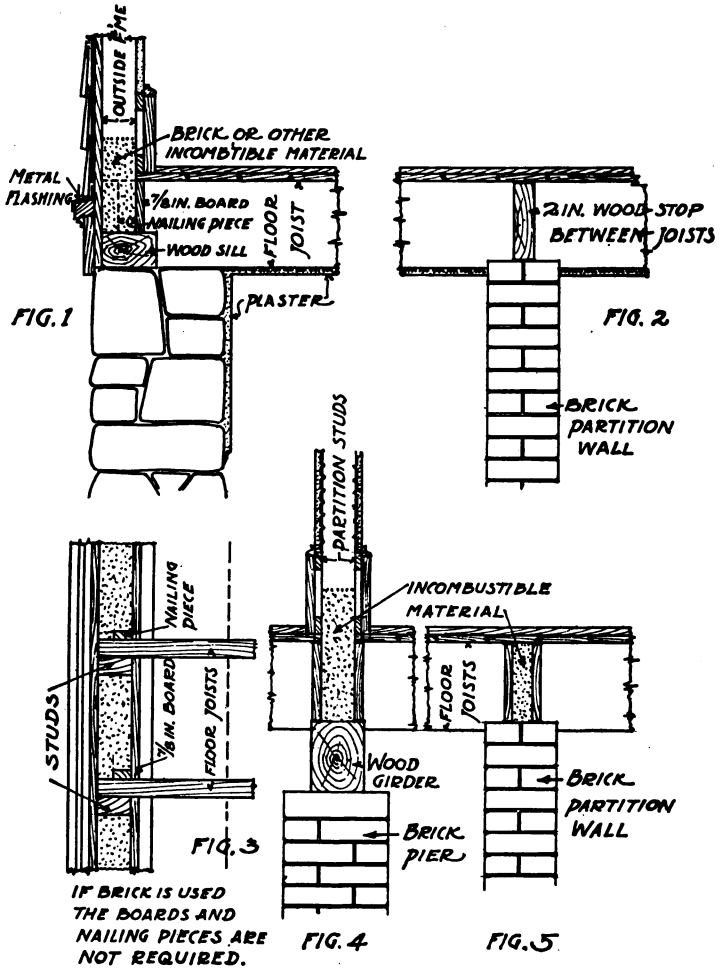


PLATE XIII.

Figs. 1 and 3.—Elevation and plan showing fire-stopping of wall of frame building at line of sill and between studs and floor joists.

Fig. 2.—Fire-stopping with timber cut between floor joists on top of brick partition.

Fig. 4.—Fire-stopping of partition resting on wooden girder.

Fig. 5.—Same as Fig. 2 except that incombustible compressible material between two boards is used instead of a timber.

NOTE.—Wherever boards are indicated as supports to hold incombustible fire-stopping in place, metal lath is recommended as a superior substitute. It is easier installed and will not burn.

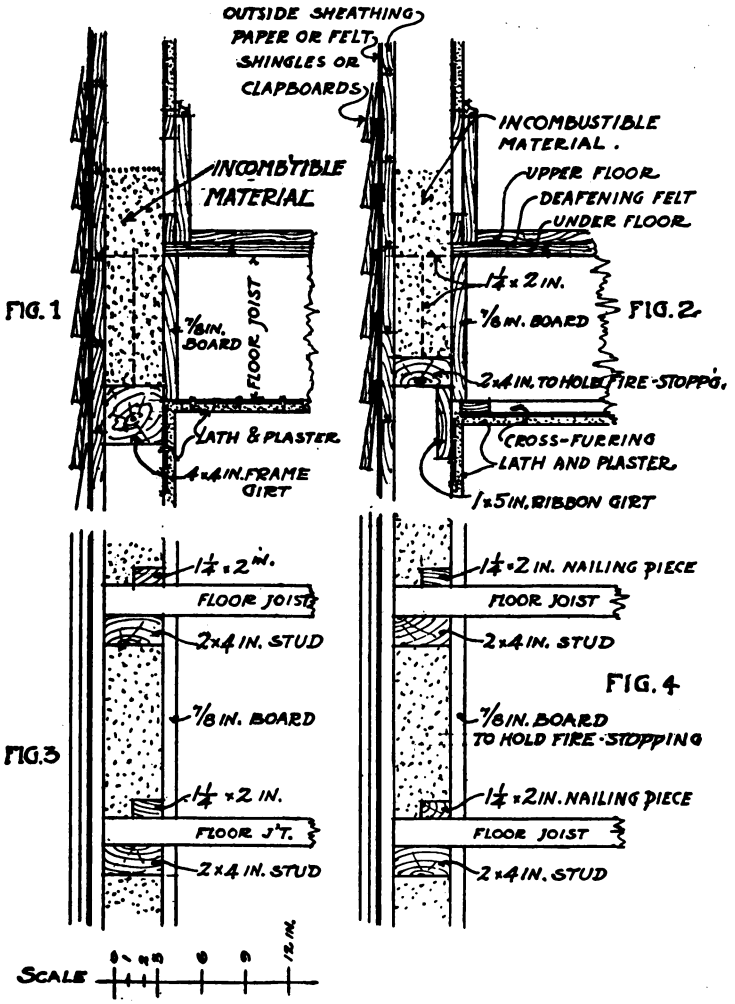


PLATE XIV.

Figs. 1 and 3.—Elevation and plan showing fire-stopping in frame wall at connection of upper floor joists with girt.

Figs. 2 and 4.—Fire-stopping at same place for "balloon frame."

NOTE.—Wherever boards are indicated as supports to hold incombustible fire-stopping in place, metal lath is recommended as a superior substitute. It is easier installed and will not burn.

plaster. Terra cotta or gypsum furring blocks or tile are much used and are quite satisfactory. They have a series of grooves in the back face which afford the necessary air space between the wall and the plaster. Plate XII, Figs. 4 and 5. There are also several styles of metal furring strips to which metal lath is attached, and so serve the same purpose. Where walls are likely to be damp, terra cotta furring would probably be most satisfactory. All these forms of furring should be fire-stopped with mortar a few inches at the bottom to prevent possibility of their acting as flues for heated gases and bringing them in contact with wooden construction in the floor above.

3. *Walls Studded-Off.* Where walls are studded-off, the space between the inside face of the wall and the studding at the floor level shall be fire-stopped with incombustible material. The beams directly over the studded-off space shall be deadened with not less than 4 inches of incombustible material, which shall be laid on boards cut in between the beams; or better still, use 4 inch solid gypsum plaster blocks cut to fit the space between the beams and supported by cleats, thus avoiding the board supports. The under side of such beams shall be protected by a covering of metal lath or plaster board, and plastered to a total thickness of ¾ inch, or a double layer of ¼ inch asbestos mill board with broken joints.

4. *Frame Walls.* In frame buildings which are to be lathed and plastered or otherwise sheathed on the inside, all stud walls shall be completely fire-stopped with brickwork or other suitable incombustible material at each floor level. The spaces between the studs shall be filled to a height of 4 inches above the floor level. Plates XIII and XIV. For protection of frame walls with severe exterior exposure, see Section 58.

5. *Partitions.* Where stud partitions rest directly over each other and cross wooden floor beams at any angle, they shall run down between the floor beams and rest on the top plate of the partition below, and shall have the spaces between the studding filled in solid to at least 4 inches above each floor level with incombustible materials.

Methods for fire-stopping various forms of partition construction are shown in Plates XIII and XV. While incombustible material only is recommended for fire-stopping, it may not always be practical to require it; therefore in some cases the sketches indicate methods for placing both incombustible and wooden fire-stopping, but incombustible material should be used wherever suitable.

There are some places in wooden construction, such as a fire-stop along the top of a brick partition over which a floor is

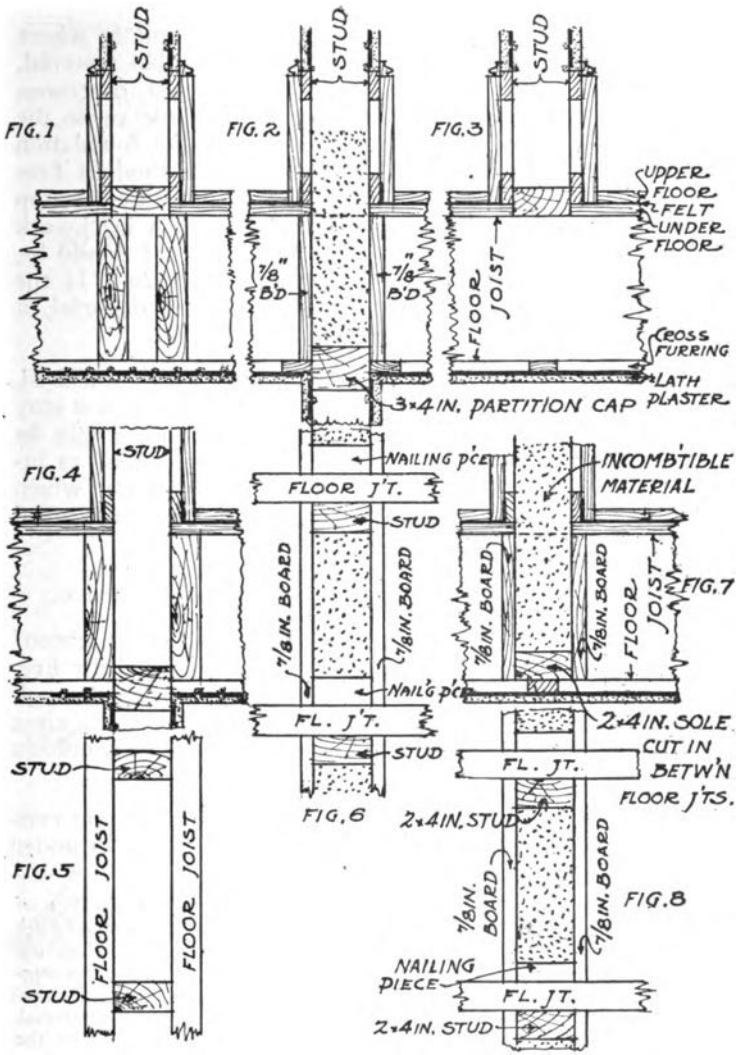


PLATE XV.

Fig. 1.—Interior partition running same direction as floor joists supported on double joists, fire-stopped at bottom by 2 x 4 inch sole.

Figs. 2 and 6.—Elevation and plan of partition footing on 3 x 4 inch cap of partition below running crosswise to joists, showing method of fire-stopping between joists.

Fig. 3.—Partition running crosswise to floor joists footing on sole used as a fire-stop. This would be improved by addition of some incombustible material on top of sole.

Figs. 4 and 5.—Elevation and plan of partition running same direction as floor joist footing on 3 x 4 inch cap of partition below used as fire-stop, and floor joist placed alongside studs.

Figs. 7 and 8.—Elevation and plan of partition running crosswise to joists footing on sole fitted between joists at bottom and fire-stopped with mineral wool between two boards. Brickwork or other solid incombustible material could be used.

laid in the story above, see Plate XIII, Figs. 2 and 5, where wooden fire-stopping, or a compressible incombustible material, such as mineral wool or gypsum block must be used, otherwise the shrinkage of the timber construction will in time cause the floor to bulge. A course of brickwork resting on the foundation wall and built between the ends of joists, is a method of fire-stopping frequently recommended as an addition to a wall stop such as shown in Plate XIII, Figs. 1 and 3. Such brickwork if built snugly against the underside of the floor, as it should be, is likely to deform the floor when the timber shrinks. If the wall stopping is effectively done with incombustible material, it is doubtful whether such secondary stop is necessary.

If the location is dry, and an additional fire-stop is desired, gypsum partition block would serve for the purpose well, or it may be made of asbestos board, or metal lath and plaster might be used. A wooden board could be used, but is not so good as incombustible material. Such a stop in an existing building in which the timber had practically ceased to shrink, could be constructed of brickwork without objection.

6. *Floors.* See Section 38, paragraphs 2 to 8 inclusive.

7. *Roofs.* Dwellings within 10 feet of other non-fireproof buildings, shall have the walls behind eaves or cornices fully fire-stopped to prevent fire from a nearby building breaking through into the attic space. Such fire-stopping will also protect against fire which might lap up under the eaves through the windows from a fire within. Plates XVI and XVII.

Metal lath and cement plaster is excellent fire-stopping construction for the underside of a box cornice or a flat finish under the eaves.

NOTE.—The most vulnerable point of attack for an exposure fire of this kind it under the eaves, for the heat banks up there and the woodwork is always highly combustible since never exposed to storms. With ordinary construction numerous cracks are almost certain to exist alongside the rafters communicating directly with the attic space which is usually difficult of access and liable to be filled with combustible material. It is therefore important that the space above the plate and between the rafters be filled as tightly as possible. Where masonry walls are used they should extend up to the underside of the roof boards, or be fire-stopped as indicated.

8. *Cornices and Gutters.* Combustible cornices are always troublesome in case of fire. They catch fire easily, are usually dry and so burn freely, and a fire travels through them rapidly. Incombustible cornices are safest. Even though the framework be of wood, it is wise to cover the exterior surface with incombustible material where practical. Metal lath and cement plaster or stucco could be used on flat surfaces on underside of cornices.

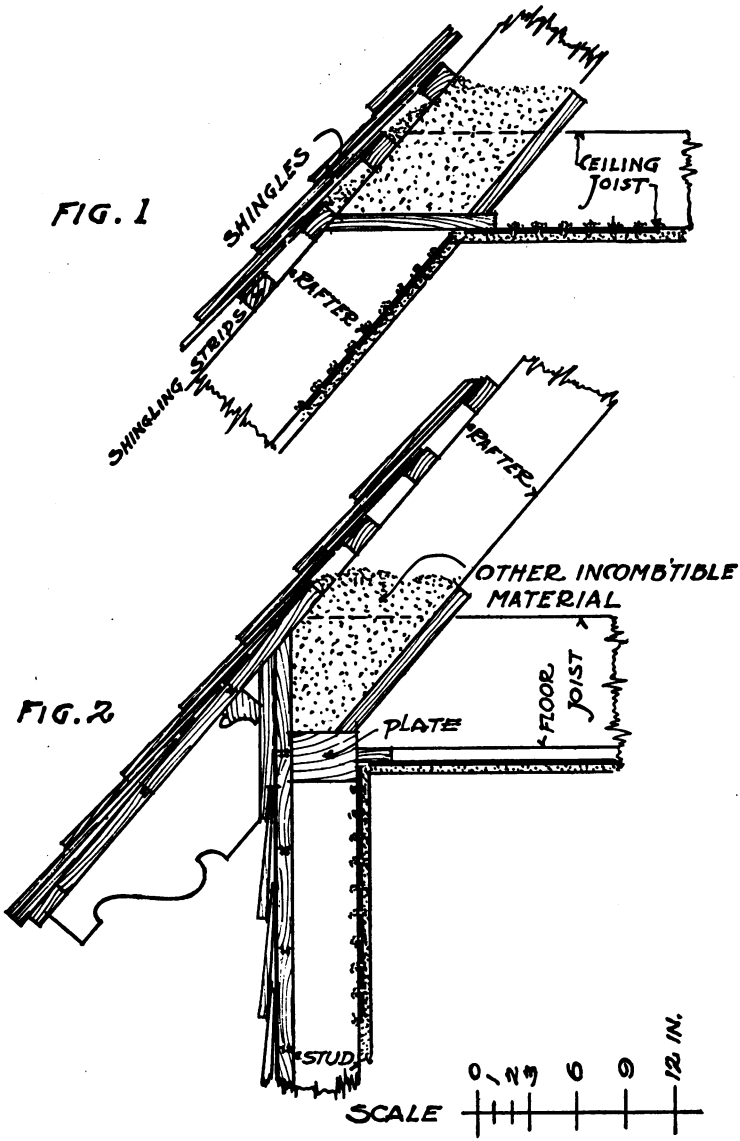


PLATE XVI.

Fig. 1.—Connection of attic ceiling joists was roof rafters, fire-stopping supported on boards fitted between rafters and ceiling joists. This protects space above ceiling often used for storage.

Fig. 2.—Connection of floor joists with outside frame at plate level, showing "open rafter end" cornice, and fire-stopping supported on boards cut between joists.

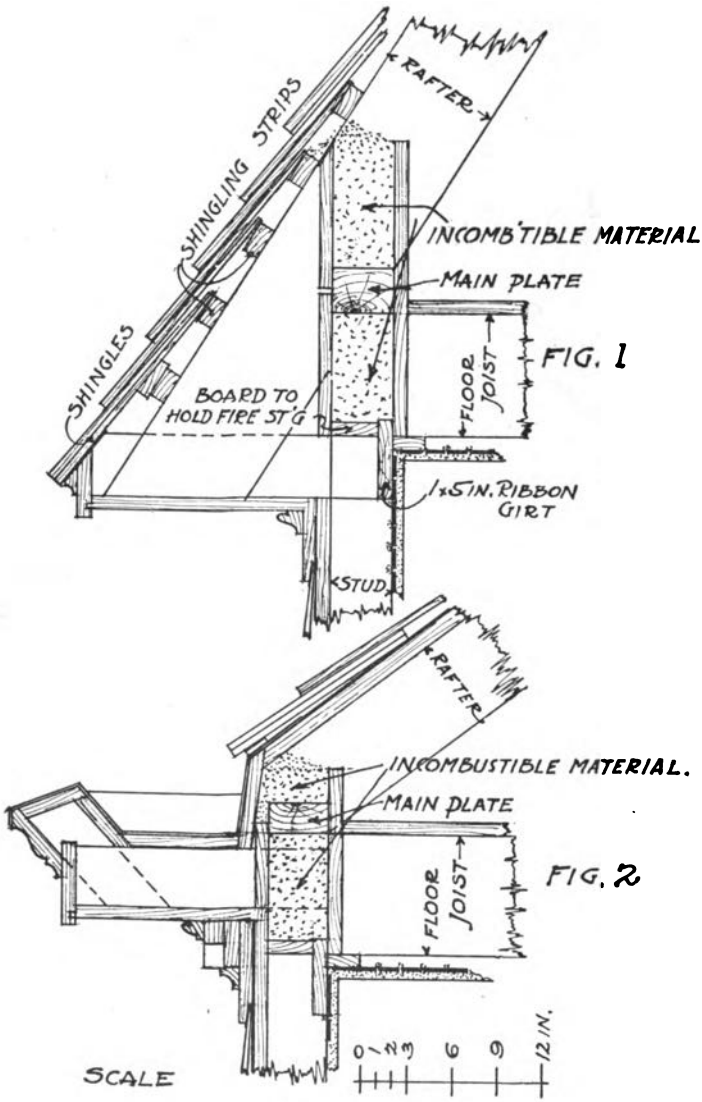


PLATE XVII.

Fig. 1.—Connection of floor joists with outside "balloon" frame. Method of fire-stopping cornice and "gambrel" roof construction. Metal lath and cement plaster or stucco would make better fire protection than wood for the flat surface under the eaves.

Fig. 2.—Connection of floor joists with outside "balloon" frame at plate level, showing "box" cornice, gutter trough, and foot of roof rafters, and method of fire-stopping. This retards fire entering building if cornice burns. Same methods employed for girt framing.

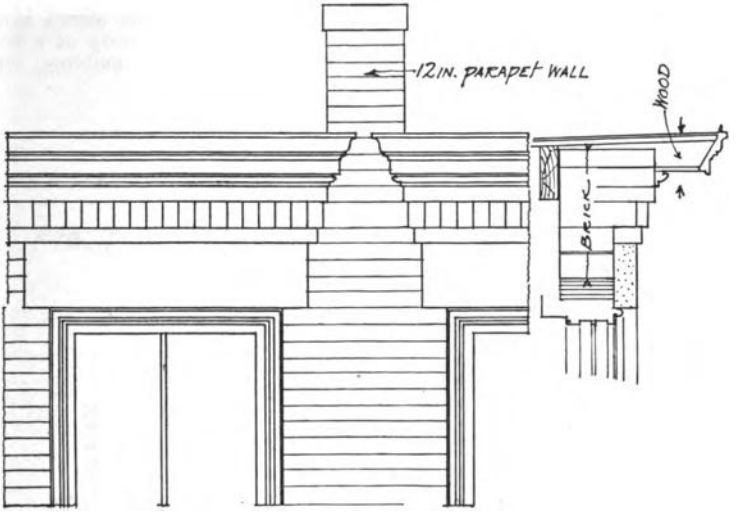


FIG. 1 FIG. 2

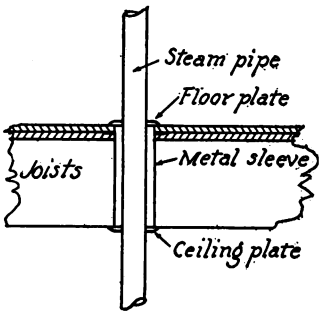


PLATE XVIII.

Figs. 1 and 2.—Elevation and section of wooden cornice on a brick wall. Note separation of cornice on line of party wall.

Fig. 3.—Protection of pipe opening through floor or partition.

Cornices built of wood or having wooden frames on rows of buildings, shall be either fully fire-stopped between each building, or shall be completely separated. Plate XVIII.

NOTE.—It is a common occurrence for a fire in a row of dwellings to communicate to several buildings through the cornice; it is much safer to make them entirely independent and it is so recommended.

9. *Piazzas.* It is important that stud walls back of or over piazzas, should be fully fire-stopped in manner indicated in Plate XIX.

NOTE.—Fire Chiefs report that fire from a burning piazza is frequently carried through stud walls to the attic or upper story of a house and becomes the cause of complete destruction of the building, which otherwise might have been saved.

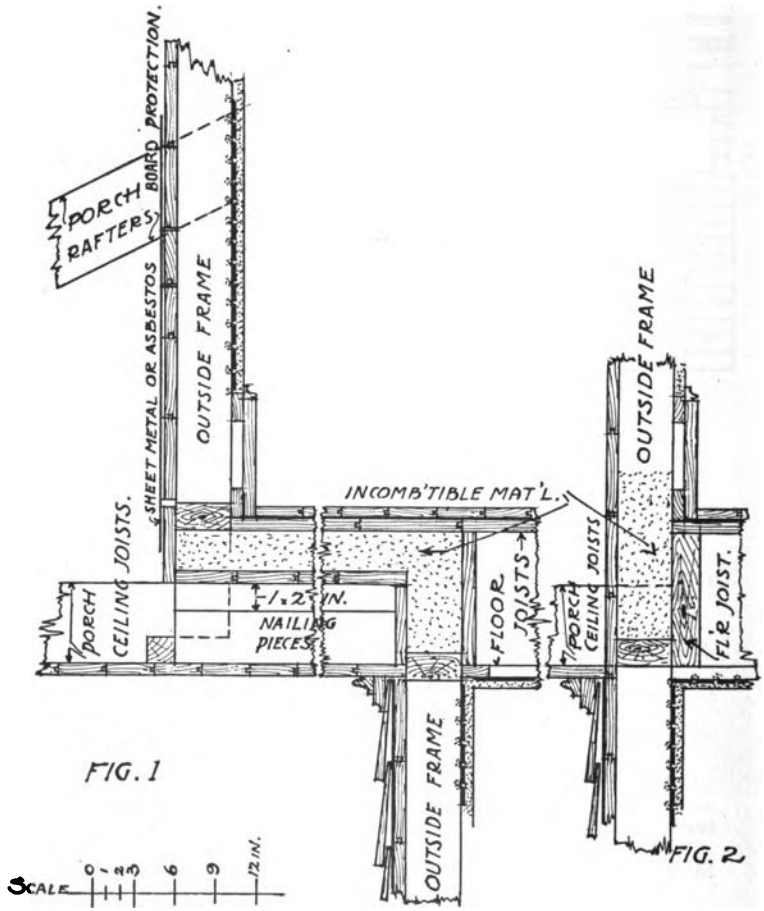


PLATE XIX.

Fire-stopping over piazza roof. See Section 55, par. 9.

Fig. 1.—Section through an outside frame overhanging at second floor level, with ceiling joists and rafters of a piazza framed into it. Method of fire-stopping over ceiling joists, also for outside of frame wall under porch roof.

Fig. 2.—Section through a flush frame with piazza ceiling joists finishing against it, and method of fire-stopping. Wall above should be protected as indicated in Fig. 1 or by metal lath and plaster.

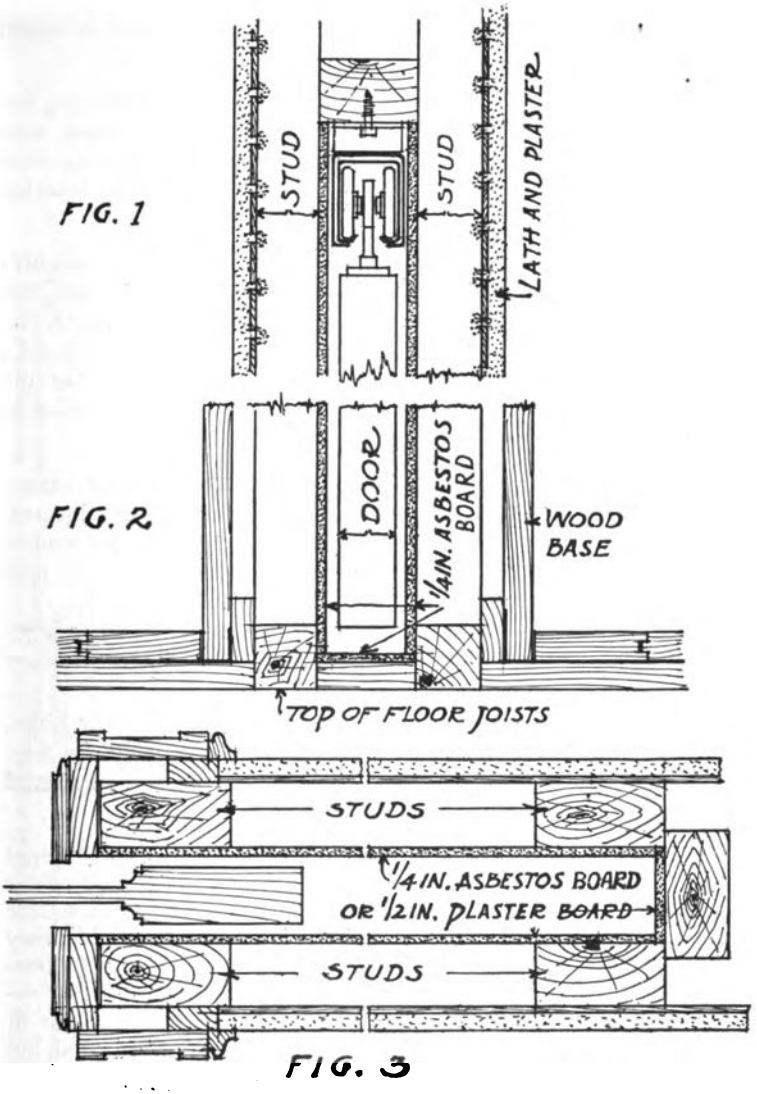


PLATE XX.

Fig. 1.—Section through head of sliding door pocket in a stud partition, showing method of fire-stopping.

Fig. 2.—Section through pocket at floor.

Fig. 3.—Section plan through pocket.

10. *Sliding Doors.* When sliding doors are pocketed in partitions, such pockets should be completely fire-stopped at sides, top and bottom. Asbestos mill board, or plaster board is suited to this use. Plate XX.

11. *Wainscoting.* The surface of the walls or partitions behind wooden wainscoting and dados shall be plastered flush with the grounds and down to the floor line. The same stopping shall be placed behind all applied wooden trim, such as fancy wooden paneling.

12. *Stairs.* The space between stair carriages shall be fire-stopped by a header beam at top and bottom. Where a stair run is not all in one room, or where a closet is located beneath the stairs, the stair carriages should have an intermediate fire-stop, so located as to cut off communication between portions of the stairs in different rooms, or between the closet and the room in which it is placed. Such stops can best be made of plank.

If a flight of stairs is so arranged as to be the only construction separating two stories at the place where they are located, as for example between the cellar and the story above, the underside of the stairs should be covered with metal lath or ½ inch plaster board and plastered to a total thickness of ¾ inch.

NOTE.—Cellar stairs properly enclosed as specified in Section 37, par. 5 are very much safer than when protected by the method above described.

13. *Ducts and Chases.* Ducts, chases, or shafts for pipes, wires, speaking tubes, and for similar purposes, shall be fire-stopped at each floor with mortar or other incombustible material so as to form tight joints.

14. *Water, Gas and Plumbing Pipes.* All exposed pipes passing through any floor or wall shall have the surrounding air space closed off at the ceiling and the floor line, or on each side of the wall by close fitting metal caps. Wherever possible they should be surrounded by mortar or other close fitting incombustible material which does not conduct heat like metal. In fireproof construction it is preferable to have the pipes or shafts fit neat in the floor or wall. For protection around steam and hot water pipes, see Section 49.

15. *Hot Air Pipes and Registers.* Where a furnace hot air pipe passes through a floor, the space between the pipe and floor construction shall be filled with incombustible material supported by sheet metal or metal lath. A light porous material, such as mineral wool or asbestos fibre, is best suited to the purpose. Plate XXI, Fig. 3.

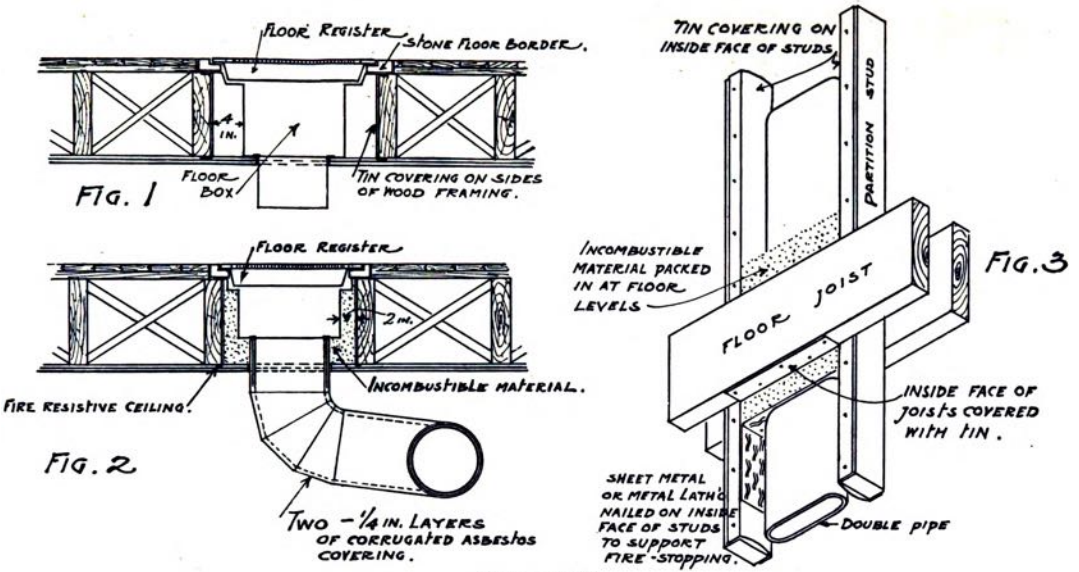


PLATE XXI.

Fig. 1.—Method of fire-stopping around floor register. Note register box extended to line of ceiling protection which simplifies installation.

Fig. 2.—A more complete method of fire-stopping, and one well suited for existing buildings.

Fig. 3.—Isometric sketch showing method of fire-stopping between floor joists around a hot air pipe carried up in a partition.

The space between a register box set in a floor and the casing protecting the floor construction shall be filled with similar incombustible material. This shall include the space around that portion of the hot air pipe attached to the register box down to the bottom of the joists in wooden floor construction, and a layer of sheet metal shall surround the pipe and be securely nailed to the underside of the joists to support the fire-stopping. When a register box is fire-stopped in this manner, the space between the box and the casing may be reduced to 2 inches; otherwise it should be 4 inches as specified by Section 48, par. 8. If the ceiling has a protective covering as elsewhere recommended, it should be made to cover the space and surround the pipe. Plate XXI, Fig. 2. When a space of 4 inches is provided on all sides of a floor register box, and the surrounding woodwork is encased in metal, the fire-stopping may be omitted provided the cellar or furnace room ceiling be completely protected by a covering at least equal to the minimum grade specified in Section 38, and that this covering fits snugly around the pipe connection as indicated in Plate XXI, Fig. 1. The fire-stopping would be more positive if the space were filled, and this is recommended.

When a register is connected to a brick hot air shaft, the space required between the outside of the shaft and the wooden floor construction shall be fire-stopped in like manner.

NOTE.—This fire-stopping is important, but seldom done. Any such space should be fire-stopped irrespective of floor construction. In fireproof floor construction, register boxes should fit the floor opening snugly, and so make fire-stopping unnecessary. The protection of woodwork as elsewhere required around a register, will safeguard the wood from the heat of the pipe itself, but the open space provided around the pipe and register box forms an easy entrance for fire occurring in the lower story to gain access to the story which the register serves. The hot air pipe and its connection will get red hot and communicate fire to combustibles surrounding the register face, such as parquet floors, carpets, rugs and furniture. If the register box has soldered joints they will open, and a passageway for flame be formed. It is futile to enclose stairways and protect ceilings as elsewhere provided unless all other openings such as these are adequately closed.

The greatest hazard is in the cellar or basement where the furnace is located. There is an additional danger from the hot air pipes themselves. Such pipes leading from the furnace, if not protected would in case of a fire become intensely hot and burn the dust which invariably accumulates in such devices thus making a flash fire, and there would be great danger of the fire being communicated to the floor above, even though the pipes and registers were fire-stopped at the floor openings. For this reason the pipes, and the furnace itself, should be fully covered with cellular asbestos or equivalent incombustible material at least ½ inch thick for the pipes, and 1 inch for the furnace. Such covering is inexpensive, and reduces coal bills by conserving the furnace heat. It is much used for this purpose alone. The covering is manufactured for the purpose, and sold in rolls. It is ¼ inch thick, and should be used in double layers with broken joints. Suitable metal bands to hold it in place are supplied.

It is common practice to simply cover hot air pipes with a sheet of thin asbestos paper pasted to the pipe. Such protection is merely a pretense. Tests have shown that it has no value as a heat insulator, and has practically none as a fire-resistant. It deserves no consideration.

16. *Chimneys.* See Section 41, par. 24, and Section 42, par. 2.

17. No fire-stopping should be in any manner concealed from view until opportunity has been given the owner or his representative to inspect same. This is particularly important when work is done under contract.

18. Although it would not be practicable to fire-stop an existing house as completely as here recommended for new construction, nevertheless it would be quite feasible to apply several of the suggestions to any existing house in which such barriers had been omitted, and would materially lessen the fire risk.

NOTE.—The great obstacle in securing efficient fire-stops in a building, is in getting architects and builders to realize the supreme importance of such precautions. The ordinary carpenter or builder has an inherent prejudice against doing work which does not visibly advance his contract. Ignorant of the serious annual life and property loss due to fires in combustible dwellings, he considers the possibility of such a fire too remote to worry about, and the general experience is that he will not put in proper fire-stops unless very carefully watched. Someone must be responsible for rigid inspection to insure that such work is conscientiously performed. Usually the owner lacks experience, and does not know what should be required. It is hoped these explanations may be of assistance.

PART IX.

FRAME DWELLINGS.

Section 56. General Disadvantages.

1. Congested districts of frame buildings constitute a distinct conflagration hazard, and a fire well started in such a locality with a strong wind blowing, is exceedingly difficult to control. As a matter of fact such fires seldom are controlled until they burn themselves out, or are blocked by some natural barrier, such as a river, canal, park, or other open space. In their sweep they annihilate everything burnable, and buildings with masonry walls fall with the rest. The truth of this statement has been proven by the sad experience of scores of cities and towns throughout our land, and fully justifies a limitation of height and area for frame buildings in congested districts, as well as restrictions upon their distance apart.

2. Nevertheless it is recognized that frame dwellings properly constructed are comfortable, and can be made architecturally

and artistically attractive at a minimum cost, therefore they are popular with the building public in spite of their fire hazard.

3. The public is gradually being educated to the advantages of incombustible homes, and the increasing price of lumber coupled with the skill and economy with which fire-resistive houses are now being erected, are all having an influence in supplanting wooden structures. These influences will continue to grow, and the future will doubtless see a gradual decrease in the proportion of frame dwellings. This reformation though is likely to be slow, and frame dwellings will undoubtedly continue to be popular and be built for many years to come where not prohibited by municipal ordinance.

4. Recognizing this fact, the self-evident duty of fire-protectionists is to broaden this public education. They should teach self-protection and clearly indicate the various precautions that must be taken in erecting a frame dwelling in order to make it reasonably safe, instead of being the highly combustible fire-traps that the majority of them now are. This is one of the principal objects of this pamphlet. It is hoped it may stimulate other efforts in the important work.

5. A well built frame dwelling fully fire-stopped as specified in Part VIII, and provided with other protective construction as elsewhere recommended, is practically on a par with masonry walled houses of same design with wooden interior construction as regards resistance to an interior fire; a fire well started in either is pretty sure to consume the building if efficient fire fighting facilities are not available, but the chances of controlling such a fire in a properly constructed house are very greatly increased. If suitable exits are provided as elsewhere urged, there should be no life hazard in either type of building.

6. As explained in Section 54, paragraphs 1 and 2, the fire-stopping in frame buildings is almost invariably carelessly done, and so far as this is true for the walls, the danger to the frame building is greatly increased over that existing in masonry walled buildings. If owners and builders could be made to realize the protection secured by prudent and careful construction of frame buildings, the annual loss now chargeable to such buildings would be greatly reduced, and prejudice against them materially lessened.

NOTE.—The possibility of being able to erect frame buildings of wood which has been chemically treated or covered with fire-resistive paint to make it non-flammable, and at an excess cost small enough not to be prohibitive for ordinary dwellings, has been a long cherished ambition that may yet be accomplished. The U. S. Forestry Service is endeavoring to perfect new processes for such treatment, which, if successful and applicable at prices within the reach of the average home-builder, will be a distinct public benefaction, of a value difficult to estimate.

Section 57. Height and Area.

Except as herein provided, no frame dwelling should exceed two and one-half stories or 30 feet in height, and should not exceed 3,000 square feet in area. The attic in a two and a half story house may be used for sleeping rooms, but not for living purposes. No family shall be domiciled above the second story. Frame dwellings occupied by not more than one family may be three stories or 35 feet high. Towers, turrets, or minarets on such buildings may exceed the foregoing limit 10 feet, provided the greatest horizontal dimension of such structure does not exceed 15 feet.

Within town limits or other congested localities, the combined area of frame buildings, sheds, and outhouses located on any lot should not exceed 80 per cent of the lot area.

Section 58. Protection from Severe Fire Exposure.

In no case shall a frame dwelling with wooden siding be erected or altered, to extend within 5 feet of the side or rear lot line within town limits, nor within 10 feet of another building, unless the space between the studs on each side be filled solidly with not less than 2½ inches of brickwork or other equivalent incombustible material, and the entire exposed side be covered with at least a ¼ inch layer of asbestos board, or ⅜ inch of plaster board back of the wooden siding. When such walls are thus filled and covered, their distance from a side or rear lot may be reduced to 3 feet; or to 5 feet from another building. If the adjacent walls of two buildings have no openings, and are filled and covered as above specified, there need be no limitation as to distance between them.

NOTE 1.—It is recommended that when such buildings are nearer than 3 feet to a side or rear lot line, or 5 feet to another building, the cornices and overhanging eaves on the side or rear walls shall be of, or covered with, incombustible material. See Section 54, paragraphs 7 and 8.

NOTE 2.—Some authorities recommended the use of ¼ inch asbestos board, ⅜ inch plaster board, or other incombustible felt or covering of same thickness under all the siding on frame dwellings as adding greatly to the insulation against cold and to the fire-resistance.

Section 59. Framing.

1. Framing timbers should have sufficient size and closeness of spacing to insure adequate strength even when subjected to unusual stresses. It is poor economy to use floor joists so small that they lack rigidity. They are always a source of annoyance due to cracking of plaster; rattling of lighting fixtures, and other defects resulting from a vibrating floor. While it is possible to secure rigid construction with timbers of small cross-section closely spaced, it is not advisable to do so from the fire protection

standpoint. Three small timbers having the same total cross-section as one large timber will burn through in less than one-third the time required to consume the large timber, with consequent danger of quick collapse. It is for this reason that balloon frame buildings burn so rapidly; a fire well started in one is seldom controlled before the structure is destroyed. Other precautions being equal, the larger the framing timbers the safer the structure as regards fire. This is the whole theory of "Mill or Slow-Burning Construction," which is used so successfully for factories.

2. Floor joists and rafters in frame dwellings shall be not less than 2 inches in thickness (commercial size). Joists 3 inches thick are recommended. They are especially desirable for floors having considerable span. All frame or wood buildings exceeding 15 feet in height shall have their sills secured to the foundations in an approved manner and be erected with sills, posts, girts and plates of suitable size and materials with proper mortise and tenon framing and braced with studs at all angles; but this does not prohibit the use of balloon framing with proper sills, and ribbon strip not less than 1¼ by 5 inches, and provided that the outside walls are fire-stopped at each floor level, as specified in Section 54.

For general requirements governing joisted floor construction, see Sections 28 and 29, which applies also to frame buildings. For roof coverings, see Sections 30 and 31.

3. It is equally important that the essential structural features necessary to prevent spread of fire through a dwelling, be incorporated in a frame house as in any other type, and the necessity for such precautions increases rapidly with enlargement of the building. Part V discusses such requirements for all types of dwellings, and should be taken into consideration when a building is being designed.

Section 60. Division Walls in Rows of Frame Dwellings.

1. In rows of frame dwellings, the dividing walls between houses shall be built of brick, hollow tile, concrete, or other approved incombustible material; or they may be built with 4 inch studs, filled solidly with brickwork laid in mortar, or with other suitable incombustible material and covered on each side with at least ½ inch of metal lath and plaster or plaster board. Such dividing walls shall rest on masonry walls or wooden girders and shall extend to underside of roof boards, and a flush mortar joint shall be made between the roof boards and the wall.

2. In rows of more than three houses, every alternate division wall shall be constructed of brick not less than 8 inches thick, or concrete not less than 6 inches thick. These walls shall ex-

tend from front to rear, be solid without openings, and shall extend at least 2 feet above the roof, and be coped. If such parapet be of concrete, or if the top six courses of brick be laid in Portland cement, the coping may be omitted.

3. The ends of floor beams entering such walls from opposite sides shall be so staggered or separated that there shall be not less than 4 inches of masonry between the beams where they rest on the walls. Joists shall not be allowed to project through the wall. If it is impossible to secure at least 4 inches of solid masonry between joist ends when they rest in the wall, they should be supported by metal wall hangers on the surface of the wall. For proper arrangement and protection of beam ends in party and fire walls, see Sec. 28.

NOTE 1.—The great danger of a fire finding its way through an 8 inch bearing wall must be recognized. Even though a separation of full 4 inches is maintained between the ends of all the joists, there is very likely to be some mortar joint left open, and if so, a fire on one side is sure to go through it. Where a bearing wall as thin as 8 inches is used, great care should be exercised in laying it to insure a maximum separation of joist ends, and that all brick joints are flushed full of mortar. Cement mortar is much the best for such walls.

NOTE 2.—There is one class of frame residence building usually built in rows which should be entirely prohibited, namely the wooden tenement house commonly known as "three decker," "four flatters," etc. This class of building is prevalent in manufacturing cities, particularly in the Eastern States. They are ugly to look at, and are a serious fire hazard. Their cheapness invites a congested occupancy of inferior grade, demoralizing in its influence and a menace to health.

PART X.

CONCRETE CONSTRUCTION.

Concrete is becoming very popular for dwelling house construction, and while it is without question a superior building material, it is equally true that with no building material is intelligent and conscientious workmanship so necessary to produce a safe and satisfactory structure; this is especially so with reinforced concrete. There are well established rules for such construction, which should be rigidly followed to insure satisfactory results, and only experienced men should supervise the work.

As the quality of concrete construction has a distinct influence upon its fire-resisting properties and the integrity of the building when attacked by fire, it has seemed advisable to state the fundamental principles governing good construction in order that they may serve as a guide to proper inspection of workmanship. Structural design should never be left to inexperienced persons.

Section 61. Quality of Concrete.

1. The fine aggregate for concrete shall consist of sand, crushed stone, or gravel screenings. The quality of cement and aggregates shall be as specified in Part II.

2. The proportions of cement and aggregates should be as follows:

For reinforced concrete—1 cement, 2 sand, 4 crushed stone, or gravel.

For ordinary mass concrete—1 cement, 2½ sand, 5 crushed stone, or gravel may be used.

For concrete for fireproofing purposes, see Section 68.

3. All concrete shall consist of a medium wet or plastic mixture.

NOTE.—The concrete mixture should be of such consistency that tamping will readily bring water to the surface, but should not be so wet that the coarse aggregate will tend to separate and settle at the bottom. Excess of water usually leaks from the forms carrying cement with it, thus weakening the concrete, and leaving it porous or "honeycombed."

Section 62. Reinforcement.

1. All reinforcement shall be accurately located and mechanically secured against displacement during the placing of the concrete. Reinforcement bars for floor slabs shall not be spaced farther apart than two and one-half times the thickness of the slab. The spacing of parallel bars in beams shall be not less than three diameters from center to center, nor less than 1 inch. The clear spacing between two layers of bars shall be not less than 1 inch.

2. Steel reinforcement shall have a minimum protection of concrete on all sides as follows:

In columns and girders, 2 inches; in beams and walls, 1½ inches; and in floor slabs, 1 inch.

The steel in footings for walls and columns shall have a minimum protection of 4 inches.

Section 63. Mixing and Depositing.

1. The separate ingredients of concrete shall be accurately measured, and thoroughly mixed in a manner to produce a homogeneous mass of uniform color and of a consistency specified in Section 61.

NOTE.—It is usual practice to consider a bag of Portland cement weighing not less than 94 pounds as equivalent to one cubic foot.

2. Machine mixed concrete is the best, but where quantities are small, a machine mixer is usually too expensive. When hand

mixing is employed, the mixing board should be watertight, and the sand and cement should be thoroughly mixed before adding water or coarse aggregate. Mix the whole mass thoroughly, turning it at least three times.

3. Concrete shall be deposited, thoroughly tamped and worked to place immediately after mixing, and shall then be kept free from shocks and disturbances of every kind until it has fully hardened. Retempering of concrete after its initial set is prohibited.

4. Before depositing new concrete upon concrete already set, the contact surfaces shall be roughened, thoroughly cleaned of float cement and dirt and then drenched with water and slushed with a grout consisting of one part Portland cement and not more than two parts fine aggregate immediately before placing the fresh concrete.

Section 64. Drying and Freezing.

1. When fresh concrete is exposed to rapid drying conditions, precautions shall be taken to keep it moist for a period of at least seven days after being deposited. Where practical, this shall be done by a covering of wet sand, burlap, or some other equally effective method. Thorough wetting twice a day is recommended.

2. Great care shall be taken to prevent concrete freezing, and it should not be deposited when the temperature is below 40 degrees Fahrenheit, on a rising temperature. Concrete which may accidentally be frozen should be allowed ample time to set after it has fully thawed out, and should be kept wet while setting. Under these conditions, if the set is satisfactory, it may be accepted: but under no circumstances should it be accepted if frozen a second time.

Section 65. Forms.

1. All forms and centering shall be built plumb and to true lines in a substantial unyielding manner, with joints as nearly watertight as practicable. Loss of water always means loss of cement. Forms shall be properly supported and braced to safely sustain both the dead load and live load that may be placed upon them during construction.

2. Care should be taken to insure that all debris is removed from forms, and that they are thoroughly greased or wetted before concrete is deposited in them.

3. Forms shall not be removed until the concrete has thoroughly set; usually several days are required.

4. All reinforced concrete shall be carefully inspected to insure its soundness and reliability before main supports are removed.

5. No loads shall be placed upon a reinforced concrete floor before the removal of the form supports which would in any way tend to overstress such supports or those below.

Section 66. Concrete Walls.

1. Reinforced concrete walls shall be securely anchored to all intersecting walls, columns, and floors, and the thickness should be not less than two-thirds that specified for brick walls, and in no case less than 6 inches. Such walls shall be reinforced with steel running both horizontally and vertically.

The amount of reinforcement shall be not less than one-fifth of 1 per cent of the cross-section of the wall. Reinforcement shall not be spaced more than 18 inches apart and shall be wired at intersections. Additional reinforcement shall be placed around wall openings and at places where concentrated loads occur. When reinforced concrete walls are made in two parts with an air space between, the effective thickness may in some cases be less than herein specified.

Section 67. Concrete Floors.

Reinforced concrete floor slabs should never be less than 3 inches in thickness, and this should be increased where spans are long. The amount of reinforcement and its disposition in the floor should be determined by a person skilled in the design of such construction.

Section 68. Concrete for Fireproofing.

1. Reinforced concrete for fireproofing purposes shall consist of a plastic mixture of one part Portland cement to not more than seven parts of fine and coarse aggregate by volume. The aggregate shall be mixed in such proportions as will give the densest mixture.

2. Aggregates for reinforced concrete for fireproofing shall be as follows: Fine aggregates shall be of quality described in Section 10.

Coarse aggregates shall consist of gravel, crushed stone, hard burned brick, terra cotta, slag, or steam boiler cinders, and shall be clean, hard, and free from deleterious material. All aggregates shall be sized to pass a 1 inch screen and be retained upon a ¼ inch screen, and shall be reasonably dry when screened.

NOTE.—Quartz gravel, or any gravel containing a large percentage of silica, should be avoided, as such aggregate makes poor fire-resisting concrete.

3. Cinder concrete may be used constructively as fireproofing, only for floors and roofs between steel beams, and for interior non-bearing walls or partitions.

4. Cinders for concrete shall be composed of hard, well burned vitreous clinker, free from sulphides, fine ashes and foreign matter. The use of gas house or locomotive cinders, or stove or heating furnace ashes, is prohibited.

5. In the selection of cinders for concrete, care shall be exercised to insure that they carry only a small percentage of unburned coal or coke. The amount shall not exceed 15 per cent.

NOTE.—Attention is called to the fact that a properly proportioned concrete made from carefully selected cinders is a most excellent fire-resistive material; but the use of inferior cinders or an improper mixture, that is one which is too lean or too dry, may be productive of danger due either to weakness, or liability to produce corrosion of metal in contact with the concrete.

Unburned coal and coke in cinders serve to introduce sulphur into the concrete, which is likely to corrode metal embedded in it unless the concrete is sufficiently wet and rich enough to furnish a coating of cement on the metal. Sulphides will also tend to deteriorate the concrete under conditions of oxidation.

Soft coal cinders should be used with the utmost caution. Satisfactory concrete can be made from clean, thoroughly calcined, soft coal clinker; but soft coal is very liable to carry with it considerable free sulphide of iron (iron pyrites), and cinders from such coal are almost sure to contain an excess of sulphides, which are fatal to good concrete.

6. Cinder concrete used for fill should consist of one part cement and not more than ten parts of aggregate.

NOTE.—Steel or iron pipes or other ferrous metal construction, when embedded in cinder concrete fill, should be given a coating of neat cement grout, or be encased in cement or lime mortar as a protection against corrosion.

7. When mesh metal fabrics are used for reinforcement in fireproofing concrete, the longitudinal members in the mesh reinforcement shall not be spaced more than 4 inches center to center, and the least dimensions of mesh opening shall be 2 inches. Mesh metal fabrics of all kinds shall have a side lap of not less than 3 inches.

Section 69. Inspection of Concrete.

All concrete work shall be done under the constant supervision of a competent inspector furnished by the owner or architect, who should keep a daily record of the work done, and who should be empowered to require that the materials employed and the methods of construction shall be in all respects in accord with the specifications.

PART XI.

GENERAL PRECAUTIONS FOR FIRE PROTECTION.

Section 70. Fire Extinguishing Appliances.

1. Every dwelling should be provided with some ready means for quickly extinguishing a fire wherever it may occur. Neglect to do this is a violation of ordinary common sense.

2. One or more approved 2½ gallon fire extinguishers, of either the soda-acid or the foam type, should be placed where ready for instant use and not subject to freezing, in every house. Such devices can be purchased for a few dollars each, and are most effective in the early stages of a fire. Their intelligent use during the first few minutes of a fire will usually extinguish it, and are often more valuable than a whole fire brigade which must first be summoned and then perhaps travel half a mile or more to reach the building. Large dwellings should have several of these extinguishers located on different floors where easy of access. One should always be in or near the kitchen.

3. Every able-bodied member of the family should be instructed how to use such devices. Be sure the extinguishers are refilled once a year. This is a simple operation which takes only a little time, and costs but a few cents; if neglected, they may fail to be efficient.

4. If gasoline, kerosene, or other highly inflammable liquids not easily extinguished by water, are used in the home, at least one extinguisher of the carbon tetrachloride, or foam type should be provided. These types of extinguishers are particularly effective in putting out such fires. One or more of them should always be provided in the garage.

NOTE.—Extinguishing compounds of the carbon tetrachloride class, when thrown upon any fire, produce a dense pungent smoke, which is very disagreeable but not dangerous unless inhaled to excess. Avoid breathing the smoke as much as possible, but do not be alarmed at the suffocating sensation of the first breath. Stay and fight the fire until the extinguisher is dry.

A pail of sand, dry earth, salt, or even sawdust is also very useful in extinguishing fires in inflammable liquids. Always keep on hand a small scoop or shovel to apply dry materials. If such fires are not too large they may often be smothered by covering with a rug or blanket. Water will spread such burning fluids rather than extinguish them.

5. A garden hose stored where handy for quick attachment to a service pipe in the cellar or basement, or outside the

house in warm weather, is a very excellent fire protective appliance.

6. A pail of water is the most primitive fire extinguisher known, and is valuable if available during the first few minutes after a fire starts; but there are few places in a dwelling where pails of water can be kept exclusively for this purpose without being unsightly or in the way. Furthermore they must be used at short range and with considerable skill to be effective. For all general purposes an extinguisher which will throw a small stream some distance with considerable force, is far more reliable.

7. For a chimney fire a few pounds of salt thrown in at the top is probably the best handy extinguisher; but a pail of sand, earth, ashes or even coal will be very helpful. If a fireplace connects with the chimney, the latter materials are not desirable to use, since they are liable to scatter the burning soot into the room where the fireplace is located.

Section 71. Care and Repair of Old Chimneys.

1. A chimney in any existing building that becomes too hot to hold the hand against comfortably, is dangerous if there is woodwork touching it. Have it carefully inspected by a reliable carpenter or mason, and apply the protection prescribed by Sections 41 and 42 as far as possible.

2. A smoke test as described in Section 41, Par. 28, is strongly recommended as an excellent means for discovering holes in chimney walls which always indicate danger. If smoke escapes through the chimney walls at any place, the chimney should be repointed or rebuilt as conditions may warrant.

3. Where soft coal is used it is often necessary to rebuild unlined chimney tops every few years, and all unlined chimneys irrespective of fuel used, are very liable to become defective through disintegration of the mortar joints. As an additional means of ascertaining if chimneys need rebuilding, climb to the top and look inside. An electric torch or a lantern let down on a string is an aid in detecting defects. If mortar has begun to fall out from between the bricks it will soon do so all the way through the wall. Take an ice pick or other sharp implement and try to push it through the mortar; if you can do so, rebuild at once as follows:

Tear the chimney down to a point where full solid mortar joints are found, and at least 18 inches below the roof. Then get fire clay flue lining of the same size as the inside measurement of the chimney, set it in the top of the flue and build up with good brick and Portland cement mortar. This will make a solid chimney through the roof where there is greatest

danger, and is the best that can be done unless the flue portion of the chimney is completely torn down and rebuilt. Preserve a clear space of at least 1 inch between the woodwork of the roof and the chimney wall, and connect the chimney with the roof by metal flashings. Build the chimney at least 2 feet above the peak of the roof. See Plates IV and V.

Section 72. Lightning Rods.

It is recommended that all dwellings, particularly those over one story high and fair size, be equipped with approved lightning rods. Carefully prepared statistics compiled for a series of years by various States of the Union, and by the Dominion of Canada, have proved conclusively that properly erected lightning rods are a decided safeguard to isolated or grouped buildings. The U. S. Government estimates the annual property loss in this country due to lightning at $8,000,000, and the life loss at about 500, with twice as many persons injured. This proves the seriousness of the hazard and indicates the necessity for protection. Although lightning rods are not an absolute protection, the figures show that comparing an equal number of rodded and unrodded buildings, the number of rodded buildings struck by lightning are but a very small percentage of the unrodded buildings which are struck.

Buildings with metal roof coverings, connected by metal leaders to a cistern, or into damp earth, are fairly well protected thereby.

NOTE.—Unfortunately there is a widespread impression that lightning rods are useless. This opinion has resulted from the unscrupulous methods employed in past years by lightning-rod vendors, but there is absolutely no doubt that rods properly made and installed are a great protection. See "Recommendations of the National Board of Fire Underwriters for Protection Against Lightning." Also Technologic Paper No. 56 of Bureau of Standards, "Protection of Life and Property against Lightning," contains valuable information upon this subject. Copies of the latter may be procured from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Section 73. Fire Alarms.

There is always danger of fire starting at some unexpected place. Immediate notice thereof may be given by an automatic fire alarm arranged to ring a gong whenever the temperature at any selected point rises faster than a predetermined rate. There are several such devices on the market suitable for use in dwellings. They are not costly, and if properly cared for, may be relied upon to sound an alarm should a fire start in the cellar, kitchen, attic or any other part of the house. The value of such a device is obvious, especially at night.

Section 74. Sprinkler Protection.

The value of the automatic sprinkler as a reliable device to insure a building against loss by fire is being more fully recognized with each succeeding year. It is without question the most efficient and certain of all fire extinguishing devices known. Buildings so protected secure the lowest insurance rates, and the saving is often sufficient to make the installation a good financial investment aside from the other advantages derived.

While the use of the automatic sprinkler has thus far been confined to buildings of business or public character, it is believed the time is fast approaching when it will be generally recognized as a suitable and desirable adjunct to the equipment of large dwellings, at least in those portions where the greatest fire hazard exists.

The cost and maintenance of such an installation might be prohibitory for moderate priced dwellings, but for handsome mansions involving large values, a sprinkler equipment would be a very prudent investment, particularly in isolated localities, or where public fire protection is weak.

It is recommended that in such establishments a sprinkler system be installed which will at least protect the cellar, basement, kitchen, laundry, storerooms, and other parts where particular fire hazards are known to exist, such as workrooms, smoking rooms, library, attic, etc. When such a dwelling is subject to exterior exposure hazard from nearby buildings, it is advised that the windows in the side subject to such exposure be protected by outside dry pipe sprinklers.

A single approved source of water supply would be sufficient for such a system. Where a suitable water supply is not available, there are sprinkler systems designed for such conditions which are supplied by water under pressure from chemical tanks located in the cellar or other convenient place. The cost of a sprinkler system would be a very moderate expense, as compared with sums frequently expended for other purposes on such buildings.

The fixtures can be so placed as not to interfere with decorations or be otherwise objectionable, and the safety secured by such an equipment would fully justify the expenditure, in fact ought to demand it.

Section 75. Miscellaneous Warnings.

Most of the following warnings have been freely published in fire prevention literature, but can well be repeated here.

1. Do not permit painters to burn off old paint with a torch. There are several liquid paint removers in the market which will do the work better and are inexpensive. Warn plumbers and repair men to exercise every precaution in using blow torches or heaters about a building. Carelessness of such workmen has caused many fires.

2. Before attaching electric irons, vacuum cleaners, cooking utensils or any other electrical device to your lighting circuits or sockets, consult an electrician as to the ability of your wiring to withstand this additional load. Electric wiring systems are designed to carry only a certain current, and if overloaded may cause fires. Numerous fires have been caused by leaving electric irons with the current on. Disconnect them immediately when through using.

3. Never keep ashes in wooden receptacles, nor pile them against wooden boxes, barrels or partitions, either in the cellar or outside the house.

4. Do not allow combustible rubbish to accumulate in or about the house; but do not burn quantities of paper, excelsior, shavings, or other rubbish in a fireplace or in the firebox of a stove or furnace. The ashes clog the flue passages, and the long flames are likely to overheat flues or to start soot fires. Burn such material in the ash box beneath the firebox, it does no harm there.

5. In burning rubbish out of doors, keep the fires a safe distance from buildings, and never light them on windy days.

6. Beware of rags or cloths used in oiling floors or cleaning or polishing furniture. They may ignite spontaneously. Be sure and burn them after using, or store in a metal container out of doors. Leaving them about for only a few hours may mean a fire.

The same precaution should be observed regarding oily waste in the garage. It is dangerous. Either burn it, or keep in a closed metal can out of doors.

7. Beware of stove polish which contains benzine or any other inflammable liquid. Numerous serious accidents have resulted from their use.

8. Never bring a kerosene can near a stove which has a fire in it, and never pour kerosene into a stove whether you think the fire is out or not. Many people have burned to death trying that experiment. If you persist in the very foolish habit of using kerosene for kindling a fire, only do so by pouring it on the wood fuel before it is put into the stove, and do that far from the stove or any open flame.

9. Keep kerosene lamps filled and clean. Dirty lamps and those allowed to burn with little oil in them are liable to explode. Avoid filling lamps after dark. If strictly necessary to do so, keep well away from stoves or other lights. Never attempt to fill a lamp while it is burning. If lamps are allowed to burn all night select one that contains more than enough oil. Small paraffine night lamps are much safer.

10. Do not fill kerosene or gasoline lamps or stove tanks quite full. Leave a little space. Read Section 52 on Gasoline Lighting.

11. Do not permit an open flame light in a room where gasoline is stored, and do not fill a gasoline stove in a closed room. Have plenty of ventilation, and always fill by daylight. Gasoline stoves are dangerous. Avoid their use.

12. Do not use gasoline or naphtha for cleaning except in the open air, or at least in front of an open door, and be sure there is no fire or open flame of any kind within the room, or any adjoining room, or even on the floor below. The vapor of such fluids when mixed with air forms an explosive mixture which is exceedingly dangerous. The vapor is heavier than air and will fall to the floor and flow over the surface or down a flight of stairs like water. It may travel a considerable distance from the gasoline itself, and if it comes in contact with fire of any kind it will instantly ignite and flash back all the way to the source of supply. This dangerous feature of gasoline should be fully understood.

13. In using such fluids for cleaning, use only small amounts, and be careful not to spill any. If a spill should occur accidentally in a room, ventilate it immediately by every possible means and look out for fire or flame within a distance of at least 50 feet.

14. Do not wash things in gasoline. Such agitation is liable to produce a spark of static electricity which will ignite the vapor. This danger is especially to be guarded against in cleaning silk. Never rub silk briskly when cleaning with gasoline. Numerous fires and loss of life have resulted from sparks generated in this way. Gasoline, and especially naphtha, aids in production of such sparks.

NOTE 1.—The fact that careless handling of gasoline during the year 1913 in the United States was responsible for over 1,000 persons being burned to death, and more than 3,000 persons badly injured, to say nothing of great property loss, ought to be sufficient argument to persuade any reasonable person of the necessity for observing the precautions here given. There is no reason to suppose the annual death rate from this cause has materially decreased since that date.

NOTE 2.—For full information on dangers of gasoline read U. S. Government Report "Hazards in Handling Gasoline," known as Technical Paper 127, of the Bureau of Mines, Washington, D. C. Distribution free. Also "The Use of Gasoline in the Home," an article in the September, 1915, issue of Safety Engineering, 80 Maiden Lane, New York City.

15. Do not build a fire in an open fireplace and go away and leave it, or use an open fireplace without a substantial fine mesh spark screen.

16. Do not use a stove unless it has proper brick or metal protection underneath.

17. Do not destroy or injure insulation by hanging electric light cords on nails or hooks.

18. Do not leave lighted kerosene lamps near inflammable material, or under shelves.

19. Do not use any matches except safety matches.

20. Do not allow children to have matches, much less play with them.

21. Do not throw burnt matches on the floor or into waste baskets, and never throw away a burnt match until you are *absolutely* sure it holds no spark.

22. Do not hang clothes in contact with or very near hot stoves or stovepipes.

23. Do not go into closets with lighted matches or candles. If necessary to have a light, keep an electric torch for such purpose.

24. Do not decorate a Christmas tree with paper, cotton, or any other inflammable material. Use metallic tinsel and other non-inflammable decorations only. Use asbestos fibre to represent snow instead of cotton.

25. Do not permit children to light or extinguish the candles. They are liable to set fire to their clothing or the tree. Be sure that the tree is securely set so that children in reaching for things cannot tip it over.

26. Do not allow Christmas trees to remain inside buildings after the holidays. The tree itself ignites readily when the needles become dry. A large number of fires usually occur in January from this cause.

27. Do not thaw frozen water or gas pipes by applying a torch or open flame of any kind. Wrap loosely with cotton cloths and pour on hot water, or send for a plumber.

Wreck of a house due to hunting a leak of illuminating gas in the second story with a lamp. Comment is unnecessary.

28. If the smell of gas is strong in a room, first open all doors and windows, and then seek the leak. Never stop a leaking pipe or fixture with wax, putty, adhesive tape, cork or wooden plug or other makeshift, except as an emergency stop pending permanent repairs. Send for a plumber. If light is not needed elsewhere in the house, it would be safer to cut off the supply at the meter.

29. Never make a light in a gas filled room, and never seek a leak with a naked flame of any kind when gas is escaping freely;

if a light is necessary use a hand electric torch. Breathe gas very cautiously, it is dangerous to life.

30. If there are rubber connections to gas appliances, substitute solid metal pipes where possible; in other cases see that the rubber tubing is in first class condition.

31. If electricity is used inspect the wiring carefully wherever exposed. If you find the insulation ragged anywhere, or if you have doubt whether the wiring is in safe condition, call an electrician and have it put in condition so he can approve it. Do not take the chance of having a fire give you the first warning that electrical hazards exist.

32. Do not pile soft coal against a furnace wall or near it. Soft coal is liable to spontaneous ignition, and heat increases the hazard. Always keep soft coal piles as shallow as possible; better not to exceed 3 or 4 feet high.

33. Do not bank houses in winter with leaves, straw, or other readily inflammable materials, unless entirely covered with earth; a chimney spark or a carelessly thrown match or cigarette may ignite it.

34. If your house has a shingle roof, and sparks are falling anywhere in its vicinity from some fire however distant, proceed immediately to wet the whole roof. Wind is very freakish, and might change in an instant and flood the roof with sparks. After wetting it, stand by with a hose, fire extinguisher, or even a pail of water and a dipper, to extinguish any coals that may fall upon it.

Wooden houses have been saved from a nearby fire by nailing carpets or blankets on the exposed side from the eaves downward and keeping them wet.

35. Do not depend upon your landlord to protect you; inspect your home yourself from cellar to garret, and insist that things which are unsafe be made safe.

36. If you do not feel competent yourself, to make the structural inspections indicated in this section or elsewhere in this pamphlet, ask the Chief of the Fire Department to send you a man, provided you are within the jurisdiction of such an organization; otherwise select a competent builder, and give him a copy of this pamphlet for his guidance.

37. Remember above all other things that *Carelessness is your worst enemy as regards safety from fire.*

Section 76. Suggestions in Case of Fire.

1. First of all and most important, do not lose your self-control. Decide what you will do and how you will do it, before you attempt it.

2. The moment a fire is discovered have someone immediately summon outside assistance; always call the Fire Department first if you have one. If the fire is not already hopelessly beyond control, use every extinguishing device at hand, and do not give up the fight until absolutely compelled to do so. It is safest to call the Fire Department when one is available, even though you may have extinguished a fire without its aid. There is always danger of some fire escaping attention and breaking out at another place when you are off guard. This is especially true when the house construction has been on fire. Better have an expert examination.

3. Permit no door to be opened into a room where a fire is burning except the one necessary to fight through. Never run from a fire and leave a door open behind you. The less air a fire has the slower it will burn.

4. Do not attempt to extinguish flaming window curtains or clothing with the bare hands; smother such a blaze with a blanket, small rug, coat, or anything available which will protect the hands. Women should never attempt to stamp out a blaze; there is great danger of their clothing catching fire, and thereby losing life.

5. If exposed to smoke or flame, wet a towel, handkerchief, or a piece of clothing and stuff it into the mouth. Breathe through it instead of the nose. It will keep smoke and heat from the lungs, and the moisture will be helpful. Do not scream or inhale deeply if in flame or smoke. A deep breath may cause unconsciousness or even death. More people lose their lives in a fire by suffocation than by actual burning.

6. Remember that smoke and heat rise, and the nearer the floor you get the better the air. If necessary to cross a smoke filled room bend low, or go on hands and knees, and follow the wall around to the desired doorway. The air is better along the wall, and the wall serves as a guide, thus preventing confusion and loss of bearings. Always breathe at an open window if possible, and keep near it if awaiting help.

7. Never jump unless the blaze is scorching, and not then if firemen are near. Wait a minute longer until they can spread a life net or reach you by ladder. Remember that a jump to the pavement or the ground from any story above the second is almost certain death.

8. If no help is at hand and you must get out of a window, throw a bed mattress out, if one is available, and try and drop on that. Better still, make a life line by ripping bed sheets through the middle, join the ends by square knots carefully tied to prevent slipping, and add to the length by tying in by the corners any blankets that may be available. Tie one end securely to a steam radiator, or to the body of a metal bedstead if either are at hand; or pull out the side bar of the bed, support it on a couple of chairs in front of the window, and at the middle tie one end of the line; or fasten it to a large table leg or a large chair so arranged as not to be pulled through the window. If there is danger of this, pull down the window sash from the outside before you slide down the line. Should there be flame issuing from a window below through which you must pass, wrap a blanket or a coat around your head, and do not drop the line until the instant you are ready to descend, otherwise it may burn and drop you. If possible to wet the line it would be a great help. Even though such a line does not reach entirely to the ground it may reduce the distance to a safe drop.

9. If a rope is available use it in the same manner, but never attempt to slide down it without protecting the hands with a towel or piece of bedding or clothing. Grasp the rope firmly in both hands, twist it once around the right leg, then place it between the feet, keeping them close together, and slide slowly.

10. Familiarize each member of the family with the operation of the nearest fire alarm box. If you are not sure how it operates, make it your business to find out. Many a fire has been unnecessarily disastrous because the person supposed to send the alarm failed to do so through ignorance. After operating a fire alarm, stay near it to direct the firemen to the fire. Every minute is significant.

11. Have the telephone number of the nearest fire station on a special card at your telephone. In using a telephone for a fire alarm do not fail to give name of the street, the house number and the nearest corner, or names of streets or roads between which the house is located, or other means of identifying the building where the fire is. Excited persons frequently make such calls and give no information except to say the house is on fire, or else give the telephone number. Such calls are useless. Be sure you make the location of the house clear before you leave the telephone.

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