SAFETY
IN
BUILDING CONSTRUCTION

THE TRAVELERS INSURANCE COMPANY
HARTFORD, CONNECTICUT

THE TRAVELERS INSURANCE COMPANY
INDEMNITY COMPANY
Hartford, Connecticut

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7899. 3-21-'16.

PREFACE

So far as we are aware, no general discussion of the hazards of building construction has been published in this country, nor does it appear that any systematic and determined effort has been made, by legislation or otherwise, to reduce the number of accidents in this class of work. Nearly every city and large town has building laws, but these relate, as a rule, mainly to the safety of the building when it is completed, and there is little in them relating to the safety of the workmen during the construction of the building. Building contractors, with a few exceptions, give comparatively little time or thought to the consideration and enforcement of safe methods and practices, as may be seen by anyone who will make even the most superficial examination of a building in course of construction. Yet the need for greater attention to the safety of workmen in the building trades is plainly evident, because many very serious accidents occur.

In the various operations of building construction, many lives are annually sacrificed that might be saved if proper precautions were taken. Not many years ago there were few buildings more than five or six stories high, and even at that time numerous accidents occurred. As modern business, both mercantile and manufacturing, became more localized and necessitated the employment of vast numbers of persons, and suitable building sites became more valuable, it

became important to increase the height of buildings, so that to-day in our large cities structures of twenty, thirty, or forty stories, or even more, are comparatively common. These greatly-increased heights, together with the radical changes in construction methods and materials that accompanied them, have naturally tended to increase the number of serious accidents.

Modern safety engineering methods have kept pace with modern construction methods, however, so that the accident rate under the new conditions is probably no greater than that which formerly prevailed, provided the inspection service and the supervision are of the best.

As a class, the men engaged in construction work are fully as heedless with regard to their own safety as employees in other industries, while the natural hazards of the work are far greater than in many other lines. It is therefore important to consider what is known as the "human element", and especially that part of it which relates to the attitude of the men with regard to accident-prevention methods and devices, and their willingness to conform to definite regulations in order to prevent accidents. This has an important bearing on accident-prevention work, because in addition to the accidents due to physical causes such as defective material and equipment, inadequate inspection and supervision, lack of suitable safeguards, and various other circumstances and conditions, a large proportion of the accidents in all industries can be attributed, more or less directly, to carelessness or negligence.

There is no more authoritative source of information with regard to accident prevention in building

construction than the Engineering and Inspection Division of THE TRAVELERS INSURANCE COMPANY. In connection with their inspection work upon buildings in course of construction, our safety engineers have made a careful and exhaustive study of this subject in all its phases. They have made continuous inspections of many of the largest buildings in the world, during the entire period of erection; and they have also followed the construction of thousands of smaller ones. They have therefore had unexcelled opportunities for gaining a practical, first-hand knowledge of the hazards that arise in work of this kind, in connection with operations of all sorts.

Experience has shown that the recommendations that our engineers and inspectors have made in connection with construction work have materially reduced the accident rate; and in order to extend the benefits of our work as much as possible, we have brought together a considerable number of these recommendations, and incorporated them in the present book.

In preparing this work, no attempt has been made to deal with the subject exhaustively, because to do this would require a volume too large for convenient use and reference. Some branches of building construction,—foundation work, for example,—have been omitted or passed over with but brief mention, because it has seemed best to treat them separately, in future publications. Many of the hazardous operations of construction work are covered, however, and we believe that the present work will meet with favor, and that it will prove itself a valuable addition to the publications on practical accident prevention that our Engineering and Inspection Division is now putting forth.

Every person who engages in construction work, and every inspector who has to follow the progress of such work, should take special care to inform himself with respect to all laws and ordinances, bearing upon the conduct of the work, that may be in force in the particular locality in which the operation is to be carried out. All such laws and ordinances must be faithfully obeyed, and preference must be given to them without hesitation in case they happen to conflict with counsel given in this book.

THE TRAVELERS INSURANCE COMPANY,

Hartford, Connecticut.

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SAFETY
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I. DEMOLITION WORK.

1. In General. In many cases it is necessary to remove existing buildings before any actual construction work can be done. The wrecking of a building appears to the inexperienced observer to be a simple and an easy task, but it nevertheless calls for experience and skill, because there are many dangers connected with it, even when the structure to be demolished is quite small; and in the case of a large structure these hazards are multiplied many times. Every such job should be supervised by a person of sound judgment, who should also be capable of handling the working force competently and effectively. The men should be selected, so far as possible, with reference to their capabilities, and each should be assigned to the particular kind of work for which he appears to be best fitted.

2. Planning the Work. Before beginning the actual work of demolition, a careful study should be made of the structure that is to be torn down, and of its surroundings; and a definite plan of procedure should be mapped out, which should thereafter be

followed as closely as possible. This is especially important when haste is essential, because the work can be executed much more rapidly and safely when it proceeds in accordance with a definite scheme than when it is carried out in a haphazard manner. In formulating the plan it is necessary to consider the security of adjoining buildings, and to make adequate provision for their safety.

3. Shoring Adjoining Buildings. Extensive shoring of other buildings is often imperative, and full provision should be made for carrying out all necessary operations of this kind promptly and thoroughly, and in a safe and workmanlike way. When a fire, flood, explosion, or other catastrophe has partially wrecked a structure, it may also be necessary to shore up or brace some of the walls or other parts of the building that is to be taken down, before the wrecking operations can be safely started. If the foundations of the building that is being razed extend below those of the neighboring buildings, only short sections should be removed at one time. The neighboring foundations may then be undermined, also by small portions, and extended to the level of the new foundations. When loose soil is encountered, and also when foundations extend to a considerable depth, it is often necessary to use sheet piling.

4. Gas and Electricity. Make sure, at the very outset, that the gas pipes have been disconnected, and that all electric wires in the building are "dead". If a strong odor of gas is subsequently perceived, stop the work until the source of the gas has been discovered; and do not allow the men to look for it with lanterns nor with open lights of any other kind.

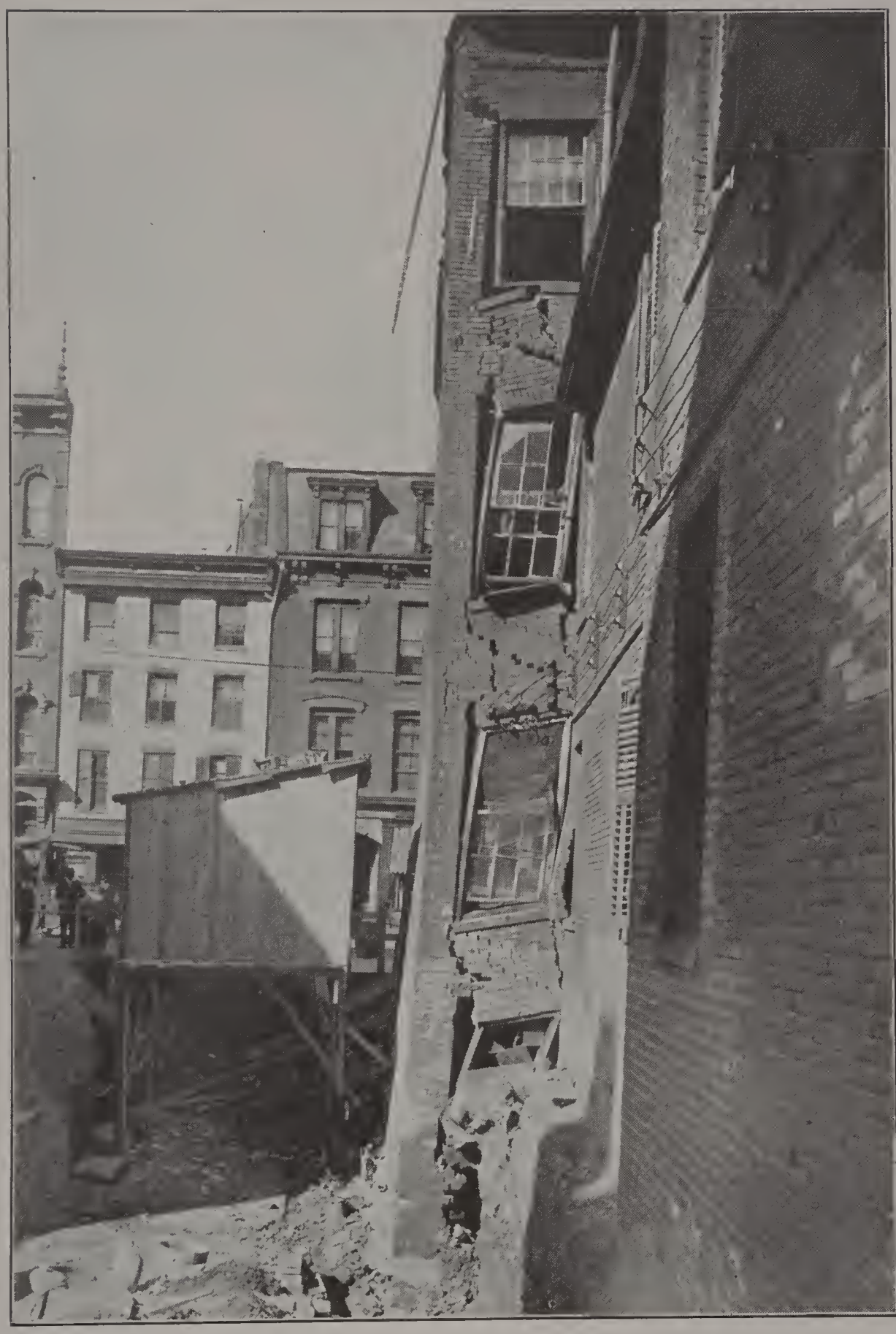


FIG. 1. DAMAGE CAUSED BY EXCAVATING WITHOUT ADEQUATELY SHORING THE WALL OF THE ADJOINING BUILDING.

5. Order of Procedure. The demolition work should always proceed systematically, story by story; and the work on the upper floors should be entirely completed before any of the supporting members or other important parts on the lower floors are disturbed. By proceeding in this orderly manner it is easy to eliminate various dangerous conditions, such as weak and unsupported walls and chimneys, towering above the workmen.

6. Throwing Down Material. If material is to be thrown from an upper floor, place watchmen on the ground where they will command every means of approach, to warn all persons who may come near, and prevent them from entering the region of danger. Except in special cases, however, material should never be thrown down in this way. It is far safer to lower it by means of ropes or hoists, or to send it down through covered chutes. The men should be specially forbidden to throw heavy masses or large quantities of material from the upper floors down upon the lower ones.

7. Material Chutes. Chutes should be provided, in all cases, for the removal of bricks and other loose debris, and they should be completely inclosed so that it will be impossible for the material to escape from them before it reaches the bottom. To prevent the descending material from attaining a dangerous speed, the chutes should not extend in an unbroken line for more than two stories. Gates or stops should be placed at both the top and bottom of each chute, and the upper gate, as well as the lower one, should be arranged so that it may be operated by the workman at the lower end in case the material becomes jammed.

FIG. 2. ANOTHER VIEW OF THE BUILDING SHOWN IN FIG. 1.
(Note the crude ladder at the right of the engraving.)

If jamming occurs, do not attempt to loosen the material by hand, but use pickaxes, shovels, or tools of some other appropriate kind. Place a danger sign at the discharge end of every chute, and do not permit workmen or other persons to stand near a chute, nor to leave teams near one, except while loading from it. Flashboards of extra height should be placed on a wagon that is to be loaded from a chute, and the mouth of the chute should be surrounded by a short length of stout canvas or burlap weighted with a short piece of scantling or studding, to prevent material from bounding from the chute into the street.

8. Removing Walls in Sections. Sections of wall should never be loosened and allowed to fall as single masses upon the floors of buildings that are being demolished, because the shock transmitted to the floor may cause it to give way; and chimneys and large sections of wall should never be pulled down bodily, even upon the ground, without taking every possible precaution to avoid accident, not only to the workmen but also to other persons. When an operation of this nature is about to be performed, a crowd of idle sight-seers usually congregates at the nearest place from which a good view may be had, with but slight regard for their own safety. The man in charge of the work should see that all such persons retire permanently to a place well beyond the danger zone before the wall is disturbed.

It is always better and safer to remove walls part by part, rather than to throw them down bodily; and if they are so thin or weak as to make it dangerous to stand upon them to remove the bricks and stones

of which they are composed, scaffolds or stagings should be erected beside them, for the men to work upon.

9. Use of the Oxy-acetylene Cutting-flame. In demolishing buildings containing steel beams or other metallic structural elements, the oxy-acetylene flame is now widely used for cutting the metal. Work of this kind should always be done by an experienced man who thoroughly understands the process, and who also has sufficient knowledge of structural principles to avoid cutting off important members that are required for supporting or strengthening the part of the building that still remains standing.

Beams that are about to be cut should first be properly secured by ropes or chains, so that they cannot drop or swing when they have been cut away from the other steelwork to which they were attached. When the cut is completed the two ends are often held together by fused oxide, so that a blow from a sledge is necessary to separate them. However well the beam may have been secured, it is likely to swing slightly when the ends are finally severed, and unless the workman is watchful his hands may be caught and crushed or bruised.

Continued exposure of the unprotected eyes to the acetylene flame acts injuriously upon them, and all operators of acetylene torches should be provided with colored-glass goggles, and should always wear them when working. They should also wear suitable gloves to protect their hands in case of accidental contact with the heated metal.

Acetylene gas is poisonous, even when highly diluted with air, and care should be taken to avoid

inhaling it. It acts upon the blood in a manner similar to carbon monoxide, the effects of which are well known in connection with coal-gas poisoning. Special care in this respect should be exercised when using the acetylene torch in confined spaces.

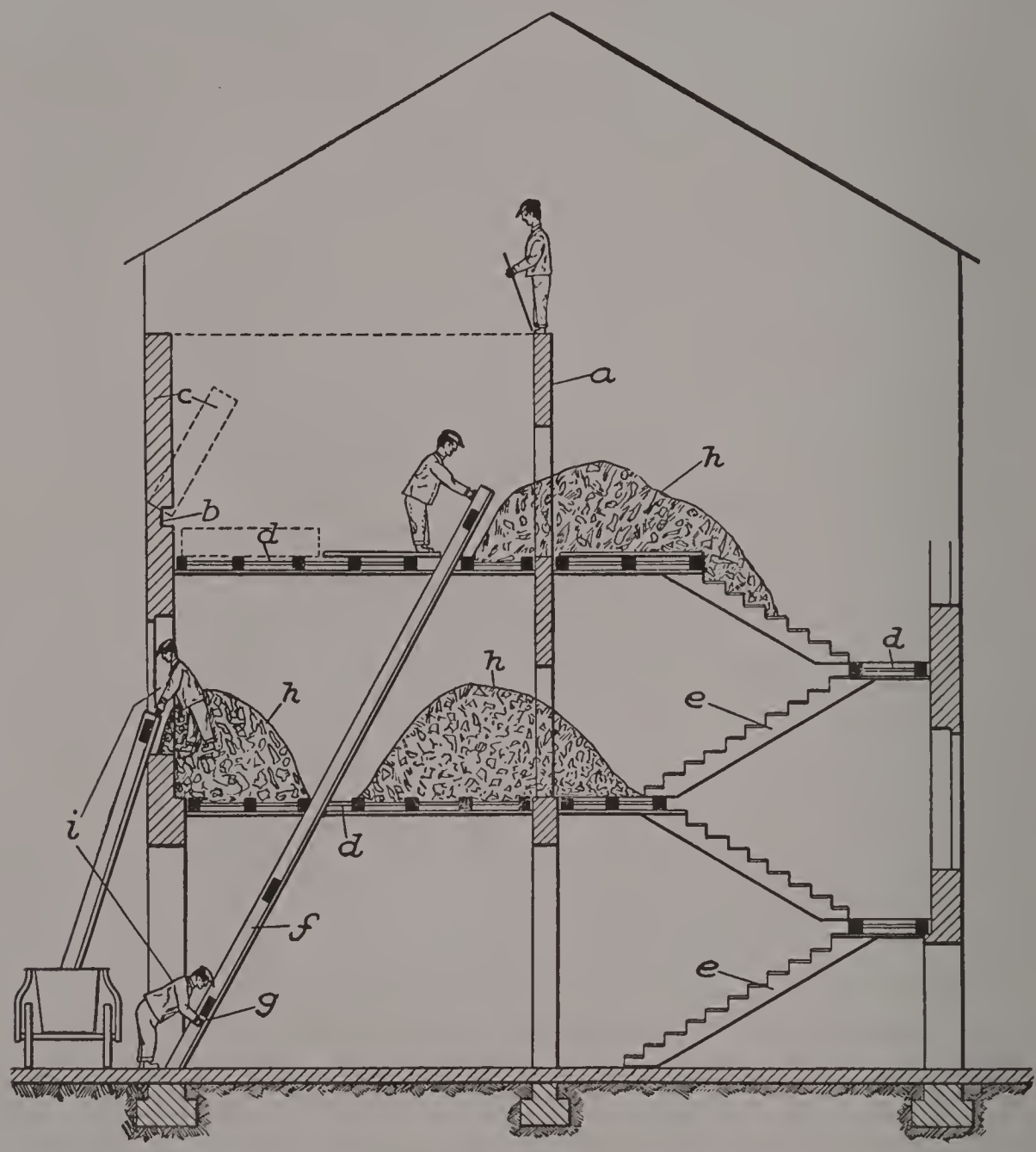


FIG. 3. HOUSE-WRECKING: DANGEROUS METHODS.

a. Thin, shaky, or insecure walls should be scaffolded.
b. Walls and columns must not be undermined.
c. Sections of wall should not be thrown down bodily upon the floors.
d. Floors or joist-layers upon which work is being done should be tightly covered over with boards.
e. Stair railings should be left in position as long as possible.

Combustible material of every kind should be removed from the immediate vicinity of the acetylene torch, because fires may be started by direct contact with the flame, or by the fall of highly-heated pieces of metal or of oxide.

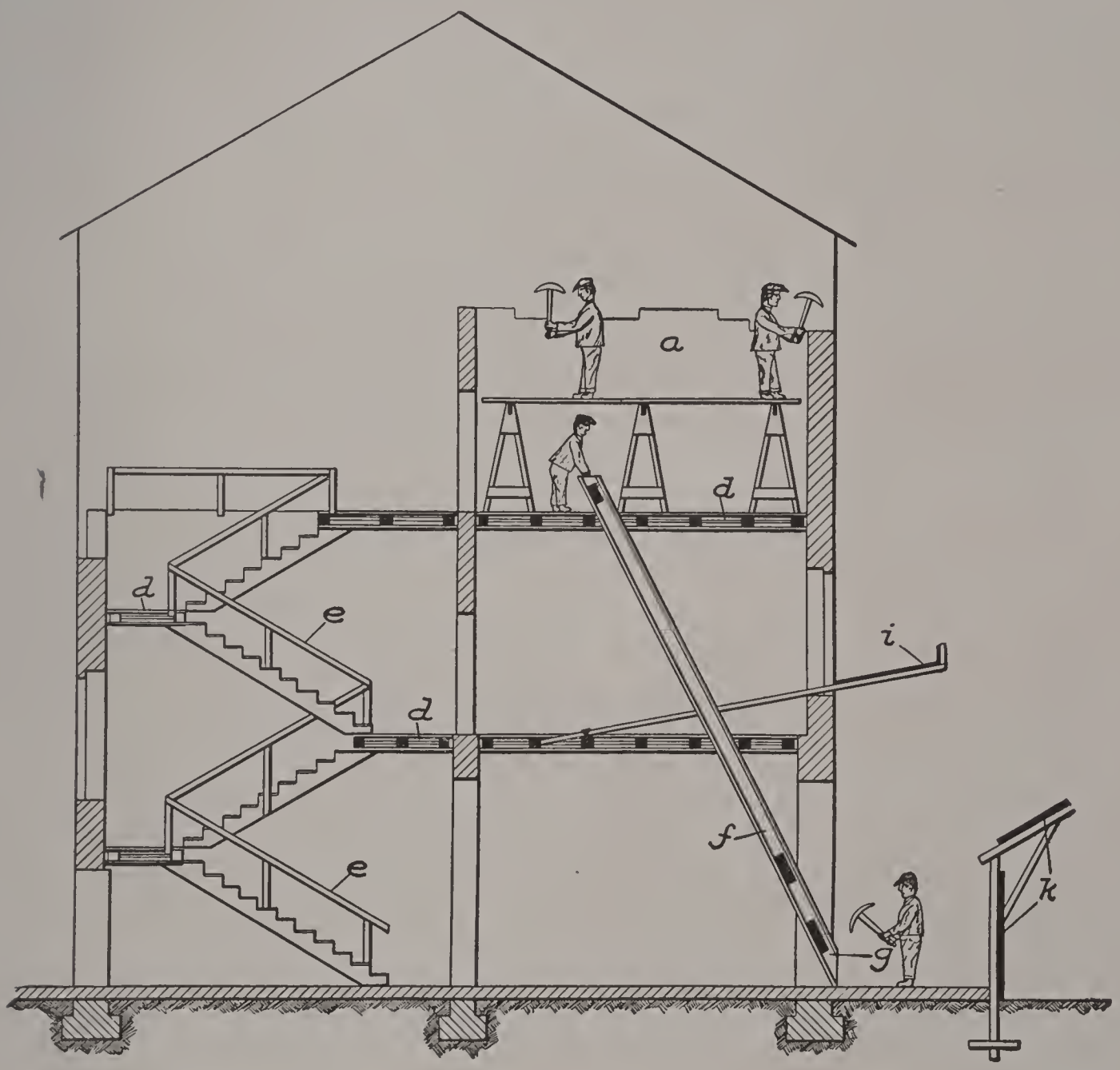


FIG. 4. HOUSE-WRECKING: SAFE METHODS.

f. Chutes must be fully inclosed, on all sides.
g. Do not remove materials from the chutes with the hands. Use picks or other suitable implements.
h. Wreckage and rubbish must not be stored upon the floors of the building.
i. Men should not work one above another without adequate safeguards.
k. Plank shields for protecting persons on the street.

Be careful in handling tanks containing oxygen under pressure, and never permit them to be dropped, nor to be subjected to shocks of any other kind. Do not allow such tanks to be exposed for any considerable time to the direct rays of the sun, nor to a high temperature from any other source, because the heat will increase the pressure and may cause the tanks to rupture.

10. Miscellaneous. To prevent tools and loose materials from falling upon persons below, openings in floors should be kept covered over, except while they are in actual use; and all such openings, when they are being used for hoisting or for other purposes, should be guarded by substantial railings and toeboards installed on at least three sides of each opening. Old materials and rubbish should be removed from the premises as fast as they accumulate, and should not be heaped up on the various floors, nor on the ground immediately outside of the building. Bricks and stones that have been removed, and that are to be preserved for future use, should be stored in orderly piles not more than five feet high, and the piles should be braced, if necessary, to prevent them from falling over. Piles of this nature should not rest directly upon the ground, but should be laid upon foundations of planks or boards. If it is necessary, for any reason, to store old material within the building for a time, great care must be taken to avoid overloading the floors.

Sharp or jagged pieces of material or refuse should be promptly and carefully disposed of, and to prevent injuries from flying pieces of glass, the windows should all be removed during the early stages of the demoli-

tion work, and no broken glass should be left lying about in the building. It is also important to wet down the floors, stairways, chutes, and various other places, as often as may be necessary to keep down the dust.

Figs. 3 and 4, which are adapted from Schlesinger's "Unfallverhütungstechnik," will serve to emphasize some of the points that have been discussed in this section. To facilitate comparison, the reference letters have the same significance in both views,—the dangerous mode of procedure being shown in Fig. 3 in every case, and the corresponding safe one in Fig. 4. In several instances, however, a letter that is present in one view is omitted from the other one, because it would have no significance there.

II. EXCAVATION WORK.

11. General Suggestions. The work of preparing the foundations for a building is too important to be fully discussed in this book; but there are certain suggestions with regard to excavating which may properly be included, and which will make the work much safer if they are followed.

Special precautions should be taken to avoid undermining the foundations of adjoining buildings. Whenever there appears to be any danger from this source the excavation work should be carried on in short sections, as already explained in paragraph 3, and the corresponding sections of the building walls should be substantially shored up or braced, or other effective means should be adopted to prevent the walls from settling or being damaged in other ways. It is also important to thoroughly prop up or brace the walls of excavations on the sides adjoining public streets, and at all other points where there is any danger of the caving-in of the earth.

Excavations should be guarded on all sides by fences or railings; and all rocks, boulders, loose soil, and material of every kind should be kept back at least four feet from the edges of the openings.

Inspect the walls of excavations frequently and thoroughly, particularly after heavy rainstorms, and do not let the employees work at any point where a cave-in seems probable, until adequate measures

have been taken to safeguard them. In particular, do not permit anyone to work under an overhanging mass of earth or rock that has not been made safe by the use of shores or props or other supports of undoubted strength and effectiveness.

When horses are used on the work, provide suitable inclines of ample width for wagons loaded with the excavated material, and see that proper precautions are taken to prevent the wagons from tipping over.

Whenever possible, the excavation work should be entirely completed before any building material is stored on the premises. Sometimes structural steel, timbers, brick, tile, and other materials are deposited in the partly-finished excavations, often with insuf-

FIG. 5. EXCAVATING FOR A LARGE OFFICE BUILDING.

(View from above. Excavation has begun on the left, and the demolition of the building previously on the site is still proceeding on the right.)

ficient care in storing and piling them, and these increase the difficulties and dangers of the work.

Various mechanical appliances are used in excavation work, including derricks and steam shovels. The chief precautions to be taken in the operation of derricks are described in Section V.

See also paragraph 56, page 92.

12. Steam Shovels. The steam shovel is a prolific source of serious accidents. Many of these result from the breaking of the ropes or cables. When a cable gives way, the engineer is likely to be struck by the loose, flying end, unless a protective device of some kind is placed between him and the winding drums. A satisfactory guard may be made of heavy wire-mesh screen secured to a stout iron framework. This forms an effective protection that will not interfere with the engineer's work, nor obstruct his view.

The necessity for oiling the sheaves or making repairs at the point of the boom has led to many accidents. Workmen, encumbered with oil cans and tools, often fall when climbing out to the boom end, and receive serious injuries. Ladders or steps (provided with hand-rails when this is practicable) can be placed on the booms without interfering with the operation of the shovels, and in this way much of the danger attendant on the care of the booms can be eliminated.

The crank-shafts, as well as all exposed gears and set-screws, should be guarded or covered, even though no employee approaches these parts in the ordinary operation of the shovel. The hoisting chain or cable, at the bottom of the boom, should also be guarded. This part of the apparatus may be out of reach of

anyone on the ground level, yet it may cause an injury to a man on a wagon as the boom swings around.

All ladders, steps, handholds, and other similar safeguards should be kept in a good state of repair. Snow, ice, and slippery mixtures of dirt and grease, should be removed; and oil-cans, picks, and other tools and implements should not be left about where persons may stumble over them.

No employee or other person should be allowed on a steam shovel unless his duties require him to be there, and all persons should keep well away from the range of the shovel's swing. This latter precaution is especially important when the shovel is loading material into wagons. Stones, or lumps of other heavy material, are likely to roll off as the shovel swings and drops its load on a wagon, and anyone standing near is likely to be injured by the falling fragments. Under some conditions, men may be engaged in drilling and blasting operations, close to the point where the shovel is clearing up the material loosened by previous blasts; and in cases of this kind special care should be taken to prevent either crew from injuring the other one. It is not at all uncommon to see a shovel with pieces of rock projecting over the edge, and these pieces often fall off. It is particularly important, in such cases, for the workmen to keep away from the path of the shovel, and to assist them in doing so the shovel operator should sound the whistle before starting to hoist.

Care should be taken to prevent the upsetting of the shovel, which may be caused by an excessive load or by the yielding of the ground upon which the shovel rests. An experienced and cautious shovelman should

be able to prevent accidents of this kind without mechanical aids. Under some circumstances, however, it has been found advantageous to secure a U-tube, partly filled with mercury, to some part of the framework of the shovel,—arranging the tube so that an electrical connection will be made and a gong sounded, in case the shovel is tilted to a dangerous angle.

Every steam shovel should be in charge of a competent man having a thorough knowledge, not only of shovels, but also of the operation and care of steam boilers and steam engines. Electricity has recently been introduced, in place of steam, as a motive power for shovels; and where it is used the hazards that are incident to electric power have also to be considered. The rough service characteristic of shovel work calls for frequent and careful inspection of the electrical apparatus, with special reference to the detection of defects that may interrupt the supply of current at critical moments. (See also the suggestions with regard to boilers and electrical apparatus, in paragraphs 21 and 22, respectively.)

III. PROTECTION FOR THE PUBLIC.

13. Sidewalk Sheds and Bridges. Whenever the structure that is being demolished or erected stands close to a street, or to a much frequented thoroughfare of any other kind, special precautions of an adequate and effective nature must be taken to protect all persons who may pass by. Under some conditions it may suffice to fence in the space to be occupied by the building, and in such cases it is advisable to construct the barricades of boards set tightly together and extending to a height of at least 7 feet, so that passers will be unable to look over or through them, and will therefore have no incentive to loiter in the vicinity. At other times it is necessary to construct a shed or bridge or a combination of the two, covering the entire width of the sidewalk in front of the property; and if the adjoining street is narrow and the building is to be of considerable height, it may be necessary to extend a protecting shed over the entire street. Structures of this kind must always be strong and substantial, because it frequently happens that heavy objects fall upon them from considerable heights. Moreover, materials are often stored upon the tops of these sheds (although this practice is not to be recommended), and for this reason, also, substantial construction is essential.

Always install a fence and toe-board on the top of every covered sidewalk shed or bridge at its outer

edge, to prevent materials or objects of any kind from sliding or rolling off into the street, whether they are stored upon the shed or fall down upon it from above. Stout wire netting having a mesh not larger than half an inch square is often used in the construction of these fences, and when netting of this kind is strongly made and firmly secured in position it answers the purpose admirably. Provide substantial guard-rails and toe-boards on both sides of uncovered sidewalk bridges, and install hand-rails on all steps leading to these bridges.

For some strange reason the office of the head contractor, on the sidewalk bridge, is often located in an unnecessarily dangerous place, where it is likely to be struck by stones or by other objects that may fall to the bridge. Convenience requires that the office be near the work, but there is frequently a great difference in the exposure, according as it is built at one part of the sidewalk bridge or at some other part. Needless hazards of this kind should be avoided.

14. Street Coverings. When the entire adjoining street is covered, and holes are left in the covering, through which material may be hoisted, hinged covers composed of two-inch planks should be provided for the openings, and the covers should be raised and lowered by means of blocks and falls. In addition, guard-rails and toe-boards should be installed on all four sides of the openings, and the whole inclosed with heavy wire netting. These guards should be set back at least two feet from the edges of the openings.

15. Protective Platforms. In addition to the sidewalk shed it is sometimes necessary, on a high

FIG. 6. A GUARD TO INTERCEPT FALLING TOOLS AND OTHER OBJECTS, WHEN MEN ARE WORKING ABOUT WINDOWS.

building, to extend protective platforms out from the building at different heights, to catch falling material and prevent it from descending into the street. A platform of this description may advantageously be 15 feet or more in width, and it should be protected along its outer edge by substantial wire-mesh screens, similar to those described in paragraph 13. In the

construction of the Woolworth Building, platforms of this kind were installed at four different levels.

16. Protecting Pavements. Where heavily-loaded teams are driven across the sidewalk it is necessary to remove the pavement, or to cover it over in some way so that it will not be broken. Municipal regulations often require that the street pavement be protected against damage also, particularly when it is of sheet asphalt. It is customary to lay heavy planks over the pavements for this purpose, and care should be taken to see that no holes are left into which persons may step, and that the planks are level and are arranged so that they will not tip up at the ends and cause persons to stumble. It is often advisable to lay beveled planks at the sides and ends of protective coverings of this kind, and it is always important to

FIG. 7. A POORLY-MADE PROTECTION FOR A SIDEWALK.

(The broken planks near the curb should be removed and replaced by others that are sound and stout; and the boards on the sidewalk should be arranged so that they cannot tip up at the ends.)

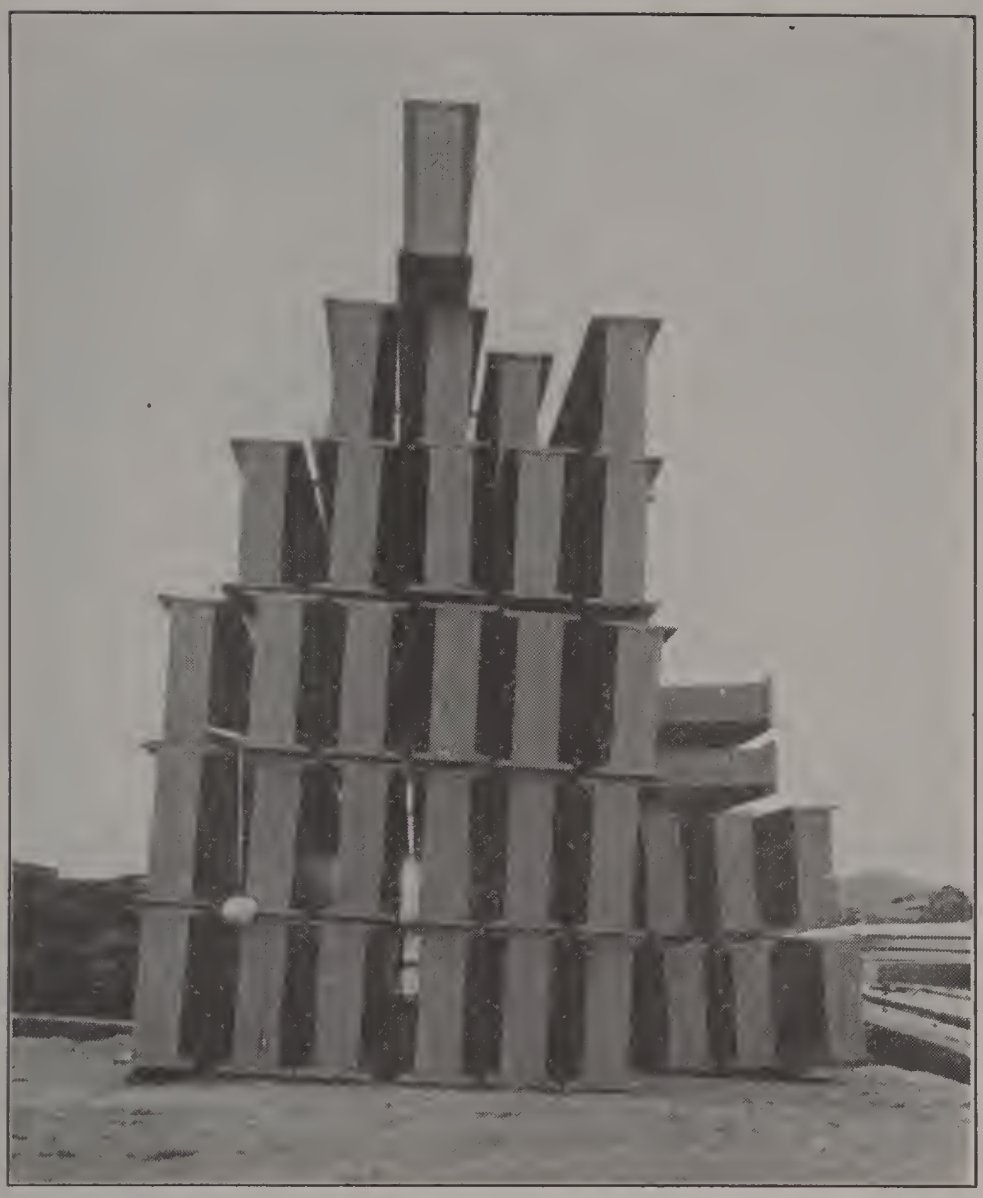


FIG. 8. UNSAFE PILING OF HEAVY STEEL GIRDERS.

(These are piled unnecessarily high. Moreover, the pile leans to the right, as shown by the improvised plumb-line.)

see that there are no projecting nails or large splinters that might cause injuries.

17. Storing Materials. When building material is stored in public highways, great care must be exercised to see that it is properly piled, so that it cannot fall over or collapse. It should be arranged so as to obstruct traffic as little as possible, and should in no case cover more than one-third of the width of any public highway. The piles should also be guarded at night by an adequate number of lights, located at conspicuous points.

18. Excluding Persons from Buildings. All unauthorized persons should be excluded from places where demolition or construction operations are going on, not only because they are likely to be injured, but also because they often interfere with the workmen. When practicable, gates or doors may be installed to keep out all persons not directly connected with the work, or watchmen may be stationed at the entrances for the same purpose. Special arrangements may be made on behalf of persons seeking employment, either by designating certain hours when they will be admitted, or, preferably, by receiving them at some convenient point outside of the region of danger.

IV. HOISTING.

19. Location and Protection of Hoisting Engines. It is often necessary, at least during the early stages of building construction, to locate the hoisting engines in the public highway. This must necessarily result in obstructing traffic to some extent, and there are also various other objections to this arrangement, so that it is desirable to install the engines within the building as soon as the work has advanced to a stage where it is possible to do so. There are many advantages to be gained by placing the engines on the second-floor level, particularly on large construction jobs, because here they are out of the way of supplies and materials that are often brought into the building in trucks or wagons and stored upon the ground floor. Furthermore, this arrangement simplifies the protection of the hoisting cables and signal cords or wires that extend in different directions to various parts of the building.

Regardless of the location of the hoisting engines, substantial roofs should be erected over them to intercept falling objects; and it is preferable to entirely inclose them, to protect the operators and the engines from inclement weather, until such time as the permanent floor immediately above is in place, and the walls of the building have been carried up beyond the floor level on which the engines are located. Whenever the hoisting engines are located in the street, all

FIG. 9. UNPROTECTED HOISTING ENGINE, CABLES, AND GUIDE BLOCKS.

(Note, also, the state of general disorder that characterizes the workplace as a whole.)

large structural steel members and blocks of stone, and all other heavy and massive objects should be hoisted on the side of the building opposite to that on which the engines are installed, when conditions will permit. Serious accidents have occurred when this precaution has been neglected.

20. Types of Hoisting Engines. Hand-operated derricks and hoists of various types are quite generally employed on small construction jobs, and for certain parts of the work on larger ones. In large operations, however, steam engines or electric motors are indispensable. Provide effective protection for the exposed gears of all hoisting engines and motors, and guard all crank-shafts, sprocket wheels and chains, projecting set-screws and keys, and all other dangerous moving parts. See that a suitable space in the vicinity of hoisting engines is kept clear of unnecessary ropes and other objects that might become caught in the moving parts. Provide adequate and effective brakes for every hoisting engine, capable of holding the maximum load in any position. All hoists should be kept under perfect control at all times, and particularly when lowering heavy loads. Reliable limit-stops should be provided on all mechanically-operated hoists, to prevent overwinding.

21. Boilers. Give special attention to the boilers of all steam hoisting-engines, because the conditions under which they are operated are likely to cause more rapid deterioration than would be the case with stationary boilers. Periodical inspections by experts are essential, and all recommendations made by them should be promptly and carefully attended to. See that each boiler is provided with a reliable safety-

valve, steam gage, water column, gage glass, and try-cocks, and test all of these devices frequently to make sure that they are in good working order. Keep the interior surfaces of the boiler clean, and free from scale and sediment. Before leaving for the night make sure that there is plenty of water in the boiler, and that the fire is properly banked and checked; and always ascertain the level of the water before unbanking the fire in the morning. See that all steam and water connections about the boiler and engine are kept tight, to prevent scalds and burns.

22. Electric Motors. Electric motors are rapidly supplanting steam engines for hoisting work in many localities, and their use is particularly desirable in congested districts where the smoke, cinders, and steam from the boilers of steam hoisting-engines would be objectionable. Care must be taken to avoid shocks and burns when electric power is used, and therefore all parts of the electrical equipment should be inspected frequently and thoroughly, to see that everything is in good condition. Never permit unauthorized persons to tamper in any way with electrical apparatus, and see that all repairs and adjustments are made by competent electricians.

An electric hoist should always be operated in strict conformity with the directions issued by the makers of the apparatus. In certain forms, for example, it is important to keep the controller handle on the last contact point, after the machine has been brought up to speed, while in other forms it is permissible to keep the handle at other points, according to the speed desired. In every case, however, the operator should avoid advancing the handle too

rapidly in starting the motor, not only because there is danger of burning out the coils if this precaution is neglected, but also because a too sudden start may cause severe mechanical strains to be thrown on various parts of the hoisting mechanism. A suitable fuse or automatic circuit breaker is essential to the safe operation of an electric hoist, and one or other of these devices should be provided in every case, and adjusted to act at not more than 50 per cent. overload.

Solenoid brakes form a desirable feature of the equipment of an electric hoist, because they provide an additional safeguard and are well worth the extra expense of installation. These brakes are applied to the armature shaft and operate automatically, but gradually, when the current fails for any reason, and also when the hoist is stopped.

Install switches and fuses of the inclosed type whenever possible, and do not permit the use of copper wire in place of proper fuses. See that all switchboards are railed off so that no unauthorized persons can get at them, and place rubber mats or coverings of other good non-conducting material in front of the switchboards for the operators to stand on.

The power is transmitted to the winding drums of some types of electric hoists by means of sprocket wheels and chains, and these should be entirely inclosed or otherwise effectively guarded, to prevent the hands or clothing of the operators from being caught.

23. Signaling Systems. It is important, in connection with hoisting, to have a signaling system that will be positive and reliable, under all circumstances. The system in which the signals are given by sounding either one or two strokes on the engineer's bell may be

replaced with advantage by the more modern one of using three different signals,—two strokes of the bell signifying to hoist, three strokes to lower, and one to stop. This code has the advantage of being perfectly definite. It also avoids the danger of giving

FIG. 10. THE SIGNAL CORDS ARE HERE INCLOSED IN IRON PIPES.

(The two 2-inch pipes shown in the center of this engraving extended from the hoisting engine to the erecting floor, and the signal cords were run through them. This method of protecting the cords is strongly recommended.)

a starting signal by the accidental fouling of the signal rope, since one stroke of the bell, on this system, has no meaning to the engineer when the load is stationary.

FIG. 11. PROTECTION FOR THE SIGNAL CORDS.

(When it is not practicable to use pipes as shown in Fig. 10, a guard of this nature should be installed on every floor, where the signal cords are exposed. The framework should not be left open, however, but should be covered with close-meshed wire netting, or its equivalent, so that nobody can interfere with the cords.)

In very noisy places bell signals may often be advantageously replaced or supplemented by a system of electric lamps, the signals being given by using lamps of different colors instead of by sounding a number of strokes on a bell.

24. Protection of Signal Cords. It is extremely important to guard the cords used for signaling to the hoisting engineer, in such a manner that nothing can accidentally strike them and cause the gong to ring. It is often possible to run them through suitably arranged two-inch pipes firmly secured in place and

FIG. 12. AN APPROVED METHOD FOR PROTECTING LEAD BLOCKS AND CABLES.

(The cables were boxed in where they ran along near the floor level, and the lead blocks were inclosed, as shown.)

leading from the hoisting engine to the signalman's station; or they may be boxed in on each floor to a height of not less than 7 feet above the floor. Cords with wire cores should be used for signaling. There should be no knots in them, and when it is necessary to lengthen them the ends should be carefully spliced,

or smooth, strong connections made in some other way. Inspect the cords frequently for the purpose of discovering worn or frayed places in them, and splice in new lengths if any defective portions are found. The breaking of a signal cord at a critical moment may result in serious injury or extensive property damage.

25. Hoisting Cables and Sheaves. It is equally important to guard the hoisting cables at all points where persons or materials might come in contact with

FIG. 13. AN EFFECTIVE GUARD FOR HOISTING CABLES.

(A similar guard, at least seven feet high, should be installed on every floor. The framework should be covered with wire mesh, however, so that the cables cannot be touched by hand.)

them. When the cables pass along near the floor level they not only present a tripping hazard, but while they are in motion there is also danger that the clothing of passing workmen may be caught. The danger is greatly increased when two hoisting cables that run in opposite directions are placed close together.

Provide suitable inclosures for all horizontal hoisting cables that are less than 7 feet above the floor level, and also inclose all vertical cables to a height of 7 feet above each floor. Take special care to guard cables that cross over stairways, and over or through passageways, and near ladderways. Workmen carrying planks, boards, and other materials are likely to be injured by having their loads caught by the moving cables, unless efficient protection is provided.

Take special precautions to prevent cables from chafing or rubbing against steelwork, floor tiles, and other objects. Cables that pass through floors composed of tile or concrete should be protected by wooden boxes about 8 inches square, set in the floors.

Inspect all cables frequently and thoroughly, and replace any that are found to be dangerously worn or frayed, or partially broken. With hoisting apparatus it is not always practicable to use sheaves as large as a proper regard for the relation between the size of the sheaves and the diameter of the cables would require, and the cables are therefore subject to bending strains much more severe than they would experience if the cables and sheaves were correctly proportioned. This results in shortening the useful life of the cables, and makes careful inspection exceedingly important.

Blocks that were originally designed for use with manila ropes are sometimes used with wire cables.

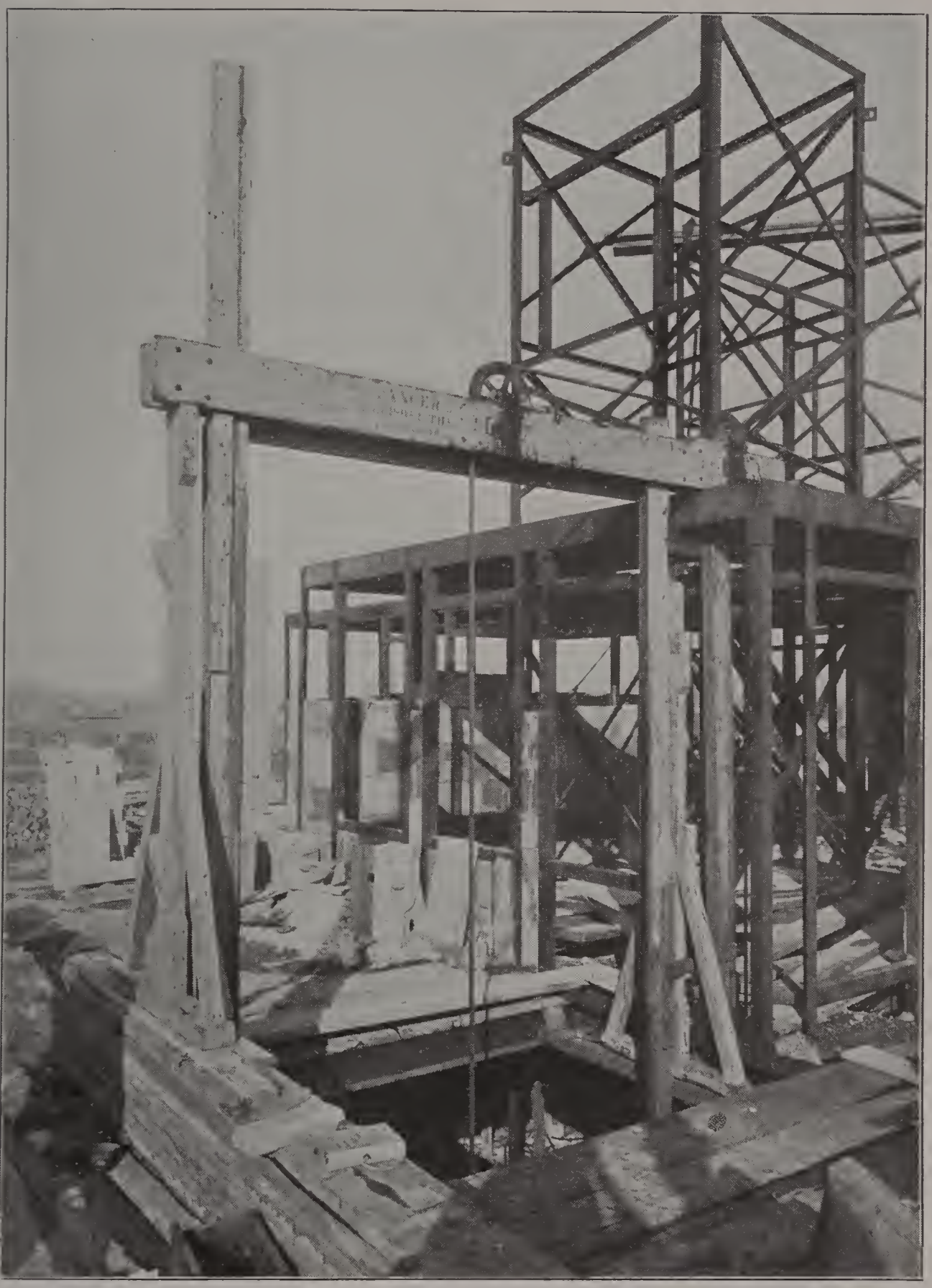


FIG. 14. AN UNGUARDED SHAFTWAY FOR A MATERIAL HOIST.

(Note the absence of railings and other protective features about the opening. Bricks and other objects should not be left lying about near openings through which they may fall upon persons below.)

FIG. 15. AN UNPROTECTED MATERIAL HOIST AND SHAFTWAY.

(The floor openings at the sides of the hoist should be covered over, and the shaftway and hoist should be guarded as indicated in paragraph 26.)

This is a bad practice, however, and should be prohibited, because the cables often do not fit the grooves in the sheaves, and both the sheaves and the cables are therefore subjected to undue wear. Blocks that are used to change the direction of the cables, and that are located near the floor or in other exposed places, should be inclosed or otherwise effectively guarded so that nothing can be drawn into them.

Provide ample and suitable lubrication for all sheaves and pulleys, and see that they are properly aligned so that the cables will not run off. Whenever possible, the blocks should be equipped with self-lubricating cast-steel sheaves. Test all cast-iron sheaves and pulleys frequently with a hammer, to make sure that none of them are cracked or broken.

26. Material Hoists. All material-hoist openings should preferably be tightly inclosed throughout their entire length, and the entrances to them at each floor should be protected by vertical-lift gates of ample height, which should always be kept in position. When this is not practicable, the sides of the shaftways not used for entrances should be inclosed at each floor to a height of not less than 8 feet, with strong wire netting having openings not greater than 1/2 inch each way. These inclosures should be located at least 12 inches from the edges of the shaftway openings. The entrance sides should be protected by bar-guards of sound, strong wood, not less than 2 in. by 3 in. in section, placed at a height of 3 feet above the floor, and at least 12 inches from the edges of the openings. Each bar should be bolted to the hoist fencing at one end by a single bolt on which the bar may swing, and a hook or wooden button should be provided, to hold

the bar up out of the way while loading or unloading the hoist. A slot should be provided at the opposite side of the hoist fencing, to receive the end of the bar when it is lowered to its normal position.

Fences or barricades of slat construction are sometimes used for hoisting inclosures, but these are less desirable than the other forms of protection already

FIG. 16. AN APPROVED TYPE OF MATERIAL-HOIST FENCING.

(This is composed of substantial wire netting, with a half-inch mesh. The engraving shows the adjustable bars, placed at a safe distance from the edges of the shaftway, and also, though not very clearly, the wooden buttons for holding the bars in an upright position while loading the hoists.)

described, because there is danger that small objects may fall between the slats. If inclosures of this kind are used, the slats should be spaced not more than 4 inches apart, and the fences should extend to a height of at least 8 feet above the floors. Bar-guards should be provided, similar to those recommended for use with the wire-mesh barricades.

The guide rails of the hoists should be kept rigid and in correct position at all times. This is a point to which proper attention is seldom given, and yet it is most important.

Install protective coverings above the overhead work of all material hoists, to prevent objects from falling down the shafts,—these coverings to be removed

FIG. 17. OVERHEAD COVERING FOR THE CAGE OF A MATERIAL HOIST.

(The cover is made in two parts, hinged together at the center so that they can be raised when long material must be transported. Note the toe-board and the bar-guards. The floor of the cage was also provided with blocks for the wheelbarrow legs, though the photograph does not show them satisfactorily.)

and replaced whenever the increased height of the building necessitates changing the location of the overhead sheaves of the hoists.

Also, install framed covers of planking or heavy wire mesh on the crossheads of all material hoists,

FIG. 18. PROTECTIVE COVERING FOR THE OVERHEAD-WORK OF A MATERIAL HOIST.

FIG. 19. AN IRON STAIRWAY, BROKEN BY A FALLING LOAD OF MATERIAL.

(A load that was being hoisted through this stairway shaft fell and demolished the lower part of the flight here shown. A workman was standing on one of the upper steps at the time, but he fortunately escaped injury.)

to prevent falling objects from striking workmen when loading the hoists. These covers should be made in two sections, and each of them should be secured to the crosshead by hinges, so that either section or both may be raised when hoisting long material.

When using a hoist for transporting long material, such as boards, planks, and pipes, the several pieces should be securely fastened together, and the whole made fast to the hoist in such a way that no part of the load can fall off, or project beyond the sides of the hoist and be caught. Heavy and massive materials, such as beams and building stones, should be hoisted outside of the buildings whenever this is feasible, and never through stairway openings.

Provide suitable guides or blocks on all hoists upon which wheelbarrows are transported, to hold the barrows securely in place.

The men should never be allowed to stand or ride on the material hoists; many serious accidents have resulted when this caution has been neglected. Contractors and foremen should refrain from riding upon the hoists, because it is easy to set a bad example to the laborers and others, who cannot see any sufficient reason why they should not ride, if their superiors consider it safe to do so.

27. Passenger Hoists. In all buildings in which permanent passenger elevators are to be installed, special hoists should be provided as soon as possible, for the use of the workmen in the building. This will tend to prevent the workmen from riding on material hoists, and will also save considerable time that would otherwise be spent by the men in climbing ladders and stairs to reach their work. The number of

stories to which the construction may advantageously be carried before passenger hoists are installed will depend largely upon the height that the finished building is to have. There should be no difficulty in deciding this point in any given case.

A regular operator should be provided for each passenger hoist, and an adequate and effective signal-

FIG. 20. AN APPROVED METHOD FOR PROTECTING A PASSENGER HOIST SHAFTWAY.

ing system should be installed. The maximum number of persons that may safely ride on a hoist should be determined in each case and specified upon a sign posted conspicuously in the cage; and no greater number than this specified limit should be permitted to step into the cage, under any circumstances.

Except on the sides used for entrance, the cages of all passenger hoists should be completely inclosed to a height of at least six feet, and preferably up to the level of the crossheads; and they should also be covered over on top. The hoistways should also be inclosed, and gates should be installed at the entrances on each floor.

Every hoist should also have an effective safety device that will prevent the cage from falling in case the cable or any other essential part of the mechanism should break.

28. Slings. These form an important part of the hoisting equipment in building construction, and every precaution should be taken to see that they are kept in first-class condition. Wire cables, chains, and manila ropes are all used for slings, their relative strengths, for similar diameters, varying in the order in which they are here named. For many reasons aside from its strength, a wire-cable sling is to be preferred to a chain or to a fiber rope of any kind. Ordinarily, deterioration is easily detected in wire cables, as it is commonly indicated by broken strands that are readily discoverable by an experienced and qualified inspector. Chains, on the other hand, may sometimes be used almost up to the moment of failure with no manifest external evidence of weakness other than the existence of a few seemingly unimportant bruises, although a careful microscopic examination

will often disclose a multitude of small cracks, showing that the metal has become either "fatigued" or strained beyond its yield-point by the severe stresses to which it has been subjected.

Wire-cable slings, on account of their pliability, are often bent at very sharp angles, not only while being adjusted to their loads, but also when they are under strain. Sharp bends of this kind should always be carefully avoided, not only because they are immediately dangerous, but also because, when taken in connection with the twisting and untwisting to which the strands of the cable are subject while in use, they cause rapid deterioration of the sling. In making a thorough inspection of a wire-cable sling it is advisable to clamp the sling in two places, and partially untwist the intervening section so that the interior wires can be seen and examined.

In placing a sling about a load, it is important to see that the turns of the sling do not lie one over another, because an excessive strain is likely to be thrown upon one of them unless careful attention is given to this point. A sling composed of a single length of wire cable, with spliced eyes, should never be used for hoisting a heavy load by hooking into only one of the eyes, because if this is done there will be a tendency for the load to revolve, thus unwinding the cable and permitting the splice to slip. On the other hand, when using a doubled sling with both ends engaged in the hoisting hook, it is important to adjust the sling so as to equalize the stress as well as possible, and prevent it from becoming unduly concentrated in certain parts.

When placing chain slings about loads, carefully

avoid twisting the chains, because if they are twisted an excessive load may be thrown upon some of the links.

All slings should be kept in good condition. To prevent rusting, chain slings should be frequently oiled, and slings made of wire rope should be treated with oil at proper intervals, or preferably with special protective dressings prepared for this purpose. The inner wires often become corroded through exposure to the weather, even when the outer ones remain in comparatively good condition.

The stresses that are thrown upon slings and ropes vary a great deal with conditions, and they are often influenced to a marked degree by circumstances which the casual observer might consider trivial and unimportant. In particular, the inclination or obliquity of the sling, in those parts which lie between the supporting hook and the points at which the sling first touches the load, must be carefully considered, because this is a highly important feature in connection with safety. None of these parts should make an angle of less than 45 degrees with the horizontal.

When the load to be lifted has sharp corners or edges, as is often the case with structural steel and other similar objects, pads or wooden protective pieces should be applied at these corners, or slings with protective coverings should be used, to prevent the slings from being abraded or otherwise damaged where they come in contact with the load. This is especially important when the slings consist of wire cable or fiber rope, though it should also be done even when they are made of chain. If pads of burlap or other soft material are used, they should be thick

and heavy enough to sustain the pressure well, and to distribute it over a considerable area, instead of allowing it to be concentrated directly at the edges of the object to be lifted. Precautions of this kind are often neglected in the United States, but they receive attention in European practice, and it is to be hoped that their importance will soon be more widely admitted in this country.

So far as weight is concerned, loads might often be safely hoisted by the use of single-part wire-cable slings; but in handling structural steel it is customary to use two-part, or "bridle" slings, so that the loads may be properly balanced, and hoisted in a horizontal position. Bridle toggle-slings are also used for similar work, and toggle column slings are often used for hoisting and setting steel columns. When toggle slings are employed it is not necessary for a man to climb up a column or go into other dangerous elevated positions to release the slings, because they can be detached by a man standing upon the ground or the floor.

It is advisable to have two complete sets of slings of various sizes constantly on hand, and all slings that are not in use should be stored in a place specially provided for them, and locked up. They should be in charge of an experienced man, who should be held responsible for their condition. The man charged with the care of the slings should give them out as they are needed, and always with due regard to the use to which they are to be put. In this way it is possible to guard effectively against the use of slings of inadequate strength. All slings should be promptly returned to the official custodian, when they are no

longer needed for the work for which they were given out. As an additional precaution, every sling should be provided with a small metal identification tag, which should be firmly fastened to it. The tag should give the maximum stress that the sling can safely withstand in use, and in the case of a chain sling it should also give the date of the latest annealing.

More detailed information with regard to slings has been published in THE TRAVELERS STANDARD for July, 1914, copies of which will be mailed upon request.

V. DERRICKS.

29. Types. The derricks that are most commonly used in building construction are of the stiff-leg, guy, and breast or house types. Some of these types are subject to slight modifications, and they may then be known by different names; but the general classification here given is comprehensive enough for ordinary purposes. Each type may be arranged to be operated either by hand or by mechanical means,—the method of operating usually being determined by the weight and quantity of the material to be handled.

30. Stiff-leg Derricks. These are usually employed in excavating for building foundations and for doing other work at or near the ground level, although they are also used to some extent in the more advanced stages of building construction. It is particularly important to see that the timbers that are used in stiff-leg derricks are sound and of adequate size for the work to be performed, and that the several members are properly jointed and fitted. Selected Oregon fir or yellow pine are most suitable for derrick construction. All irons, such as the goose-necks, and the connection plates at the heels of the stiff legs, should be of the proper sizes. All bolts should be of the best material, and provided with adequate heads and a sufficient number of threads. Washers should be placed on both ends of the bolts, and the nuts should be drawn up tightly. Lock-washers or jam nuts

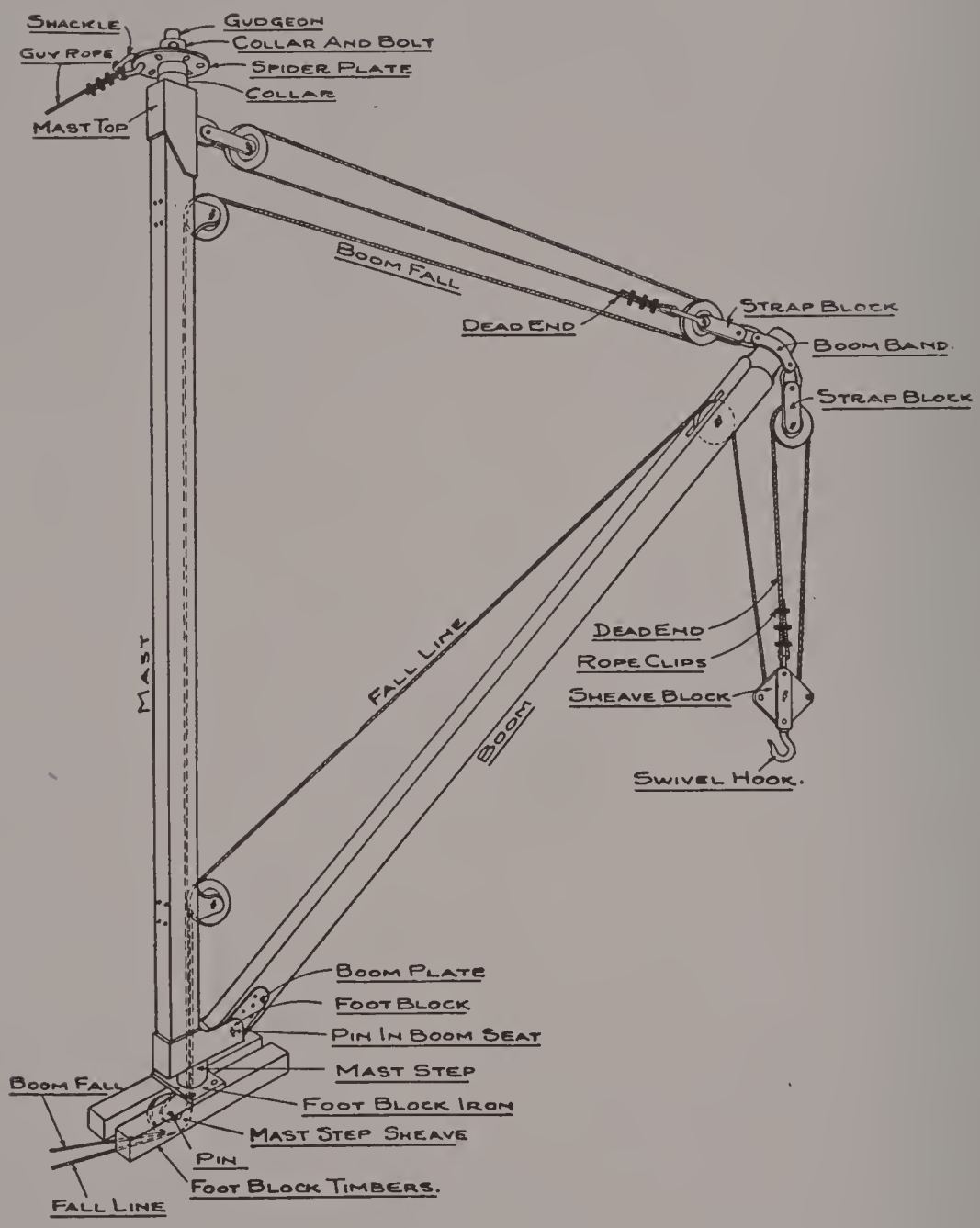


FIG. 21. DIAGRAM OF A GUY DERRICK.

(This is simply a diagram for the purpose of showing the names of the various parts of a guy derrick, and is in no respect a design for a derrick. For convenience, only one guy rope is shown, but in practice there should be at least six, as described on page 55. The boom should fit loosely in its seat, and the pin in the boom seat should never be omitted.)

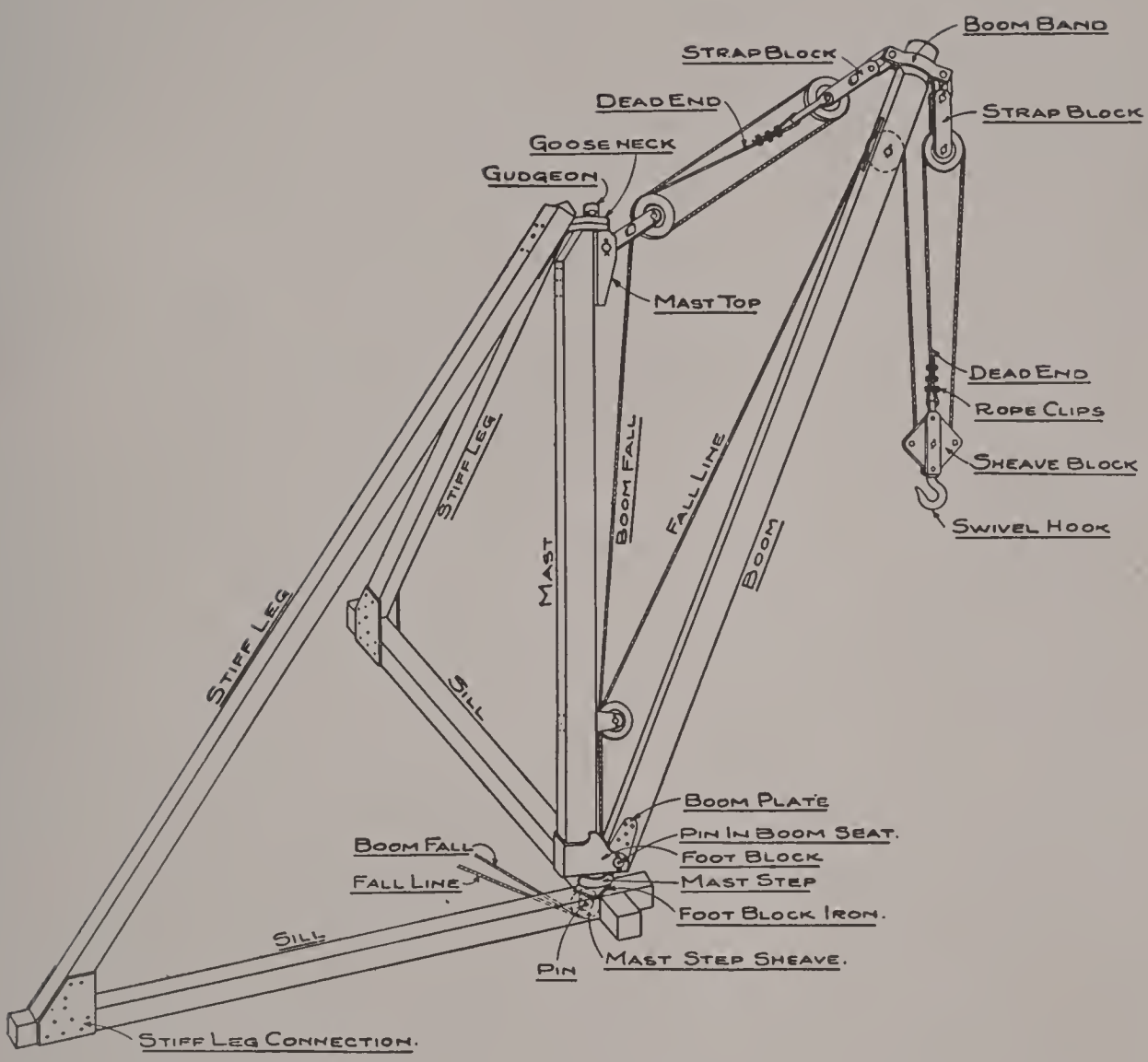


FIG. 22. DIAGRAM OF A STIFF-LEG DERRICK.

(See the foot-note on page 48, in connection with the diagram for a guy derrick. For a further description of stiff-leg derricks refer to page 47.)

should be used, to prevent the nuts from working loose, or the same object may be attained by checking the threads on the bolts after the nuts have been tightened. The pins securing the connection plates to the bed sills should be of adequate size, and fitted with cotter pins at both ends. Inspections often show that the connection-plate pins have been lost, and that ordinary bolts, frequently of too small a size, have been substituted. Such a practice should be prohibited.

See that the goose-necks are fitted to the stiff-legs in a proper manner, so that there will be no undue friction on the gudgeon pin. If the goose-necks are improperly fitted, or the heels of the stiff-legs are incorrectly set on the bed sills, the holes in the goose-necks will be worn into an elliptical shape, making it more difficult to handle the derrick, and also causing it to jar when the boom is swung around. Furthermore, it is quite possible that the gudgeon pin will become so worn that it will fracture and cause an accident. A collar should be placed on the gudgeon pin, above the goose-necks, and a hole should be drilled through this collar and the gudgeon pin, through which a bolt should be passed to hold the collar in position.

See that all of the derrick sheaves are of suitable size, that they are secured in place by pins of the proper diameter, and that cotters are placed in both ends of every pin. Pay particular attention to the recess for the sheaves at the end of the boom, because if this is too wide the sheaves will wabble or work along on the pin, and this may cause the cables to run off the sheaves. If the recess is found to be too large, place filler plates on both sides of the sheaves, to make them run true.

Give particular attention to the weighting of stiff-leg derricks, because this is an item of extreme importance. The necessary weight should be calculated by a competent engineer, in every case The material used for the weighting should always be inclosed in well-constructed boxes, so that the weights will remain in the proper position and will not be dislodged or shifted about by the vibration of the derricks, or in any other way.

31. Guy Derricks. Derricks of this type are used in nearly all of the operations of building construction, and they are made both of timber and of latticed steel. All the guys should be of good, sound galvanized wire of ample strength, and eyes should be formed in them, at the masthead end, by bending back the ends of the cables and clamping the ends with at least three clamps specially designed for the purpose. Place thimbles in these eyes, in all cases, to prevent chafing the cables. Secure the guys to the guy plates by means of shackles, and place cotters in the ends of the shackle pins. Collars should be secured in place above the guy plates in the same manner as recommended for stiff-leg derricks.

The way in which guy derricks are anchored will naturally depend upon the location and upon the conditions under which the work is done. When logs buried in the ground (commonly called "dead-men" or "dead-logs") are used for anchorage, they should be placed at a suitable depth, in trenches. After the trenches are filled they should be planked over and additional weight placed upon them. The weights used for this purpose should preferably consist of well-constructed boxes filled with sand, earth, or stone.

FIG. 23. A TYPICAL HOISTING TOWER.

The dead-men should be of ample size, and of strong, sound timber. Old blasting logs or limbs of trees are sometimes used, but these should never be trusted unless they have been thoroughly inspected before being put in the ground. Inclined trenches should be excavated leading to the dead-men, so that the guys may be placed properly about the centers of the logs, and so that each guy will pull upon its anchorage in as straight a line as possible.

In building construction guy derricks are mainly used for erecting and setting steel, and when they are so employed they must be guyed by some method

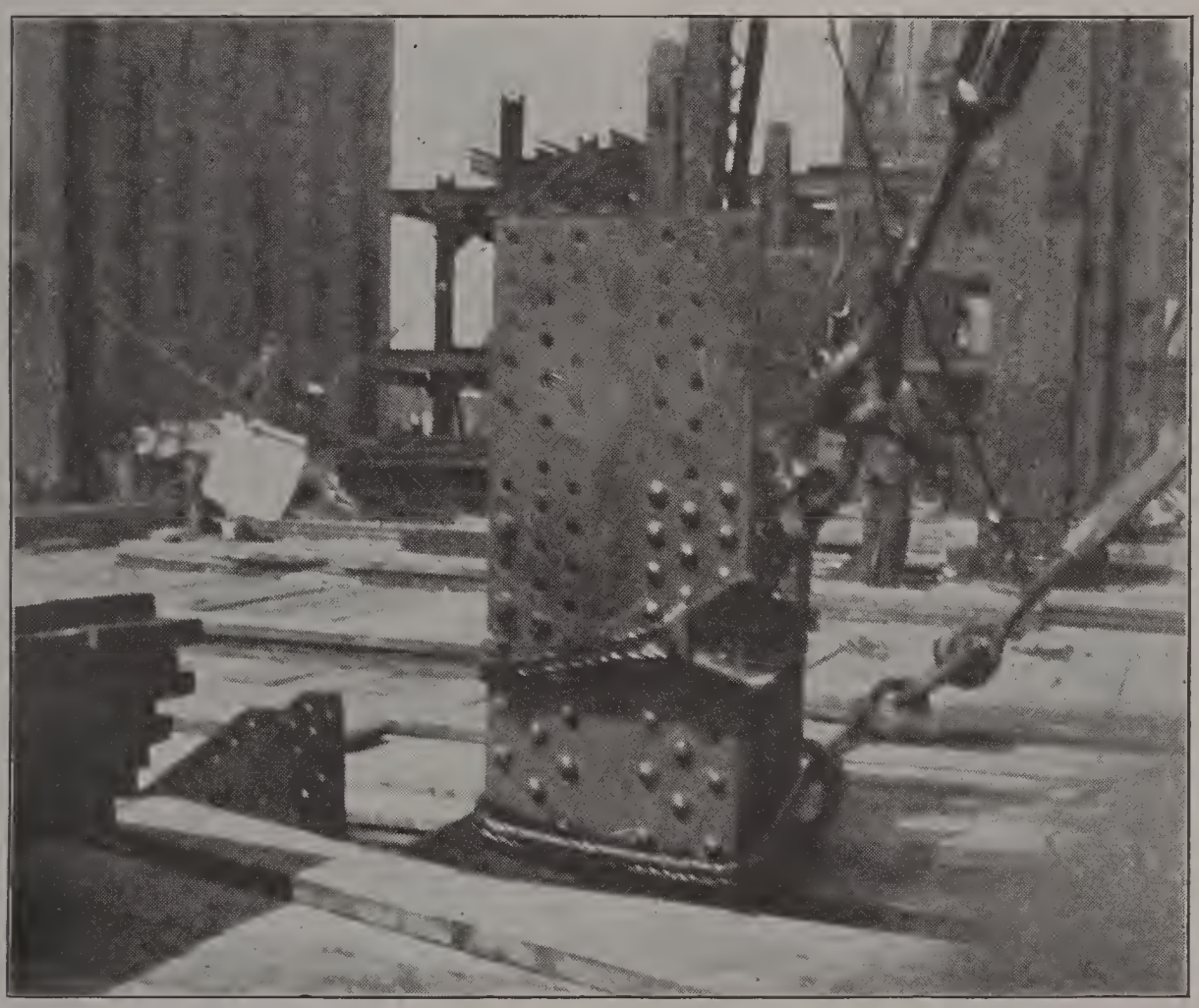


FIG. 24. WIRE-CABLE SLINGS INSTALLED FOR ANCHORING DERRICK GUYS.

(Owing to the position of the camera, the apparent steepness of the inclination of the nearest guy is much exaggerated in the photograph. Wire-rope slings are far better and safer for this purpose than chains.)

FIG. 25. AN APPROVED METHOD FOR ANCHORING DERRICK FOOT-BLOCKS.

(Cables are passed around the foot-blocks, as shown. They are then crossed, and their ends are made fast to four of the steel columns of the building. For further security clips are placed at the points where the cables cross, as indicated by the arrows. This arrangement prevents the foot-blocks from moving in any direction.)

other than the one described above. Each derrick mast should be provided with at least six equally-spaced guys, and each of these guys should be anchored, by a wire-cable anchor sling, to the columns of the building in course of erection. The bay in which the derrick is to be erected should be fully bolted or (which is far better) fully riveted, and four heavy timbers, each 12 in. by 12 in., or 12 in. by 16 in., should be placed beneath the foot-blocks of the derrick. These timbers should be long enough to extend the entire length of the bay, or from one row of columns to the next. Supporting bents framed of heavy timbers should be placed beneath the floor system on which the derrick rests, unless the construction is unusually strong. When the span is ten feet or less, and 12-inch or 15-inch beams are used, it may not be necessary to use bents. With a fifteen-foot span and 12-inch or 15-inch beams, one bent, on the floor immediately below the derrick, should be used. With a fifteen-foot span and beams having a depth of 10 inches or less, supporting bents should be placed beneath the derrick on *two* floors. Each bent should be fastened to the floor immediately above it by means of ropes, and should be made to bear tightly against the beams overhead by driving in double wedges, which should be toe-nailed, or secured in some other manner, so that they cannot work loose and fall out.

When derricks are being raised from one floor to another, the work should be done with great care. The boom is commonly used as a gin pole in this operation, and it should be securely lashed to the steelwork on the uppermost floor, and also at the foot.

FIG. 26. ANOTHER VIEW OF THE FASTENING SHOWN IN FIG. 25.

It should also be properly guyed. Some contractors omit the guys, but that is bad practice because the guys add greatly to the safety of the operation. The foot-blocks should be properly secured, either by timbers or by wire cables; and if cables are used they should be drawn tight by means of steamboat ratchets. Turnbuckles are often used in place of steamboat ratchets, but we do not recommend them because the workmen tighten up the turnbuckles by means of bolts or bars, which are often left in position and forgotten,—the result being that they frequently fall out and drop to the lower floors.

Before raising the derrick mast a block and fall should be secured to its lower end, and the line paid out as the mast is raised. In this way the mast is kept plumb, and is prevented from striking against the steelwork as it is raised. A single hemp line is sometimes used instead of the block and fall, but the method we have described is considerably safer and more satisfactory in every way.

When raising derricks it is bad practice to take a turn of a hemp rope around a steel beam or column, because there is danger that the rope will be cut by the corners of the steel members. It is far safer to lash a heavy timber to the floor beams, to be used for such a purpose.

32. Breast or House Derricks. In building construction, derricks of this type are principally used for setting stone. They are usually operated by hand, and as a rule are not equipped with brakes. Mechanical brakes can easily be provided, however, and this should be done in every case. The usual method for braking a breast derrick, when no mechanical brake

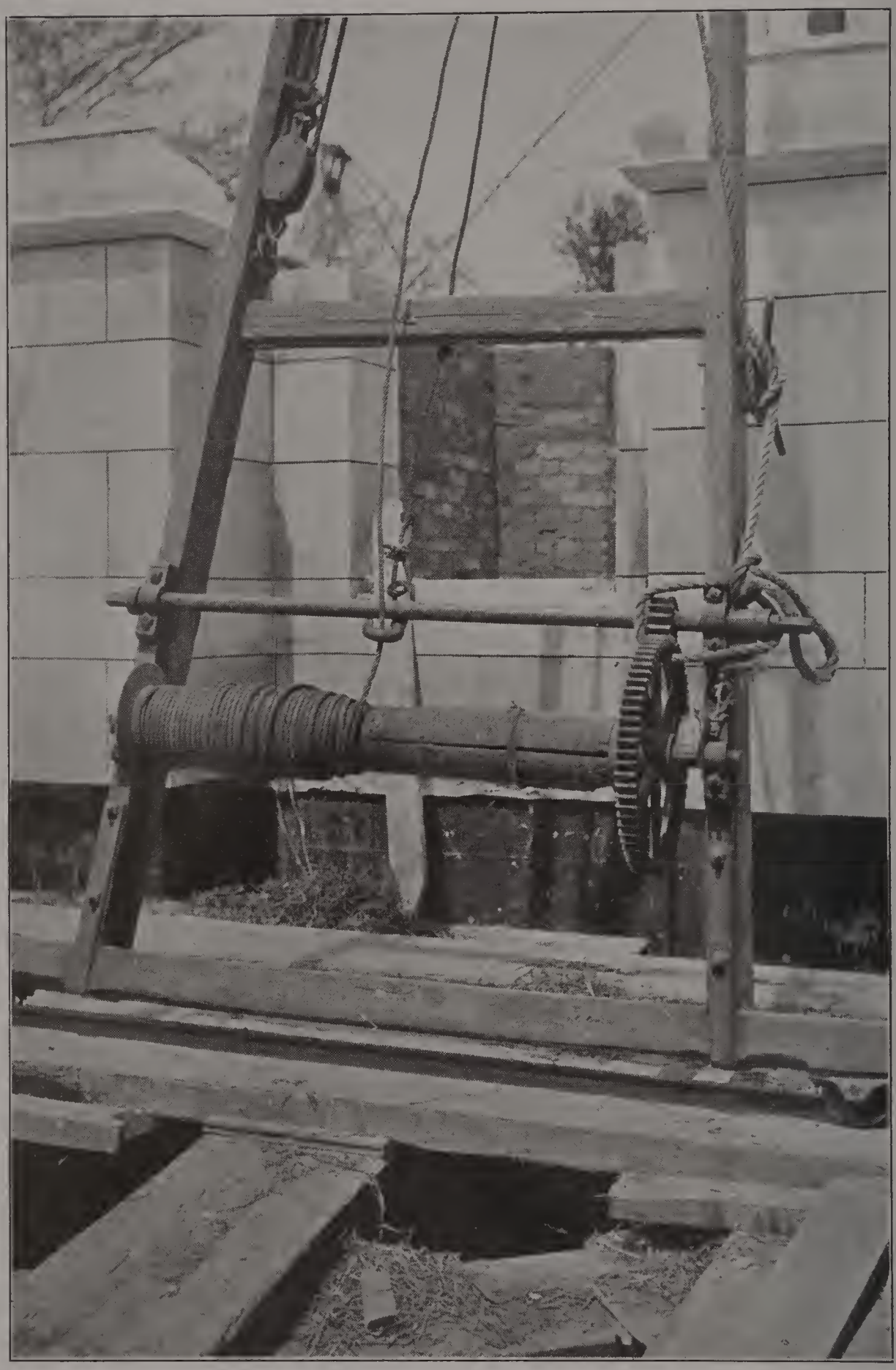


FIG. 27. A BREAST DERRICK WITH UNPROTECTED GEARS.

(The gears of breast derricks could be guarded very easily, and mechanical brakes could also be provided with but little trouble. Attention is also called to the dangerous holes just in front of this derrick.)

is provided, is by means of a "bull-tail." This consists merely of a length of rope, which is wrapped about the shaft several times; one end is then secured to the frame of the derrick, the other end, or "tail," being held by a workman when lowering a load. By pulling upon the rope sufficient friction may be brought upon the shaft to stop and hold loads of considerable weight. The most efficient bull-tail is made by separating the strands of a 3-strand rope, and braiding them together so as to form a flat surface to bear against the shaft. The men sometimes have their hands and fingers crushed when using these bull-tails, and the rope sometimes breaks and allows the load to drop. For these reasons, among others, we strongly prefer special mechanical brakes, as already explained.

A hole should be drilled in each end of the gear shaft, outside of the corresponding handle or operating lever, and a cotter pin should be placed in each hole so that the handle cannot work off from the shaft. Accidents often result from neglect of this precaution. Nails, pieces of wire, and other similar objects are sometimes used in place of cotter pins, but this should never be allowed. When lowering loads the handles should always be removed, so that no one can be struck by them.

As a rule, breast derricks are guyed from only one direction, and under ordinary circumstances this would be sufficient. When moving the derricks, however, they are straightened up, and are then likely to tip over backward; and the same trouble will occur if a heavy object should drop on the guys, or if the hoisting rope should suddenly break while raising a load. To guard against a possibility of this kind,

FIG. 28. A ROW OF BREAST DERRICKS USED FOR SETTING STONE.
(These derricks are guyed from the front as well as from the back, as required by good practice. Gear guards and mechanical brakes are lacking, however.)

a front or head guy should be secured to the derrick and to some fixed object on the floor above. If there is no higher floor, the derrick should be made secure against falling backward by some other method.

All breast derricks should be set on heavy planks or timbers, of sufficient length to extend from one girder or floor beam to another. They should never be allowed to rest directly upon floor arches,—this counsel being specially important when the arches are newly laid. The base of each derrick should be secured in a suitable manner by means of ropes or cables, or by timber bracing, so that it cannot become displaced.

33. General Precautions in the Use of Derricks. When leaving the work, either for the night or at any

other time, it is advisable to lay the derrick booms down, if possible, or to "top them up" (that is, raise them into a vertical position). This will prevent the booms from swinging about and fouling cables or doing other damage, in case of high winds. They should also be secured by guys or otherwise, if the conditions are such that this appears to be necessary or desirable. At least as often as every other day, all parts of every derrick should be inspected, and the moving parts thoroughly lubricated. Special attention should be given to the gudgeon pin at the mast head, and to the bearing at the foot of the mast, for these will wear rapidly if allowed to run dry. Every derrick should be equipped with adequate and effective mechanical brakes, and the brakes should be tested frequently to make sure that they are in good order. All hand-operated derricks should also have suitable ratchets and pawls. The loads should be lowered slowly, and never at a rate of speed exceeding the hoisting speed; when depositing the loads special care should be taken to avoid shocks and jars. Provide substantial and effective guards for all exposed gears, and for all projecting set-screws, keys, and other dangerous moving parts.

VI. SCAFFOLDS.

34. Introductory. Only a few general suggestions with regard to scaffolds can be given in this place, because many different types are used, and there is so much to be said about them that an entire volume would be required to treat the subject adequately. The Engineering and Inspection Division of THE TRAVELERS INSURANCE COMPANY has made a special study of scaffolds, however, and has published a large special treatise on the subject. It has also published a small booklet for general circulation, copies of which will be gladly furnished upon request.

35. Pole Scaffolds. Pole scaffolds are often built of utterly unsuitable material, and erected in defiance of constructive principles that would be considered supremely important in a permanent structure. Great care should be given to their design and construction, and a plentiful amount of first-class lumber should be used in erecting them.

36. Suspended Scaffolds. As a rule, the swinging scaffolds that are used for bricklaying and similar work, and that are supported by steel cables from the framework of the building under construction, are much safer than pole scaffolds when the work must be carried up to a considerable height; but they should be inspected, thoroughly and carefully, every time they are used, and at suitable intervals while they are in use, and nothing should be taken for granted about

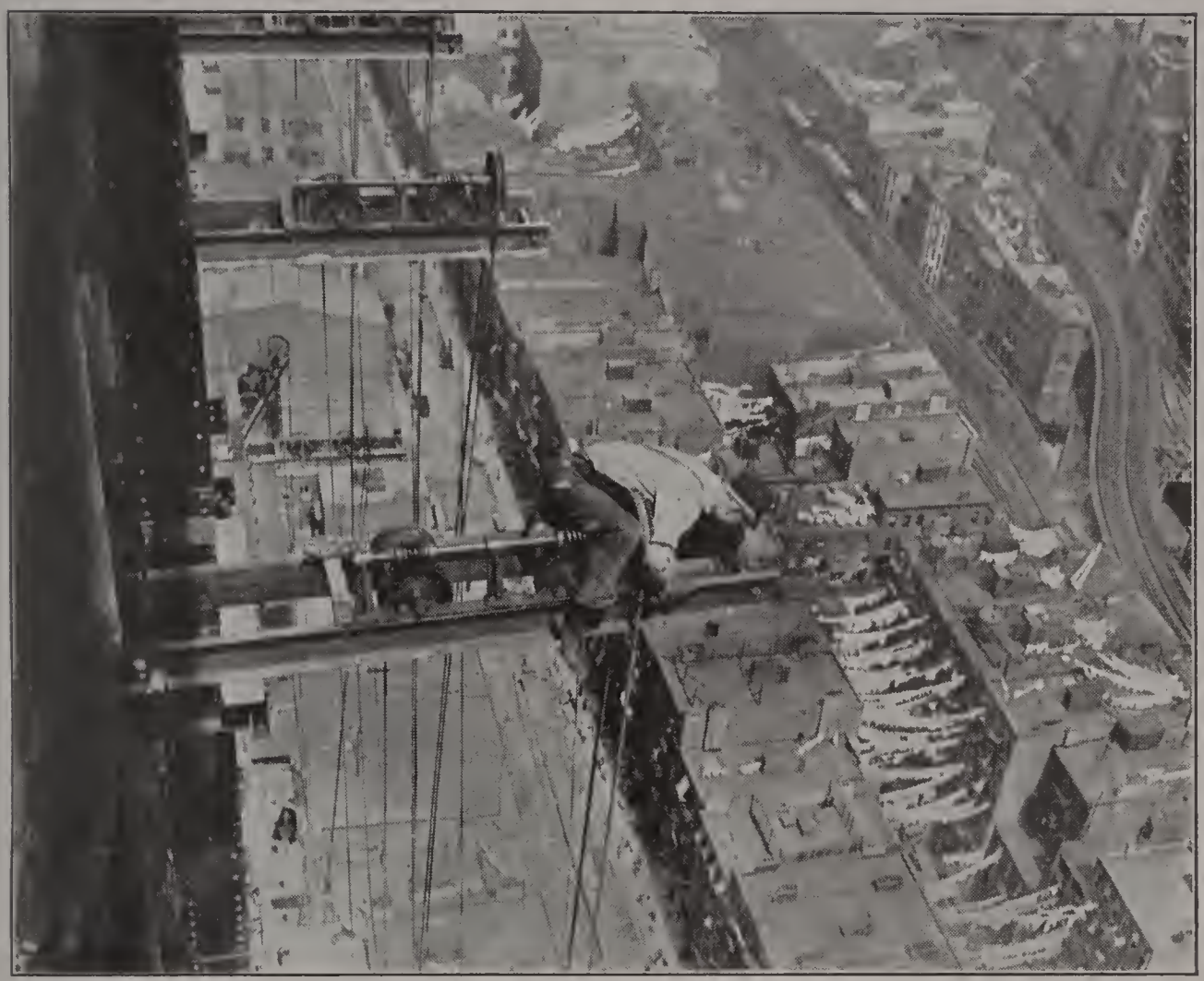


FIG. 29. ONE OF THE HAZARDS CONNECTED WITH THE USE OF SUSPENDED SCAFFOLDS IN BUILDING OPERATIONS.

them. Every bolt and nut should be examined, and the cables and their fastenings should be inspected with special care.

37. Horse Scaffolds. These are used for many purposes, both in demolition and in construction work. They should always be of substantial construction, and should rest upon a firm and level foundation. They should never be erected so that they rest upon beams alone, but should always stand upon solid floors. If the permanent floor-covering has not been installed, a temporary layer of planks should be placed upon the beams to support the horses. Sound, strong material should be used when extending the legs of horse scaf-

folds. The work should be carefully done, and the legs should be braced near the joints to stiffen them. It is always far better, however, to use horses of special construction, rather than to extend the legs of existing ones for the purpose of attaining the necessary height. Piles of brick, stone, or other loose material should never be used by the workmen in place of scaffolds or platforms, nor should scaffolds, platforms, or horses rest upon such piles, or be supported by them.

38. Riveters' Scaffolds. The scaffolds used by riveters are moved about so frequently that it is hardly feasible to safeguard them as completely as other types. Guard-rails should be provided whenever practicable, however, and every other precaution should be taken to avoid accidents. Only sound, strong planks should be used for the platforms, and they should be laid so that they cannot tip or slide. Special care should be exercised in selecting the needle-beams for scaffolds of this kind, and they should be inspected frequently to make sure that they are in good condition.

When it is necessary to use a scaffold of this nature in such a position that one needle-beam is considerably higher than the other one, the planks should be provided with cleats to insure a good foot-hold for the men, and each plank should also be pierced, *about one foot from each end*, with a hole about 5/8 of an inch in diameter, through which a loosely-fitting bolt should be passed. These bolts should be provided with nuts so they cannot drop out when the planks are turned over, and in laying the platform of the scaffold the bolts should come *outside* of the needle-beams in all cases.

A riveters' scaffold, when used near the line of a public street or other thoroughfare, should be provided with a wire-mesh screen arranged so that if the man on the scaffold fails to catch a rivet the screen will stop it and prevent it from falling into the street.

39. Painters' Scaffolds. The light, swinging scaffolds that are used for painting should preferably be secured to the building at all times, so that they cannot swing materially in any direction; and they should always be lowered to the ground, or lashed, when leaving the work for the night. All tools and

FIG. 30. A DANGEROUS METHOD OF SUPPORTING A HORSE SCAFFOLD.

(The horses should always rest solidly upon the floor, and should never be blocked up in this way, upon tiles or other insecure objects. The floor conditions here shown are also unsatisfactory. Waste material should never be allowed to accumulate in such large quantities.)

materials should likewise be removed from such scaffolds when the men are not at work upon them.

Painters' scaffolds and other light, swinging scaffolds that are supported by ropes, should be carefully tested, immediately before using, by raising them a foot or so from the ground and loading them with a weight at least four times as great as the maximum load they may have to support while in use. The ropes of all such scaffolds should also be carefully protected from contact with acids and other chemicals, and they should be tested from time to time to see that their strength remains unimpaired.

40. In General. Except in certain special cases where the working conditions make the adoption of such safeguards impracticable, scaffolds should be provided with hand-rails, and also with toe-boards to prevent materials or tools from falling over the edge of the platform. In addition, wire-mesh side screens are strongly recommended; and whenever scaffolds are located so that there is a considerable height over them from which materials and tools might be dropped, they should also be provided with efficient overhead guards of planking, wire netting, or some other effective substitute. It is common indeed to see the hand-rails, toe-boards, side screens, and overhead protection entirely omitted from scaffolds, and many of the scaffold accidents that occur are due to these omissions.

The planks forming the platforms of scaffolds should be laid tightly together, so that there will be no chance for tools or materials to fall down between them. The planks or boards forming the platforms should also be placed so that they cannot tip up under the weight of a workman, at any point whatever.

Scaffold platforms should not be used for the storage of materials, except such as are immediately required by the workmen; and they should be kept as free as possible from obstructions, so that the work-

FIG. 31. A STUDY IN DANGEROUS SCAFFOLDING.

(This scaffold is constructed in an ingenious way, but its only other merit is that it is bad enough to be interesting as well as dangerous. The main platform, which can be seen at the top of the picture, was about 35 feet above the ground. Note the bend in the plank supporting the upper barrels.)

men may move about upon them in safety. Accumulations of snow and ice should be promptly removed, and when the platforms become slippery they should be liberally sprinkled with sand or ashes.

If heavy stonework must be handled on scaffolds, extra reinforcement should be provided wherever necessary, to make the scaffolds safe under the unusual loads.

Men should preferably be kept away from places directly under scaffolds, whether these are outside or inside of the building. Under some conditions, however, this course is impracticable; and when men must work on or beneath scaffolds where there is danger from falling objects (as, for example, in elevator shaftways, ventilating shafts, and other similar places) substantial protective coverings should be installed above or below the scaffolds, as may be necessary, to guard all the exposed men against injury.

Doorways and passageways, where men have to pass under a scaffold or under some other place where construction work is going on, should be effectively covered with roofs or sheds. Mortar beds are often placed almost immediately under scaffolds. If they cannot be placed elsewhere, they should be protected by substantial roofs.

In building a scaffold of any kind, always use strong, first-class material, and plenty of it. Furthermore, be sure the scaffold is rigid as well as strong, so that it will not yield or shake when the men move about upon it, nor when portions of the load that it has to support are shifted; and never intrust the building of such a structure to anybody but a responsible man who knows what ought to be done, and who is willing to do it.

Every man who has to make use of a scaffold should be required to satisfy himself of its safety before he ventures out upon it.

All scaffolds, stagings, and other similar temporary structures should be removed as soon as the need for them ceases to exist.

VII. LADDERS, STAIRWAYS, AND RUNWAYS.

41. Ladders. As fast as the work progresses, safe means should be provided to give access to all points in the building. For this purpose numerous ladders are necessary, and as too little attention is given, in general practice, to making them strong and substantial, many accidents result. Ladder manufacturers are giving increased attention to this matter, but crude ladders are often made up by the men on the job from any material that is at hand,—cross-pieces being nailed to a pair of stringers of the necessary length, with little regard to the proper strength and spacing of the cross-pieces, or the ultimate safety of the finished structure. The stringers and rungs are often rough and full of slivers and splinters, and projecting nails are also common. The workmen have to go up and down these ladders many times a day, and they are subjected to great and wholly needless danger because of the poor construction.

Every ladder should be strong and substantial, composed of the best materials obtainable, and constructed with great care. The stringers should be of spruce, Oregon fir, or selected yellow pine, and the rungs or cross-pieces should be of oak, white ash, maple, or hickory. Special attention should be given to all ladders that are used for connecting the various floor levels prior to the installation of the regular stairways. These ladders should be set in place

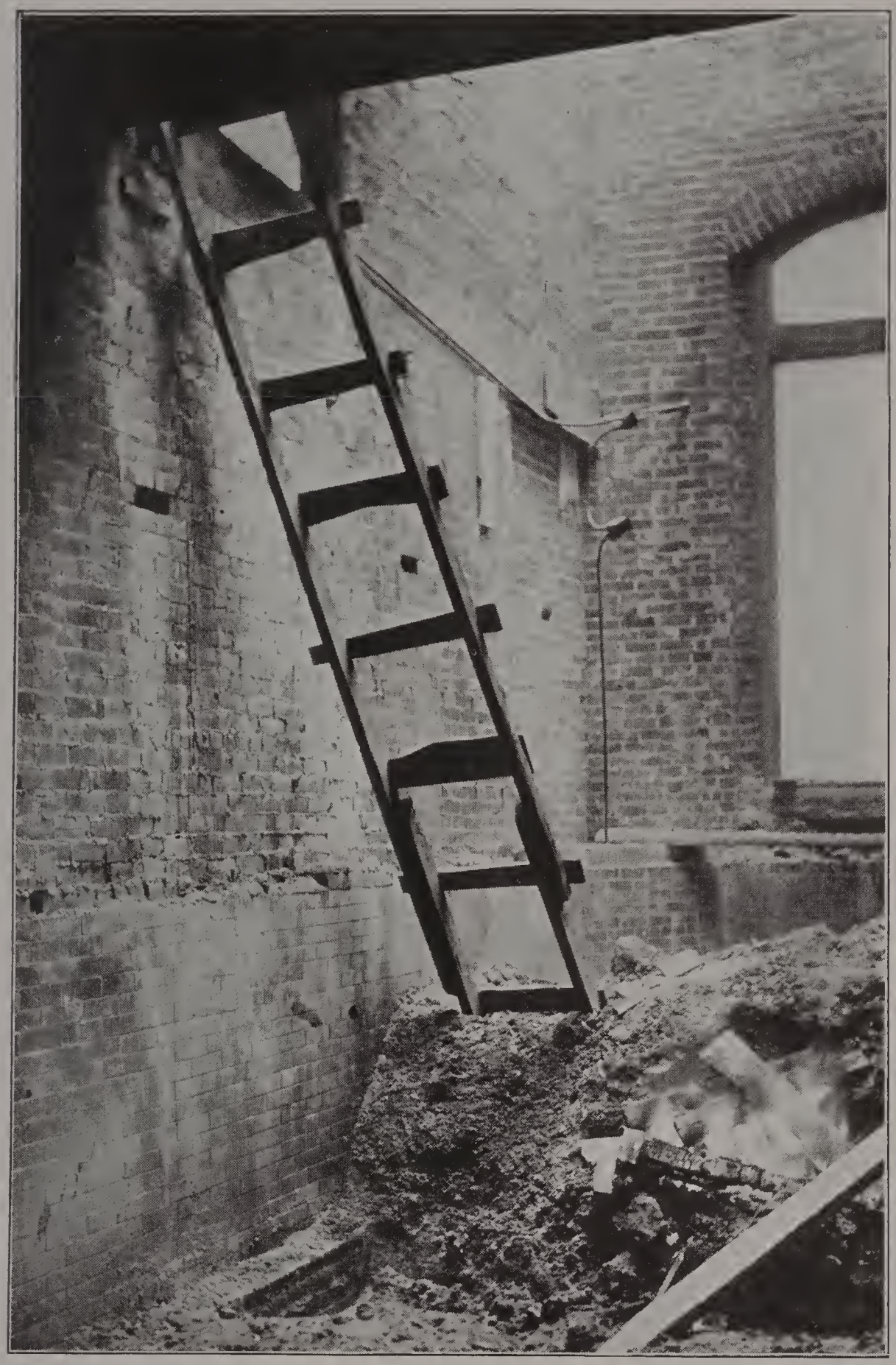


FIG. 32. A POORLY-CONSTRUCTED LADDER.

(Similar ladders are often found on construction jobs, and they cause many accidents. In this case the danger was also increased by maintaining a bright, open fire close to the foot of the ladder.)

immediately after each rise of the derrick, and they should not be removed until the stairways are in proper condition for use. On large construction jobs, ladders used for this purpose may be made double the width of an ordinary ladder, with an extra stringer in the center. Preferably, however, there should be two separate ladders, side by side,—one to be used for ascending and the other for descending. Provide suitable landing platforms at the upper and lower ends of these ladders, and at all other points where the workmen must step on or off them; and see that each ladder is long enough to extend at least 5 feet above the highest platform, to enable the workmen to grasp it firmly before descending. In installing a ladder for any purpose, it is advisable to have one of its rungs come flush with the platform to which the ladder leads. When this is not practicable, care should be taken to have the rung that is nearest the platform stand two or three inches *above* it, rather than below it, because a better footing can be had in this way.

See that every ladder is securely fastened both at the top and at the bottom, so that it cannot move in any direction; and if necessary, it should also be braced at the middle of its length to prevent it from swaying, bending, or shaking. Do not permit tools or other objects to be left upon the landing platforms.

Take care to place all portable ladders on a firm and level foundation, and see that they are so placed that they can neither tip over, nor slide sidewise, nor slip at the bottom. Ladders should be equipped with safety pads or shoes, or with spurs, whenever they rest upon any material on which they are likely to slip. The shoes may be made of some abrasive sub-

stance, or of rubber or other suitable material. Sharp metallic spurs are effective when the ladder rests upon a surface that these spurs can penetrate. Inspect all ladders frequently, replace all worn or missing rungs, and make all other repairs that may be necessary.

Ladders up which materials are to be transported should not be more than 30 or 35 feet in length. If it is necessary to proceed to a greater height than this, two or more separate ladders should be used; but in such a case the successive ladders should not come one over another, and no one of them should extend over a place where men are at work, nor over any passageway. If such an arrangement is impracticable, each ladder should be sheathed underneath in such a way that objects falling from it will be arrested by the sheathing, and prevented from falling upon the ladders or workplaces below,—the sheathing being placed far enough from the under surface of the ladder to insure a good foothold for the men, upon the rungs. Helpers carrying material in hods or otherwise should be instructed not to go upon a ladder when another man is already upon it. Serious accidents frequently occur when this precaution is neglected, because it is not uncommon, when two men are using a ladder at the same time, for the upper one to fall or to drop his load or some part of it, thereby knocking the lower man from the ladder. It is best to have at least two ladderways, one to be used exclusively by men going up, and the other exclusively by men going down. When this plan is in force it is easier to make the men go up one at a time; because when a single ladderway is used for travel in both directions, they naturally form the habit of ascending with their loads, in gangs

or groups of three, four, or five, in order to avoid confusion and delay through meeting others who wish to come down.

Workmen using ladders should not be permitted to carry loads that will interfere with the free use of both hands for holding on to the side-bars. Sliding down ladders should be forbidden, and the men should always face a ladder when ascending or descending it.

Except in case of real necessity, ladders should never be extended by joining two of them together. It is far better, whenever practicable, to arrange them in single lengths with a landing platform at the top of each ladder. Whenever it becomes necessary, for any reason, to join ladders together, the operation should be performed with great care, by a person skilled in the work; and the joint should be solidly braced and supported, so that no bending stress can be thrown upon it.

42. Stairways. The stairways should be installed as rapidly as the progress of the work will permit,—temporary stairways being installed in preference to ladders, whenever practicable. Stairway openings should be effectively guarded by toe-boards, and all treads, risers, and railings, whether permanent or temporary, should be of sound, strong material, firmly secured in place. No openings should be left through which objects of any kind may fall, and the stairs should be kept free from bolts, nuts, rivets, small pieces of brick or tile, and other similar objects that might cause the men to fall. Storing material on stairways should be strictly prohibited, and every effort should be made to keep them free from obstructions of every kind, so that a safe passage will be assured. To

prevent falls that might be caused by tripping, install a suitable platform or landing wherever a riser at the top of the stairway projects above the floor arches or the temporary floor levels. Be sure that ample light is provided on all stairways during the entire working period.

In demolishing buildings, stairs and stair railings should be left in place as long as possible, because they are in constant use and are much safer and more convenient than ordinary ladders.

43. Runways. All runways should be substantially constructed, and effectively braced or otherwise supported, to prevent bending, swaying, or vibration. Single-plank runways for wheelbarrows should not be used. It is far better to make the runways at least

FIG. 33. A STEEP SINGLE-PLANK RUNWAY.

(Below it, on all sides, are boards and miscellaneous pieces of lumber with projecting nails. In the background is a pile of fine, dry sand which was blown about by the wind, and often into the eyes of workmen in the vicinity.)

FIG. 34. DANGEROUS CONDITIONS ABOUT A RUNWAY.

(The runway itself, which is marked with a white cross, does not show as clearly as could be wished; but the dangerous features are quite distinct. Observe, in particular, the poorly-constructed and unsafe platform, the large hole at the top of the runway, and the obstructions at the bottom of the runway.)

three planks wide, because this gives a sufficient width for most purposes, and it also affords a good track for the wheel of the barrow, which then has a full plank for its support instead of having to travel along a crack, as is the case when two planks are used. Runways on which wheelbarrows or trucks have to pass one another should consist of from five to seven planks. All runways that are four feet or more above the ground should be provided with substantial hand-rails, and cleats should be nailed to them, whenever necessary, to afford a firm footing for the workmen. A clear space of moderate width, free from cleats, may be left in the center, if necessary, for the wheels of the barrows. Runways that are six feet or more above the ground should also have foot-boards along their sides.

See that all runways are kept free from projecting nails and screws, and also from slivers and splinters. If the planks of the runway are laid so that they lap over each other, a beveled piece of wood, running crosswise with respect to the runway, should be fastened against the ends of the overlapping planks. The piece so used should be at least nine inches wide, and it should be of the same thickness as the planks on one side, and be thinned down nearly to an edge on the other side. If the planks of the runways are laid flush with one another for the purpose of avoiding overlapping, the supports upon which they abut must be of ample width to insure safety, and in such cases it is also important to nail the planks firmly to the cross-pieces upon which they rest.

VIII. STEELWORKERS.

44. Erecting Gangs. The work of erecting the steel framework of a large building is extremely hazardous, and there is little that can be done to safeguard the men in some of the operations. Dependence must mainly be placed, in such cases, upon the caution, skill, and good judgment of the men themselves. They should never be allowed to expose themselves to danger unnecessarily, nor to ride upon loads, nor on the hooks, cables, or slings of the hoisting apparatus, nor to slide down ropes or cables. Proper ladders should be used for giving access to the work, wherever possible, and the men should not climb up nor slide down on columns. Work should be discontinued during severe storms and high winds, and also when the steelwork is slippery from ice or frost; and the men should not be allowed to work in exposed places more than a reasonable number of hours, nor to become unduly fatigued.

Steelworkers should avoid wearing shoes with the soles and heels *nailed* on, because nails are likely to cause the men to slip when walking about on the steel beams. Leather shoes with rubber soles and heels are recommended. It is an almost universal custom among steel-erectors to wear gloves while at their work, and many cuts and bruises on the hands are thus prevented. The gloves should not have stiff gauntlets, however, and it is better to avoid gauntlets altogether, because

FIG. 35. A WORKMAN TAKING UNNECESSARY CHANCES.
(Photograph by Brown Brothers.)

they may catch upon projections, and thereby cause the men to lose their balance. They may also catch upon tools that are lying about, and cause the tools to fall.

45. The Immediate Riveting of Beams. When a new tier of beams is laid upon the upper ends of columns at any given stage of the construction, it is common practice to bolt the beams in position for the time being, and to do the final riveting later. In New York City at least half of the rivet holes are supposed to be filled with bolts, when the work is done in this way, and considerable time is required for setting these bolts in place and removing them

FIG. 36. STEEL MEN BEING LIFTED TO THEIR WORK.

(This practice is dangerous, and wholly unnecessary. Many engineers consider it safer to raise the men in this way than to have them climb the columns; but the use of suitable ladders is far safer than either of these methods.)

again. It is better, for economy as well as for safety, to do away with most of this preliminary bolting, by riveting the beams to the columns as soon as they are set in position. Experience has proved that this is entirely practicable. In following this plan each of the newly-set beams is secured in place by two or three bolts at each end, according to its weight, and a gang of riveters *immediately* follows, to completely rivet up the entire top tier. The columns are then made plumb by means of sway cables, and when that has been done the riveting is completed on the sections below. By thus securing the beams solidly to the columns at the earliest practicable moment, greater safety is assured in case a beam or a derrick should fall. A falling derrick will bend a fully-riveted beam, but will usually be held by it; whereas a beam bolted in the ordinary way is likely to fail by the shearing of the bolts when a falling derrick strikes it, and in a case of this kind the derrick, and very likely the beam also, will probably crash down through several floors, and perhaps to the very basement. The suggested method eliminates something like 40 per cent. of the work of placing and removing bolts. It also saves the shifting of floor-planks to enable the men to get at the rivet-holes at a later stage of the work, and it has other advantages that will readily occur to the steelworker.

46. Erecting Floors. Cover over the erecting floor tightly so that there will be no openings left through which tools, bolts, rivets, or other small objects may fall. The men should not leave drift pins, dollies, wrenches, or other objects lying on beams or in other elevated positions. (See also paragraph 52.)

When leaving the work care should be taken to secure all objects, or to place them where they cannot be disturbed by the wind. Rivet-heating forges should receive attention in this respect, and empty rivet kegs, paint pots, and other similar objects should be safely stowed.

47. Rivet-heaters' Platforms. Lack of care is often noticeable in the location and erection of the platforms for rivet-heaters' forges. These platforms should be at least 13 feet long and 8 feet wide, should be provided with toe-boards, and should be located as near as possible to the point where the riveting is being done. The planks should also be laid closely together, so that nothing can fall between them.

48. Throwing Rivets. Rivets should never be thrown across shaftways or toward the outside of a building. When riveting is being done on an outside wall the rivets should be passed by hand or should be thrown as nearly as possible in a direction parallel to the wall. Buckets with flaring sides are not recommended for catching rivets, because the rivets are more likely to bound out of them than out of buckets or cans with straight sides. Empty powder cans may often be had where building construction is being carried on, and these are recommended for catching the rivets. False bottoms of soft wood should be placed in them, to prevent the rivets from rebounding. It is often possible to pass rivets for considerable distances through suitably-arranged iron pipes, and this should be done, if feasible, whenever the forges are located some distance away from, and above, the place where the riveting is being done. (See also paragraph 38.)

49. Pneumatic Hammers. The snaps and plungers of pneumatic riveting hammers sometimes drop out,

and they may even fly out with considerable force, and injure persons. To prevent this, one end of a piece of No. 8 annealed iron wire should be secured around the snap and the other end around the handle of the hammer, in such a way that there will be sufficient slack to permit the hammer to operate properly, but not enough to allow the snap to drop out of place.

50. Care of Air Hose. Riveters should carefully avoid allowing the air hose to become wrapped about their legs or other parts of their bodies, because it is likely to twist and turn, and may cause them to lose their balance and fall. The playing of so-called "practical jokes" with compressed air should be absolutely forbidden, because severe injuries are often caused in this way.

51. Handling Structural Steel. Ropes should be attached to loads of structural steel that are being hoisted, by which workmen, stationed on the erecting floor or in other positions where good footing is obtainable, may assist in guiding the loads to suitable resting places. In this way it is possible to avoid, in large measure, the danger to which steelworkers are exposed when they have to push or pull the loads into position while standing on narrow beams, or in other places where the footing is insecure.

IX. GENERAL PRECAUTIONS.

52. Covering Floors. All openings in the floors should be either planked over, or substantially guarded with fences or with rails and toe-boards; and the unauthorized removal of planks that have been laid down to cover up openings should be absolutely prevented. It is of course necessary at times for sub-contractors' gangs to remove temporary flooring and

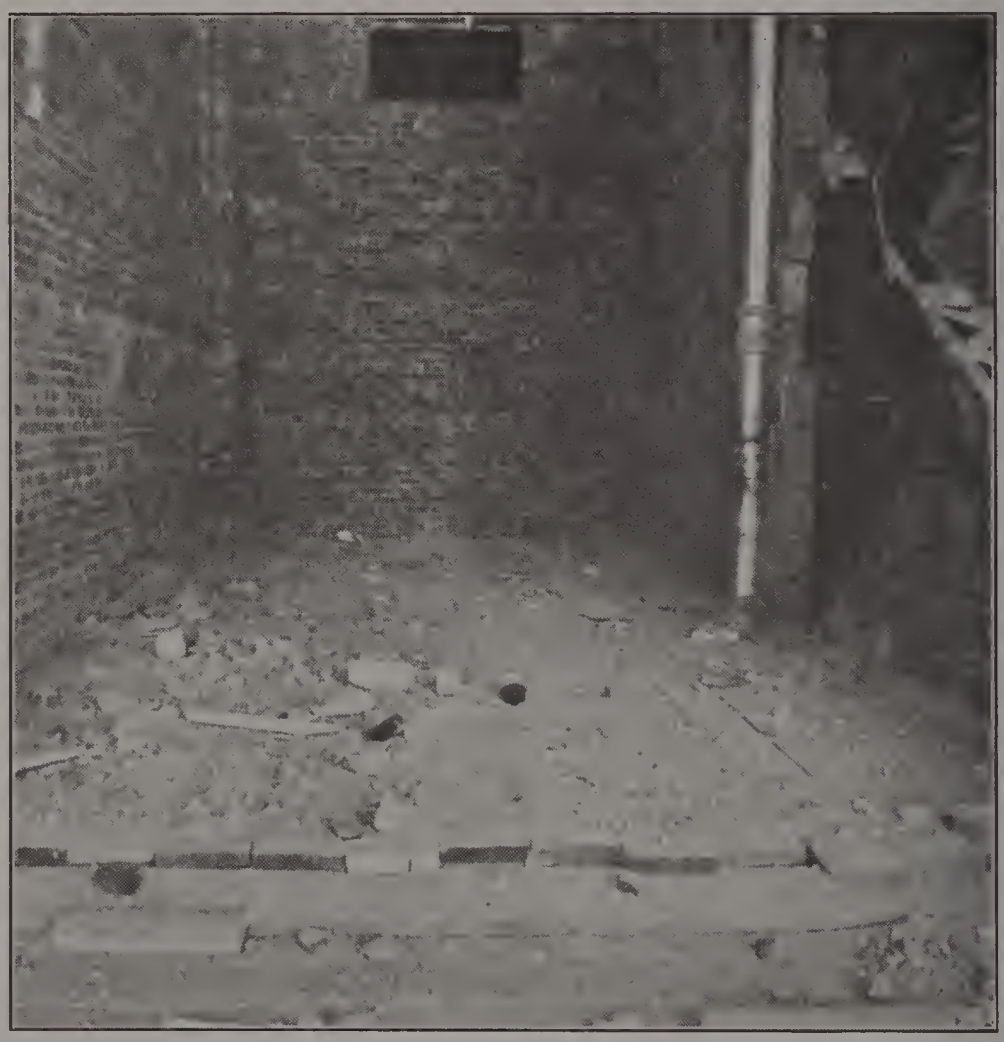


FIG. 37. PROTECTIVE PLANK FLOORING IN A VENTILATING SHAFT.

(Note the material that has fallen from above and been caught by the covering.)

FIG. 38. A DANGEROUS FLOOR-OPENING.

(If a man coming through the doorway should heedlessly turn at once to his right, he would probably step into the opening and fall 15 feet to the basement floor. Guard-rails should always be installed about such openings, at the earliest practicable moment.)

FIG. 39. AN ACCIDENT-SOURCE THAT IS FREQUENTLY OVERLOOKED.

(The opening under the end of the runway should be boarded up, to prevent objects from passing through it and falling to the floors below.)

guard-rails, but they should be required to replace every such safeguard as soon as the exigencies of the work will permit. Unfortunately, the workmen on construction jobs usually have but little regard for this precaution, and they often remove protective planks and put them to other uses, as soon as the safety-inspectors go to another floor. They do this, not maliciously, but merely because they do not understand the paramount importance of keeping the openings covered over.

It is essential not only to cover up large openings in this way, but also to fill in small apertures about

FIG. 40. AN UNGUARDED ELEVATOR SHAFTWAY.
(A workman fell into the shaftway at this point, and was killed.)

columns, and all other similar places. Fragments of bricks, tools, small pieces of board, and other objects frequently fall through such openings and strike the men below. For this reason, also, the planks used for temporary flooring must be laid closely together, so that no small objects can fall between them. (See also paragraph 46.)

In construction work the floor arches should be laid as soon as possible after the steelwork has been set, and should be kept within two floors of the derricks, whenever practicable. If it is not practicable to do this, the second floor below the erecting floor should be entirely planked over. One system that has been tried with marked success consists in com-

pletely planking over the erecting floor and the second floor under it, and shifting the lower of these two floors to the top every time the derricks are raised, so that it becomes, in its turn, the erecting floor. By this means all the men on the lower levels are protected, at all times, by at least one complete floor of planking, regardless of the operations that may be going on upon the erecting floor. It might be thought that the procedure here suggested would be a source of considerable expense, but experience shows that such is not the case. It saves a great deal of time for the steel contractor's men, by giving them a good flooring

FIG. 41. APPROVED GUARD-RAILS FOR PERMANENT ELEVATOR SHAFTWAYS AND OTHER SIMILAR OPENINGS.

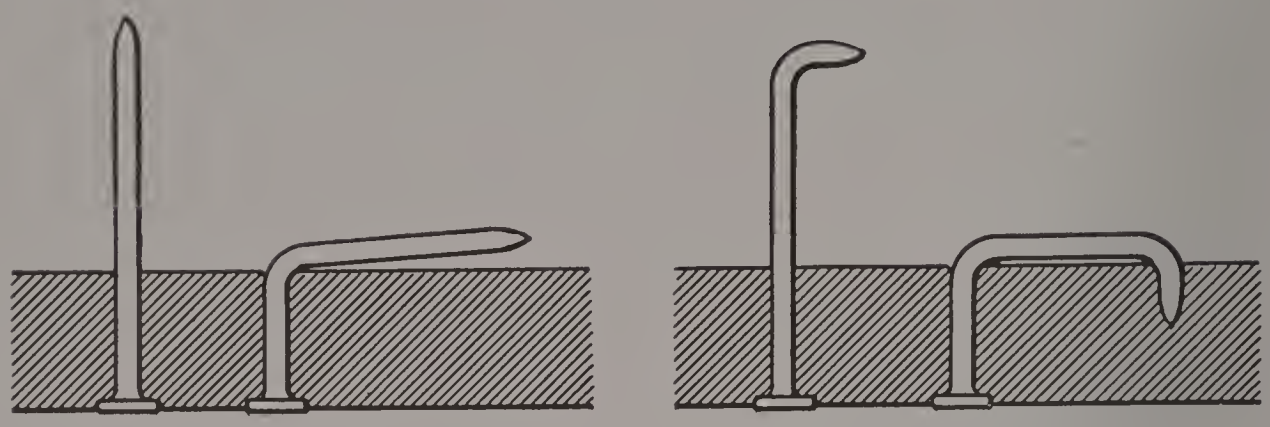
(In the center of the picture there is also a guard for the protection of signal cords. In this connection, however, note the remarks under Fig. 11, page 29.)

upon which to work at their bolting and riveting operations while the next tier of beams is being placed; and the gain that is effected in this way should more than offset the cost of providing and handling the extra lumber.

It is particularly important that the floors on which the derricks stand should always be planked over solidly, because men are traveling about upon these floors constantly, and tools and materials are specially likely to be dropped upon the other workmen below. In planking a floor, no matter for how short a time, special care should be taken to see that none of the planks are placed so that they can be tipped by stepping upon their ends. Planks so set are often called "traps," and they have brought death or serious injury to many persons. (See also paragraphs 10 and 46.)

53. The Nail Hazard. It is often extremely difficult to impress upon the men the importance of guarding against injuries from projecting nails; and yet it is probable that in building construction more accidents result from this particular hazard than from any other single cause. It is true that most of the injuries caused by nails are of minor importance, yet quite a sensible proportion of them result seriously, and the loss of a hand or a foot, from infection received in this way, is by no means uncommon.

An injury from a nail should receive immediate medical treatment, because septic material is likely to be carried into the wound by the nail. Nails covered with dirt or rust are especially dangerous in this respect, but clean nails may also give rise to serious trouble by introducing septic matter from the skin or clothing of the injured man. When a nail-



USUAL METHOD. (Dangerous.) CORRECT METHOD. (Safe.)

FIGS. 42 AND 43. HAMMERING DOWN A PROJECTING NAIL.

wound is properly treated it will usually heal in a short time, but if it is neglected, blood poisoning or lockjaw may follow.

All projecting nails in boards, planks, and timbers should be carefully removed, hammered in, or bent over in a safe way; and if time will not permit of doing this immediately, the material should be temporarily stowed in piles with the points of the nails projecting downward, and attention should be given to the nails at the earliest practicable moment. Scaffold materials, concrete forms that have been removed, and boards that have been used for protecting the corners of building stones are often thrown down carelessly, and these usually have numerous nails projecting from them that should be withdrawn or made safe.

54. Hand Tools. It is extremely important to keep all hand tools in the best possible condition. Edged tools should be kept sharp, and hammers, sledges, cold chisels, drift pins, drills, and other similar tools should be dressed frequently, to remove burrs that might otherwise fly off when the tools are struck, and cause injuries.

Axes, picks, hoes, sledges, and other such implements should be immediately repaired or discarded

if their handles become split or broken. Provide protective handles for cold chisels and drills, to avoid injury in case the strikers miss the heads of the tools when cutting or chipping stone, concrete, or metal.

Tools should not be left lying about on scaffolds or stepladders, nor on beams, nor in elevated places of any kind from which they might fall and cause injuries.

Men working in gangs should be careful to keep a suitable distance apart, to avoid striking one another with their tools and implements.

When a number of tools or other small objects are to be hoisted to the working level they should not be lifted by the use of slings or ropes alone, but should be placed in suitable boxes, barrels, or buckets, in such a way that they cannot fall out.

Mortar hods and brick hods should be kept in good condition, and any that are defective should be repaired or discarded. Brick hods should be loaded with care, and every precaution taken to prevent any of the bricks from falling out when the helpers are going up ladders, or passing along scaffolds or runways.

55. Wheelbarrows. See that all wheelbarrows are maintained in good condition. If the workmen have to push them through narrow doorways or passageways, protective handles should be provided, to guard the workmen's hands against being crushed or bruised. In placing a barrow on a material hoist, always make sure that no part of it projects beyond the edge of the hoist.

When wheelbarrows are transported on hoists, the floors of the hoists should be provided with blocks to receive their legs, as noted in paragraph 26, page

40; and care should be taken to see that the legs of the barrows are in proper position with respect to the blocks, before the hoists are moved.

Do not allow the men to leave wheelbarrows so that their handles project out into passageways. Many serious accidents have been caused by persons colliding with these handles, in unexpected places.

When barrows are empty, the men sometimes tip them to a nearly vertical position, and run with them. This practice is dangerous, especially when going down inclined runways, because the men are likely to stumble and be injured.

56. Explosives. Explosives are frequently used in preparing foundations for buildings. It is also necessary, at times, to do more or less blasting in connection with demolition operations, although this should be avoided as far as possible. When explosives of any kind are used, they should be put in charge of some one person who is known to be experienced and thoroughly trustworthy, and who should be held responsible for the exercise of all possible precautions in connection with the storage and use of them. The shots should preferably be fired electrically, and in case of a misfire nobody should be permitted to approach the place where the charge is located for at least two hours. Ample warning should be given to all persons in the vicinity before a charge is fired, and when fuse is used it should not be lighted until it is absolutely certain that everybody has removed to a safe position. Smoking, and the use of open flames of any kind near explosives, should never be tolerated. It is impossible, in the space here available, to review the various dangers that are associated with the use of explosives.

FIG. 44. WORKING UNDER DANGEROUS CONDITIONS.

(Steelworkers are necessarily exposed to many grave risks, and it often happens that they must rely, for safety, mainly or wholly upon their own coolness and judgment. The man here shown should wear a safety belt.)

Detailed information on this subject is given, however, in a special booklet issued by the Engineering and Inspection Division of THE TRAVELERS INSURANCE COMPANY, and copies may be had upon application.

57. Life Lines and Safety Belts. Many serious accidents might be averted if the men were required to wear safety belts secured to stout life lines whenever it is practicable to do so. Under certain conditions, for example during the early stages of construction, the steelworkers can seldom use these safeguards with advantage, because they have to move about freely and almost continuously. There are times, in fact, when life lines might be distinctly dangerous

FIG. 45. PAINTING THE STEELWORK OF A "SKYSCRAPER".
(The workman should have worn a safety belt and life line.)

to the men, by impeding their movements in critical situations; but there are other times, beyond all question, when the safety of the steelworkers would be materially increased by the use of life lines.

Life lines and safety belts should be used by men working on steeply-pitched roofs, and by those who are installing, adjusting, and inspecting the machines and other parts of suspended scaffolds. Painters should also be provided with these safeguards while at work on the steel columns and other structural members that have been erected, and should be required to use them faithfully. There are numerous other operations, also, which would be made less hazardous by requiring the men to use these safety

FIG. 46. KEEP ALL MATERIAL WELL BACK FROM THE EDGES OF OPEN FLOORS.

devices. The safety belt is used quite generally in other countries, and there is no good and sufficient reason why we should not adopt it far more generally in the United States.

Great care should always be taken to see that the life lines are safely secured to strong, firm supports, and they should be no longer than is necessary in order to permit the work to be done without inconvenience. Otherwise, if a man should fall, the rope would be subjected to a snapping stress of unnecessary severity, and it would be more likely to break than if it were shorter.

Inspect and thoroughly test all life lines and safety belts at frequent intervals, and see that they are in first-class condition in all respects.

58. Miscellaneous. Provide adequate artificial light wherever necessary, throughout the building, and especially in passageways and on stairways. Incandescent electric lamps that burn continuously throughout the working period should be inspected twice a day, and all broken or burned-out lamps should be immediately replaced by new ones.

FIG. 47. POORLY-PILED FLOOR TILES.
(These should be stowed much more carefully, in orderly and regular piles not more than six blocks in height.)

It is especially important to keep all stairways, passageways, and gangways free from obstructions of every kind, and the men should not be allowed to store materials or supplies in these places.

Keep all materials and supplies well away from the edges of hoist shaftways, stair wells, and other

similar openings, and also from the outside walls of the building. Do not permit material to be piled to an unsafe height, nor in an unsafe way. Floor tile blocks, for example, should not be piled to a height exceeding 6 feet. Make sure that all piles of material

FIG. 48. A DANGEROUS PILE OF BRICKS.

are safe against falling over, and brace them effectively, or make them secure in some other way, whenever support of this kind is needed. Loose, light material should not be left lying about on roofs, nor

FIG. 49. USING A CLOTH SCREEN TO PREVENT CHIPS OF STONE FROM FLYING INTO THE STREET.

(The workman was less mindful of his own safety, however, as he was not wearing eye protectors.)

on upper floors that are not closed in, especially when high winds are prevailing, because it is likely to be blown off into the street and cause injuries.

Bolts, nuts, and rivets should not be left lying about, but should be collected daily and placed in kegs or other suitable receptacles.

Caution the men with regard to handling bags containing lime, because these bags sometimes burst and the lime gets into the eyes of the workmen, causing serious and painful injuries.

Men engaged in cutting or chipping concrete, stone, or metal, should wear suitable goggles or eye-protectors to prevent injuries to the eyes from flying chips. Similar eye-protectors should be worn by the

men when doing any other work that is likely to cause injury to the eyes.

When chipping is being done in exposed places the public should be protected against flying pieces of stone or metal by stout screens placed in positions where they will intercept the chips. When a number of men are working in a group upon cutting or trimming operations of this nature, they should also be protected *from one another* by means of similar screens.

Provide facilities for giving first-aid treatment in case of accident. On every construction job a first-aid cabinet should be kept in the contractor's office, or in some other convenient and accessible location. It should contain all of the supplies needed for use in first-aid work, and it should be placed in charge of some person who is known to be competent to render first-aid treatment properly and effectively, and whose services are immediately available at all times. On many large construction jobs hospital rooms are provided, having facilities for more extensive treatment, and with trained nurses in constant attendance. These are recommended wherever it is practicable to provide them. In all cases, arrangements should be made so that a competent physician may be procured with the least possible delay. The addresses and telephone numbers of several who are near by should be posted in a conspicuous place.

59. Inspections. No one thing is more essential to safety in building operations than intelligent and thorough inspections; and the service should be frequent, because the conditions that prevail in such work change quite rapidly. If the operation is a large one, it is often advisable to have at least one inspector on

the premises constantly, while the work is progressing most actively; and on the very largest jobs it may at times be wise to have two or even more men thus engaged. On a small job it is not feasible to maintain a man continuously for inspection work only, but in a case of this kind it is easy for the foreman to have personal knowledge of every important condition, and with the assistance of a professional inspector at reasonable intervals he should be able to conduct the operation in a safe way.

A plan that has been found to work well in operations of average size consists in making a preliminary inspection as soon as the work is started, and submitting recommendations for the improvement of conditions and the installation of suitable safeguards. On his next visit the inspector sees that the recommendations have been carried out, or are in process of fulfilment, and submits new recommendations to cover new conditions that have arisen on account of the progress of the work. This routine is followed at each inspection visit, to insure safety at all times.

It is reasonable to suppose that the best inspection service will be rendered by a corporation that has a large money-interest staked upon the safety of the men, because a corporation of this kind has a definite and positive material incentive to thoroughness and efficiency. The contractor also has an interest in the matter, financial as well as humane; but he has many other things to think of at the same time, and he can hardly give the safety problem the minute attention that it must receive, if accidents are to be prevented or effectually reduced. The compensation and liability insurance company is the most logical

source from which efficient inspections may be expected, and if it is alive to its possibilities and responsibilities it will maintain an inspection force that is competent to deal with the accident problem in an intelligent and effective manner.

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FOR SEVEN CENTS A DAY

a 20-year paid-up life policy

SUPPOSE the case of a man of thirty who has a wife and family to provide for. He pays $25.45 a year twenty times and then no more. When he dies, his family receives $1,000—either in a lump sum, or however else he may have directed.

Meantime other benefits have been available, among them the privilege of borrowing on his policy.

ANOTHER example: The man's wife is thirty years old. He pays $49.66 a year twenty times, and then no more. Less than fourteen cents a day! When the man dies his wife receives $10 a month income for the rest of her life. If she dies, the payments go on, to her heirs, till a twenty-years period is completed.

For seventy cents a day, an income of $50 a month for life is provided.

These are only random examples. The TRAVELERS writes all kinds of life policies at the most advantageous terms.