

Publications of the

BRITISH FIRE PREVENTION COMMITTEE.—No. 9.

Edited by Edwin O. Sachs.

LESSONS
FROM
FIRE AND PANIC

A Paper

BY

THOMAS BLASHILL,

FELLOW OF THE ROYAL INSTITUTE OF BRITISH ARCHITECTS,
FELLOW OF THE SURVEYORS' INSTITUTE,
SUPERINTENDING ARCHITECT TO THE LONDON COUNTY COUNCIL,
ETC., ETC.

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OBJECTS :

The main objects of the Committee are :—

To direct attention to the urgent need for increased protection of life and property from fire by the adoption of preventive measures.

To use its influence in every direction towards minimising the possibilities and dangers of fire.

To bring together those scientifically interested in the subject of Fire Prevention.

To arrange periodical meetings for the discussion of practical questions bearing on the same.

To establish a reading-room, library and collections for purposes of research, and for supplying recent and authentic information on the subject of Fire Prevention.

To publish from time to time papers specially prepared for the Committee, together with records, extracts, and translations.

To undertake such independent investigations and tests of materials, methods and appliances as may be considered advisable.

The Committee does not hold itself in any way responsible for the opinions expressed, or methods advocated, by members and others who kindly contribute to these publications.

Comments on the opinions expressed in these papers, or further information on the subjects under consideration, are cordially invited by the Executive, at whose discretion they will be circulated among the members of the Committee.

NOTE.

IT has been the good fortune of the Surveyors' Institute to have had read before it one of the most important papers on Fire Protection that has been prepared during the present decade, and by a noteworthy act of courtesy the Institute has now permitted a reprint of this valuable paper to form one of the British Fire Prevention Committee's publications, in order that its contents may procure a still wider hearing.

The great importance of the paper will be obvious to all who peruse it; for in its pages much from the vast experience accumulated by the chief building official of our metropolis stands recorded in concise and popular terms. As I have so often had occasion to point out the official controlling the execution of local regulations, whether he be architect, surveyor, or engineer, gains a far wider experience as to protective measures than is possible in the case of a professional man in private practice. And when these duties of control are combined with those of an architect actually carrying out from day to day considerable quantities of new work, the experience gained must be of yet broader character, leaving no grounds even for the too frequent accusation that controlling officers regard building work solely with the eye of a legislator, as distinct from that of a practitioner. But, in reality, there is no necessity to speak in these introductory words of the high qualifications of the author; the paper speaks for itself.

As in other publications of this description, it is not my purpose to comment on the contents. In connection with it, however, I am anxious to express from experience gained at home as well as in other countries, that no

matter what the legislative requirements may be in regard to the construction and equipment of buildings, a satisfactory issue depends mainly on the reading given to the regulations, the spirit with which the official enforces them, and the spirit in which he deals with applicants. In no other form of legislation can it be more difficult to define the detailed requirements necessary to meet general purposes, and in no other form of legislation is it more essential that the executive should be able to apply wisely any discretionary powers given them. It is, in fact, curious how the identical wording of regulations framed for different localities, not to speak of countries, is differently interpreted, and has a different effect according to the character and methods of the officers in charge.

As one, too, who has had the fortune to contend with the bureaucratic methods of some foreign countries and the characteristic despotism, caprice, and reckless disregard of the interests of the applicant so often met with there, I cannot help taking the opportunity of this paper to express the opinion that the architects and surveyors of the metropolis, no matter how satisfied with the general administration of our Building Act, really can not appreciate what it means to have the powers of the Superintending Architect under that code vested in such able hands as those of the author of this paper.

EDWIN O. SACHS.

LONDON,

1st August, 1898.

Lessons from Fire and Panic.

WHEN I undertook this subject the fatal fire at the Paris Charity Bazaar had not happened, nor did we anticipate that great disaster among the warehouses at Cripplegate, which has added its own unnecessary lesson. Indeed, neither of these events was necessary, for they conveyed no warning not already known, and they were useless, for by this time they are practically disregarded.

The fact that the destruction of a building by fire is an improbability removes it from the class of considerations with which the architect usually deals. In proportion to the number of buildings fires are exceedingly few, considering the variety of risks I might say surprisingly few; and if it is a hundred thousand to one against a fire in a particular place on a given day, the ordinary man, environed by more threatening perils, will scoff at precaution and take his chance. But after a calamity the general public with all its tongues asks why the precaution was not taken, and looks out for a victim. By the standard then set up, and not by any doctrine of chances, the architect may expect to be judged.

It is a question whether danger from fire is not increasing in spite of Building Acts. Our buildings are getting more lofty, more closely packed together, and more thickly inhabited. In commercial buildings the rooms are larger and more encumbered with goods, among and over which manufacturing processes are carried on. There is more machinery actuated by heat. The timber we use is more easily combustible, fittings

are lighter, and everything is kept warmer and drier. All our arrangements for obtaining light, from the lucifer match to gas and mineral oil and electricity, are novel and productive of new dangers. The proportion of window openings to wall space is much increased, and with the growth of honesty outside, or trustfulness within, shutters have been abandoned. The old-fashioned solid window frame that stood flush with the face of the wall, and being dangerous had to be abandoned, is through modern fashion being brought out again from its reveal and made in thin casing which will catch fire and fall into the street. Lifts going through several stories neutralise the advantage of fire-resisting floors, lighting areas common to different premises do away with the security of the party-wall. Unrestricted skylights bring ridicule on the incombustible roof covering of the Building Acts. In fact the most scrupulously legal building of brick or stone and slate may be no more than a kind of grate in which its internal structure and its contents can be most conveniently burned. So in the Cripplegate fire, the progress was about as rapid, and the destruction over its limited area no less complete, than in the Great Fire of 1666; and if our arrangements for the extinction of fire had not made immense progress, this recent event might have rivalled that great calamity.

Our own lesson from this must be to improve by all means the construction and arrangement of buildings, even though we may be in advance of Building Acts. We cannot widen the streets, nor increase the unoccupied areas, nor reduce the necessary openings for light, nor dictate to the trader modes of conducting his business which would make his business impossible, nor can we do much in advance of public opinion to diminish the numbers of an audience or spread them over a larger area. The most that we can do is to diminish the chances of fire and to delay its progress, to prevent its passage from room to room and from house to house, to

so arrange the construction that a fire may be more easily put out, and as regards the safety of the inmates, to provide the best means of escape.

We should be wiser if we knew more of the causes of fires. The final comment on most of our great fires is "cause unknown." They have destroyed the evidence of their origin. We learn something from the records of those that are most easily extinguished, and we should learn more from the far greater number that are discovered and dealt with on the first alarm without troubling the fire brigade. In one of those summer exhibitions that are spread over buildings of a temporary character, I had information of ten such alarms within six months. In my own house we have had, through no fault of ours, at least three of the narrowest escapes from the kind of gas explosion by which the house of one of my friends was lately wrecked. We may learn something from these and other failures, but our great lesson must be to distrust the safety from fire of any building unless the greatest care is taken in its construction, and on no account to think that any deficiency in that particular will be made up by carefulness in its occupation and management.

The points which I think it most useful to notice are the following :—

- (1.) The structure and arrangement of buildings generally.
- (2.) Certain legal and other provisions for preventing loss of life in dwelling houses.
- (3.) Certain legal and other provisions for preventing loss of life in factories.
- (4.) Certain legal and other provisions for preventing loss of life in public buildings generally.
- (5.) Certain legal and other provisions for preventing loss of life in theatres and music halls.

With respect to structure, the party-wall as a separation between buildings is, I think, effectual if no illegal openings are made in it. Whether or not it need be

carried up through the roof has been a question, but no satisfactory evidence seems to be forthcoming as to the stoppage of fire by party-walls that are not so carried up. When the London Building Bill of 1893 was before Parliament, the Committee took a great interest in this question, and decided that the old height of fifteen inches above the roof should be raised in the case of a warehouse to three feet.

As to openings in external walls where the streets or back areas are narrow, we want shutters that will delay the passage of fire from without, if only for half an hour, and will obstruct the passage of fire from within. It may be that fire-resisting blinds occupying little space will be found useful. The common lighting areas are formed by what are supposed to be external walls, and the provision of shutters or blinds to the openings in them is even more necessary. Every contrivance of this kind should be easily closed, and should be actually closed every night.

I am quite unable to understand the slow progress made in this country by the fire-resisting floor. In Paris fire-resisting floors were common five-and-thirty years ago. I was then carrying out such work here on a large scale, but the case was exceptional; the weight of the floors was great, the walls had to be thickened, and the cost was excessive. Cheap steel and light substitutes for concrete have changed all that.

In the Cripplegate fire, although many of the warehouses were modern, and some had already been burnt out once or oftener, there was not a single fire-resisting floor. There were wooden floors carried on iron girders, but we are familiar with the behaviour of wrought-iron girders under such conditions. They expand and contract so as to overthrow the walls, or they become soft so as to hang down like tapes. There are now available fire-resisting floors in great variety in which the iron is more or less protected from the fire. In using them care must, however, be taken that no leakage of gas can

accumulate in any hollow spaces. I have seen a large and handsomely decorated house in which fire-resisting floors were used in conjunction with battened walls. Upon applying a light in the usual way to the suspected point of escape the mixture of gas and air accumulated in the hollows exploded, and the ceiling with the wall battening in two stories was stripped away, littering the floors and mixing with the broken window glass. In that case there were also severe personal injuries.

In the great re-housing schemes of the London County Council I have made every floor fire-resisting by the use of steel joists wide-spaced, and filled in solid with coke breeze concrete upon which the floor-boards are nailed, the plastered ceiling being done under the concrete direct. The cost is no more than that of a good wooden floor, while the total thickness is only seven inches, which saves two or three inches in the height of each storey. They are not complained of by the tenants in respect of noise, but in a house where this would be of great consequence a cork covering to the boards under the carpet would be a sufficient remedy.

If it is necessary to adopt wooden construction for floors, the ordinary pugging should at least be used. Joists of double the usual thickness placed two feet apart, and filled in solid with some form of concrete, would offer great resistance to fire. As to the material for pugging, coke breeze and cement concrete, mixed four parts to one, stands fire and water better than anything else. In Switzerland they use coarse plaster stuff, into which long wet shavings have been stirred as hair is stirred into plaster for ceilings; and this, though an imperfect substitute for concrete, will resist a fierce fire for a considerable time, but more experience is required in the use of light solid materials.

I think we have now arrived at a time when architects should at least try to secure an incombustible roof. This is stipulated in the building leases of some very important London estates, and I am told that it raises

no difficulty. If the space in the roof is wanted, pug-ging or concrete is sometimes put between wooden rafters. If a steep roof is necessary, sheets of asbestos put on the roof boarding in place of felt will afford some protection. In a building professing to any degree of fire resistance, the roof should be protected by a ceiling of concrete put over the topmost storey. Ceiling on perforated or expanded metal will give some protection against a small fire.

As to partitions, lath and plaster should be quite abandoned, and brick-nogging also, for a half-brick wall in cement is as easily constructed. There are many kinds of thin partitions from which to choose. I commonly use coke breeze cement concrete two inches in thickness, which is light, tough, and strong enough for storeys of the ordinary height. Old lath-and-plaster partitions may be filled in with this material or with brickwork by removing the plaster from one side only. If the structure is otherwise fire-resisting, any wooden panelled partitions may be considered as fixtures and disregarded, particularly if in hard wood.

I mention these and similar details, not as being unknown, but as being too often neglected, even where the cost would not be a serious item. If fire-resisting materials were in more regular demand workmen would become familiar with them and they would cost less. Exaggerated estimates of the cost of fire-resisting construction do much harm. Very important steps can certainly be taken in that direction with very little extra cost on ordinary construction.

The great danger of a staircase arises from the cupboard underneath its lower flight, which will probably be stored with combustible materials. If it is constructed of thin deal it will take fire easily. If more solid or made of hard wood it will resist a small fire for some time. If it is to be fire-resisting, concrete is safer than stone. But if everything about a staircase is incombustible it may be rendered useless by accumulated

smoke arising from such a cupboard as I have mentioned, or from an adjoining room.

There are certain precautions necessary in construction whether the materials are fire-resisting or not. I have already suggested the danger of hollow floors and hollow partitions, but all hollow spaces that can contain gas or transmit flame or inflammable vapour, or will even allow a supply of air to pass towards a fire, are highly dangerous. The lining of walls with matchboarding is the most ordinary case of this kind. By means of it fire communicates instantly all over a shop, and up through the floor to the rooms above. The hollows formed in heavy plaster cornices and the hollow spaces behind skirtings transmit flame or inflammable air without any outward warning to adjoining or even distant rooms. One instance or two will illustrate this.

In a fire near Clapham Junction that originated among the Christmas decorations in a draper's window, the smoke and flames passed in this way to the upper floor so quickly, that two girls at work over the back part of the shop lost their lives, although there was an easy means of escape by getting out of the back window on to a flat. In a similar case several persons, probably seized with panic, jumped from first floor windows into the street, instead of stepping out at the back. These are indications of the quick effect of fire in a badly-constructed building.

As to the passage of fire or inflammable vapour by hollow spaces, cases have happened where the origin of a considerable fire was inexplicable until it was traced back to some source at a considerable distance from the scene of the damage. In a "fireproof" building, a workman hung his coat in a cupboard leaving his pipe in the pocket. The coat took fire and fell, setting light to the skirting, behind which a small hole had been left in the brick internal wall. The floor-boards of the adjoining room had been laid on wooden strips that stood above the service of the concrete. The fire passed

along the hollow space, doing three thousand pounds' worth of damage in this "fireproof" building. Unless the elasticity of a floor is an object, the boards should be nailed down on to a surface of coke breeze concrete.

If no more serious measures than those I have described are taken in respect of a purely domestic building, they may give very material security as to its behaviour in case of fire. For many years past companies have been erecting artizans' dwellings in London, one of them having put up blocks containing nearly six thousand tenements. In only one case has a fire in any artizans' block extended from one tenement to another. This is due to generally careful construction, though there has been no rigid adherence to fire-resisting principles.

In these descriptions of the parts of a fire-resisting building, the work of the carpenter is practically excluded, and there are many buildings in which this principle should be carried out. There is, however, much convenience in the use of timber, and if posts and girders are made in large sizes, they are safer than if made in iron. Solid floors made of deal joists set close together withstand fire for a long time, but are ultimately destroyed by great heat.

Many attempts have been made to render fir timber fire-resisting or slow-burning by chemical treatment or by covering it with paint. Some of these applications are useful when applied to textile fabrics and to thin slips of wood, but I have been unable to meet with any process that renders the mass of a joist or beam fire-resisting throughout. This is a matter well worth further inquiry and experiment, for joinery at least might be protected in this way. As to the public experiments sometimes reported, those in which tar or mineral oils are liberally used are untrustworthy, for these are light-giving and smoke-producing liquids, and do not imitate the conditions of an ordinary fire.

Although we may succeed in rendering new buildings

satisfactorily fire-resisting, a much more important question for the present generation is the improvement of the condition of old buildings. This is well worth the attention of those who have the charge of building estates already covered, of ordinary town property, or of those old historic mansions filled with family treasures, one of which as I write has been added to the number of those wrecked by fire. In an ordinary building, purely domestic, if the joists are not strong enough to carry a filling in of concrete they will carry ordinary pugging, and if no more than a breadth of three or four feet all round a floor is well filled in on some fire-resisting system, every hollow behind adjacent cornices, skirtings, and partitions being carefully stopped, a very considerable amount of resistance to fire will be afforded. If, besides, the points of contact between chimney stacks and floors and roofs be examined and timber cut away, the condition of an old house might be made approximately as good as that of a new building. In certain cases, where in London a domestic building is changed into a public building, and where a building partly domestic and partly used for trade is increased in area, something of this kind has now to be done.

Even more important than these details of construction is the question of arrangement of buildings with the view of preventing loss of life from fire. Warned by frequent disasters, the legislature has from time to time made provision for protecting persons from sudden fire and panic, and for insuring to the inmates of certain buildings reasonable means of escape.

Examination of this kind must be thorough, for it is difficult to exhaust the possibility of mischief caused by careless workmen in old or in modern times. I have found in an old house the brickwork of a chimney breast cut away to enlarge a cupboard, a thin board being substituted, which had evidently done duty for years in that position.

And with regard to any building, the architect cannot

be too cautious against assuming that reasonable care will be taken in managing it. Most houses are at times, often for a very long time, left in the hands of people without sense of responsibility. That is an additional reason for making every structural provision against the chance of a fire. The fate of Cowdray House, in Sussex, though the story is a hundred years old, contains nothing that might not now be paralleled.

The mansion, which was one of the grandest in the country, was being repaired and decorated in preparation for the owner's wedding, and it was left in the hands of caretakers and workmen. All the more valuable of its contents were temporarily stored in a gallery, and a room close to this place was selected for the carpenter's shop, the fires being closely surrounded with shavings. During the night on which all was finished, fire was observed in the workshop. The neighbours assembled. The moat was full of water, but nobody could find the key of the engine-house. The destruction was practically complete.

The London Building Act, 1894, provides, by Section 61, that every building over 30 feet in height used wholly or in part as a dwelling house or factory, *and having a parapet*, shall have a dormer window or door opening on to the roof, or a trap door with a fixed or hinged step-ladder leading to the roof, or with other proper means of escape. If there happens to be no parapet there is no such provision. I venture to think that it would only be ordinary prudence to make this provision in any house or factory where there is reasonable doubt as to the means of escape by the ordinary route. Section 62 partially meets this view by requiring that any storey in the roof, the floor of which is over 60 feet above the street, shall be constructed of fire-resisting materials; and Section 63 provides that every building over 60 feet high shall have on the storeys, where the floors are over 60 feet above the street, "such means of escape in the case of fire for the persons dwelling or employed therein as can be reasonably required in the circumstances of

each case." No such storeys can be occupied until the London County Council certifies that this has been done. This is new legislation, and it has now become a very important part of the duty of the Council to say what can be reasonably required in such cases.

The height of 60 feet is fixed because that is the greatest height to which a movable fire-escape will reach, and without some special provision the only means of escape from these high storeys would be by descending, if that were possible, to the lower storeys, and increasing the number of persons there in peril. Schemes to be applied to lofty hotels and houses more or less crowded at night have come before me in great variety, many of these very inadequate. It seems clear that the law, which leaves the occupiers of floors up to 60 feet in height to take their chance, intends that those on higher floors shall escape. They may have a gallery or an iron ladder or staircase for access to the roof of an adjoining building, or a series of ladders may be contrived that will conduct them clear of the windows of the burning building down to the ground. But 60 feet is a great height from which to expect women, children and sick persons, scantily dressed, suddenly alarmed in the night, and for the first time in their lives, to descend by an external ladder, in any weather, and probably in the dark. We may realise the condition in which people escape, from the account of a fire that happened at the Scottish mansion of the Duke of Argyll, in which praise was given to the Princess Louise for her presence of mind in running back from the garden to get stockings for the rest of the household who had rushed out barefooted. For people in that condition steep ladders with ordinary rounds are useless. They must be of tolerably good slope, have flat treads and hand-rails and there must be suitable protection where necessary against falling into areas or through skylights. The escape door must have such fastenings only as can be easily opened from within. It must be easily found by night, and the bottom of the escape must be in some

open space quite clear of danger. But whether the escape delivers to the ground or on to some willing neighbour's roof, there is risk that it will be made use of by burglars and by inmates of both premises for improper purposes. If a separate staircase leading down to a separate door of exit is provided in the building, it will very likely be allowed to go out of use, and will be turned into a store place for lumber. On the other hand, if the construction of dwelling rooms above the 60 feet limit is of very great consequence, the owner may reasonably be required to make and keep up such arrangements, however costly, as will be really efficient.

By the 74th Section of the London Building Act, when a building over 1,000 feet in area is used in part for purpose of trade and manufacture and in part as a dwelling house, the two parts must be separated by walls and floors of fire-resisting materials, and all means of approach to the dwelling house portion must be constructed throughout of fire-resisting material. But the walls of staircases and passages may have openings fitted with fire resisting doors to communicate between the two portions, for which purpose hard wood two inches thick is reckoned fire-resisting. For staircases hard wood two inches thick is also permitted, and good concrete when filled in between the joists of floors is fire-resisting.

It will be observed that the term "fire-resisting" is used and not "fireproof." The construction must not add fuel to the fire, but resist it for at least a considerable time, during which the inmates of a building may escape and fire appliances be brought to bear. If the contents of the room or even of the building cannot be saved, so much the worse for the owner or the insurance company; but the fire should rarely extend to the adjoining apartment on either side or to a storey above or below, and the smoke should be kept from staircases and passages. This means giving to adjoining sections of a house as nearly as practicable the same protection against each

other as a good party-wall affords to the inhabitants of an adjoining house.

By the Factory Act, 1891, every new factory in which more than forty persons are employed must be provided on the storeys above the ground floor with such means of escape in case of fire as can reasonably be required under the circumstance of each case. Every old factory must, after notice, be similarly provided, subject to arbitration in case of difference. The Factory Act of 1895 extends these provisions to certain workshops and laundries. I think that the chief fatalities during recent years have been in factories employing less than forty, but there are other provisions for safety and for facilitating escape which may be put in force by the inspectors if the provisions above mentioned are not applicable. As to the application of these structural provisions, it has been said that if the workpeople on the upper floors are provided with means of getting to the ground floor they cease to be subject to the Act, but this view does not seem to be supported by the words of the Act, which require that such persons are to have "means of escape," and the ground floor might be on fire and not available for that purpose. These persons therefore must have means of getting clear of the building either into a street, or by arrangement on to adjoining premises, or into an open yard of ample area. In a confined yard they would be subject to the glow and heat of the fire, and this is fatal. Many of the victims at the Paris Bazaar fire died in the open yard at the rear, which was of some size, but which afforded no shelter from the fire.

The circumstances of each case which the authority or the arbitrator is to take into account appear to be such as arise from the nature and quantity of materials used, the processes employed, the danger from lifts which will communicate fire and smoke, the numbers of workmen and workwomen respectively, and the description of the premises surrounding the factory. It is sometimes argued that "the circumstances of each case!" which are

to be taken into consideration include such as arise from the insufficiency or inconvenience of the site, the owner's system of supervision, or other matters which might have been foreseen and provided against in the selection of the site or the construction of the building, and that allowances should be made for such matters of difficulty. But there must at any rate be means of escape, and those which may be sufficient in an ordinary case may reasonably be increased and not omitted if the site, or the buildings, or the system of management are worse than common. If a factory has combustible floors and roof, the requirements may be more stringent than if it is fire-resisting throughout. But unless the plan is satisfactory, the smoke from a very small fire will quickly spread, disabling the workpeople or causing a sudden panic, whether the building is fire-resisting or not.

Some of the causes of danger are the inflammability of the stock, the way it is allowed to accumulate so that insufficient room may be left even for passages, the chance that access to staircases may be cut off by the fire, the insufficient width of the staircases, the bad arrangement of their steps, and their liability to become filled with smoke. As in theatres, there should be alternative means of escape at different extremities of the building. Two rooms may be united by a doorway, each room having its staircase at the other extremity, or two buildings having their own staircases may be united by a bridge on each floor. Generally the staircases should be of concrete, secondary staircases of minor importance being of oak or teak, the treads 10 inches, the risers $7\frac{1}{4}$ inches, the width 3 feet 6 inches to 4 feet 6 inches. There should be a fire-resisting enclosure to each, with self-closing doors opening by pressure in the direction of each, but not so as to obstruct the landings. The staircase should be well ventilated and should adjoin an external wall. If that is impracticable, it should communicate with the street by a very short passage of fire-

resisting construction. The roof of the staircase should be fire-resisting. If iron or other fixed sashes are to be used some should be made to open, so that persons could be rescued by means of them.

I will here allude to other means of escape which are no doubt contemplated. Iron external staircases kept clear of windows through which fire can pass may be constructed. Movable fire-escapes are to some extent recognised, for the factory inspector may require them and the magistrate may order them. But these are things properly within the duty of the tenant, and do not seem to be what the Acts require of the owner, whose duty it is to put his building into a proper state structurally. Movable escapes are not satisfactory as substitutes for structural requirements. When a new staircase was demanded in an old building the occupier pointed out that there was a movable escape ready to be let down at one of the windows. When asked to show how it worked the window was found to be fastened down, and he proposed to send for a carpenter, who was in the basement. I need not enlarge on the risks of such contrivances when used by persons not in the frequent habit of using them.

Escape downward by means of the staircase being liable to interruption by fire and smoke, other means must be made available. Very little has so far been done to provide escape by the horizontal route towards adjoining buildings or upwards through the roof. To both of these there are, however, serious objections.

The London Building Act prohibits openings through party-walls between houses in different occupations; besides which, few people would run the risk of the improper user of such convenient modes of getting from house to house without the knowledge of the owners. The late Sir Henry Bessemer showed me an ingenious arrangement by which this last objection was sought to be removed. An opening only 16 inches wide by 3 feet 6 inches high was made in the party-wall at a foot above

the floor level. On each side was a very strong iron door and frame, on the inner side of which was a pair of knockers. On an alarm of fire in either house the inmates would open their own door, and ply the knockers on that of the neighbour, who might be expected to come quickly to the rescue. The outside balcony is a much better arrangement, and if it could be generally adopted on each storey, or only for alternative storeys, there would be in most cases reasonable facilities for rescue. But the balcony, though a beautiful architectural feature, is almost unused in this country. It might cause apprehension of improper access from house to house or from room to room. I have, however, lived for many years in a district where every house has a spacious balcony above the ground storey, and I have not heard of this objection. There is an easy means of passing from the window of one house to the nearest window of the adjoining house by fixing a short length of balcony between them crossing the end of the party-wall.

But the best means of escape after the staircase is by way of the roof, a good flight of stairs being provided to the roof door, which should have an automatic fastening. The Cripplegate fire happened to originate in one of the manufacturing warehouses which was first dealt with by the London County Council under the Factory Act of 1891. The two upper storeys were occupied by seventy or eighty workgirls, and the owner willingly put a proper door to lead on to the roof. By this route he and they got away, and without it they must all have perished. But easy as it was, there was considerable difficulty in getting the girls out in the few minutes available, some having fainted or become uncontrollable in their excitement. As the workwomen are usually accommodated, often by hundreds, on top storeys, this is a useful lesson in the construction of means of escape.

I do not suppose that roof doors will be willingly adopted where valuable stocks are kept, but in a district of warehouses where the roofs were properly adapted for

escape there might be a watch kept on the roof against thieves and the outbreak of fire.

The construction and arrangement of public buildings, that is, places of worship, schools, hospitals, workhouses, theatres, halls, exhibition rooms, and other public places of assembly in London, are in certain respects regulated by the London Building Act, 1894. The general construction must be to the approval of the district surveyor, subject to a tribunal of appeal, but the Act requires that the floors of lobbies, corridors, passages and landings, and the flights of stairs shall be of fire-resisting material. Besides this the dimensions of passages, staircases, and exits of new churches, chapels, meeting houses, public halls, lecture rooms, exhibition rooms, or places of assembly are laid down in the Act. Staircases must be carried and enclosed by nine-inch walls, and with the corridors and passages shall be not less than four feet six inches wide, but if not more than two hundred persons are accommodated this is reduced to three feet six inches. If for more than four hundred persons an addition of six inches for every additional hundred is to be made up to a maximum of nine feet and when the width is over six feet there is to be a dividing hand-rail. If two staircases or passages are put instead of one, each must be of two-thirds the above dimensions, but not less than three feet six inches. And if one portion of the public is accommodated over another portion they must have a separate exit. All doors and barriers must open outwards, and no outside locks or bolts are to be fixed.

As regards public buildings in general these are new provisions. They are a somewhat mild adaptation of the much more stringent regulations that have long been applied to theatres and music-halls, and they were very much required.

I was once asked by a member of a Parliamentary Committee who desired to ridicule our theatre regulations why we did not seek to apply them to churches,

and could only suggest the comparatively infrequency of accidents in such places. But the reason was inadequate and Parliament has since recognised this in the above provisions. There are many more accidents in places of worship than is commonly supposed, and the most serious have happened in such places. The crowds are often more dense, and precautions are hardly thought of. One, or perhaps, two doors are thought enough for many hundreds of people. The organ and heating apparatus and vestry are in dangerous proximity, artificial light and decoration are on the increase. A senseless panic ensues on the least alarm.

To go back rather a long way, in 1120 the monastic church of Vezelay, in France, was burnt, with 1,127 men and women. And other similar fatalities are found in old records. Some seventy years ago, at a festival, when the cathedral of a South American city was crowded with the whole female population, the elaborate decorations which thoughtless people always add on festal occasions, took fire, and 2,000 perished, hardly any escaping. A few months ago some decorations in Pisa Cathedral took fire, and in a panic twelve persons were crushed to death and twenty injured. A few weeks ago, fifty-four people were killed and eighty injured at a fire in a church in Russia. A few days ago, the organ and gallery of a chapel in Hull were blazing when the Sunday morning congregation assembled. If this outbreak had been delayed for half an hour we might have had an object lesson in panic. I mention these matters because the architect will feel that he ought not to provide anything less than the moderate securities demanded by the London Building Act; and if one or two additional doors are required, they are at all times a convenience to a crowded congregation. If the precautions above mentioned are required in a new building, I am unable to see why they should not within a reasonable time be demanded in old buildings as well.

But these are matters in which we must expect no help or sympathy from the persons whose lives are thus safeguarded. Twenty years ago the densely crowded church of which I was the people's warden had outer doors opening inwards, and with the support of the vicar I insisted on an internal lobby with doors opening outwards. We did this in spite of unanimous opposition and as no panic has occurred the opponents may say they were in the right.

A few years ago a thoughtful architect provided to the west end of a new church the only efficient arrangement of exit doors that I have seen, but fitted them with a lock. I went to the opening service to see the result. The place was full, even to the standing room, and when the procession from the choir turned to come down the centre passage they could not advance a step. Then, if ever, was the time to throw open the exit doors, but the key was in the vicar's pocket, and he could not be reached except by means that would have been impracticable, and with delay that would have been fatal in case of a panic.

I think it probable that we may not again hear of the fitting up of one of our great churches for some important function with a forest of timber, in stages and seats and galleries, so that either through accident or through malice, a fire may be raised which might result in a calamity even greater than any that has hitherto been known. At the induction of the Dean of Canterbury, when a great crowd was expected, those in charge of the Cathedral were properly careful, and limited the admissions to those who could be accommodated with a reasonable chance of safety to themselves.

Our theatre regulations are made under the Metropolitan Management Amendment Act, 1878, and have been much strengthened in recent years, largely through the advice of Sir E. M. Shaw, K.C.B., formerly the chief officer of the Metropolitan Fire Brigade, while the

application of the regulations has become more stringent as their necessity has been more generally appreciated. They are applicable to all places where the public are invited, for music, or dancing, or stage plays, whether on payment, or by ticket or free. I can only mention a few of the things which must now be done in the case of a newly-licensed building, and which are demanded so far as is reasonable and practicable in the case of an old building. As to the latter there is an appeal to the arbitrator.

I am not sure that many theatre architects entirely approve every one of our regulations, but some approve certain of them and others probably approve the rest, for whereas a few years ago not many plans were submitted that would bear examination, there is now a large and increasing number of architects who, so far as their clients will permit them, produce excellent plans and heartily concur in our regulations as a whole. And as to clients, all the more experienced managers are alive to the risks of their undertakings, and very large sums have been willingly spent by them in the improvement of old buildings. Manchester has taken a good lead in theatre architecture. At the present time, when new theatres are being built in all our London suburbs, and even in small provincial towns, no class of buildings is better understood.

In London the site for a new theatre or music-hall must abut for one-half of the boundary upon public thoroughfares, one of which must be not less than forty feet wide. This is exactly one half of the requirement as to site in most continental cities, where, as in Manchester, the theatre must be entirely isolated. But our own moderate demand may be relaxed if the building is of small importance or if the design or surroundings seem to warrant it. We are now actually getting isolated theatres, whereas a few years ago there was not one in London. Not many years ago the owner of a site intended for a theatre would insist on devoting the

best portion of his frontage to shops. If the site consisted chiefly of back land, the owner would consider it particularly eligible for a theatre. Of such a site I once said to the proposer, "Surely nature intended this for a "coal yard," but he was careful to correct me—it had really been a timber yard.

Our regulations provide for the separation of dressing-rooms, and such sources of danger as workshops, stores, painting-rooms, property-rooms, scene-docks, engine-rooms, and gas meter rooms, and regulate the supply of gas, electric light, lime light and water. They require a fire-resisting curtain and a high roof with lantern light over the stage. The mischief of windows opening near adjacent property is sometimes imperfectly guarded against by protecting them with hoppers. Recently a fire was caused in a music-hall by an old accumulation of rubbish carried by the wind into one such hopper and fired by burning soot from a neighbouring chimney. Our greatest difficulties arise out of staircases, corridors, and exits.

People who talk of clearing a theatre in two or three minutes fail to realise the suddenness with which smoke and poisonous vapours spread, nor do they appreciate the effect of a panic, which may prevent an audience getting out at all. If a fire breaks out among the scenery the whole is alight at once ; the vapours make for the upper parts of the auditorium, and the people die where they sit. In the great theatre fires it has been estimated that all the victims died from suffocation within five minutes. These are matters which can be reckoned with, hence the provision of "fire-proof" curtains and high roofs over the stage. But no one can reckon with panic. It needs no fire or other danger. It is a madness to escape from no one knows what. The exits from a public place must allow for panic as well as for fire. Two exits, well-lighted by some independent means, must be provided from every part of the building, and as one may be blocked, each must be capable

of taking the whole of that part of the audience They should deliver into different streets. One of these, which will also be an entrance, may be connected with a vestibule that is common to three entrances, and the doorways of this vestibule must be one-third wider than the combined widths of these three separate entrances. The least width for an exit is four feet six inches in the clear. Too frequently I find that the exits are actually made of this dimension between the brick-work, so that after deducting the thickness of doors and projecting handles only three feet four inches is left. I consider it unfair to expect one to overlook such mistakes in so important a matter.

All exit doors having fastenings must be fitted with bolts yielding to pressure from within. This necessary regulation gives rise to great difficulty. A manager will suspect that persons get access through these exit doors, and also that his servants get out at improper times. In view of the importance of this point, and the impossibility of securing by any system of inspection the opening every night of a door that has locks and bolts, it may be hoped that there is mechanical ingenuity enough to get over any such objection as I have indicated.

The impossibility of getting the employés about a public place to understand that exit doors and passages are meant to be at all times free and well lighted may be illustrated from experience. The first new theatre that was opened in my time had been rebuilt after a fire, and the proprietor, confident in his arrangements, invited my inspection on the opening night. I found the exits without lights and their doors blocked by the débris thrown out of the building at the last moment. In another case a few years ago the architect had provided admirable exits, but insisted on fitting the doors with locks. In the middle of the first performance I found every door locked and the key at the box office, to be used I was told if required. In a third case, when every-

thing had been found in order, a final visit an hour before the opening disclosed that handsome fixed grills were being put to every exit door, only to be removed in case of need. We have found exit passages turned into lumber rooms, or obstructed by spare tables, by chairs intended for extra and illegal seats in the gangways, by perambulators, and by bicycles. In one case the exit was the home of a savage dog. The architect must never depend on the care with which his building will be managed, and in spite of good intentions the accumulation of spare scenery belonging to pieces that have been taken off or are coming on, and the storing of rubbish, is always a danger. In important continental theatres a separate warehouse is provided as near as possible to, but detached from, the building, and there all scenery and properties not actually in use are kept.

And with respect to this last consideration, experience teaches that in cases of sudden danger no audience, no crowd in a house or factory, and indeed no individual, can be trusted to take the obviously reasonable course to prevent accident or to get to a place of safety. Their escape must be ensured for them by the provision of unobstructed exits that are used habitually, that are as short as possible, and that will take a crowd of people as fast as they can get away. Thus the planning of a building in relation to its exits is often of even more importance than its materials or the question of its site and surroundings, which last is a question often beyond the architect's control. I have advised a theatre architect to begin by laying down on his plan eight staircases and ten or twelve exit doors, and then see whether he had room left for a stage and auditorium. This is more reasonable than planning first these last-named parts and then using up any spare corners for scanty and inconvenient stairs and passages.

There is no class of public building so risky as the parochial or mission hall or club room which exists for purposes of instruction or social recreation. The licensees

of such places are very often too inexperienced to feel any sense of responsibility, and the amateurs who usually manage such matters have no sense of danger. Having consented to preside at an amateur charity performance where the stage had been fitted up by the company, I found the footlights to consist of a row of dwarf candles, each being simply stuck down on a penny piece. During the play one of the canvas wings fell upon these footlights.

Unwarned by the Paris disaster, bazaars are got up regardless of the danger from stalls heaped up with flimsy materials and lighted up by Japanese lanterns, without any special means of fire extinction and with indifferent means of escape. In a particularly bad case, while the chairman of the committee was arguing against the possibility of accident, a lantern took fire and fell. No more than this is necessary to produce the worst of those accidents which such premises may be said to invite, and the contents of only one stall would have sufficed.

In view of the wide range of this Paper and the familiarity of this audience with the details of construction, I have for the most part been content to suggest principles upon which we ought to act. And on account of the importance of these questions in relation to the safety of life, I trust we shall agree that there is a moral duty in every one charged with the erection or care of a building to make it as secure against fire and panic as he can. I confess to some feeling approaching pain when an architect, assuming something like the position of a legal advocate, endeavours to argue that provisions made by law for the safety of life and property mean less than they are commonly supposed to mean, or struggles to get some relaxation of the law which, perhaps unfortunately, the public authority has power to grant. Every relaxation beyond what a prudent man would consider safe is in the nature of a wager that nothing shall happen during the whole time that the building will be in

existence which will call for the particular precaution which on the responsible advice of the architect has been injudiciously omitted. It may be that the wager will be won, but the risk is considerable and always there; and this is a consideration which I desire to impress most strongly upon those who are charged with such responsibilities as I have indicated.

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