SLOW-BURNING CONSTRUCTION.[1]

THE fearful losses of life and property by fire in the United States have lately attracted the attention which is due to the causes of such loss and to the means for preventing them. Coincidently with these investigations a very profound change in the conduct of the business of fire insurance companies is in progress. Until within a very recent period the management of an insurance company issuing policies of indemnity against loss by fire has consisted mainly in taking risks as they might happen to be, a more or less careful inspection having been made into the condition of the property before issuing a policy, for the purpose of estimating the rate of premium to be charged rather than with a view to improving such conditions.

The notice of the owners or occupants has sometimes been called to glaring defects, and a somewhat desultory inspection has been maintained; not so much with the intention of informing the owner or occupant how to protect the property against fire so as to reduce the loss to the lowest terms, but rather for the purpose of informing the underwriters, that they may not take or maintain too low a rate of premium. In fact, there has been until recently a passive indifference and sometimes a frankly acknowledged objection on the part of prominent underwriters to the introduction of the most effective safeguards, lest the reduction of premiums that might be demanded should diminish the profits of the insurance companies.

It may be admitted that under this system many fire insurance companies have been established and conducted by men of conspicuous ability, with great profit to the stockholders and indirectly with great benefit to the assured. These companies have done a world-wide business, scattering their risks, and by the very breadth of their operations and income they have been enabled to reduce their premiums to the very lowest terms that the system itself would permit, subject as it has been to an excessive expense; but as the amount of property at risk has increased in recent years with very great rapidity, the companies of a safe kind have been unable to carry the full lines required in the concentrated hazards of our great cities. Owners have therefore been obliged to seek insurance wherever they could get it, sometimes exhausting all the fire insurance companies of the world. At the same time an unwholesome competition has grown up among the underwriters themselves by which their previously heavy expenses in the conduct of their business have been increased, while badly managed or small companies have been led to take risks at less than cost — a method ending inevitably in bankruptcy or in withdrawal from business.

In the opinion of competent experts from eighty to ninety per cent. of all the stock fire insurance companies organized to transact business within the limits of the United States, or empowered thereto, have agencies in the State of New York, which renders it incumbent on them to make returns to the Commissioner of Insurance of that State giving a statement of all their transactions in the United States. There could be no better indication of the rapid growth of wealth in this country during the last twenty-five or thirty years than a comparison of the sum of the insurance written by these companies. In 1859, before the civil war, the sum of the risks taken by companies making these returns was a fraction under $1,500,000,000. In the year 1887 the amount in round numbers was $12,250,000,000.

The proportion of loss to the value of the property insured has slowly diminished: there has been a little improvement in the construction of buildings in some of the great cities, though not much elsewhere, so that the loss by fire now ranges from $100,000,000 to $130,000,000 a year. The cost of sustaining fire insurance companies whose function is simply to distribute this loss over a wider field is about $65,000,000 a year; to this must be added the cost of sustaining expensive fire departments, which may be computed at a minimum at not less than $25,000,000 a year, and is probably more, to say nothing of the additional cost of water supply for fire purposes. The fire tax of the United States may therefore be estimated at a minimum of $180,000,000, or at a maximum of over $200,000,000, in a normal year in which no great conflagration occurs.

Within the last five years a great change has taken place in the views of the leading men who conduct the business of the fire insurance companies, and a system is rapidly coming into vogue for the frequent inspection of buildings with a view to the prevention of loss by protecting them, so far as their generally bad construction will permit, from the dangers which must occur from fires that are unavoidable, by installing apparatus to check the rapid spread of fires when they do oc-

cur. Doubtless a very considerable part of the present losses may be saved in this way, but the relief is only a palliation; the true remedy will come only when the owner of the insured building realizes the simple fact that he himself is chiefly responsible for all the losses that happen. It must be brought home to him that the true function of an insurance company is to distribute a loss when it occurs. True, it may be a part of the function of the officers of an insurance company to instruct an owner how to build his building and how to guard it after it is built; but the owner himself, by his own control over the construction and the occupation of his building, is the only person who can remove the causes of loss by fire. It must be made apparent to the owner of property that if he pays a high rate of premium for a policy of insurance *it is his own fault:* he makes the rate high by neglecting his own duty, and when he may afterward undertake to procure a contract of indemnity or policy of insurance at less than cost, he is an illustration of the old adage, "A fool and his money are soon parted." A contract made under such conditions is not worth the money paid for it.

The cause of this enormous fire tax may be attributed mainly to the common practice of what has been perhaps well named "the art of combustible architecture."

How can this waste be avoided? It is useless to suggest the construction of buildings modeled on those of Europe, especially of those upon the Continent: we have not a general supply of the soft and easily worked stone of which most of the buildings in Paris and in many other of the foreign cities are constructed—a stone which cuts like cheese and which hardens like iron upon exposure to the weather. In some of the States west of the Alleghanies there are considerable deposits of easily worked stone which hardens on exposure, but in the Eastern and the Middle States no such building-stone is found. Neither have we that abundance of low-priced manual labor which will enable us to construct buildings exclusively of brick and iron, without exceeding in cost the capital which can be applied to buildings required for ordinary purposes. Many labor-saving devices indeed have been adopted in the building trades, but on the whole a building of any kind is to a large extent the product of the hand rather than of the machine; the stone must be cut, the mortar must be prepared, the brick must be laid, the timbers must be adjusted by hand work, and all the costly finish must be put on by hand. Hence, although it is a rule that in all the arts to which modern machinery can be applied a low cost of production is consistent with or is the correlative of high wages or earnings, yet in arts which remain mainly handicrafts the rate of wages becomes one of the elements of a high cost of production or construction; therefore the higher cost of building in this country as compared with the cost in Europe is in itself a proof of the greater relative prosperity of the members of the building trades, even though it results in higher rents to all others. Moreover, many of the articles which enter into the construction—especially of city warehouses, in which the greatest losses by fire occur—are heavily increased in their cost by the present system of duties on foreign imports; for instance, structural iron and steel, window glass of the better quality (especially plate glass), cement, and many building stones, to say nothing of the tax imposed upon Canadian lumber. We have, however, a greater relative abundance of timber than of other suitable building materials, and it follows that wood rightly enters into the construction of our buildings more than it does in most European countries, even in our factories, city warehouses, churches, and the like. Again, in the northern parts of the United States wood, properly cut and disposed in the building in a suitable manner, is almost a necessary part of the construction because of the climatic conditions; stone and brick, when exposed to the extreme cold of the outer air of winter, draw moisture from within the building, which condenses on the inside of the walls and is apt to make the buildings very damp; especially churches, wherein the furnace may be lighted and the building kept warm for only a part of the week.

The question therefore arises, Can buildings be constructed either wholly of timber, or of brick, stone, or iron for the outer walls, combined with wood for the inside construction, in such a way as to eliminate the greater part of the causes of the fearful fire tax which now constitutes a waste equal to an average of at least fifteen per cent. on the net savings or possible additions to the capital of the country in a fairly prosperous year?

To this question an affirmative reply may be given. It is based on many years' experience in the construction of textile factories under the supervision and guidance of the mutual underwriters by whom these factories have been insured on an absolutely mutual principle for a period ranging from thirty to fifty years in respect to the principal companies.

Witness the necessity for the solution of this problem. There are even now more cities than one in which a great conflagration exceeding that of either Boston or Chicago awaits but the accident of a spark and a favorable wind. It is therefore to be hoped that the time may not be far off when, by the bankruptcy or the withdrawal of only a moderate number of the

existing insurance companies whose losses and expenses now exceed their income, a few great and powerful fire insurance companies may be enabled to impose conditions upon those who apply to them for insurance, under which conditions a remedy may be found for the existing faults, even if that remedy be not found sooner under the system of inspection and prevention now beginning, by which the danger of such a great conflagration may be almost if not wholly removed.

It is not too much to claim that if a sum of money equal to that which is annually paid in premiums for policies of insurance on property situated within the so-called "dry goods district" of New York and its immediate vicinity, covering about one hundred acres, were put at the disposal of the officers, engineers, and architects who are employed by the factory mutual insurance companies of New England, to be by them applied to suitable appliances and safeguards for the protection of that district, the danger of a great conflagration would be wholly removed and the destruction of even a single warehouse and its contents would be of the rarest occurrence.

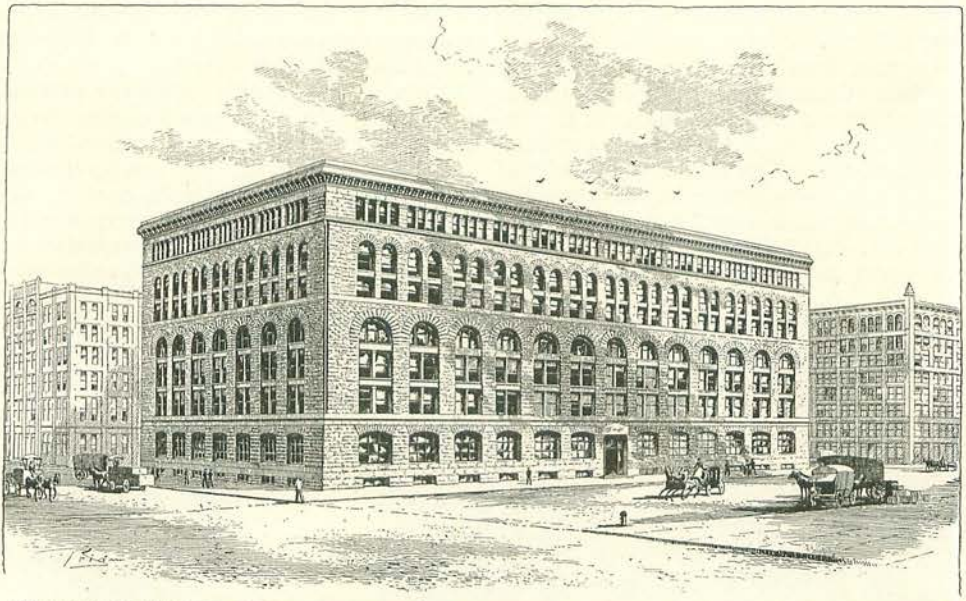
Strange to say, some of the worst examples of combustible architecture are to be found among our prisons, hospitals, asylums, and almshouses; next, among college buildings, libraries, and schoolhouses; to these may be added churches, hotels, and theaters. In the year 1887, according to the tables compiled by the "Chronicle" of New York, there were burned within the limits of the United States —

45 hospitals, asylums, almshouses, or jails, being nearly four per month, in many cases accompanied by the loss of a large number of lives.
126 college buildings and libraries, being ten and a half per month.
146 churches, being two and eight-tenths per week.
52 theaters and opera houses, being one per week.
515 hotels, being one and four-tenths per day.

The bad construction of these buildings is due mainly to habit, to fear of innovation, and to distrust of theory. These inherited faults in construction may be readily traced to their origin. In order to make this matter plain, the evolution of the modern factory will be fully described in this article, illustrated by examples of the several types of building which have been from time to time constructed. When the textile factory system was first established, water power only was applied to the movement of machinery. The larger factories were thus customarily placed in narrow valleys or upon very limited areas of land, below the falls of rivers and alongside the streams; it therefore became necessary to economize the area of ground covered by the factories and to build them many stories in height. When other arts began to be conducted upon the factory system the buildings were apt to be in cities or towns where the price of land forbade large areas being devoted to the purpose, and, again, buildings of many stories in height were constructed. As time went on, however, steam took the place of water power, while cheap railway service or rapid transit made it possible to scatter the factories over a wider area. Factory buildings then began to be constructed in the open country, but apparently it did not occur either to the owner, the managers, the architects, or the builders that the reasons for constructing a building many stories in height did not apply to places where land could be had at a very low price; therefore the customary bad and unsuitable form of construction was adopted and is still practiced where it is not only useless and unsafe, but less adapted to the purpose to which the building is to be put than a one-story or a two-story building would be. Moreover, the whole method of cutting timber having been developed with a view to the supply of material required in the ordinary unsafe and unsuitable method of construction, it was for many years difficult to obtain material cut in a proper way for what has been called the slow-burning use of timber. Hence it follows that the art of slow-burning construction is little known outside the limits of New England, and until very lately it was little known even there except to those who had become accustomed to the construction of textile factories, paper-mills, and other works which are customarily insured by the factory mutual insurance companies. It is only within a very short time that the methods which have been practiced for many years in the construction of textile factories — which are only the old methods of almost prehistoric time, when timbers were shaped by the ax or by hand, before the modern sawmill had rendered the construction of a sham building possible — have been taken up by a few architects of capacity and responsibility to be applied to warehouses, churches, college buildings, and occasionally to dwelling-houses.

A most conspicuous example of the right method of dealing with timber and plank in a commercial warehouse may be found in the inside work of the huge building lately finished and occupied by Mr. Marshall Field of Chicago, on plans made by the late Mr. H. H. Richardson and carried out by his successors, the motive of the plan having been derived from the customary method of constructing a textile factory.

In what does slow-burning construction consist? It may be considered somewhat amazing that so simple an art should not have been common for generations. We will begin at the weakest point in the common art of combustible



WAREHOUSE OF MARSHALL FIELD, CHICAGO, ILL. (H. H. RICHARDSON, ARCHITECT; COMPLETED BY HIS SUCCESSORS, SHEPLEY, RUTTAN & COOLIDGE.)

architecture, to wit, with the roof, and describe its evolution. It may be admitted that the modern factory roof waited for its possibility until right methods of covering a flat roof had been invented; but even with respect to the roofs that are not flat, about ninety-five out of every hundred of those which are now building are models of everything that is bad. They convert the attic stories into ovens in summer, refrigerators in winter, and fire-traps all the time. It seems as if hardly any one, owner, architect, or builder, had ever put to himself the simple question, "What is the purpose of a roof?" The plain answer obviously is, "To keep out the rain." Many of these "crazy roofs" of irregular form and full of leaky valleys fail even in that essential point. May it not be added to this main object of keeping out the rain that the subsidiary purpose of a roof is also to keep out the heat of the summer sun and to keep in the warmth of the winter fuel? May it not even be added that a roof may furnish a comfortable and convenient place to get a little fresh air by those who dwell in crowded cities; or at least may not a good roof add one floor to a building where work which requires the outer air may be done comfortably and conveniently? Are not the roofs of buildings in nearly all hot countries made great use of by the inhabitants? Are they not invariably of thick, solid construction, flat enough to be occupied in hot summer nights? In what country is there greater need for such a place of comfort and fresh air than in our Northern cities during the extreme heat of our summers? In the country or upon the factory the flat roof might not be treated for use; yet aside from use it is better in every respect, so far as safety, ventilation, and other elements of comfort or utility are considered, than any other form of roof which can be put upon any kind of building. Are our architects capable of making a flat-roofed building artistic, or pleasing to the taste? It has been done in many instances; why not in nearly all?

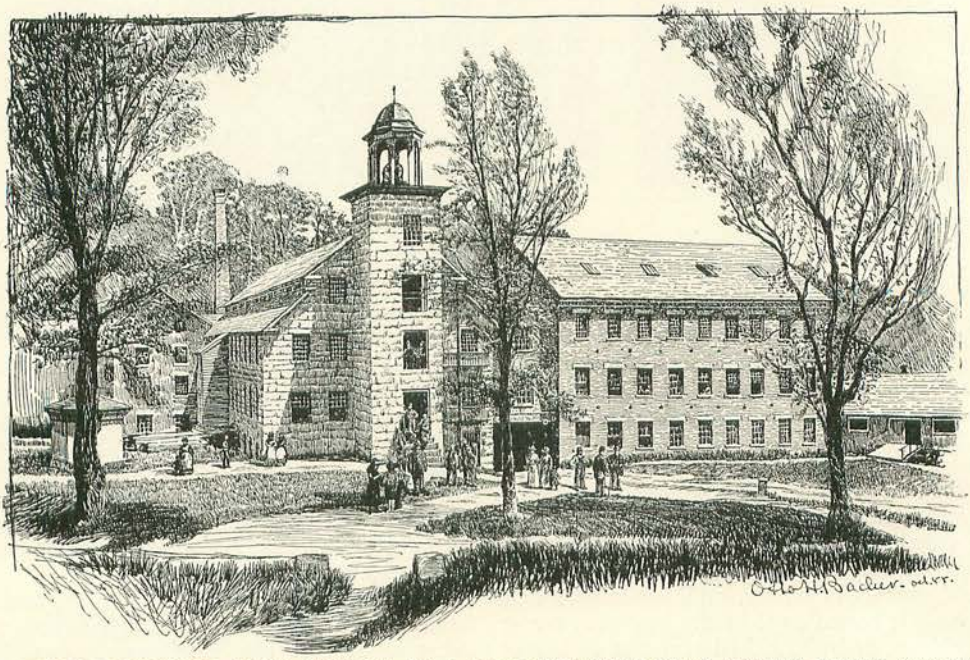
In the evolution of the factory all the faults have been discovered and remedied which now infest nearly all the warehouses, hospitals, dwelling-houses, schoolhouses, college buildings, and other examples of combustible architecture of this country.

The first form of factory roof resembled the gambrel roof of the dwelling-house. In early days it was constructed of solid timbers set wide apart, as they should be, covered with good thick boards and shingled; in some cases the shingles were laid over mortar. I have an example of shingles which are more than fifty years old yet still in good condition, having been preserved by the interposition of the mortar between the shingles and the roof boards.

This method of outside construction might not be objected to in itself; on the inside, however, the owners were apt to put vertical sheathing at a little distance from the eaves and horizontal sheathing across the upper timbers of the roof, making a cockloft. These hollow spaces, in which fire may spread out of the reach of water, are among the most dangerous elements of bad construction, especially when connected with the basement or the

cellar by vertical flues in the walls or partitions of the building.

The next form of roof came into vogue when heavy timbers were displaced by joist or plank rafters set closer together. It is commonly known among factory people as a "barn-roof," consisting of an ordinary pitched roof made of rafters set eighteen inches or two feet apart on centers, covered outside with thin boards and slated, sheathed inside vertically at the eaves, and horizontally across the apex. self through the hollow walls of a building of ordinary construction. Thus the thin-slated roof fails in summer as well as in winter. In this kind of roof a fire is completely protected from water; the slates when exposed to outside heat are readily cracked; they then fall and cut open the firemen's heads; the interspaces at the eaves also make excellent nesting-places for the rats, which carry into them oily waste and other combustible substances to be ignited by spontaneous combustion in the



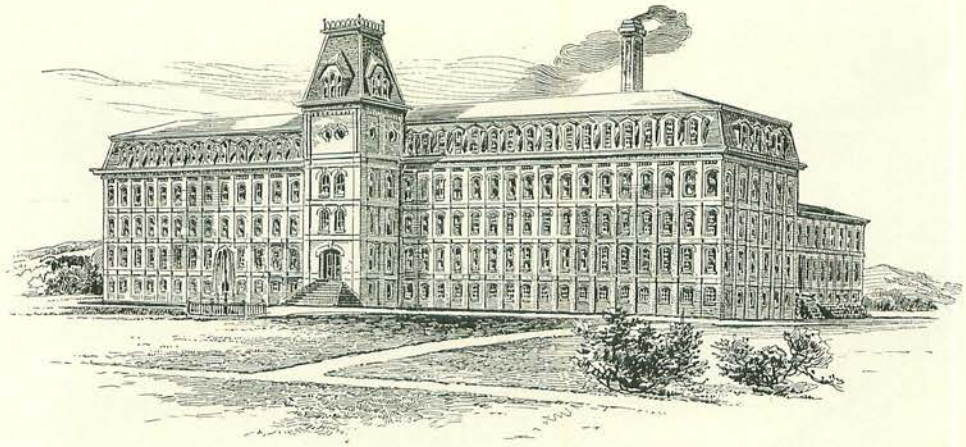
A VERY OLD WOOLEN MILL IN NEW HAMPSHIRE, AND A MILL OF THE SECOND PERIOD ATTACHED THERETO, SHOWING THE BARN-ROOF, SO CALLED,— THE GERM OF A LARGE ESTABLISHMENT.

The older factory roof and the barn-roof are both shown in the accompanying illustration, which delineates an old mill from which a large establishment has been subsequently developed.

This barn-roof is the most abominable, unsafe, and atrocious roof ever devised for the covering of buildings of any kind. The slates serve to attract the heat of the sun, which beats in through the interstices of the open boards and converts the interspaces of the roof into ovens for the concentration of heat and for its distribution throughout the building, especially when the roof spaces are connected with hollow walls. The most effectual method of diffusing heat in a factory has proved to be to suspend the steam-heating pipes overhead, at some distance from the walls — the warm air following the cold air as it passes out by bottom ventilation. By analogy it may be assumed that the heat concentrated by the slates in the interspaces of a hollow roof diffuses it- heat of summer, to the partial or total destruction of many a mill.

The next abomination came with what is called the French roof. This, when put upon the top of a factory, is nearly as bad as the barn-roof: it restricts the space in the attic within, adds greatly to the cost of the building, while in it are commonly repeated nearly all the faults of construction of the barn-roof.

The next roof was a little better. It consisted of a flat roof made of ordinary plank rafters set eighteen inches or two feet apart on centers, covered on the outside with boards and then with composition or metal and sheathed within upon the under side of the rafters. The humidity generated in any room warmer than the external air and in the processes of many of the manufacturing arts passes into the interstices of this roof, where the moisture is condensed on the under side of the thin boards of the outer covering, from which it drops upon the sheathing and rots it, while



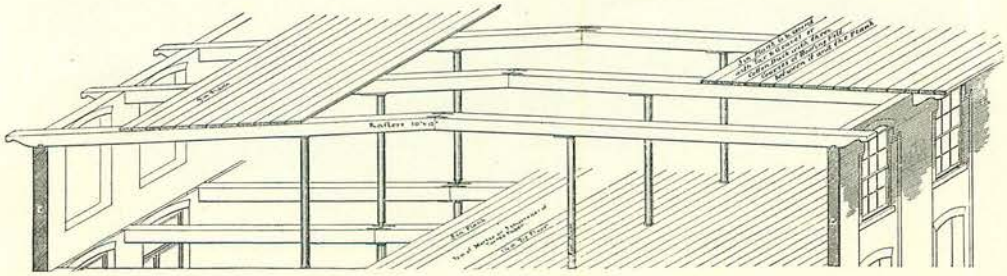
A COTTON FACTORY IN MAINE, WELL CONSTRUCTED EXCEPT THE ROOF.

the interspaces add not only to the danger of fire, but work the speedy destruction of the whole roof by the rotting of the rafters, especially near or upon the walls. This roof was usually furnished with a hollow wooden cornice, also bad and dangerous.

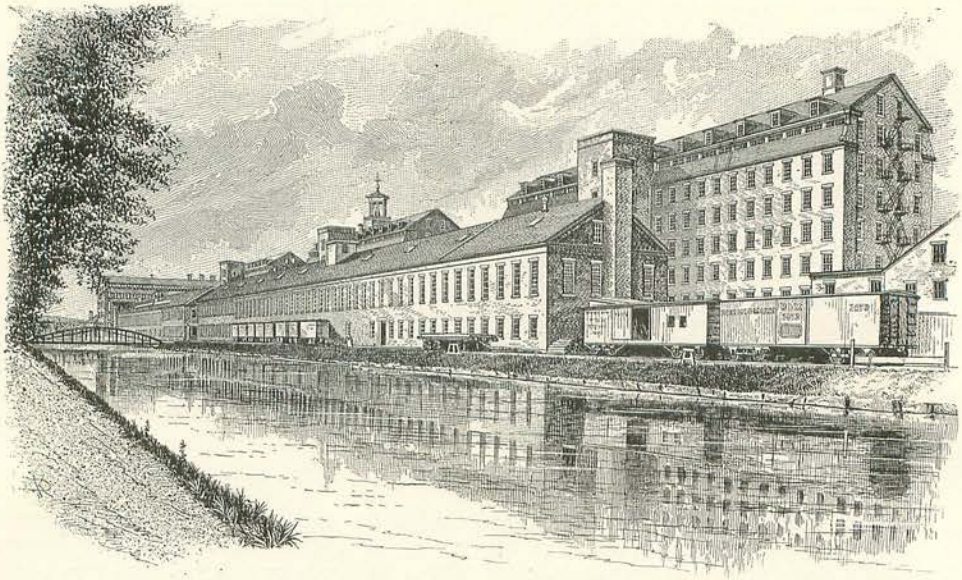
It remained for the officers of the Factory Mutual Insurance Company to suggest that the same solid floor which is required in the construction of the mill might well be adopted in the construction of the roof, only changed so as to give a pitch of half an inch to the foot. It was also suggested by the underwriters that the wooden covings and gutters and the sham hollow cornices, by means of which fire was conveyed from building to building in the great Boston conflagration, were a dangerous and superfluous element in the construction of the roof of the factory. In pursuance of these suggestions all the former bad forms described gave way to a simple deck constructed of three-inch plank grooved and splined, placed on timbers set from eight to eleven feet apart on centers, sheathed underneath between the timbers if the owner desires a fine finish, and covered on the outside with any of the customary materials; the ends of the timbers sometimes projecting outside the wall and the deck carried far enough over to form a suitable coving, according to the height and character of the building; or else the finish may consist of a brick cornice, without gutters, the drainage being below.

Again: the old type of textile factory, from which the plans of a great many other factories have been derived, was very narrow and very high. It had not entered the minds of the constructors of the earlier factories that the spaces of wall between the windows might be very narrow and that the windows might be very wide; nor had it apparently occurred to any one that the tops of the windows had better be carried up flush or even with the ceiling of each room in order that the light might be better diffused within. Consequently the wall of the factory consisted mainly of a great blank of brick-work with small holes in it for windows, the mill being seldom more than fifty-two feet wide, often less, and many stories in height. The first illustration on page 572 shows mills of this type, nine stories high, including attics.

The width of the mill was gradually extended and the size of the windows enlarged by degrees; for many years about sixty-two feet was considered the proper width and the



THE FACTORY ROOF, FIRST DEVISED BY W. B. WHITING.

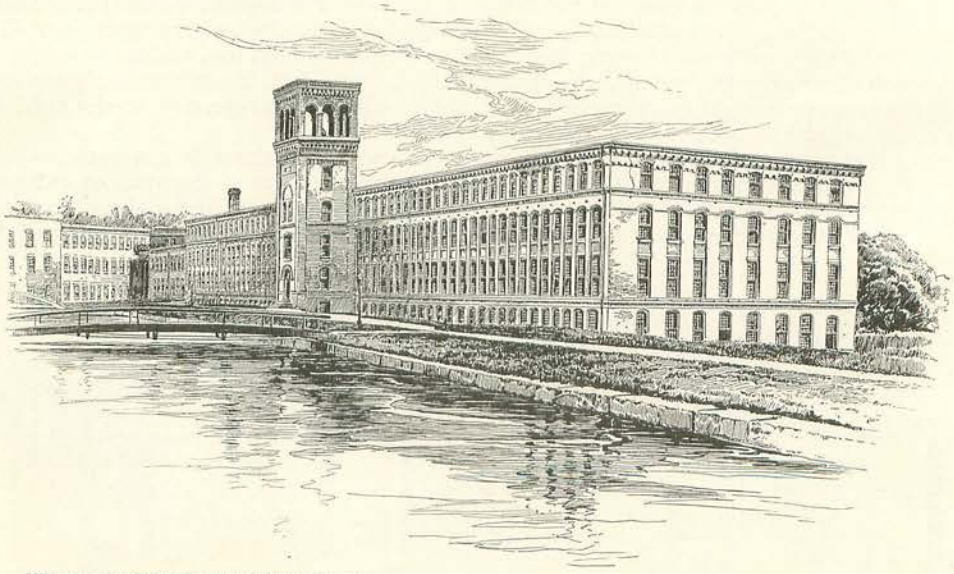


BAY STATE MILLS, LAWRENCE, MASS. TWO OF THE THREE MILLS TAKEN DOWN TO GIVE PLACE TO MODERN TYPES; ONE MILL DESTROYED BY FIRE.

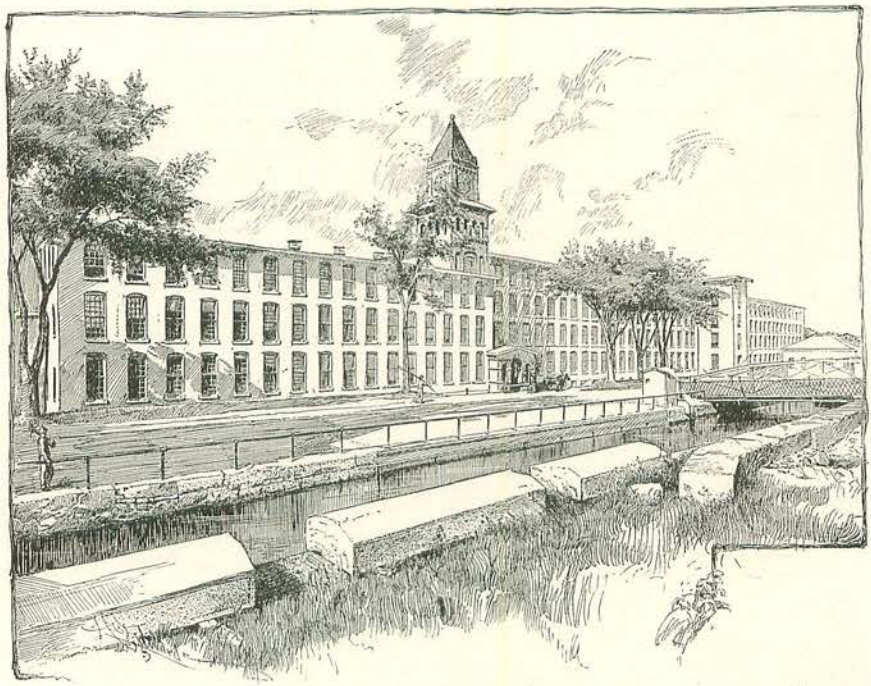
windows began to occupy a larger part of the wall space, while the wall itself was increased in thickness.

At last it was discovered that if the tops of the windows were carried up flush with the ceiling and as much space, or a little more, was devoted to windows as to wall, the width of the mill might be carried to ninety feet; then to a little over one hundred feet.

Until now in England, where the light is less intense than in this country, cotton-mills have been built five or six stories in height and one hundred and twenty-eight feet wide,—that being the width in which certain kinds of machinery can be most economically placed and operated,—with six feet of window space to four feet of wall, the tops of the window panes being absolutely flush with the ceiling between the beams, and the window caps placed opposite the floors. Of late, however, the mutual underwriters, having discovered the great danger of high buildings as compared with those of wide, low construction, began to ask their members who were about to build mills to be operated by

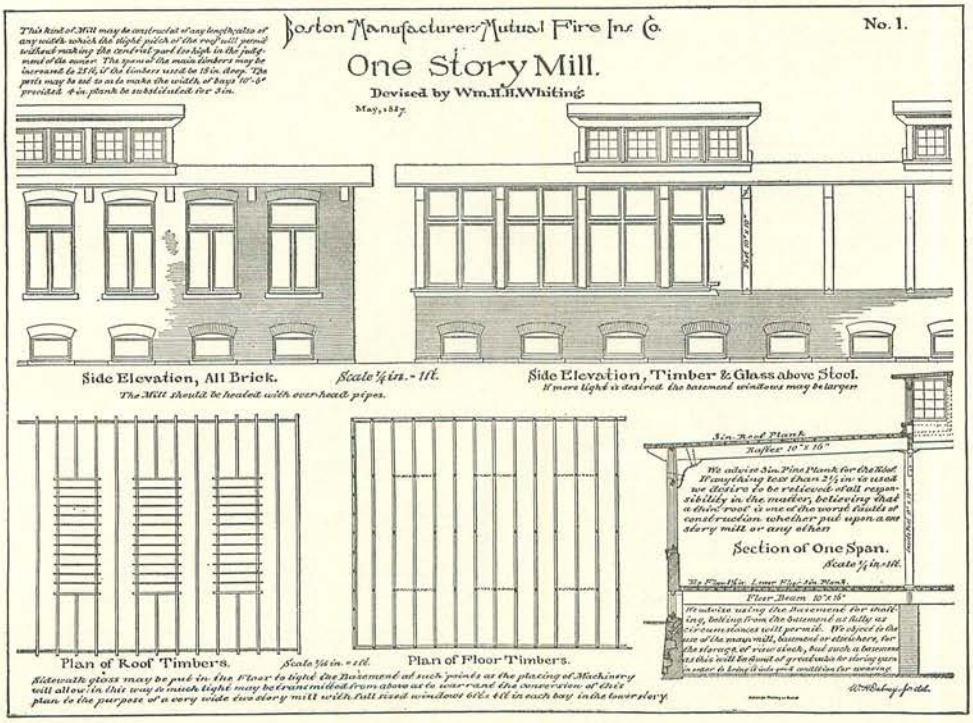


MILL NO. 1, CHICOPEE MANUFACTURING CO., CHICOPEE FALLS, MASS. (EDWARD SAWYER, ARCHITECT, BOSTON.)

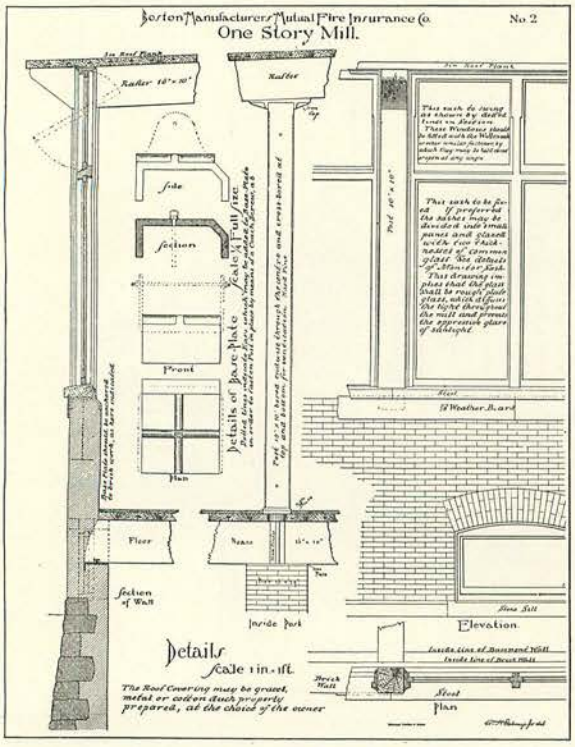


AMOSKEAG MANUFACTURING CO., MANCHESTER, N. H. (CONSTRUCTED BY W. T. STRONG.)

steam power in the open country, "Why do you follow this inherited and bad type of building? A mill of two or three stories in height can be constructed at less cost per square foot of floor than a mill of any greater number of stories; if you have room enough, even a one-story mill properly constructed may be built at as low a cost per square foot of floor as the



ONE-STORY MILL DEVISED BY MR. W. H. H. WHITING, C. E.— NO. I.

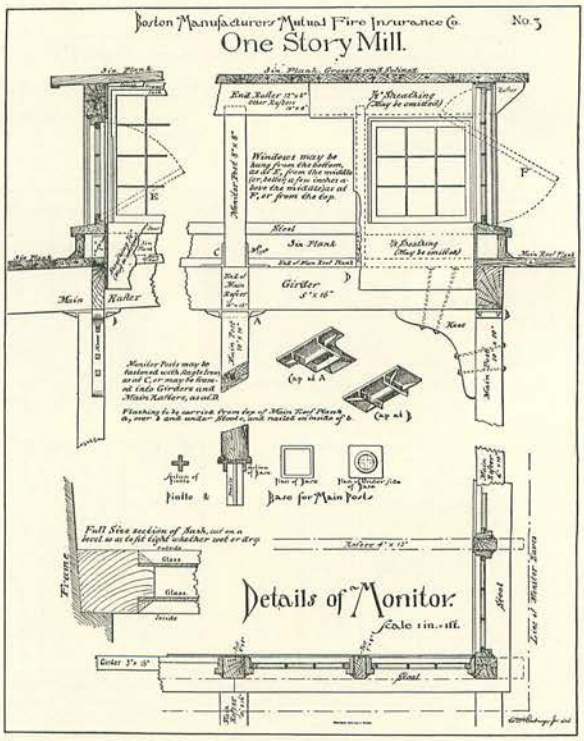


DETAIL OF ONE-STORY MILL.—NO. 2.

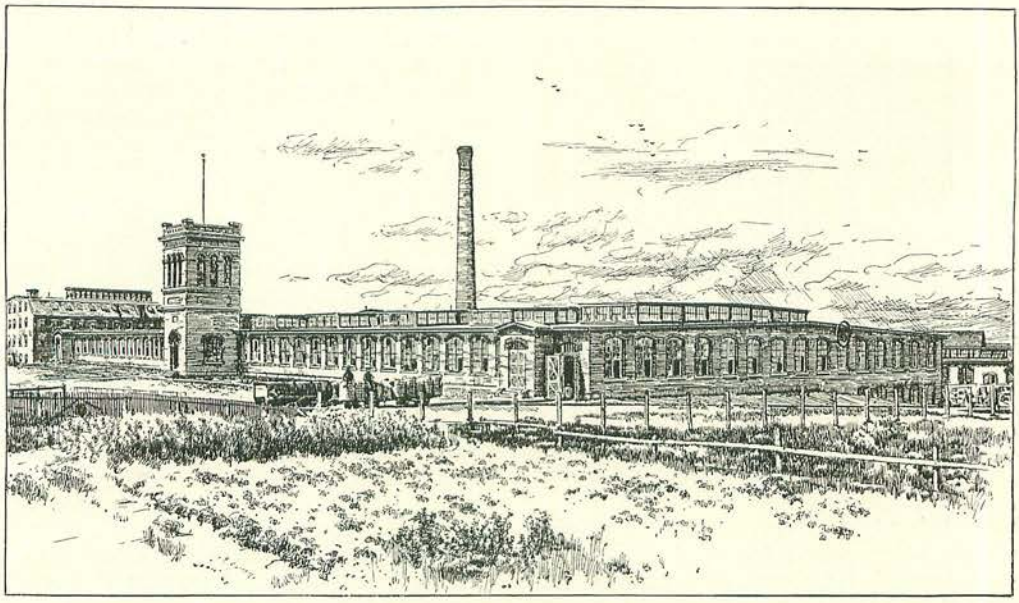
mill of four or five stories, while it will be as warm in winter, cooler in summer, and lighter and better ventilated all the year round than any other type of mill can possibly be." Since that suggestion was made a large number of factories of only one story in height, covered in with three-inch pine roofs, protected outside with gravel roofing, tin, or with cotton duck properly prepared, and lighted with what are known as monitors, have been constructed in many parts of New England, ranging from half an acre to three and a half acres in size; a very common type being a mill of sixty thousand feet on the main floor, constructed on a moderate slope so as to give a basement under one-third of the mill for wet work or for other subsidiary purposes. Such one-story buildings are best adapted to weaving, and are often built in connection with spinning-mills of two or three stories in height.

In one instance, in a case where the machinery is very heavy and is subject to great vibration, a one-story mill of this sort was substituted for one of two four-story factories which had been burned; the owners were advised to reconstruct a one-story mill in place of the burned mill, but to make it large enough to accommodate all the machinery then in the other four-story mill which had not been destroyed. They were warned that the new mill would bankrupt the old one on account of the greater economy of the work and the better conditions for its operation. The prophecy has proved true: sixty-seven men accomplished the work in the new one-story mill on the same machinery which required one hundred men in the old four-story mill; therefore that old mill has been taken down in order to make way for the extension of the one-story factory, and the old material has been put together in a better form.

What, then, is the slow-burning construction? It consists simply in consolidating the wooden material in frame, floor, and roof in such a way that a fire can be held long enough in any room in which it may originate for a fairly competent fire department, public or private, to get it under con-



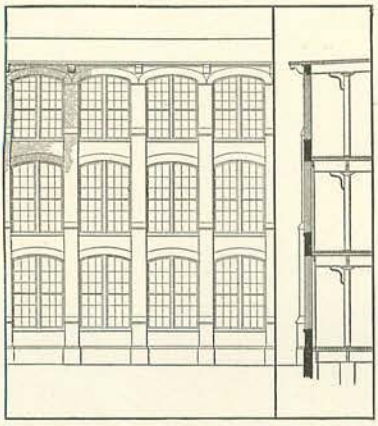
DETAIL OF ONE-STORY MILL.—NO. 3.



ONE-STORY MILL OF THE PLYMOUTH CORDAGE CO. (CONSTRUCTED FROM PLANS AND SPECIFICATIONS MADE BY THE BOSTON MANUFACTURERS' MUTUAL FIRE INSURANCE CO.)

trol, or where it may be extinguished or held in check by sprinklers. The timbers used may be solid or may be cut in two parts to be bolted together. The latter is perhaps the better way, in order that the air may reach the center of the timber and season it, great care also being taken in mill practice not to paint, oil, or varnish the outside of any heavy timber for at least three years after it has been placed in the building, lest what is called dry rot should occur from the fermentation of the sap in the green timber. Where an outside finish is required some architects use the timbers in two parts bolted together with an air space between, each timber being also bored through the center lengthwise for ventilation. This latter plan is the customary method with posts when wood is used for supports, a crossway hole being also bored near the top and bottom, connecting with the center. Upon these heavy timbers — which are commonly placed eight or ten feet on centers resting directly on properly adjusted posts without the interposition of any girders lengthwise of the building, in lengths or spans from eighteen to twenty-two feet — the floors are laid of plank not less than three inches thick when the beams are eight feet on the centers. If the beams are ten feet or even twelve feet apart on centers, ordinary weights will be carried by floors consisting of four-inch or five-inch plank; the timbers themselves may be from fifteen to not exceeding twenty-two feet in length from wall to post and from post to post, for ordinary factory loads. If provision is required for extraordinary loads, a special computation should be made to meet the case. If a fine finish is desired, sheathing may be placed underneath between the timbers, nailed close to the under side of the plank; if the most absolute security against fire is called for, the finish may consist of plastering laid on wire lathing close against the plank. This plastering may be carried around the outside of the timber on the line of the timbers, provided no skim coat of lime putty is put upon the plastering, thereby cutting off the air from the timber. The top floor may be laid directly upon the plank, or a layer of mortar may be laid between the plank and the top floor; in some cases asbestos paper has been interposed. The layer of mortar offers great security in preventing the passage of fire downward. The roof which has been described corresponds substantially to the floor, to wit: three-inch plank laid upon the timbers, one-inch sheathing on the under side if desired, and sometimes one-inch boarding on the plank; then the ordinary outer covering of whatever kind may be adopted. If the roof is exposed to great humidity within, as in the machine-room of a paper-mill, one inch of mortar may be interposed between the roof boards and the plank. This latter roof proves to be impervious to cold or heat, and with proper means of ventilation gives security against any possible condensation of moisture from the atmosphere within.

An alternative plan consists in setting the first line of posts at the right distance from the wall to make a passage-way, the floor of the



CONSTRUCTION OF FACTORY DEVISED BY EDWARD ATKINSON, THE PURPOSE BEING TO CONSTRUCT THE ALLEYWAYS SO THAT THEY SHALL BECOME HORIZONTAL TRUSSES, TO PREVENT THE VIBRATION OF THE STRUCTURE.

alley being laid of two thicknesses of plank crossed — the posts being fitted with hackmatack knees. This form of horizontal truss braced to wall and post gives great stability to the building.

If the building is over one story in height the stairways ought to be placed either in separate towers outside the building proper, or else in the corners of the building surrounded by brick walls, the doorways being protected by adequate fire-doors consisting of wood encased in tin, iron being one of the most treacherous materials customarily made use of for the protection of doorways in party walls. In such a factory no cornice is required or permitted, and no sheathing within set off by furrings from the wall can be tolerated. No concealed space is allowed anywhere in which a fire can pass from room to room or from cellar to attic. Every part of the building must be open, so that water from bucket or hose can be thrown anywhere.

If these plans and specifications are compared with the ordinary method of combustible architecture, the reason will be apparent why textile factories, paper-mills, and other works are better fire risks and are insured at less cost than the average so-called stone church, brick hospital or asylum, or iron warehouse, although the nature of the work done carries with it almost every cause of fire hazard from ignition, friction, or spontaneous combustion, while in many cases the material used is almost explosive.

The method of Sartor Resartus may well be applied to the average hospital or asylum. What is it but a sham? a picture composed of brick or stone clothing or screening a whited sepulcher well prepared for the cremation of the inmates? It consists of an outer wall of brick or stone inclosing a wooden structure of the most dangerous kind; it is usually but a system of combustible wooden cells each connected with the other from cellar to attic by open wooden ways in walls, floors, and partitions alike. Had the motive been to house the inmates of most hospitals, asylums, and hotels under conditions which should assure the greatest possible destruction of life and property from the least possible cause, greater success could not have been secured than has been attained in most of these buildings, in many of which the danger is enormously increased by the use of gasolene vapor for lighting. How soon a remedy may be found for these faults rests with the public to decide. The builders of factories in city or in country may perhaps derive some useful information from this description of slow-burning construction, for the reason that if carried out consistently and economically it will cost less than the ordinary method of combustible architecture.

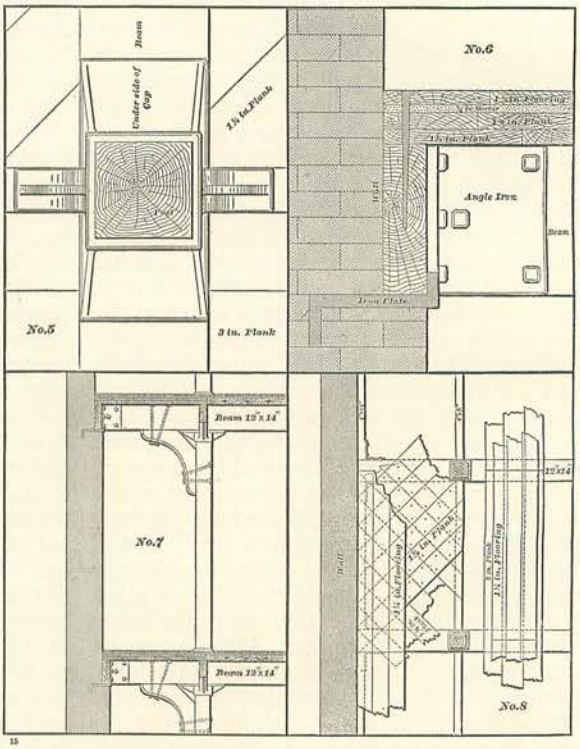
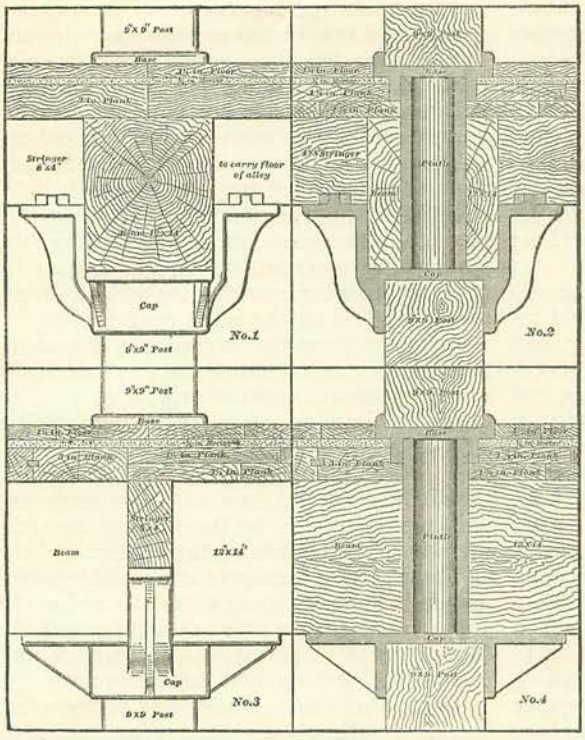


DIAGRAM SHOWING THE OUTER LINE OF POSTS (HORIZONTAL TRUSSES OR ALLEYWAYS) AND OUTER WALLS, SO ADJUSTED THAT THE FLOORS INSIDE THIS LINE OF POSTS MAY FALL AWAY FROM THEM WITHOUT STRAINING THE POSTS OR THE WALL. IN ANY CUSTOMARY METHOD THESE POSTS SHOULD BE FIRE-PROOF.

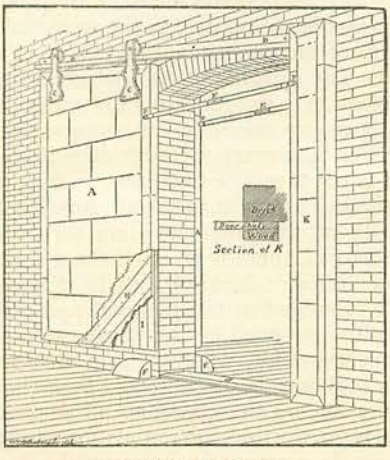


POSTS, PINTLES, AND CAPS CUSTOMARILY ADOPTED IN MILL CONSTRUCTION.

It may be interesting to add that a mill building of from three to five stories in height can now be constructed in New England in accordance with these plans at a cost above the foundation varying from sixty to seventy-five cents per square foot of floor, counting every floor, but not counting the basement unless it is a high basement, to be made use of in the same way that the other floors are used. The cost per square foot of floor will vary somewhat according to the position, and according to the interior finish required with respect to sheathing and other matters. A mill two stories in height, *i. e.*, of two floors for use, can be constructed at somewhat less cost, as the walls may be lighter in proportion to the area.

Under ordinary conditions a mill of one story in height can be constructed at about the same cost per square foot of floor as the four or five story mill if the ground is level and the subsoil is such as not to require any excessive expenditure in the foundation. A lighter framework and less expensive methods have been adopted in some cases in one-story construction, so that the cost of the building per square foot of floor has been considerably less than the sum named —even as low as fifty cents per square foot of floor. For many purposes, such as for shoe factories or other light work, these changes and this kind of economy may be admitted, provided a false economy is not applied in the construction of the roof. The whole comfort and welfare of the operative in the one-story factory depends upon the solid construction of the roof and the monitors, the plank to be three inches thick. Ordinary sloping skylights should never be permitted, as they transmit heat; while the monitor, with its vertical windows, reflects the heat and may be made use of to promote ventilation. In all cases the windows in the monitor either should be double or the sash should be glazed with two plates of glass in the same frame, in order that the condensation of moisture on the inside of the windows may be avoided. Experience proves that these flat-roofed buildings, even when constructed from one to three acres in extent, are not more liable to collect snow than are other forms of roof, and they are very much more easily cleared of the snow when it does collect. The English saw-toothed roof, so called, generally placed over their weaving buildings, has not proved to be desirable in this country north of Philadelphia owing to the tendency of the snow to collect in the valleys; it is also more costly than the roof of the one-story building lighted by monitors, as given in this plan. The light in the saw-toothed roof being always taken from the north it may possess a slight advantage, but in the monitor the windows towards the south can be clouded so that there will be no objectionable glare within the room.

The plan has been adopted in many cases of carrying the brick-work to the roof between the windows; more often, though, the brick



AUTOMATIC FIRE-DOOR.

or stone work is carried only to the window-sills, the superstructure being wholly of timber and glass.

In many cases it is desirable that there should be no open space under the floor, both with the view to avoid danger and to give stability and freedom from vibration to heavy machinery. To meet these conditions special plans are furnished by the factory mutual companies for laying plank directly on the ground without danger of decay.

It is not a pleasant experience for the officers and inspectors of the factory mutual insurance companies to pass, day by day, bad examples of combustible architecture occupied as shoe factories, clothing factories, and the like, or to see other unsafe buildings in which branches of industry are conducted which have not yet come under the supervision of skilled inspectors and underwriters, but which in their intrinsic hazard are safer than the textile arts. It is not pleasant to witness the mushroom growth of five-story wooden buildings standing often in the middle of a field where land is of little value, in which hundreds of people may be daily exposed to great danger, and hundreds of thousands or even millions of dollars' worth of property are subject to a heavy charge for insurance because the buildings have no right to exist. These officers and inspectors know from their own experience or that of their predecessors, covering fifty years, that more commodious, better ventilated, better lighted, more comfortable, and safer buildings could be constructed for the same or for less money than these examples of combustible architecture usually cost.

It would not be within the province of this article to describe the customary equipment of factories with pumps, pipes, hydrants, automatic sprinklers, watchman's electric record clocks, fire-escapes, and the like; all these safeguards are fully described in the technical publications of the factory mutual insurance companies. The purpose of this paper is only to call attention to the relatively low cost of slow-burning construction, and to suggest that because the customary methods of building are bad it is not therefore necessary to rush to the opposite extreme and to spend money in futile attempts at fire-proof building for ordinary uses. In fact, there is no such thing as a fire-proof building: a building may be constructed wholly of incombustible material and may yet be totally destroyed by the combustion of the contents, especially when the iron members of such a building are unprotected from the heat of a fire among the contents. Granite is one of the most worthless materials for withstanding heat. In a recent fire in one of the factories insured under the supervision of the writer a granite post 12 × 12 inches was reduced to sand by the same fire that burned into a wooden post next to the granite less than one inch. Sandstone and marble are not quite so bad; unprotected iron is most treacherous and unsafe, especially cast iron; brick, having already passed the ordeal of fire, is substantially indestructible, and when combined in a suitable manner with heavy timber and plank, the latter being protected by wire lathing or by other methods for retarding the action of heat, serves the best for the safest construction.

In recent years the profession of the architect has been raised above that of a mere artist or draughtsman, capable only of making an attractive elevation and of planning a building with little regard to the safe or suitable disposition of the material, to the level of some of the architects of old time, who, like Brunelleschi, combined with the functions of the artist the skill of the craftsman, the builder, and the engineer. The progress of combustible architecture is therefore likely to be checked as the young men who are now graduating from the Massachusetts Institute of Technology and from other architectural schools supply the places of those who, having had no technical knowledge themselves, have been unable to prevent the owners and contractors from committing the follies in construction by which our cities are now rendered so dangerous.

Objection has at times been taken by some architects to the comments of the mutual underwriters upon the architects' customary methods, that the factory building planned and constructed under their supervision is but a shell or skeleton of the building which the architect is commonly called upon to plan and supervise. This may be admitted; yet there have been, and are, architects who have proved themselves competent to clothe this skeleton and to adapt it to more æsthetic purposes than the factory, by covering the timbers in such a way as to make the method of construction even safer and more slow burning than when the timbers are left clear, without losing sight of the prime motive—safety of property and of life. The great warehouse built by Richardson and his successors for Marshall Field is but a glorified cotton factory, and the lovely little building connected with the home office of Mr. Richardson in which his art treasures were safely housed was but the picker building of a cotton factory with a touch of genius added.

Moreover, the architects themselves are now finding it expedient to adopt the same method of subdivision in their work which has become necessary not only in many of the practical arts but even in the legal profession, viz., either to employ special experts in the different de-

partments, or else to organize firms in which one should be the artist, another the builder, another the engineer. Modern requirements make specialization necessary, and there are few indeed who can qualify themselves for all the requirements of almost any profession.

In view of the attention which is now being given to the application of the "factory floor" (as it is called) and the "factory roof" to other buildings, it may be that the time is not far distant when it will be safe and prudent for the owner who intends to construct a textile factory to employ a professional architect without incurring the danger that the purpose to which the building is to be put will be lost sight of in the attempt to apply meretricious or misplaced art to a building in which economy and utility must not be disregarded.

Edward Atkinson.

TWO NEGATIVES.

I. HER LETTER.

BY a change, which in the order of evolution seems natural, the feminine portion of the Confederate States Treasury Department at Richmond was lodged in a building which had served originally as a fashionable dry-goods store. There exists, in men's minds at least, an indissoluble connection between women and dry goods. One cynical husband of the period was known to say that the irony of fate decreed that where women used to spend good money for worthless rags they were now converting good rags into worthless money.

The fifth and uppermost story of the old dry-goods store was occupied by the aristocracy of the Department. For there, as elsewhere, there was an aristocracy. In every community, as in every pan of unskimmed milk, there are elements which detach themselves from the rest and rise to the top. The cream of the Treasury consisted of a score of pretty girls who, high up under the roof, signed their names to bits of blue paper and made money at the rate of a million dollars a day. Ask any old Treasury clerk of the sterner sex — they are all old fellows now — what name was given the room in which those slim-fingered girls forged the sinews of war. Ten to one his eyes will flash with the light of other days as he answers, "Angels' Retreat."

Now "Angels' Retreat" was a dusty, cobwebby attic, bare of furniture, except for a lining of shelves, which gave evidence of its former use in storing purple and fine linen, and rough writing-tables adapted to its present purpose. The lodgment was poor enough, but there was no question about the angels. They were as good as can be made. The Retreat during working-hours had the appearance of nothing so much as a young ladies' school at writing-time. Twenty girls bending over desks and twenty pens scratching in unison. Absence of school discipline was indicated by twenty tongues often talking at once. The sun coming in through dormer windows on two sides of the room shone on the usual medley of fair and brown types, only that in this instance the types were unusually fine. Among them there was of course a beauty par excellence; likewise a vivacious girl they dubbed chief speaker, and a lovable one they called the favorite of the Retreat. Beauty answered to the name of Rose Chandler. The chief speaker was one Norah Grattan; while the favorite, Madge Dillon, an enthusiastic young Carolinian who had gained the sobriquet of "Palmetto," her companions, with the superlative speech of feminine youth, declared to be "the nicest girl in the world."

Rose Chandler's supremacy in the matter of looks did not admit of doubt. She was a beauty of the loveliest type, with a fabulous number of "Lee's miserables" at her feet. Norah Grattan would have been plain but for a clever, satirical mouth and a pair of keen, gray eyes. Palmetto, a tall, slender brunette, was ordinarily not pretty, but capable of great illumination on occasions.

The Confederate Treasury hours were from 9 A. M. to 4 P. M., and within that time the clerks signed from two to four thousand notes, according to their ability. Palmetto's signature, "M. Dillon," being short, and her writing rapid, she was able to put in the larger number every day without troubling herself to be punctual, so she rarely made her appearance before 10 o'clock. This in another would have been a finable breach of Treasury rules. Palmetto, the angels complained, was in some incomprehensible way independent of rules. But this is not an altogether haphazard world, and people who seem independent of rules balance the account somewhere, and are, for the most part, exceptional people who do better without rules than others with them. Palmetto's work, clean, swift, and clerkly, was the best in the Treasury. Why should she bother about rules? She was the poorest and of necessity the proudest of the angels. She did not explain what household drudgery she had to do at home before she came to the Department,