FACTORY·MUTUAL·INSURANCE

The achievements of seventy five years
Compiled to observe the 50th anniversary of the

ARKWRIGHT

Mutual Fire Insurance Company

a. W. [illegible]

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Edward V. French comp

1860—FIFTY YEARS—1910

Arkwright Mutual Fire Insurance Company

ONE OF THE ASSOCIATED FACTORY MUTUAL FIRE INSURANCE COMPANIES, OFTEN CALLED THE "NEW ENGLAND MUTUALS" OR THE "FACTORY MUTUALS"

An Association of Manufacturers for the Prevention of Fire Loss. One of the Oldest and most Successful Organizations for the Conservation of Resources

The Development of the Prevention Idea

FROM ITS BEGINNING TO THE PRESENT TIME IS TOLD HEREIN, THAT ITS STORY AND LESSONS MAY BE MORE WIDELY KNOWN

An Ounce of Prevention is Worth a Pound of Cure

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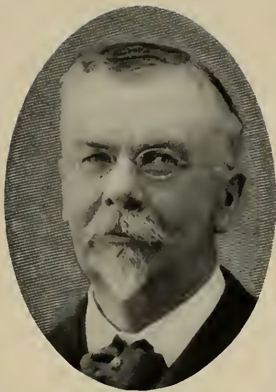

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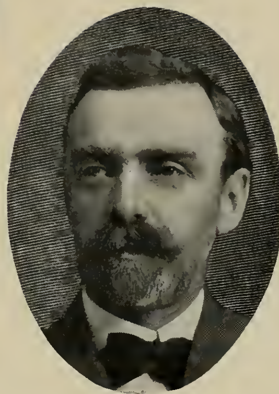

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ABSTRACT

The Arkwright Company, in observation of its Fiftieth Anniversary, has compiled a brief history of the development of Factory Mutual Fire Insurance during the past seventy-five years. These five pages abstract the book for the busy reader.

FOUNDATION

THE foundation of the Mutual System is the idea that losses should be prevented rather than distributed. Insurance is obtained at cost, no profit being made from the business. Every policy-holder is a member of the system and each company is conducted by its members, who are manufacturers. Simple but efficient business methods avoid the heavy expenses for commissions, fees, and other large outlays common to the ordinary business of fire insurance.

ORIGIN AND GROWTH

A New England manufacturer started the system in 1835. He interested other manufacturers in the idea; it was agreed to share losses in their factories on a mutual plan. They studied the causes of fires, profited by each other's experiences and, through this live interest, reduced the cost of their insurance materially. A Mutual Insurance Company was formed, and later other similar companies were organized. Page 111 gives their names. Insurance was distributed among the companies so that large lines could be carried. For efficiency and economy the companies cooperated in engineering and inspection work.

Thus the great present system developed until it is now overseeing the protection, and providing the insurance, for a large part of the better manufacturing properties in the United States and Canada, aggregating over two thousand million dollars in value.

FIRE WASTE CONTROLLED

This work is one of the earliest and most successful efforts for the conservation of resources. The control of the fire waste which has been accomplished in this field has prevented the destruction of many properties and saved the further losses which result from an interruption of business. Formerly large fires caused the greater part of the aggregate loss. Between 1880 and 1895 there were thirty-one large losses, amounting to $7,500,000. In the last fifteen years, since fire protection has been greatly perfected, and provided in all factories insured, there were only eight large fires, costing but $1,400,000. In the first period the average amount at risk was about five hundred and fifty million dollars; in the last, about twelve hundred million dollars. There would have been seventy great fires between 1895 and 1910 if the same ratio had continued as in the previous fifteen years. The equipment which has nearly eliminated the big fires, confines most of the others within small limits, so that the aggregate loss from all fires is reduced greatly. Many fires are prevented by the skilful treatment of hazards. Fire waste is, therefore, controllable. The diagram, page 106, illustrates this.

COST OF INSURANCE

In the early years the Mutual method reduced the cost of insurance at least one-half, and probably more. In the ten years, 1850–1860, the yearly cost of $100 insurance for the average Mutual risk was about forty-five cents. This cost decreased steadily as the prevention idea gained ground, until, in the last ten years, the net cost per year for the average risk, excluding interest, was only six and one-half cents per $100. Page 121 shows this by diagram. For the last few years this cost has dropped to about four and one-half cents for the average risk.

CONSTRUCTION AND PROTECTION

Substantial construction has always been urged. Mutual factories are mainly of brick, stone, or concrete, with reasonable subdivision by fire walls. Floors and roofs are generally of plank and timber or of concrete in some of the later buildings. Stairs, elevators, and belts have cut-offs at floors and preferably are put in towers so as to avoid vertical openings which permit fire to go quickly from story to story. This is "mill" or "slow-burning" construction, and pages 67 and 69 show illustrations of it. The protection of the early mills consisted of fire-pails and stand-pipes for hose supplied by small attic tanks and force pumps, driven from water wheels. Perforated pipe sprinklers into which water was turned by hand when fire was discovered were next provided and proved of considerable value. Automatic sprinklers, introduced in 1875, revolutionized the science of fire fighting and have been the main factor in bringing about the control of the fire hazard. To-day practically every Mutual risk is completely protected by sprinklers. In the later years larger gravity water supplies, stronger pump service, and more liberal pipes have been provided.

INSPECTIONS AND ENGINEERING

To create and maintain these conditions necessitated an engineering and inspection force. Every new problem of construction, protection, or the safeguarding of a hazard, required special study, and men of experience who could handle such questions broadly were secured by the companies and their services made available for all members. Quarterly inspections of all risks are made so that good conditions, once created, may be maintained. Owners thus have, periodically, the benefit of the experience in controlling fires obtained from the whole field. Modern fire protection engineering originated and developed from this work.

BUSINESS METHODS

A manufacturer desiring Mutual insurance opens negotiations with one of the companies. His plant is examined and such improvements as may be necessary are laid out. When the risk is sufficiently protected the insurance is divided among the other Mutual Companies, and each company writes its own policy. A broad blanket policy, free from co-insurance restrictions, is the standard. A premium is collected at the beginning, and on the expiration of the policies that part of it which has not been absorbed by losses and expenses is returned, thus the insurance is obtained at cost. Mutual policies cover, without extra cost, any loss from accidental leakage of the sprinkler system. Losses are adjusted on the basis of paying the owner in full for the damage sustained. Use and Occupancy insurance is provided at about three-quarters of the fire rate. The amount of insurance written on a single risk is limited, and risks in conflagration districts are avoided. The large size of the system to-day gives it a broad base and great stability.

COOPERATION

The results accomplished represent the work of many earnest men connected with the Mutual Companies. The spirit of cooperation between these workers, and between owners and underwriters, has been a vital force. The Mutual System is, in fact, an association of manufacturers working through these Companies for loss prevention and insurance at cost. That which adds strength and stability to any part benefits the whole system. After sharing in the work for fifty years the Arkwright Company takes this opportunity of presenting a brief account of that which has been achieved in the whole Factory Mutual field, as a record of the past and an inspiration for the future.

The following pages tell of the remarkable growth and achievements of Factory Mutual Methods of Fire Insurance. The broad experience of seventy-five years shows what is good, and what is bad, in construction, occupancy, and fire protection, and gives the reasons. The book must be read through to appreciate the full benefit of this experience, which has many valuable lessons for owners, managers, and superintendents of manufacturing properties, and for the designers and builders of them. ——

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The Factory Mutual System

From 1835 to 1910

A HALF CENTURY OF ARKWRIGHT DEVELOPMENT

ON the first day of October, in the year 1860, this Company wrote its first policy. A half century of healthy growth and successful business has now been completed. These fifty years span nearly the whole main development of the great manufacturing industries of this country. The cost, per year, of one hundred dollars insurance has decreased from about forty cents in 1860, to about four and one-third cents in 1910, and has averaged for the whole period only twelve cents. During these fifty years policies aggregating $3,680,000,000 have been written, losses totaling $3,118,000 have been paid, and $21,700,000 has been returned to policy-holders, this being that part of the original premium deposit which remains after the payment of losses and expenses; for the whole period these returns have averaged 84.5% of the original deposit. At the end of its first half century the Company had $270,000,000 at risk, was returning 94% of all premium deposits and taking active part in studies for fire prevention and control.

No better commemoration can mark this fiftieth anniversary than to record something of the origin and development of that which, from small and unpopular beginnings, has become the great mutual system, and to show the underlying principles on which it is founded, and on which it must be continued, if it is to maintain its wonderful success in the future.

Previous to the origin of the mutual method, fire insurance was mainly a business of fixing rates at such a point that the premiums received would pay the losses and expenses and in addition give a profit to the organizers. It was, in a way, a legitimate system of betting on the chances of fire starting in risks. The business was done by stock companies, into which people put money by the purchase of shares. Skill and judgment were necessary in conducting such companies in order that risks should be selected and liabilities so limited as to enable a Company to collect more in premiums than might be required for losses and expenses, and thus be able to make a return to the stockholders. While here and there some little attention had been given to the elimination of hazards, with the aim of preventing loss, this feature was entirely secondary — the chief business being to make the rate fit the hazard.

THE ORIGIN OF FACTORY MUTUAL INSURANCE

Zachariah Allen

THE factory mutual insurance idea originated with Mr. Zachariah Allen, who, in 1835, owned a woolen mill in Allendale, R. I. Mr. Allen was one of the able men of his day, and did much for his home city and state, always having deep interest in every work which seemed to be for public welfare.

As a boy he was given a chest of tools and the range of his mother's attic for his experiments, and to this early influence Mr.

Allen always ascribed his great taste for mechanics. He was fitted for college at Exeter, entered Brown University in 1809, and was a trustee of this latter institution for many years. He wished to make medicine his profession, on account of its great field for usefulness and investigation, but was opposed in this desire by his guardian, and gave it up; he then studied law, was admitted to the bar, and for a time seemed wedded to this profession, in which he would undoubtedly have attained

Mr. Allen's Mill About as it Appeared in 1835

distinction, had it not been for the tastes acquired in the juvenile laboratory which led him into mechanics.

Mr. Allen was the inventor of the automatic cut-off valve for the steam engine; constructed the first furnace for heating dwelling houses, before the use of anthracite coal; undertook and carried out the first systematic measurement ever made of the flow of the Niagara River over its famous falls; he traveled much in both America and Europe, wrote numerous articles in connection with his study of the application of power, and kindred subjects, and was a tireless worker and earnest student all his life.

In his mill he exercised his ingenuity to prevent fires, and provided such apparatus as was available to extinguish those which were inevitable in a textile mill. Believing that he would thus lessen the number of fires in his mill, and reduce the amount of loss from those which occurred, it seemed to him fair to ask some consideration of these facts in connection with his insurance rate, but his application for reduction was refused.

Mr. Allen was not a man to become discouraged at this, but immediately set about interesting some of his manufacturing friends in the study he was making of fire prevention. This resulted in the organization of the Manufacturers Mutual Fire Insurance Co., of Providence, R. I., the first mutual fire insurance company for insuring factories (1835). These manufacturers entered into agreement to share all losses mutually, and from this small beginning grew the study of how best to avoid fires, and how most quickly to extinguish those which started, true and intelligent self-interest being a powerful factor.

This was the foundation principle of Factory Mutual Insurance as practiced by the first company and, though the field of activity now covers an immense territory and has a membership list representing the largest and most successful manufacturing plants in this country, the basic idea of Factory Mutual Insurance is just the same to-day as it was in 1835. It is an association of manufacturers to study fire prevention, to encourage the use of every effective means of checking and extinguishing fires, and to obtain insurance at actual cost.

Tablet still in a Wall
of Mr. Allen's Mill

THE EARLY MILLS AND THEIR FIRE PROTECTION

1835 - 1850

THE Mutual Companies, beginning among the textile mills of New England, found the average mill a substantial structure of stone or brick, with small windows and steep roof covered with shingles, or occasionally slate.

A Mill of the Early Type with Ridgepole Walk

Lengths of one hundred and fifty to two hundred and fifty feet and widths of about fifty feet were common. Although there was much available land, these early mills were built five or six stories in height and frequently had a basement and attic in addition. In some cases the shingles were laid in lime mortar, thus getting a warmer roof and some resistance against fire. Sometimes the roofs had plank walks along the ridgepole to enable men to pass easily from one end to the other with buckets of water and put out fires if the shingles became ignited.

Old Mills

Frequently the roofs were supported by trusses which carried purlins and joists; loft floors were put in making attics and cock lofts and this construction with its considerable quick burning fuel and general inaccessibility proved bad, from the fire standpoint.

The floor construction was often better, some of the early mills having floors of plank on solid timbers, spaced about eight feet on centers, and this was the beginning of slow burning, or mill, construction. In many of the early mills it was also common to put a layer of mortar on the planks and on this lay the wearing floor; thus providing a convenient means of leveling the top floor, and gaining additional warmth and fire-resistance.

Old Plunger Pump
Diameter of Plunger, 3½ Inches
Length of Stroke, 12 Inches
Revolutions per Minute, 76

The Mansard type of roof was of later origin and many mills were built with this style. They contained a good deal of wood and the projecting windows were specially liable to attack from an exposure fire and caused the serious spread of many fires. While the top story with a Mansard roof was better than that with a steep roof, it was still much inferior to the full story obtained with the flat roof, which came into use at a later date and is now the standard everywhere. The development of a suitable covering for roofs with slight pitch probably aided the adoption of the flat roof.

Mill with Mansard Roof

Some of the first mills in the country were built in Lowell, Massachusetts, and many of these early mills were provided with a force pump, in the basement, driven from the water wheels, and a tank high up in the peak of the lantern roof; a stand-pipe, extending up through the mill, either in, or near, the tower, furnished a hose connection at each floor, and there was always a supply of water casks and pails. A type of plunger pump with five pistons was the unit, and this had a capacity of one fire stream. The mills had from two to five sets of these pumps. Colonel James Francis, agent of the Proprietors of the Locks and Canals, obtained in 1897 from Mr. Ferdinand Rodliff, who had been connected with the Hamilton Manufacturing Company since 1828, and was then ninety-one years old, the measurements of one of these old attic tanks. It was about five and one-half feet in diameter, by eight and one-half feet in height, giving a total capacity of about fifteen hundred gallons. In case of fire it was expected that the tank would furnish a hose stream until the pump could be thrown in, and water obtained at better pressure.

James B. Francis

While exact information is lacking, it is probable that mills in other parts of New England had similar protection in these years. Later it became the practice to lay pipe to which hydrants were connected in the yard in front of each mill, and in the mill cities, where a number of factories were built along the rivers, these yard pipes were connected so that the mills could help each other.

At an early date the Lowell mills gave special attention to the fire hazard problems and similar work was carried on by the more progressive mills in other places. The Lowell developments, therefore, may be considered as typical though somewhat in advance of the general progress. A very efficient system of watch service had been established at the first, and rigid inspections were made through all the mills by employees of the Proprietors of the Locks and Canals.

This organization, formed by the mills for handling the water-power, was given supervision of general fire protection matters, and under the direction of Mr. James B. Francis, the system reached a high standard. Mr. Francis was a man of great foresight, common sense, and ability, and contributed much to the general study of the causes of fires and means for controlling them. In this way danger points were discovered, corrections required, and a very strict oversight was given to all of the fire apparatus, coupled with constant instruction as to its use, so that the greatest efficiency was obtained from the equipment. In many of the mill yards watchhouses were provided where men slept at night, and went out for their meals in the day-time by turn, thus always leaving on duty a sufficient force to attack a fire vigorously either day or night.

Modern Mill with Flat Roof

In 1850 these mills entered into an agreement for mutual insurance among themselves, which continued until 1887, when the mills entered the Factory Mutual system. This agreement provided for the distribution of all losses among the mills, in proportion to their respective capital stocks. Nothing, however, was paid on losses of less amount than $1,000, and no member was obliged to contribute more than 2% of its capital stock on account of any loss. The whole number of losses covered by this mutual agreement during the thirty-seven years of its existence was twenty-six, amounting to $211,180, the average annual loss being $5,707, or less than five one hundredths of one per cent. per annum on the aggregate capital stock of the mills, which was $13,600,000. This mutual insurance among the mills was discontinued at noon of June 1st, 1887, and the Factory Mutual Companies, in which excess insurance had been carried by the Lowell mills for some time previous, assumed the whole amount. This change was considered advisable on account of the greatly increased value of the manufacturing plants, and fear that complication might arise in settling heavy losses. It was a most successful and interesting local application of the mutual idea.

The Rhode Island Mutual Fire Insurance Company was organized in Providence in 1849. In 1850 this company and the Manufacturers Mutual Fire Insurance Company, organized in 1835, were the only Factory Mutual Companies then in existence. They confined their business principally to New England, and the larger mills undoubtedly either carried a part of their own insurance risk, or had policies in the Stock Companies.

GROWTH OF THE FACTORY MUTUAL IDEA

1850 - 1880

DURING the fifteen years from 1835 to 1850, the Mutual method of solving the fire problem demonstrated its possibilities to an increasing number of manufacturers. Additional companies were organized, and rapid expansion followed during the next thirty years. With this growth the field constantly widened, and methods of handling fires improved.

In 1857 Mr. Edward E. Manton, of Providence, who had managed the affairs of the Rhode Island Companies with success, became executive head of the Boston Manufacturers Mutual Fire Insurance Company, the first of the Factory Mutuals incorporated in Massachusetts (1850). Mr. Manton had the reputation of being one of the ablest men in insurance work at that time, and during his connection with the Mutual system it developed rapidly.

EDWARD E. MANTON

The following extract from the records of the Boston Manufacturers Company, furnished through the courtesy of Mr. Joseph P. Gray, President, shows an interesting early attempt to outline the main requirements for a good textile mill.

"In compliance with the vote passed at the meeting of the Board of Directors, Monday, October 4th, 1858, the Secretary Respectfully Reports the following description of a cotton or woolen mill that may be insured at 8/10 pr. ct. pr. annum.

"The Building should be built of brick or stone with solid walls, plastered or whitewashed on the walls inside, stone caps and sills, brick or stone or metal jet and cornice, roof covered with metal or slate, — well fitted lightning rods, plank floors with board on top, and ceiled or plastered on the underside, would be much safer with mortar between the floors, the attic or upper story finished by plastering on the roof boards between the rafters, or planeing and painting, or whitewashing the inside of roof boards and rafters. The stairways in one or more projections built of brick or stone, the elevators in the porch; or if in the rooms, should be closed by a self-closing hatch, wash-rooms, when projecting from the Mill, built of brick or stone, no openings in the floors from room to room. Furnished with good force pumps connected to the Water Wheels, or pipes from a reservoir of sufficient head and size to protect all parts of the building, with fixed ladders and platforms at each story and at least one iron pipe at a fixed ladder with hydrant at each story, also in the porch or washroom, casks of water and pails to each story, particularly pails of water in the window of Carding Room. The fire apparatus should be equal in power to at least one good force pump to every 5000 Spindles."

"The building should be warmed by steam and all dressing of yarn, making sizing, or coloring done by steam heat. The boiler should be outside the mill and chimney separate from the walls of the mill. Iron pipes should be fitted to admit steam into each room of the mill in case of fire, and all pipes for warming the mill should not be in close contact with woodwork — and all pipes should be kept clear of cotton or wool stock and waste. Gas light should be used, and the gas works so situated as not to endanger the mill building."

"The picking should be performed in a building separated from the Mill, and connected with the Mill by a passageway of brick, with iron doors at each end, and the room provided with sprinklers connected with a proper reservoir, or the force pumps, hydrants from the force pump near, and steam pipe from the boiler to use in case of fire."

"A good watch clock, the pins driven in each room each half hour, by the night watchman."

"The waste and dirt should be all removed from the mill each day, before lighting the mill for evening work, — or in summer, before leaving off work, and the mill kept in good order at all times."

"The building should not be near enough to any other building to be endangered thereby."

(Signed) E. E. Manton, *Secretary.*

It will be noted that substantial construction, incombustible cornices and roof coverings, solid floors, elevators in outside towers, or with hatches, no opening between stories, and many other features which are a part of the standard of to-day, were being considered over fifty years ago. Flat plank roofs had not then become general, as the idea that an upper story must be clear of columns for mule spinning still resulted in a steep trussed roof.

Many of the older mills did have a stand-pipe on the outside, with small landings at a window in each story and an iron ladder running from bottom to top. However, standpipes in towers were found generally more serviceable. The provision for blowing live steam into the various rooms in case of fire is of interest and was used in a number of the older mills. In cases where areas were small this was of some value, but it does not appear to have ever been an important factor. Sprinklers, first of the perforated pipe type, and then the automatic, proved much more efficient. The general care required as to maintenance and all details well illustrates the basis upon which the system was founded.

Mr. Manton's opinion on risks was accepted by all the Mutual Companies, and from a little incident which one of the present officers recalls, his foresight and judgment are shown. As a young man this officer was sent to Mr. Manton's office on an errand, and having finished the business, Mr. Manton kept him a few minutes in conversation. Standing by the window of his office, overlooking the roofs of the city, the conversation turned on the construction of a building where the workmen were then engaged, and he remarked, "Those Mansard roofs will burn Boston some day." Naturally this remark was recalled with startling clearness when the great Boston fire of 1872 swept through these roofs and destroyed a large section of the city. This incident simply illustrates the fact that study of fire hazards soon shows the relationship between cause and effect, and suggests remedies. Only by removing causes of fires and conditions conducive to rapid spread can the enormous waste by fires be prevented.

William B. Whiting

Mr. William B. Whiting, who took up insurance work in 1862, was associated with Mr. Manton, holding the office of Vice-President of the Boston Manufacturers Mutual Fire Insurance Company. Previous to his connection with the Mutual Companies he had worked in a cotton mill, had been a practical machinist, and agent of cotton factories; therefore he had an intimate knowledge of manufacturing conditions, and through his wide acquaintance with manufacturers, was able to exert much influence, in a way to extend the success of the mutual system.

Mr. Whiting was a keen observer, with a remarkable memory for detail, and was one of the most prominent examples of the early "close personal touch" method of inspection. He had much interest in the development of the perforated pipe sprinklers, was among the first to advocate placing steam-pipes overhead in rooms, and thus saved the mills from many fires caused by hot steam-pipes, near the floor, in accidental contact with stock. Mr. Whiting was probably the first man to suggest the building of a steam-pump especially for fire purposes. In the early days few of the mills developed sufficient steam pressure to give a strong fire stream, and the steam and water cylinders of the pumps were of about the same size. Mr. Frank Curtis, of Newburyport, in consultation with Mr. Whiting, built a pump with its steam cylinder about twice the size of its water cylinder, and thus obtained a stronger water pressure for fire fighting than had before been obtainable. This is simply one of the many examples of the work which these men did in the early days to make the mutual system a progressive force.

As the principle that the proper way to control the fire hazard is to study causes of fires, and from each experience devise remedies to prevent a recurrence of such loss, was applied in a constantly widening field, new Factory Mutual Companies were organized — the Firemen's of Providence, Rhode Island, in 1854; the State, also of Providence, in 1855, and the Worcester Manufacturers of Worcester, Massachusetts, in 1855.

The field was still new and the pioneer companies of course had to learn, by experience, much that to-day seems too simple to need special thought, and this method of instruction proved no easier road to knowledge for them than for others who have found experience a hard teacher.

PERFORATED PIPE SPRINKLERS

IN 1852-3 perforated pipe sprinklers, as they were commonly called, were introduced. The best of these were lines of wrought-iron pipe with holes one-tenth inch in diameter drilled about sixteen inches apart on opposite sides of the pipe and staggered, thus giving an outlet every eight inches. Other, and less durable, pipes were made from sheet iron. These pipes were secured against the ceiling, one line ordinarily for each mill bay, and were connected

PERFORATED PIPE SPRINKLER FEEDERS

OLD MILLS AND SPRINKLER FEEDERS

with longitudinal feeders supplied by a riser from a yard main, all very much in the same general way as in automatic sprinkler equipments to-day. The holes were drilled at such an angle that the water was thrown upward so as to wet as much of the ceiling as possible. Each floor, or section of a floor, was usually supplied by a separate riser, controlled by a valve near the ground level. When fire occurred the valve controlling the section was opened, the pumps started, and the whole room, or section, deluged with water. The first cut shows the main feeders for the perforated pipe sprinklers in each story and the attic fastened against the outside of an old cotton mill, built about 1830.


EXTERIOR OF VALVE HOUSE

Below it is another view of the same mill, taken from an adjoining roof, again showing these feeders, and in the distance a mill of about the same date with its old steep roof and lantern windows. In the foreground the roof of the brick valve house which sheltered the different valves controlling the feeders to the perforated pipe sprinklers is visible. The small cuts show a nearer view of this valve house and its interior, giving an idea of its substantial construction and the care with which the valves were arranged. A gas jet was always kept burning in these valve houses and they were sometimes heated.


INTERIOR OF VALVE HOUSE

The idea of perforated pipe sprinklers apparently came from England, and was taken up by one of the mills in Lowell in a somewhat crude way. Mr. Francis immediately saw the possibilities in this method of extinguishing fire, and developed it into a complete system. He made experiments to determine the proper size and number of perforations in the branch pipes, the size of feeders, and other details, arranging all so that a hard and uniform rain was delivered over the entire area to be protected. Mr. Manton and Mr. Whiting also used their influence to extend the use of the perforated sprinklers.

By 1859, in Lowell, this protection was required in carding and spinning rooms, as well as picking departments, and in all other buildings and rooms liable to the rapid spread of fire, or difficult of access. Outside of Lowell perforated sprinklers were quite generally put into picker buildings, but more rarely into main mills, though some few plants were thoroughly equipped with them.

From the preceding pages we see briefly the field and the conditions into which the Arkwright Mutual Fire Insurance Company entered in the year 1860.

ORGANIZATION OF THE ARKWRIGHT MUTUAL FIRE INSURANCE COMPANY

THIS company was incorporated in 1860, and began business October 1st, with thirty-five subscribers, who agreed to take amounts of insurance varying from ten thousand to one hundred thousand dollars. The subscription carried as a condition that no risk should be taken or policy signed until the sum of one million dollars was subscribed to be insured, all to be placed at risk at the same time. The final total of the original subscription list was $1,140,000, and on the following pages we give a facsimile of this old document, the paper of which bears a London water-mark. The amount to be written on any single risk was conservatively limited to $15,000.

The first Board of Directors for the Arkwright Company represented the textile industries, and was as follows:

Mr. George R. Minot, Lyman Mills and others
Mr. Edward Atkinson, Indian Orchard Mills and others
Mr. J. Wiley Edmands, Pacific Mills
Mr. T. C. A. Linzee, Lancaster Mills
Mr. T. Wigglesworth, Everett Mills
Mr. J. S. Fay, Washington Mills
Mr. Eben Wright, Otis Company and others
Mr. John R. Brewer, Hamilton Woolen Co.
Mr. Henry J. Gardner, Salisbury Mills
Mr. Eben Dale, Pittsfield Mfg. Co., and others
Mr. Waldo Higginson, Great Falls Mfg. Co.

The Company was called Arkwright, for Sir Richard Arkwright, who in 1769 patented the spinning frame, the first machine having drawing rolls, the main princi-

The undersigned, hereby agree to take Insurance, to the amount set against their several names, in a new Manufacturers' Mutual Fire Insurance Company, to be established in Boston.
It being a condition of this subscription, that no risk shall be taken, & no policy issued, until the sum of one million of dollars ($1,000,000.) is subscribed to be insured, which shall be placed at risk at the same time.

Boston Nov. 30. 1859

J. Skinner & Co.	One Hundred Thousand Dollars
William Dwight	Sixty thousand
Wright & Whitman	One hundred thousand dollars,
Charles Amory	Sixty Thousand dollars.
W Amory	Sixty Thousand Dolls
Edw Hobbs	Sixty Thousand dolls
J. Wiley Edmands	Sixty Thousand dolls
Geo Howe Prsd	Twenty thousand dollars
Edw. Atkinson Tr. Low	Twenty thousand dollars.
Read, Gardner & Co	Twenty thousand dolls
Geo L Ward Tr.	Ten thousand dolls
T. L. Richardson Tr by Dickinson	Ten thousand dollars
Jas A Brown Tres	Thirty Thousand dollars
Wm S Eaton Treas	Twenty thousand dollars

FACSIMILE OF ORIGINAL ARKWRIGHT SUBSCRIPTION LIST

Amounts brought up	Six hundred & thirty thousand Dolls.
Thos. C. A. Lorzee Treas	Fifty thousand dollars
Salisbury Mills. J. Garner. Tr	Sixty thousand
Chas. F. Loring Jr Treas	Ten thousand
E. H. Eldredge Treas	Ten thousand dollars
Geo. W. Ellis Agt	Ten thousand dollars
E. R. Mudge Treas. Saratoga Victory Manuf Co	Thirty Thousand Dollars
Wm. Means Tr	Twenty thousand dollars
John Aiken Treasr	Forty thousand Dollars
John Webster Treas	Twenty thousand —
John Balch Treas	Ten thousand dollars
T. G. Cushing Treas	Thirty thousand dollars
B. W. Gleason & Co	Forty thousand dollars
Geo. W. Lyman Treas	Forty thousand dollars
Jos. S. Fay Treasr Washington Mills	Thirty thousand Dollars
Geo. W. Chapin Treasurer	Forty thousand dollars
A. & W. Sprague	Fifty thousand dollars.
B. B. & R. Knight	Ten Thousand Dollars
Warren Mfg Co. [illegible] Treas.	Ten thousand dollars
Jno. Tiedman Paul Treas of the Washington M. Co. Gloucester N. J.	Twenty Thousand Dollars
Social Mfg Co. A. Lippitt Treas	Ten Thousand Dollars

FACSIMILE OF ORIGINAL ARKWRIGHT SUBSCRIPTION LIST ple of all spinning machines, and the predecessor of the ring spinning of to-day.

Mr. Waldo Higginson was elected President of the Company, and continued in that office until 1891, when ill health compelled his retirement. Many pleasant anecdotes are related concerning Mr. Higginson, and in a letter which was sent to him by the members of the Conference of the Associated Companies at the time of his resignation, special emphasis is laid upon the loss which his retirement means to those who have learned to prize his judicial friendliness, his fairness, trust, and sincerity.

Waldo Higginson

Mr. Edward H. Sprague was elected Secretary and held that position until the long illness, preceding his death in 1890, obliged him to give up all active work. The duties of the Secretary in the early days included personal visits to all risks, and adjustment of losses, meaning personal acquaintance with different plants, and this was the forerunner of the inspection work which is now organized and carried on by men who give all their time to it.

In these early days each company acted separately in taking insurance, and inspections of risks were made by officials of the company to which the owners made application for insurance. If the risk seemed suitable to the official visiting it, he so reported to his company, and, after fixing a rate at which the insurance could be written, if fire protection apparatus was installed, the insurance was distributed among the companies, policies written, and the manufacturer became a member of the mutual system.

Edward H. Sprague

When the risks were few in number, and the individual plants small, it was possible for men to carry in mind a great deal of detail concerning each one. The active officer of a Mutual Company therefore knew the managers of the mills insured, and had intimate knowledge of the manufacturing plants. This personal contact was of great value in the early formative days and kept the principles of mutual insurance freshly before the minds of manufacturers and underwriters.

Policies were written for a term of twelve months, and cash was paid to cover the premium at the time of receiving the policies. In the early days "Deposit Notes" were given also for an amount equal to five times the premium, to cover a possible assessment. Later the assessment liability was printed on each policy and the issuing of notes abandoned, but in all the life of the Arkwright Company no assessment has ever been made.

At the expiration of policies all the paid-in premium not needed to pay losses and expenses during the twelve months preceding, was returned to the members in cash. This simple and absolutely mutual arrangement is continued to the present time, and every policy-holder secures his indemnity for each twelve months at its actual cost. Of course it was impossible to foretell what amount of premium would be returned, as this depended upon the losses occurring during each year. As a matter of fact, the cost of insurance has steadily decreased, as the Company has grown and as improved methods of handling fires and preventing loss have come into common use. The occasional bad fire has increased the cost of insurance temporarily, but the main movement has been rapidly forward, because each expensive lesson has been followed by increased efficiency and energy in fire prevention work.

EXPERIENCES AND LESSONS

THE prevention of loss has always been a primary aim of the Mutual System. Every fire has been studied carefully, therefore, and when possible a lesson learned, and a remedy devised to prevent similar fires in the future. It is of special interest to note that this method of insurance originated with textile manufacturers, and grew to stability and success mainly among the cotton mills, later extending to less hazardous classes. At first thought it seems singular that this new, and untried, method should have succeeded in one of the most hazardous kinds of manufacturing, for the cotton mill, with its large quantities of loose inflammable stock, was bound to have frequent fires, and now and then a fire was sure to get beyond control and cause serious destruction.

Mr. Edward Atkinson used to tell of trying to place the insurance on a large cotton mill in about 1850, when the president of a prosperous Stock Company offered to "insure any cotton mill to burn up" but not *against* loss by fire at *any* rate of premium. This stock company was wrecked by the Boston fire in 1872, while no one of these Factory Mutual Companies has ever failed to meet its full obligations. Is it not probable that the frequent fires and bad losses in the early days kept alive interest in the study of fire prevention, accumulated experience rapidly, and thus compelled development which, in a more favorable field, might not have been achieved?

The first large loss which the Arkwright Company met was the total destruction of the cotton mill of A. and W. Sprague, at Warwick, Rhode Island, and the amount paid by this Company was $19,560. This was a heavy blow to the young company and the percentage of premium returned was reduced to twenty, the lowest ever paid except in the year following, when a loss at the Saratoga Victory Manufacturing Company reduced it to fifteen for one month. An abstract from the Secretary's record of the Sprague fire may be interesting as giving a glimpse of the conditions found by the Mutuals in 1865.

The factory consisted of main building, of stone, 312 x 68 feet, four stories and attic, and ell building, 80 x 50 feet, three stories and attic. It contained 22,144 spindles and 560 looms for weaving printing cloths.

The protection consisted of a force pump, fire pails filled with water, and "several hydrants" near the mill to which hose was attached. Water was supplied by a small reservoir, but the streams were so feeble they proved of no effect on the fire.

The factory had been stopped for about two weeks for repairs on the water wheel, consequently the force pump could not be used when the fire came.

An employee of the mill who had charge of the oils, paints, etc., of whom the report says, "He had the character of being more than ordinarily careful, faithful, and neat in his work," brought a ten-gallon can of benzine into the mill about 6.30 P. M., and took it into a room under the first floor of the mill to empty it into a barrel kept for the purpose. He went into the oil room with an open light, which he placed on the head of a barrel, four or five feet away from the one into which he was to pour the benzine.

With another man he then took the can into the oil room and turned the contents through a tunnel into the barrel which was laying on its side with the tunnel in the bung-hole. He then discovered that there was a little leak around the faucet, and some of the liquid on the stone floor, so he took the open light and held it down near the faucet to discover the leaking place, which he did, placing the light down beside the barrel — then the benzine ignited and it is reported that the fire spread with great rapidity, totally destroying the entire factory.

This experience showed the danger from volatile oils, and also the certainty of heavy loss if fire got away from the feeble fire-fighting equipment available. The fact that from twenty to thirty men were on the premises when this fire started amounted to nothing in the way of checking its spread because the means which they had at hand for fighting fire were entirely inadequate.

Lack of appreciation of fire hazards was not confined to the managers of cotton mills, as illustrated by fires like the following, which occurred in woolen mills. Detailed descriptions of these early fires are preserved in small books, their pages filled with fine old writing using the long S, and show how earnest was the endeavor to find the cause and lesson of each fire.

The building was of stone, with slate roof, about 45 x 30 feet, one and a half stories in height. The first story had no floor laid, and was used for drying cloths on tenter bars. The main flue (sheet iron) from the boilers passed through the length of this story near the ground, and up through the floor overhead, and thence through the south end wall, and into the chimney outside the building.

There were two wood stoves in this first story, the pipes from which entered the main flue. The half story was used wholly for drying wool spread on the floor, the heat from beneath ascending through the cracks between the boards in the floor. Fire started in the south end of the building, supposedly from the sheet-iron boiler flue.

In another woolen mill a fire occurred in the drying room, which was in a stone building with slate roof, three stories in height, 240 x 43 feet. The first story was used as dye room; the second story for storage of dried yarns and cotton after being colored; the third story for drying wool and colored cotton and yarns.

The drying room where fire originated was kept heated to a high degree by a large number of steam pipes laying near the floor, " resting on pieces of wood," and some it is thought on the floor, the hot pipes probably igniting the wood.

The steep roofs and bad attics were a constant danger in these mills, and as many were used for drying wool, it is not surprising that fires occurred in them. In 1868 the Washington Mills of Lawrence, Massachusetts, a woolen mill, suffered a severe loss from fire which originated in one of these attics.

The room had formerly been used for drying wool, and had racks throughout with steam pipes underneath. At the time this fire occurred, the room was used for drying shawl yarn after dyeing, and on this particular day some yarn waste which had been used for wiping machinery, but had been scoured to remove the oil, was placed on these racks to dry. The fire is supposed to have started from spontaneous combustion. As the stories below were used for storing picked and colored wools much damage was caused by water.

The bad features of these attics were pointed out to owners, and, acting on the suggestion of Mutual officers, many mills changed their poor roofs for good ones, and when one of the old steep roofs burned off it was replaced

Old Steep Roof Burned Off

by a flat plank and timber roof, and the character of the risk greatly improved thereby. This is one of the early, and important, examples of the benefit gained from an intelligent study of fire hazard.

Between 1870 and 1880 there were eleven fires each of which caused a loss of over $100,000 to the Mutual Companies. Several of the largest of these with the amount of loss to the Mutual Companies were as follows:

CHICOPEE MILL BEFORE THE FIRE

1873 CHICOPEE MANUFACTURING COMPANY. Loss, $520,000
Chicopee Falls, Massachusetts. Cotton Mill.

A machinist, working alone on the crown wheel and gear in the basement of No. 2 Mill, knocked his lantern into the oil-soaked wooden box enclosing the gears. As the chief force pump was at the seat of the fire, it was useless, and the only remaining apparatus was a No. 4 Fales and Jenks pump, and two sets of old style plunger pumps.

CHICOPEE MILL AFTER THE FIRE

The fire spread throughout the No. 2 Mill by means of the belt drives, and it was supposed to have entered No. 1 Mill through openings where the watchman had failed to close the heavy cast-iron fire-doors, which were probably hard to move.

Lessons: Danger from repair work; need of two men working together; great hazard from belt openings which so rapidly spread fire; and the importance of keeping fire-doors closed.

1874 Social Manufacturing Company. Loss, $524,000
Woonsocket, Rhode Island. Cotton Mill.

Fire was first seen burning briskly in the belt way which contained four belts, one wide and heavy belt coming horizontally from the engine room, and three 9-inch belts running to stories above. The cause of the fire was unknown. It spread throughout all floors of the mill. A 2-inch connection to the gas meter was broken, and burning gas poured into the mill for five or ten minutes before shut off. Two rotary pumps were started promptly and the apparatus worked well. In two to five minutes six streams were available, and in fifteen minutes eighteen or twenty.

Lessons: Danger from belt openings, through which fire spreads, and the difficulty of conquering a fire which once gets well started with several large vertical chimneys furnished by belt drives.

1874 Granite Mills. Loss, $247,000
Fall River, Massachusetts. Cotton Mill.

This was the first time that loss of life resulted from a fire in a Mutual mill. The fire originated from friction in a mule head, and the operatives were so frightened by its instantaneous spread, they did not use the means of extinguishing it which they had. The stair tower became impassable on account of the fire and twenty-three lives were lost. Nothing to check the fire was done for five or six minutes, but in about fifteen or twenty minutes twenty hose streams were playing upon it. The upper story, attic, and roof were entirely destroyed, and machinery in the floors below damaged by water.

Lessons: The danger of rapid spread of fire over loose stock, need of having operatives understand the use of fire prevention apparatus, and again the inability of hose streams to prevent large loss, though they were able to prevent total destruction.

1877 Border City Mill. Loss, $398,000
Fall River, Massachusetts. Cotton Mill.

About 6.00 a. m., a boy lighting the gas in the mule room on the fifth floor was frightened by the gas streaming up, dropped his lighted match, which ignited the cotton, and fire swept over a mule and through the room, reaching the floors below before much apparatus could be brought into use. Perforated pipe sprinklers had been recently installed and the supply, from a large street main, had two gates on it. The gate inside the yard was opened immediately on alarm of fire, but it later was discovered that the gate in the street was closed, so no water went to the perforated pipe sprinklers. The mill operatives and the public department worked with energy, but did not succeed in saving the mill.

Lessons: Danger of a "back" gate, and probability that any complication of this kind will lead to failure in the excitement of a fire, and again the limitations of hose streams alone.

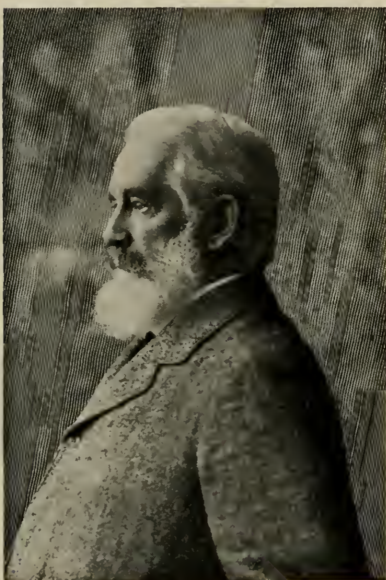
These four fires, causing an aggregate loss of nearly one and three-fourths million dollars, tested the system severely, but although the total amount at risk in the Factory Mutual Companies in 1875 was only about $175,000,000, these great losses were paid promptly. The cost of insurance for the decade of 1870-1880 was practically the same as for the preceding ten years — twenty-four to thirty cents per $100 at risk — which was probably about one quarter what insurance would have cost in the Stock Companies.

Although perforated pipe sprinklers sometimes failed to control fires, there were other occasions when they proved of great value, as the following report of a fire in Fall River well shows.

"A peculiar light" was seen in the fourth story mule room of the mill, and immediately a man was stationed at the valves controlling the perforated sprinklers, and when the fourth floor section valve was opened the light disappeared, but appeared in the third floor; then the third section valve was opened, and the fourth floor valve closed; but when light again appeared in the original fourth floor, the valves for both sections were not only left open, but the steamer was connected to the lake to reinforce the sprinkler supply, and the fire was extinguished.

In this case the loss to the Mutual Companies was $48,700, largely due to water damage. This amount was small compared with that of the similar fire which started in the mule room of the Border City Mill, and which has been previously described. This is one instance among many where the perforated pipe sprinklers did effective work when properly supplied with water.

After the death of Mr. Manton, President of the Boston Manufacturers Company, in 1878, Mr. Edward Atkinson was elected as his successor, and was a familiar figure in the Mutual field for many years. Being a ready writer and speaker, he delighted in telling of the development in fire prevention studies, and thus made the Mutual idea known to many who had not before understood its principles or appreciated its methods. He took keen interest in the work of the following years, and was ever ready to encourage new ideas of promise.



Edward Atkinson

The broad lesson which had been learned from the experience of forty-five years was that intelligent study of fire hazards and willingness to adopt remedies resulted in great reduction of loss, and consequently in lower insurance cost. Self-insurance, on a mutual plan, encouraged care, made each owner a partner in the study of fire prevention, and placed in every factory alert men, whose interest it was to stop fires.

The study of fire prevention and control was soon to become a more exact science; men having special training in mechanics, hydraulics, electricity, chemistry, and other special lines, were to add their contribution to the cause. The result was to be a lowering of insurance cost to an annual charge of but a few cents per $100 at risk. Beyond this, the old theory that the function of the underwriter was simply to "distribute losses" and "make the rate fit the hazard" was changing gradually to a recognition of the broader and higher calling — the prevention of fire loss. These methods were to leaven the whole field of fire insurance, and point the way which leads to checking the enormous fire waste which is a disgrace to our country. Thus did the early manufacturers of New England establish, perhaps the first, certainly one of the greatest, business organizations for the conservation of resources.

There were, however, some disquieting conditions. Mills were becoming larger, new processes and hazards were being introduced, and the large losses, from 1873 to 1877, showed the possibilities and dangers. More effective apparatus for preventing fire, and checking its rapid spread, must apparently be devised if better results were to be secured, or even as good results maintained.

Ingenious minds had been working on the problem, and in 1875 the automatic sprinkler was brought into practical shape. This was to revolutionize the science of fire fighting, as completely as the iron-clad monitor which steamed up Hampton Roads thirteen years earlier revolutionized naval warfare. It has even excelled this, for, in its best development, it eliminates conflagrations, while war is still with us. The next years cover the development of this new weapon for fire fighting, and the growth of a very efficient system of inspection and general cooperation.

At the close of 1879 the amount at risk in the Factory Mutual Companies then existing was $204,000,000, and the risks were almost entirely located in New England, New York, New Jersey, and Pennsylvania.

THE EXPANSION OF THE MUTUAL SYSTEM

1880 - 1910

THIS period has witnessed great expansion of the Mutual System. By an elevenfold increase, the two hundred millions at risk at the close of 1879 have become the twenty-two hundred millions of to-day. This covers only selected manufacturing properties, all thoroughly protected by efficient fire-extinguishing apparatus. The most important work of this period was the development of automatic sprinkler protection. In these thirty years the study of fire prevention has become an important branch of general engineering. The result of this growth, and these new factors, has been reduction in the net annual cost of insurance, from about 29 cents per $100 for the decade preceding 1880, to about 6½ cents for the ten years preceding 1910. This has been accomplished despite greatly increased hazards, due to larger factories, concentration of value, higher speeds in machinery, new processes, and general increased pressure for production. For a prosperous manufacturing plant to be free from the interruption of business which fire causes, is often of more importance than reduction in annual insurance cost, and this freedom is secured through Mutual methods.

In 1890-91 the Arkwright Company lost both its executive officers, through the death of Mr. Sprague, the Secretary, followed by the resignation, on account of ill health, of Mr. Higginson, the President, both of whom had served the Company since its organization, — the long term of thirty years. A plan was developed for consolidation with the Mill Owners Mutual Company, which had been organized in 1873, and this was effected in 1891 by reinsuring all risks of the Mill Owners Company under Arkwright policies. The new Board of Directors chosen comprised five of the former Mill Owners Board and six of the Arkwright Board. Mr. Roland W. Toppan, who had been President of the Mill Owners, was elected President of the Arkwright, and Mr. D. Wendell Bartlett, who had been appointed Secretary of the Arkwright after the death of Mr. Sprague, continued as Secretary. Mr. W. H. H. Whiting became Assistant Secretary at this time, having entered the Mutual field in 1871, as the first inspector employed by the Companies, after an earlier experience in practical mill construction and operation.

Mr. Toppan came to the Company after a broad experience in underwriting and with a strong belief in Mutual methods. He had entered the Mutual field in 1873 as assistant to Mr. Manton, President of the Boston Manufacturers Company. Previous to that time he had been connected with the Stock Underwriters and had placed insurance on many large mill plants for Mr. Manton, where the total amount desired was in excess of what the Mutual Companies could carry safely in those days. In 1881 Mr. Toppan was made Assistant Secretary of the Boston Manufacturers Company and three years later its Assistant Treasurer. In 1889 he accepted the presidency of the Mill Owners Mutual Company, and in 1891 became President of the Arkwright, which office he still holds. During the twenty years 1890-1910 the business of the Arkwright Company increased from fifty-three millions to two hundred and seventy millions. The policy of the company in these years has been conservative underwriting, efficient business methods, constant oversight of risks and insistence on high standards of equipment and maintenance. Sound growth and constantly decreasing cost of insurance have resulted.

Mr. Bartlett also became connected with the Mutual Companies in 1873, as assistant to Mr. Higginson and Mr. Sprague, of the Arkwright Company. Beginning thus early, Mr. Bartlett has seen the business of the Company increase from twenty-seven millions in 1873 to ten times that amount in 1910. He has occupied the positions of Assistant Secretary and Secretary, and is now Vice-President and Secretary. The Arkwright Company therefore has the unique distinction of having had but two presidents and two secretaries in its whole fifty years of existence. This has enabled it to bring, to the workers who entered this field later, a first-hand knowledge of the foundation principles upon which the great system of to-day stands. The rapid expansion of recent years sometimes obscures the fundamentals, but knowledge of them and reminders of their continuing importance are of benefit to the entire system.

Paper mills had been insured by the Mutual Companies, but the losses in them had proved serious and the Companies considered giving up insuring them. The better plan, however, of improving the mills and removing the special hazards was adopted. To aid this work and give the paper manufacturers a closer connection with the Mutual Companies, the Paper Mill Mutual Insurance Company was formed in 1886. Mr. Edward Atkinson was the first President, and was succeeded in 1889 by Mr. Roland W. Toppan, who has continued as head of the Company ever since.

FURTHER EXPERIENCES

IN the first ten years of this period eighteen fires occurred, each with loss over $100,000. The automatic sprinkler played little part in these, and in several the limits of the perforated pipe sprinklers were shown. The conditions of the risks, and the lessons and losses to the Mutual Companies in the more serious of these and in those having some special point of interest were as follows:

1880 KEARSARGE MILLS. Loss, $355,000
Portsmouth, New Hampshire. Cotton Mill.

Mill of brick, six stories, bad hollow floors and roof. Fire started on fifth floor, Mule Room, by spinner dropping waste which became ignited in wiping a shaft. Fire confined to the Mule Room for a time, then it burned through to the fourth floor, rendered tower standpipe useless, and was beyond control. Yard hydrants too near the mill for service. Public department saved surrounding buildings, mill destroyed. There were no sprinklers and loss was due to a combination of poor construction and scant protection.

1881 HORACE A. KIMBALL. Loss, $130,000
Pascoag, R. I. Woolen Mill.

Fire started in a cloth drying and tentering machine. The main building was protected with perforated pipe sprinklers and there were two rotary pumps. The mill firemen thought they had the fire subdued, but it worked its way into an ell building where there were no sprinklers and as there was a high wind became uncontrollable.

1881 BARTLETT STEAM MILLS. Loss, $271,000
Newburyport, Massachusetts. Cotton Mill.

Fire discovered at 11 P. M. in brick picker, three stories, probably due to ignition of lint and fibre getting under floor through a hole which had recently been cut on account of changing machinery. Fire fought by watchmen, but got away from them.

Steam pump worked well until town steamer, drawing from same 6-inch pipe, took all water from it. Perforated pipe sprinklers in peak of roof, none elsewhere; fire spread to No. 1 Mill through passage and No. 2 Mill through windows; plant destroyed. This was another case of weak protection.

1882 Flint Mills. Loss, $569,000
Fall River, Massachusetts. Cotton Mill.

Stone mill of six stories, with flat roof; belts (largely inclosed by wooden boxes) from engine fly-wheel to all stories. In afternoon smoke was seen in Engine Room, coming from main pulley housing, and in a few minutes fire had extended through the belt boxes to all stories. There were perforated pipe sprinklers in the three upper stories, but the fire quickly became so general that there was not sufficient water to supply them all. There were ample hose streams, but again they were unable to control a fire which so rapidly reached all stories. Mill totally destroyed. The chief lesson is the great danger from large beltways making vertical openings from story to story. The limitations of perforated pipe sprinklers are also shown.

Ruins of the Flint Mill

1883 Annisquam Mills. Loss, $205,000
Rockport, Massachusetts. Cotton Mill.

Fire started by a stone mason using gas lamp on rubber hose while working in Engine Room. It spread through belt holes into the Weave Room. The mill had automatic sprinklers except in the Weave Room. The main pump was in the Engine Room and could not be reached. There was a smaller pump and an 8,000-gallon tank, but the fire gained such headway in the unsprinkled Weave Room that it could not be stopped with the small amount of water available, and the mill was destroyed.

Ruins of Annisquam Mill

1884 Sagamore Manufacturing Company. Loss, $376,000
Fall River, Massachusetts. Cotton Mill.

Fire started in some cotton stored in the basement, quickly spread into the tower, so that the valves controlling the perforated pipe sprinklers could not be reached. It went up the tower and entered the different stories. Hose streams were used, but the mill was destroyed. The insurance companies decided after this to require mills to build storehouses for cotton, also that accessible brick enclosures must be provided for valves controlling perforated pipe sprinklers, both as a condition for renewal of insurance.

1887 Cocheco Manufacturing Co. Loss, $171,000
Dover, N. H. Print Works.

Fire apparently started in a cloth dryer, due to friction of the rolls. It spread so rapidly through the building that the help barely had time to get out. There were perforated pipe sprinklers in the at-

Ruins of Cocheco Print Works

tic but no automatic sprinklers had been put in as it was thought the moist air in the rooms would condense on the pipes, drip on the goods, and spoil them, also that the sprinklers would corrode. Nine mill force pumps were used, throwing thirty streams, and the city fire department furnished five streams. The fire was extinguished and adjoining buildings saved.

1888 Collins Manufacturing Company. Loss, $230,000
North Wilbraham, Massachusetts. Paper Mill.

This was a brick paper mill building. Fire started at 2.40 A. M. in a rag room in the third story, spread to the attic and through the roof boards, and after a long fight of several hours, succeeded in getting over the fire wall into the adjoining building. The weather was exceedingly cold, being about 15° below zero. There were automatic sprinklers in the rag room, with water supply from steam pump only, which was supposed to be kept running constantly. It was found in operation early in the fire; but, due to a wrong arrangement of valves, water wasted through a rotary pump running it backwards. This was corrected, but fire was beyond control, and only the lower parts of the buildings could be saved. The sprinklers had no water and were worthless. This showed the need of a gravity supply for sprinklers, also the need of better pipe systems.

1888 Henry Disston & Sons Co. Loss, $173,000
Tacony, Philadelphia, Pa. Iron and Steel.

Fire occurred in straw used to pack crucibles by radiation from hot steel bars. It was thought to have been extinguished, but broke out again in the night and set fire to the roof. There were no sprinklers and the mill and city fire departments finally put out the fire. The heavy machinery was damaged much more than was thought possible with the small amount of fuel there was to burn.

1889 Buchanan and Lyall. Loss, $516,000
Brooklyn, New York. Jute Mill.

This was a jute mill of good construction, four stories high, equipped with automatic sprinklers except in the basement, where there seemed little hazard, though sprinklers were soon to be provided. From some unknown cause fire started in the basement, was fought unsuccessfully by hose streams, spread through a doorway to connecting Weave Shed, and in such volume was beyond the control of automatic sprinklers with the water supply available. Plant destroyed. This showed the danger from leaving any point uncovered by automatic sprinklers, for, with the limited water supplies generally available in these days, unless a few sprinklers could act upon a fire in its first stages it was likely to get quickly beyond the extinguishing power of the water available.

1889 HARTFORD CARPET COMPANY. Loss, $160,000
Thompsonville, Connecticut Carpet Mill.

Fire discovered at 11.25 P. M. Thanksgiving Day in storehouse used for storage and sorting of wool; it was thought to have been set by an insane person. There were perforated pipe sprinklers in the attic, supplied by steam pump only, which could not be run as steam was not kept up on holidays. The mill and town fire departments fought the fire with ten hose streams. The building had two fire walls, but the fire doors were left open by the watchman, as was his custom. Fifteen minutes before the fire was seen by an outsider the watchman had been through the storehouse.

While these severe fires were giving additional proof that heavy losses were inevitable if no better protection than that of the past was available, many other fires were being extinguished by automatic sprinklers, and a mass of evidence was gradually accumulating to show their great value. It is true that in several of the above fires sprinklers failed to prevent heavy loss, but this was not due to any fault of their own, but rather to inadequate water supplies, or because the water from the sprinklers could not reach the fire until it had gained great headway. During this time many fires were caught and held by a few automatic sprinkler heads under conditions where, unless thus checked at the very start, several more heavy losses would have occurred. An account of the origin and development of the automatic sprinkler will therefore be of interest.

AUTOMATIC SPRINKLERS

THERE were several early inventions embodying some of the principles of the automatic sprinkler, but it was not until about 1875 that a practical device was completed. At this time the sprinkler developed by Mr. Henry S. Parmelee, of New Haven, Conn., was offered for use, and experiments were made before several officers of the Mutual Companies. This sprinkler was manufactured by Mr. Frederick Grinnell, of Providence, R. I., who did much in the following years to forward the adoption of automatic sprinkler protection. In 1875 Colonel Thomas J. Borden (who later served for many years as President, first of one, and then of several Mutual Companies) equipped the Troy, Richard Borden, and Mechanics Mills, of which he then had charge in Fall River, with Parmelee sprinklers, installing about twenty-five hundred in all. He arranged the pipes in lines supplying the heads, and fed them by central risers. This followed the general arrangement of the perforated pipe sprinklers and to-day the standard practice differs only in details.

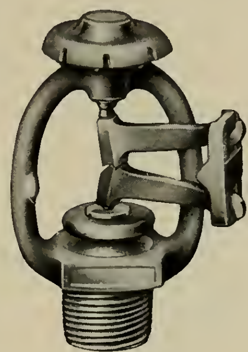
PARMELEE SPRINKLER
About half-size

In this sprinkler a brass cap fitted over the orifice and was held in place by a soft solder, making a tight joint. This solder melted at a temperature of about 160° F. It took several minutes, ordinarily, to heat the considerable mass of brass, and the water in the cap, so that these early sprinklers were rather slow to open. However, when the solder melted, the water pressure forced the cap off and discharged through a one-half inch orifice. A revolving deflector pivoted above the

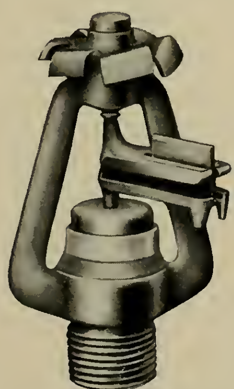
PARMELEE SPRINKLER WITH CAP MELTED OFF

jet, distributed the water over an area of about one hundred square feet.

Since 1875 other forms of valves, held closed by ingenious arrangement of links and levers, have been invented, and the records of the Mutual Companies show several hundred patterns, few of which ever attained practical shape. The whole aim has been to get a form of valve which would not be likely to stick after long remaining seated, and an arrangement of levers and links which would allow the solder to become quickly heated and which would themselves not be liable to stick. At the same time, the whole device must be simple, rugged, and such that it could remain in repose for years and then respond — almost instantly and with full effectiveness — when a fire occurs. Further, the sprinkler must withstand various changes in the atmosphere, and all ordinary tendencies to corrosion.

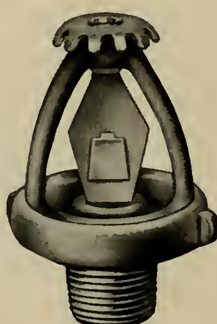


To accomplish all this has proved no simple problem, as shown by the fact that to-day there are but six heads approved by the Mutual Companies, cuts of which, at about half actual size, are given on this and the following pages. This despite thirty-five years of experience and an enormous field, there being to-day approximately six million sprinklers in mills insured by the Mutual Companies, and many more in other properties. It is true, however, that new and promising devices have often been purchased by prosperous companies who install sprinklers, and only the one deemed best adapted to the general field kept on the market.



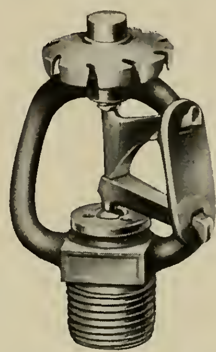
The great value of the automatic sprinkler lies in the fact that it is on duty twenty-four hours a day, and three hundred and sixty-five days a year. It can work as well in smoke and out-of-the-way places as in the open, can reach fire where men with hose streams could not live, and can pour water into sections out of the range of fire streams. Generally the heads which open are those over, and near, the fire, thus the automatic sprinkler is the remedy which strikes the seat of the trouble.

There was naturally much opposition to the automatic sprinkler in the early days. It was new, and untried, and its value and reliability after some years of standing unopened was questioned. Further, it was very expensive to equip a whole mill, and owners desired more certainty of success before making such an outlay. Mr. Atkinson saw the possibilities from the first, and much is due to him for persistently urging the introduction of automatic sprinklers. His early attempts to interest the presidents of a number of the large Stock insurance companies met with ridicule, and a frank admission that if the sprinkler should be as successful as he hoped, premiums would be reduced and consequently commissions, and therefore it would be a bad thing for the underwriter in business for profit. This was before the days of the broader view, now more common, but unfortunately not yet universal, that the best work of the underwriter is the prevention of loss, not its distribution.



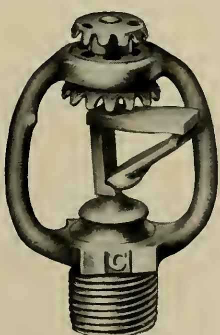
Naturally the early work of automatic sprinklers was watched with the greatest interest, and in many cases their prompt action extinguished fires which, starting under similar conditions with no sprinklers available, undoubtedly would have added to the list of bad fires. A few examples, typical of the many which occurred, are given in the following paragraphs.

Fire started in some sheeted wool piled in the attic of a mill. This room was not visited by the watchman on his regular round, but he discovered smoke coming from the window and gave an alarm. Hose lines were quickly laid, but before they could be used water was seen coming through the floor and it was found that four automatic sprinklers had extinguished the fire, confining it to a space not over ten feet in diameter. The loss in this case was $248.



In another instance fire occurred in a gauze room containing about three hundred pounds of loose stock, mixed cotton, wool, and shoddy. Within thirty seconds after the fire flashed over the stock the sprinklers were in operation and the fire was extinguished in about two minutes.

A large overhead bearing in the weave room of a mill became heated, and the oiler was working on it, trying to remedy the difficulty. The hanger was enclosed in a metal cover to prevent oil dropping, and suddenly fire flashed out. Six automatic sprinklers opened immediately and extinguished the fire, which had spread to the stock on the floor and around the machines. There was some water damage and the ceiling and stock were scorched, but the loss was only $308.



A table compiled from records of fires in risks insured by the Mutual Companies in 1888 showed the following results for the ten years 1877-87.

Total fires without automatic sprinklers		759
Total Loss	$5,707,000	
Loss per fire	7,500	
Total fires with automatic sprinklers . . .		206
Total Loss	$87,600	
Loss per fire	1,080	

A loss of seven times as much where there were not sprinklers as where there were, gave good ground for urging their general extension. It will be noted also that for this period, based on the number of fires, it may be roughly estimated that less than one quarter of the property insured had sprinklers.

The original idea was that a few sprinklers, catching a fire at its start, would control it, and the general supposition was that if a fire gained headway sprinklers could not be expected to hold it. With this theory, supply pipes were made only large enough to feed a limited number of open heads, and tanks of but a few thousand gallons were provided.

It was found later that sprinklers could do a much greater work if given liberal supply pipes and ample water. This made it possible to protect the center of wide buildings, such as the modern weave shed, the upper stories of high buildings, and other similar areas which would be out of the range of hose streams. The efficiency of automatic sprinkler protection is a chief cause in permitting the construction of very long and wide buildings, which bring about great concentration of value, which could not be risked at all if only the older methods of protection were available.

There is danger, however, of going too far in this direction, for the wonderful work of automatic sprinklers should not let us forget that water may be shut off, or some other derangement may throw them out of commission temporarily, and solid brick fire walls and other good fire cut-offs must be provided, as secondary barriers, and as positive lines of separation between great values. The large areas, which are permissible because of this means of protection, greatly aid manufacturing on a large scale at low cost. Thus fire protection brings a direct and substantial return to the manufacturer.

A few examples of this larger possibility of the automatic sprinkler may be of value.

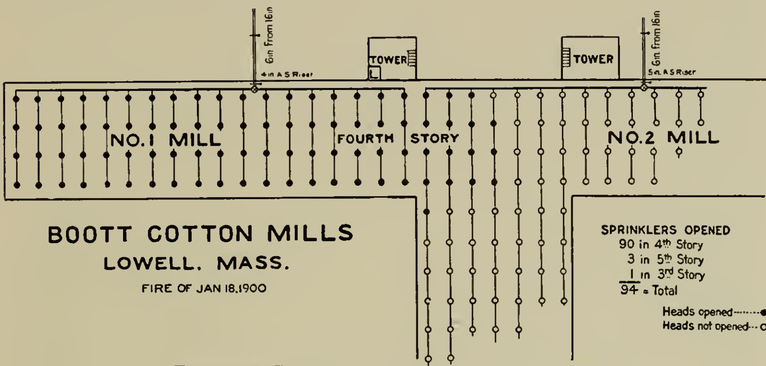


Diagram Showing Action of Sprinklers

At the Boott Mills, Lowell, Mass., a serious fire occurred in a Mule Room in No. 1 Mill. Investigation proved that water was either off the sprinklers when the fire started, or was shut off too soon. Two pairs of mule carriages were nearly all burned up and the ceiling charred deeply. There was ample water at good pressure, and as soon as the fire reached No. 2 Mill, where the water was on the sprinklers, it was driven back by the deluge discharged from 16 open heads, and almost no damage was done in this section, except by water. This plainly showed that sprinklers could prevent the advance of a fiercely burning fire if given ample water.

The ability of sprinklers to guard a great mill when attacked by a very hot fire was shown in the yard of the Merrimack Manufacturing Company, Lowell, Massachusetts, in July, 1903.

A large wooden coal shed took fire from spontaneous combustion in the coal, and was destroyed, together with the light roof of a boiler house adjoining. There were no automatic sprinklers in either building. The boiler house had some old perforated pipe sprinklers, but these had been practically abandoned, and though water was turned into them, it is probable that many of the orifices were obstructed, and they did little good.

The fire was very quick and hot and the flames shot high in the air, igniting the overhanging wooden cornice and the window casings of the big mill and adjacent picker building of the Tremont & Suffolk Mills, about thirty feet away.

One hundred window casings were burned out, or badly charred, the glass broken and sashes burned. The automatic sprinklers just inside the windows opened and were the chief means of keeping the

Exterior of Picker House at Left, Showing Burned Out Windows, and Mill at Right with Burned Cornice and End Windows also Burned Out

Interior of Fourth Floor of Picker House, Showing Window Casings Destroyed while the Frames just Inside and Pile of Bobbins at the Right were Unharmed

fire out. The mill force used hose streams with much intelligence, but without the sprinklers both mill and picker would almost certainly have been badly damaged, if not destroyed.

It was estimated that at the height of the fire the combined draft of water through hose streams, automatic sprinklers, and three perforated pipe sprinkler connections, broken by the falling of the boiler house roof and not immediately shut off, was about 14,000 gallons per minute. So large a volume of water is available in but a few places. The loss on the Tremont & Suffolk Mills was $40,000, and on the Merrimack Manufacturing Co., $78,000.

Another more recent fire showed the same excellent work by sprinklers and also the value of a courageous factory fire brigade.

In a fire of August, 1910, a building occupied by the Riegel Sack Company, Jersey City, N. J., soon to be abandoned for a new and isolated plant, was fiercely attacked by a most unexpectedly violent fire in a small four-story brick building used for manufacturing corks, seventy-five feet distant on the opposite side of Morgan Street. The whole block in which the cork factory was located was totally destroyed and help from New York City and all adjoining towns was called.

View of Morgan Street after the Fire

Cork factory ruins on left. Riegel Sack on right, just out of picture.

The fire entirely burned the wooden casings and frames from about thirty windows, and burned the wooden roof tanks belonging to the Riegel Sack Company until the water ran out. In this plant sprinklers opened opposite the attacked windows, and aided by hose streams from a standpipe in a central tower, kept the fire from entering the building. The sprinklers and standpipe were fed by a 750-gallon Underwriter steam pump as a part of the Mutual fire equipment. The damage inside the building was by water only and amounted to $29,000. The men of the Riegel Sack Co. handled the hose streams from the standpipe and made a most valiant fight, but probably could not have kept the fire from entering the building without the automatic sprinklers.

Automatic sprinklers followed the history of their predecessors, the perforated pipe sprinklers, and were first put into the more hazardous sections; then as one loss after an-

Riegel Sack Company Building, Showing Burned-out Windows, also the Tanks Charred by the Fire

Morgan Street comes between the Cork factory ruins in the foreground and the Riegel factory.

other occurred, under conditions where, had there been sprinklers, the fire would have been checked at the start, their use was extended until they became an absolute requirement in all manufacturing buildings — except where construction and occupancy are *both* non-combustible.

When the growth of sprinkler protection reached the point where nearly all manufacturing buildings were fully equipped with sprinklers, it was found that the loss per one hundred dollars insured in storehouses was exceeding the loss per one hundred dollars in factories, the storehouses being largely without automatic sprinklers. The complete protection of storehouses by sprinklers was then undertaken. As many of these buildings were not heated, it was necessary to shut off the water in winter and drain the pipes. It was thought that water could be quickly turned on if fire occurred, but repeated experiences showed that the delay in letting the water into the pipes gave time for fire to spread, and increased the loss greatly, emphasizing the fact that the first value of the sprinkler was its ability to put water on a fire at the start.

Dry-pipe valves therefore came into general use for cold buildings. With these the sprinkler pipes, in winter, are filled with air, under pressure, and the valve, located in a warm place, holds back the water. When sprinklers open the air escapes, automatically releasing the valve and allowing water to enter the pipes. This causes some delay, according to the size and arrangement of the system, and the number of heads which open. The delay is not serious in well-planned equipments except in places containing very inflammable occupancy, though of course wet systems are preferred, where water is always in the pipes, and many storehouses have been heated to permit this. The modern drp-pipe valves have proved to be reliable and satisfactory.

One more illustration of the action of sprinklers may be of interest, as the conditions were unusual.

In the summer of 1902 an old-style, wooden, cotton storehouse belonging to the Nashua Manufacturing Company, Nashua, N. H., was struck by lightning. The section contained about 3200 bales of cotton and the lightning started fires which quickly spread over the whole surface of the piles. The sprinklers were controlled by a dry-pipe valve, and the fire was so rapid that nearly all the sprinklers opened at the start. To limit the air capacity of the system, and so get water to an open head quicker, the supply pipe from the valve to the building had been made only 4-inch. This small pipe so restricted the supply of water that the sprinklers in the peak of the roof had no water for the first few minutes, until the fire pumps were put into full operation, and the fire burned through the roof. The sprinklers lower down, however, operated effectively, and with the aid of hose streams extinguished the fire. It is interesting to compare the loss of $8,700 here with the much greater one of $122,000 from a similar fire at the Pepperell Manufacturing Company, in 1880, where there were no automatic sprinklers.

Some days after the fire, experiments were made with the sprinklers in this storehouse, and it was found that the highest sprinklers had no water with the ordinary city water pressure, but when a pump was started and pressure increased, all were supplied and the whole interior of the section was flooded with a torrential downpour. In this test seventy-five sprinklers discharged 760 gallons per minute, or an average of 10.2 gallons per minute for each sprinkler.

Those who witnessed the deluge from these seventy-five open sprinklers were convinced that no fire could live under a good sprinkler equipment supplied with ample water at

NASHUA STOREHOUSE, SHOWING THE DELUGING DISCHARGE FROM SEVENTY-FIVE OPEN SPRINKLERS

good pressure. This experience showed a slight deficiency in the arrangement of the supply; but despite this, the sprinklers controlled the fire, and it was from such experiences that the high standards of to-day have been developed.

The amount of water discharged by a single sprinkler under various pressures is about that given in the following table.

DISCHARGING CAPACITY OF SPRINKLERS

Lbs. Pressure at Sprinkler	Gallons Discharged Per Minute
5	12.2
10	17.5
20	25.3
30	31.3
40	36.3
50	40.6
60	44.6
70	48.5
80	52.0
90	55.2
100	58.2

When many sprinklers are open in one system the average pressure at the heads in many cases will not exceed ten pounds, on account of friction in the pipes.

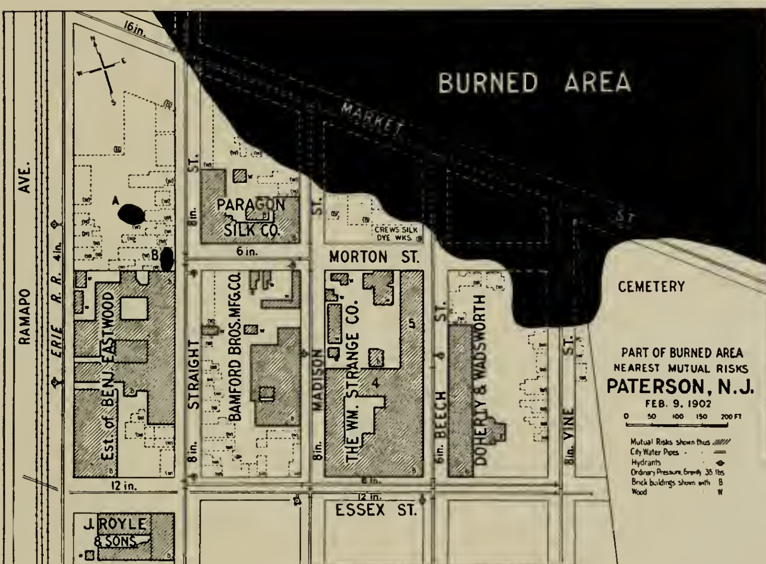
FIRE PUMPS AND STREAMS

IN the protective equipment of mutual mills the fire pump has always been an important piece of apparatus and in early days fire streams furnished by pumps were the chief means of fighting fires which spread beyond the extinguishing power of water pails. While to-day the primary water supply for sprinklers and hydrants comes by gravity, from either public water works or large elevated tanks, fire pumps are the usual secondary source of supply and frequently must be relied upon for the greater part of the water needed in a severe fire. A fire pump furnishes water at high pressure, giving powerful hose streams and ample water for sprinklers. Many instances where fire pumps have done admirable work are noted in the accounts of fires given in these pages.

Hose streams with good water pressure furnish one of the best means of protecting property endangered by fires in surrounding buildings. The work done by fire pumps in saving a number of valuable silk mills from destruction in the great conflagration at Paterson, N. J., in 1902, is one of the best examples of this service. The public fire department forces were greatly overtaxed and totally unable to cope with the conditions at this part of the fire. Following is a brief account of this most striking case.

On Sunday morning, February 9, 1902, shortly after midnight, fire started in a street railroad repair shop near some wooden car sheds and spread rapidly. The temperature was about twenty degrees above zero and the wind was blowing a gale from the northwest. All the fire department apparatus in the city of Paterson and its surrounding towns responded promptly but the fire got beyond control. The fire was stopped about three-quarters of a mile from its starting point and the average width of the burned area was about 1,000 feet.

About a half-mile from where the fire originated was a group of mills equipped with fire-protective apparatus according to the mutual standard. When finally stopped the fire had reached to within fifty feet of one of these mills, seventy feet of another, and seventy-five feet of another. Several of the mills were at times on fire, but by constant vigilance the men in the mills succeeded in extinguishing



Mutual Mills Saved by Fire Pumps

each small fire before it had opportunity to spread. The sketch above shows the location of these mills and the adjacent burned area.

These mills had fire pumps and water supplies for them as follows:

Paragon Silk Co.— Duplex pump 14 x 7 x 10. Suction from two 20,000-gallon cisterns and city water.
Est. of Benj. Eastwood.— 500-gallon Underwriter pump. Suction from 75,000-gallon cistern and driven well.
Bamford Bros. Mfg. Co.— 500-gallon Underwriter pump. Suction from 30,000-gallon cistern. (Not now in Mutuals.)

The William Strange Co.— 1000-gallon Underwriter pump and 14 x 7 x 12 Worthington pump. Suction from 100,000-gallon cistern, driven well and 3-inch pipe from city main.
Doherty & Wadsworth — 750-gallon Underwriter pump. Suction from 50,000-gallon cistern fed from city main through 1½-inch meter.
J. Royle & Sons — 500-gallon Underwriter pump. Suction from 50,000-gallon cistern.

As the conflagration approached from the north and west the mills prepared to make as good a fight as possible. Soon after four o'clock A. M. flying brands ignited the wooden building west of the Paragon Mill, marked " A " on the sketch, and this fire was extinguished by the Paragon and other mill crews. Later on, another similar fire in the building adjoining the Benjamin Eastwood office, marked " B " on sketch, was extinguished by the men at that mill. Without waiting for the fire to reach their own properties the mill men laid lines of hose to windward, met the fire as it swept towards them, and only yielded ground when they were driven back by the heat. Soon the mills were enveloped in the smoke and heat of the great fire coming towards them and were showered with burning brands and cinders. While acting independently in protecting their own properties, the combined force was really defending a line across which the fire must not pass if the mills were to be saved. The mill pumps were practically the sole defence of these properties, as careful inquiry showed that the only steamer in this vicinity was one from out of town which took its stand at the corner of Morton and Madison Streets, taking water from a city hydrant. The excellent result was a triumph for mill fire pump protection.

The Paragon Mill brigade put out the small fire west of them, wet down the wooden buildings north of the mill and then worked across Madison Street back of the Crews Mill, towards which the fire was approaching.

The William Strange pump furnished two streams, though capable of supplying four, in order to economize water. When the fire was under control the wisdom of this was shown by the fact that less that one hour's supply remained after seven hours' running.

At the Doherty & Wadsworth plant four lines of hose were laid ready for use, but only two at a time were in use, and so they had enough water, though when the fire was finally under control the water in the cistern was drawn to within eighteen inches of the top of the suction pipe.

The Eastwood Mill, being less exposed, held its forces in reserve, aided in extinguishing fires starting near them, and guarded their own property.

As the ragged line of the burned area on the diagram shows, it was the splendid fight made by the Mutual mills which prevented the conflagration extending farther in a southerly direction in that locality, and by this means a large area outside of, and beyond, the Mutual mills was also saved. None of the fire pumps failed in any respect during this long fire and all were well supplied with steam. The average water pressure maintained by the mills at the pumps during the fire was about 120 pounds.

While to-day the automatic sprinklers catch and extinguish a great majority of the fires before they become large, and often control fires which have reached dangerous proportions, conditions do arise where the hose stream is the only reliance. Then this secondary barrier, like the fire wall, is a necessary and valuable defence. Gravity water supplies of ample capacity and strong pressure furnish excellent hose streams, but in many cases it is the fire pump which must be depended upon for this service.

THE INSPECTION DEPARTMENT

IT has already been seen how inspections were made by the officers of the companies in the early days. The field was small, mills were simple in organization, there was little fire protective apparatus, and the wonderful memories possessed by Mr. Wm. B. Whiting and Mr. Edward E. Manton enabled them to keep in mind the main points in the whole mutual system. Their versatility and ability made them the natural leaders, and they practically directed the development of the system and set the standard for all the companies.

Prior to 1878 the inspections made had no systematic order, and the different companies exchanged reports as occasion dictated. In 1878 the Companies agreed to a joint arrangement for inspections of all risks, and for the distribution of the reports to all the companies, a method for equitably sharing the expense being provided. This work was done under the general oversight of Mr. Whiting, and in 1887 the Companies appointed him Chief of the Bureau of Inspections.

The early inspections gave special attention to general care and cleanliness, for the good results obtained had resulted largely from maintaining such conditions that small fires could be confined and extinguished with the fire pail or hose line from standpipe, experience having shown that if fire was once well under way serious and often total loss occurred. Fire pumps were tested, but there was no way of measuring the amount of water delivered, and it was a common practice to see if streams could be thrown over the mill tower or roof. Hose was examined, fire-pails inspected to see if they were full, and in general the aim was to inspire owners to feel that membership in the Mutual System brought personal responsibility to each member to keep his mill in such condition that serious loss, which all would have to share, should not occur as the result of his neglect. Brief reports were made on a simple card, reproductions of each side of which are here given.

GENERAL REPORT.

Totoket Co. (Cotton) Mills,

at Occum Conn., near Norwich

Hall sprinkler in Picker room, out of order,

a bend in one of the main pipes.

A belt hole over one of the fire doors

should be closed up —

Date of Policy,

Feb 4 1880 Thomas G. Estes Ins.

Inspection No.

GENERAL ORDER.

Very Bad. Bad. Indifferent. Fair. Good. Excellent.

WASTE.

Neglected. Removed Properly.

POSITION OF WASTE BOXES.

good

STEAM PIPES.

Combustible Matter on Steam Pipes.

All Clear. Pipes Overhead.

CASKS AND PAILS.

Scant Supply. Neglected. Part Full. Good Supply. All Full.

HOSE.

Neglected. In Fair Order. Good Order.

FIRE DOORS.

Out of Order. Good Order.

FIRE SERVICE.

Bad. Fair. Good.

ACCESS TO SPRINKLER VALVES.

PUMPS.

Neglected. In Fair Order. Good Order.

HYDRANTS.

Neglected. In Fair Order. Good Order.

SPITTOONS.

none

WATCH RECORDS.

Bad. Fair. Good. Excellent.

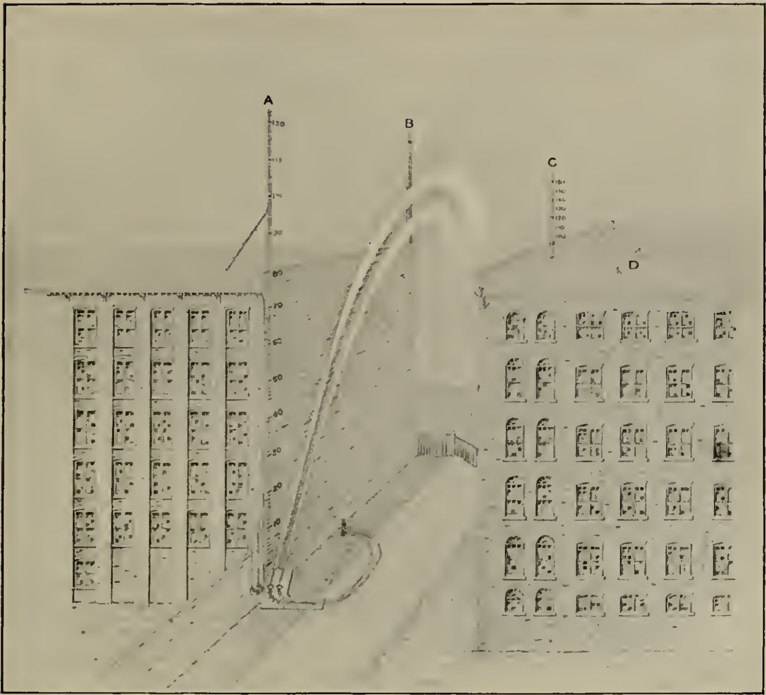
AS A WHOLE.

Very Bad. Bad. Indifferent. Fair. Good. Excellent

As mills grew larger, and improved fire-protection devices were installed, there was much more apparatus to care for, and naturally methods of inspection grew to meet the new demands. In 1890, Mr. John R. Freeman, now president of several of the Associated Mutual Companies, became Assistant Chief of the Inspection Department, after several years of special work in it. He had spent ten years in practical engineering, after his graduation from the Massachusetts Institute of Technology, and brought into the insurance field the exact training and spirit of the true engineer. On the death of Mr. Whiting, in 1894, Mr. Freeman was made Chief of the Department, and began building on the excellent foundation which had been laid, contributing much which has given breadth and thoroughness to the inspection work in its later developments. It is growth along these sound lines, led by a few men, and carried on by many, which has made the Mutual system truly the father of all fire-protection engineering.

One of the first steps in this work was to develop a more accurate method of testing pumps and public water systems, so that the true capacity could be ascertained. It was found that the only tables giving discharge of hose-nozzles were inaccurate, and an elaborate series of tests was made at Lawrence. Nozzles of all kinds were tried, the streams being thrown up between two high mills, the pressure at the nozzle noted, the quantity discharged measured, and the height at which the stream would do effective fire work determined. The arrangement and method were as fully shown in the cut and description opposite. A standard type of play-pipe was then developed. With this data convenient tables were made, from which, by noting the pressure at a hydrant while streams are flowing, the amount of water delivered can be readily determined. These tables became at once a standard in all fire-protection work, and marked a distinct advance in the measurement of water by nozzles, and in general hydraulic knowledge. A sample of these tables for 1⅛-inch nozzle, which is the standard size for general work, is given on the following pages.

It had been known that a line of hose several hundred feet long would often absorb so much pressure in friction that but a feeble stream could be produced. Different



Experiments on Fire Streams at High Elevations

The final experiments on which tables for height of jets are based were made at this site, but in these only one nozzle was used at a time.

Sketch illustrates experiments to determine which of two nozzles (ring or smooth, for instance), was the better, or would throw stream highest and with the least spraying, — pressure at base of each play-pipe being the same. For this the two 50-foot lines of hose leading to play-pipes were of same kind; bends in hose at base of play-pipe were carefully laid flat on the inclined platform, as shown, and clamped between blocks jig-sawed from 3-inch plank, so each hose lay in flat curve of 3-feet radius. One to 2 feet of hose next base of play-pipe was straight.

The masts, A and B, were graduated in feet, and reached to a height of 124 feet above nozzle. Below the masts, scales, made of strips of wood strung on heavy steel wire, marked each foot in height along face of wall.

Horizontal distances from end of nozzle were marked by wooden rods 10 feet apart, nailed to top of wall.

When height of jet was more than 130 feet, the mast, C, and sighting bar, D, were used in estimating height, proper allowance being made for parallax.

The play-pipes and their supporting platform could be set at any angle of elevation required, and securely clamped.

End of nozzle was set level with zero of mercury pressure gauges and zero of scale of height.

An assistant regulated pressure to within 1/10 of a pound by valves at hydrant and, when all was ready, one observer read the mercury gauges each half minute, while another observed and noted height and characteristics of jet, as seen from the mill roofs.

(From "Fire Stream Tables")

1⅛-INCH SMOOTH

Hydrant Pressure Required—Discharge

INDICATED PRESSURE by Gauge attached at Base of Play-Pipe, and set level with End of Nozzle.		Extreme Height of Jet.		Extreme Horizontal Distance reached by Jet.		Gallons per Minute Discharged.	Pounds Pressure Required at Hydrant (or first column, through								
							Length 50 ft.			Length 100 ft.			Length 200 ft.		
		Average of Highest Drops, Vertical Jet, Still Air	Maximum Limit of Height as Good Effective Fire Stream with Moderate Wind.	Average Extreme Drops at level of Nozzle, with Still Air.	Maximum Limit of Distance as Good Effective Fire Stream with Moderate Wind.		Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.
	lbs.	ft.	ft.	ft.	ft.		lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Feeble Streams.	5.	11	....	19	....	84	7	7	6	9	9	7	13	12	9
	10.	22	cent. higher. 18	39	cent. farther. 22	119	15	14	12	18	17	14	26	24	17
	15.	32	27	59	31	146	22	21	19	27	26	21	38	35	26
	20.	43	36	80	38	168	29	28	25	36	34	28	51	47	34
Ordinary Fire Streams. Fair.	25.	54	is about 10 per 44	99	is about 12 per 44	188	36	35	31	45	43	35	64	59	43
	30.	64	52	115	50	206	44	42	37	55	52	42	77	71	52
Good.	35.	74	59	130	54	222	51	49	43	64	60	49	89	82	60
	40.	84	65	142	59	238	58	56	50	73	69	56	102	94	69
	45.	94	fire stream" 70	152	fire stream" 63	252	65	63	56	82	77	63	115	106	77
Excellent.	50.	104	75	162	66	266	72	70	62	91	86	70	128	118	86
	55.	113	80	170	69	279	80	77	68	100	95	77	140	130	95
	60.	122	83	178	72	291	87	84	74	109	103	84	153	141	103
Unusually Strong Streams. (Difficult to hold Nozzle without special appliances.)	65.	130	limit as a "fair 86	185	limit as a "fair 75	303	94	91	81	118	112	91	166	153	112
	70.	136	88	191	77	314	101	98	87	127	120	98	179	165	120
	75.	142	90	197	79	325	109	105	93	136	129	105	191	177	129
	80.	146	92	203	81	336	116	112	99	145	138	112	204	188	138
	85.	150	Maximum 94	209	Maximum 83	346	123	119	106	154	146	119	217	200	146
	90.	153	96	214	85	356	130	126	112	164	155	126	230	212	155
	95.	156	98	219	87	366	138	133	118	173	163	133	242	224	163
	100.	158	99	224	89	376	145	140	124	182	172	140	255	236	172

80 pounds per square inch is now considered best hydrant pressure for general use; 100 lbs. per sq. in. should not be exceeded, except occasionally for very high buildings, or lengths of Hose exceeding 300 feet.

If nozzle is much higher or lower than hydrant, allowance for difference of level must be made on hydrant pressure (10 feet in height corresponds to 4.33 lbs. water pressure).

1⅛ s.

NOZZLE. (This is the size preferred for general outside use.) —Height and Distance of Jet.

TABLE A.—No. 4. (From experiments of J. R. FREEMAN, 1888.)

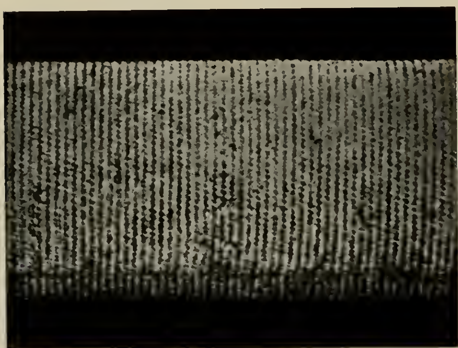
Steamer) while stream is flowing, to maintain pressure at base of play-pipe, as per various lengths and kinds of 2½-inch Hose, as below.

Length 300 ft.			Length 400 ft.			Length 500 ft.			Length 600 ft.			Length 800 ft.			L'gth. 1000 ft.		
Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose.	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.	Unlined Linen Hose	Inferior Rubber-lined Cotton "Mill Hose."—Inside Rough.	Ordinary best quality Rubber-lined Hose.—Inside Smooth.
lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
16	15	10	20	18	12	24	21	13	28	25	15	35	31	18	42	37	21
33	30	20	40	36	24	48	43	27	55	49	30	70	62	36	84	75	43
49	45	31	60	54	35	71	64	40	82	74	45	105	93	54	127	112	64
66	60	41	80	73	47	95	85	54	110	98	60	139	123	73	168	149	85
82	75	51	101	91	59	119	107	67	137	123	75	174	154	91	211	186	107
99	90	61	121	109	71	143	128	80	165	147	90	209	185	109	253	223	128
115	105	71	141	127	82	166	149	94	192	172	105	243	216	127	...	261	149
131	120	81	161	145	94	190	171	107	220	196	120	278	247	145	....	....	171
148	135	92	181	163	106	214	192	120	247	221	135	...	278	163	....	...	192
164	150	102	201	181	118	238	213	134	274	245	150	...	....	181	....	....	213
181	165	112	221	200	130	262	235	147	....	270	165	....	....	200	....	....	235
197	180	122	241	218	141	....	256	160	....	....	180	....	....	218	....	....	256
214	195	132	261	236	153	....	....	174	....	....	195	....	...	236	....	....	....
230	209	143	....	254	165	....	....	187	....	....	209	....	...	254	....	....	...
246	224	153	....	...	177	....	....	201	....	....	224	....	....	...	....	...	....
263	239	163	....	...	188	....	....	214	..	....	239	....	....	....	....	....	....
....	254	173	....	....	200	..	....	227	....	...	254	....	....	....	...	...	....
....	....	183	...	....	212	...	...	241	....	....	....	....	....	...	....	...	....
....	....	194	....	..	224	....	....	254	....	....	....	....	....	....	....	....	....
...	....	204	....	....	236	....	....	....	...	...	....	....	....	....	....	....	....

TAKE NOTICE. — The above is pressure at hydrant head *while stream is flowing.* The corresponding Static Reservoir Pressure, or Fire-pump Pressure, must be greater than hydrant pressure by an amount equal to friction loss between hydrant-head and pump or reservoir.

1⅛ s.

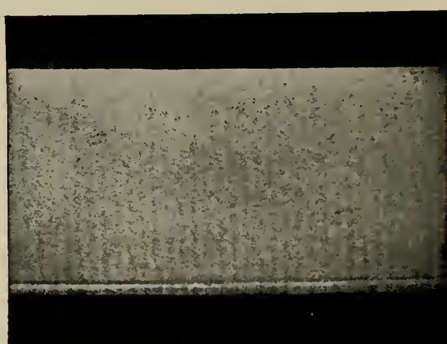
kinds of hose were tested in these experiments and it was found that a rough interior as in linen hose caused a loss of thirty-three pounds for every hundred feet, with the draft of an ordinary fire stream. Cotton hose, having a smooth rubber lining, caused a loss of only fourteen pounds per one hundred feet, thus being generally better for fire fighting.



Cast of Unlined Linen Hose

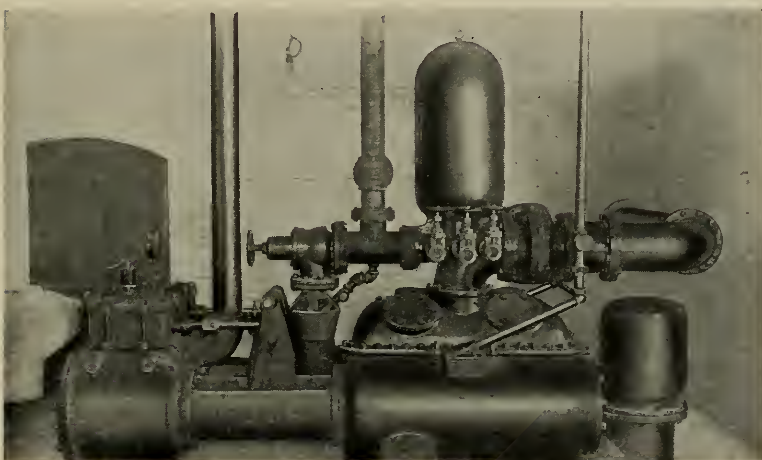
To get a measure of roughness, lengths were filled with plaster of Paris and kept under pressure until it had hardened, then the hose was cut off. It was found that some rubber linings were nearly as rough as the linen. Hose makers were then induced to greatly improve the linings.

It was also found that much hose was poor and would burst quickly; poor rubber linings were used, and linen hose was sold, "simply to hang up for insurance inspectors" and when tried nearly all the water escaped before reaching the nozzle. Good specifications were made, requiring strength and durability, and hose manufacturers were encouraged to live up to them. A better hose-nozzle was developed. All of this was greatly to the benefit of fire protection in general, and to all users of fire apparatus.



Cast of Best Rubber-lined Hose

From the beginning many tests of automatic sprinklers were made and finally a permanent testing equipment was erected in the Inspection Department for this purpose. New automatic heads were tested, and sprinklers which had not acted properly in mills were investigated carefully. In this way faults in many of the early types were discovered and remedies worked out. Time tests were devised in which, by subjecting sprinklers to an excessive pressure, weakness which might not have developed for years was discovered in a few months. This was one of the

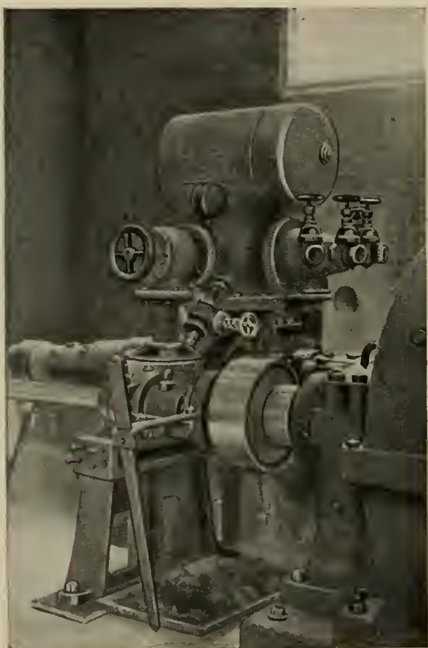


Underwriter Steam Fire Pump

important parts of the Inspection Department work, for of all protective equipment the automatic sprinkler has proved to be the greatest single factor in reducing loss.

Steam fire pumps were often found in poor condition by the inspectors, pistons or plungers stuck by corrosion, small steam and water passages preventing large delivery, and other faults. The problem was stated, the aid of practical manufacturers solicited, and specifications made for a pump specially designed for fire purposes. All was made very strong, moving parts were rust-proofed, passages made ample, and a reliable and powerful pump resulted, which is now universally used. Later similar work was done on the rotary pumps.

Advice was constantly given as to good forms of construction, and cautions were sent out warning against bad types of buildings, dangerous methods, and other features affecting the fire risk. The Boston Manufacturers Company issued many plans and reports, calling attention to the various experiences of the Mutual Companies and the lessons which should be drawn from these. Brief accounts of all fires were issued regularly, pointing out the special danger and the remedy which each case showed might be applied to advantage in the future.



Rotary Fire Pump

Many fires were caused by hot bearings, and many others from spontaneous combustion in oily waste or rags. With the assistance of outside experts tests of various oils were made to determine their lubricating qualities and fire danger. The result of this work was a very distinct advance in methods of lubrication and a most beneficial reduction in fires from this cause.

The better type of New England mill was constructed with floors and roofs of heavy plank and timber, commonly called " mill " or " slow-burning " construction. This kind of construction is in direct contrast to the joisted floors and roofs so largely used in the older factory buildings, and which, unfortunately, are still found in some factories, as well as in a great majority of city buildings used for mercantile and manufacturing purposes.

The columns used are of wood or cast iron, and both types have given entire satisfaction. In recent years structural steel is sometimes found, but in many locations must

Plank and Timber Construction

be completely protected, as it quickly softens and buckles in case of fire. A pintle is used to carry the load from the bottom of one column to the top of another.

Where the loads are too heavy for a single timber of commercial size, two timbers bolted together are commonly used. It was the practice to leave a space of about three-quarters of an inch between them. The Cocheco fire experience, which is described on pages 99 to 101, showed a danger in this method, and it is now

Plank and Timber in Detail

advised that the timbers be bolted close together, or that a strip be nailed on the underside to cover this space. Such a strip, however, should not be put on until the timbers have seasoned, just as it is unwise to paint them until thoroughly dried, for fear of dry rot if opportunity is not given for seasoning.

Plank and Timbers with Double Beams

Plank and timber construction has many advantages over the joisted type. Being in solid heavy mass, the wood is not quickly ignited and burns very slowly. For example, a 12″ x 16″ timber is weakened but about twenty per cent. if burned to a depth of one inch, where an ordinary 2″ x 12″ joist would be destroyed, with similar burning. Again, the thick mill floors made with three or four inch plank, and top wearing floor of hard wood, giving a total thickness of four or five inches, are very slow to burn through. There have been but few cases in the whole experience of the Mutual Companies where fire has burned through such floors, except when the whole building was destroyed.

With joists the floor would generally be only two layers of one-inch stuff, and fire quickly burns through it. With a mill floor in ten-foot bays and 12″ x 16″ timbers the surface exposed to fire is a little under thirteen square feet per foot of width of building, while for a similar extent of joisted floor, using 2″ x 12″ sticks, spaced one foot on centers, there would be over thirty square feet, with the cross bracing, or about two and one-half times that in the mill construction. Finally hose streams and sprinklers can wash a larger percentage of the surface of the smooth plank ceiling, whereas the sprinklers below joists can throw water in but a few spaces, and only imperfectly at that; thus it is much more difficult to reach a fire in the joisted type of construction, all as the cuts plainly show. Why one type is called "slow-burning" and the other "quick-burning" is clearly apparent.

Plank and Timber in Construction
Showing Cast-iron Columns and Pintles

This feature of construction, and a constant effort to have floors tight — stairs, elevators, and main belts being enclosed in incombustible towers — so that there are no openings from floor to floor through which fire can spread quickly into several stories, are among the important factors in the success of the Mutual Companies, and are to-day vital features in the prevention of serious fires. The continual

Joisted Construction

effort of the Mutual Companies, by advice, circulars, and general agitation, to make known the benefits of good construction has been a strong influence in improving the whole general type of factory buildings. The examination of plans for new buildings and the working out of improved construction during changes have always been important parts of the work of the Inspection Department and the Companies.

Joists in Detail

When it was recognized that automatic sprinklers could do a much larger work than simply to hold a fire in check, if caught at the start, it was found that larger pipes and better distribution of water were needed to obtain the full benefit from this feature. No good data was at hand to determine just what was necessary, and comprehensive tests were made in the yard of the Jackson Co., Nashua, N. H., through the courtesy of the owners and the Water Co., to determine the friction loss in various sizes of pipe, and in the ordinary pipe fittings. Much information was secured, and by the aid of it a new schedule for sprinkler piping was worked out, and has become the general standard. Such work as this was done by young engineers from the Inspection Department under the personal direction of Mr. Freeman.

PRINTED MATTER ISSUED BY THE INSPECTION DEPARTMENT

Specifications Underwriter Steam Fire Pumps
" Rotary Fire Pumps
" Centrifugal Fire Pumps
" Steam Pump Governors and Auxiliary Pumps
" Fire Hose, Playpipes and Hose Houses
" Wooden Tanks and Notes on Steel Tanks
" Valves, Indicator Posts and Hydrants
Notes and Suggestions on Fire Pumps
Rules for Installing Sprinkler Equipments
" Dry-pipe Systems of Automatic Sprinklers
" Laying Cast-iron Water Pipes in Factory Yards
" Installing Electric Light and Power Apparatus
Sprinkler Protection in Picker Trunks, Dryers, etc.
When Putting in Fire Protection — Suggestions

"Fire" "Steam Pumps" "Rotary Pumps" "Mill Fire Brigade"	Suggestions as to the general care and handling of fire apparatus and what is desirable for a mill fire brigade.

Suggestions for the Arrangement of Oil Fuel Apparatus
Standard Mill Construction — Illustrations

Approved Electrical Fittings Approved Fire Protection Appliances	Lists issued semi-annual
Weekly Inspection of Fire Apparatus Inspection of Valves	Suggestions for blanks
Fire Pump Protection for City Risks Beltway Fires	Experiences

The points mentioned cover simply some of the larger work done, and are sufficient to show that the actuating spirit was to determine accurately all necessary facts before making requirements, carrying on special experiments and investigation beyond all previous work where this was necessary. In a similar way many other problems were taken up, and the results of such tests and investigations are condensed in specifications and pamphlets for general use, as shown by the preceding list.

REGULAR INSPECTIONS

AS the field of Mutual insurance widened the regular inspections had to cover more features, and from the simple blank of 1880, as on page 59, the form of to-day

WEEKLY MEETING OF INSPECTORS

has evolved. Two samples of present-day regular inspections are shown on the following pages — one for a mill where conditions were found generally good, the other where they were poor. These blanks are filled out by the inspectors on the road, sent to the Inspection Department, duplicated by a lithograph process, and copies sent to each insurance company and to the owners.

This inspection service is vital to the Mutual system. It brings to each owner a quarterly examination of every feature in his plant affecting the fire hazard, made by men especially trained in this work. Such oversight aids each member in maintaining a care and supervision of fire features easily overlooked in the press of business. Manufacturers long in the Mutual Companies have repeatedly stated that, while the low cost of insurance was of course very desirable, and the perfect indemnity in case of loss a constant satisfaction, the inspection service was of inestimable value to them in their effort to maintain their properties at the highest standard.

SPECIAL INSPECTIONS

AS the whole science of fire prevention developed, and protective equipments grew from a simple pump, tank, and small yard pipes, into a strong system of pumps, yard mains, sprinklers, and other apparatus, many problems arose. It was necessary to organize a force of special inspectors and engineers to study the conditions where the old arrangements existed, and to lay out the modern comprehensive and efficient equipments.

In the modern system the aim is to make available at any one danger point in the risk, all of the water from the several fire pumps, public mains, tanks, or other sources, at full fire pressure, and without necessitating the use of long hose lines. This requires special study in each case to secure the best results, and good hydraulic engineering is necessary if efficiency and economy are to be combined.

With the great development in manufacturing, new processes are constantly coming into use, frequently involving untried hazards; new types of construction must be considered; the best methods for improving old buildings must be studied, and, for the best results, all of this requires the service of trained men to advise on the fire hazard features, working always in full cooperation with the

This is full copy presented by Inspector and duplicated to insurance offices.

INSPECTION DEPARTMENT Assoc. Factory Mutual Fire Insurance Companies, Long Distance Tel. Main 8314. 31 MILK ST., BOSTON, MASS.

OFFICE COPY.
REGULAR INSPECTION.

Hours Time in Mill Yard......3½..........
After Insp'n conferred with Mr. Jones, Supt.

Factory of......B---- Cotton Company.......................Index No. 21420
Inspected by { H. S. Thomas
At........................B-------, Mass.......................on Aug. 2, 1910.

GENERAL ORDER and NEATNESS—Neglected. Fair. Good. Excellent.
Combus'le Waste Stock...all...removed before night. Floors—oil soaked.
OILY WASTE—Neglected. Well cared for. Receptacles—Scant. Poor. Good.
CLOSETS, Etc.—Too many. Mostly disorderly. Neat.
STEAM PIPES—Examined. Combustibles in contact. All clear.
Heating pipes,—Mostly, all, at side, overhead.
FIRE DOORS—Pattern—Defective.....Fair.....Good.....Self-closing.
.........More needed Repairs needed. In good repair.
ELEVATORS, STAIRS, BELTS—Cut-offs at floors—Poor. Fair. Good.
FIRE PAILS—Supply scant, good. Neglected. Well filled.
SMALL HOSE—In ....important rooms
2½" HOSE—Condition suspicious. Good. Supply—scant, ample.
Examined...1200...tested...200...apparently good 1200...ft. ...C.R.L.
NOZZLES—Supply scant, good. Mostly, All, poor, good.
SPANNERS, Fire-axes, Bars, Ladders, Straps—Supply scant, good.
MILL FIRE BRIGADE—Unorganized. Undrilled. Org'zed. Drilled.
Probable Efficiency: Doubtful. Fair. Good.
WATCHMAN {Service & record} —None. Poor. Fair. Good. Rounds made. ...Hourly
NIGHT MEN—In yard available for fire...3...Sundays...3...Week days.
LANTERNS {Watch & repair} —Open. Risky. Fair. Good.
LIGHT—Kerosene. Gas,—retort, gasoline. Electric,—incand, arc. ...mainly
ELECTRIC EQUIPMENT—Old style. Modern. Poor. Fair. Good.
FUEL OIL, Gasoline or.............. Well arranged. Dangerous.
TOWN STEAM FIRE ENGINES ...4...in 10 min....2....more in 30 min.

The condition is indicated by the word under which a line is drawn.

AUTOMATIC SPRINKLERS—...Esty & Grinnell Glass (Name)
Fed from: Tank. Pump,-Auto. gov'n'r. Priv. reserv. Public mains.
Pressure: on highest spr.....64.....lbs. from Pub. Supply, Priv. Resv.
On highest sprinkler..............lbs. from bottom of Tank or
Shut off in winter—None. Shut off in
Valves shut in winter: Location poor. Doubtful. Convenient.
Dry Pipe System Grinnell......in...No. 1 Storehouse (Kind of Dry Pipe Valve.)
Arrangement of Pipes: Poor. Fair. Good. Improper circulation.
VALVES—Examined. All inside sealed. All found open
Inspection Records:—None. Poor. Fair. Good. ....Weekly
TANK or Private Resv...............gals................empty...............full.
Used for: M'f'g. Toilets. Spr. only. Hyds., giving.........lbs. at yd.
YARD SYSTEM—Outside shut-offs on all pipes over 2½" enter'g bldgs. ....Yes
YARD HYDRANTS—Con. to Pub. Supply.....Old style dry...Frost-proof
All examined. Yes Tested.....Yes....All apparent good order. ....Yes
FIRE PUMPS—Used objectionably for mfg. Power nights & Sundays.
Started how often?..Weekly... Turned over to-day.
PUBLIC WATER SUPPLY—Direct pump pres. only. Gravity delivery.
Not connected into yard. Gate kept shut. Obstructed by meter.
Diam. Main Into Yard...10" & 10"...Diam. street main...10" & 12"
Special fire pres..........lbs. Ord. pres. by day...83...lbs. Tested.
PROB. NO. GOOD 1⅛" STRMS. all sources (pmp. pble. & res.) can simultaneously furnish at any point in yard (Include steamers first alarm only.).....16

Risk placed by O.A.B. Ins. Co.

GRADING AS A WHOLE:

Class of Manufacture.......Cotton Yarns.......... Specific kind of Work.....Fine Yarns
Stock or Storage in mill, more than ordinary for class?......No..................Storehouses—None. All examined. Neat. Sub-division urgent.
Bldgs. Height max....3.......Stos. mostly...3.....Stos. Walls mostly...Brick..... Floors mostly...P on T..... Roofs mostly...P on T
Gen. type of constr.....Slow Burning

Inspector's judgment of present conditions within:

Gen. Discipline (Mgt. & help)	Lax Fair Good	Excellent
Extent of Sprinklers	None Scant Tolerable	Ample
Supply to Sprs. {Primary / Total}	None Scant Tolerable	Ample
Pump Service	None Scant Tolerable	Ample
Hydrants & Yard Pipes	None Scant Tolerable	Ample
Outside Aid {Public dep't / or mill near by}	None Dbtfl. Fair	Good

Quality as a Fire Risk as a whole at present, compared with best of ...Cotton... Class

EXPOSURE	Bad.	Consid'ble.	Moderate.	Slight.	None.
CONSTR'C'N	Poor	Fair	Good	Excellent.	
OCCUPANCY	Poor	Fair	Good	Excellent.	
PROTECTION	Poor	Fair	Good	Excellent.	
AS A WHOLE	Poor	Fair	Good	Excellent.	

Special inspection needed regarding

These lines not copied on

Improvements urgently necessary.

APPROXIMATE PER CENT. FLOOR AREA SPRINKLED.
Of main manuf'g blogs. including towers, foundries and wet-work, but not detached buildings of slight hazard or small value. } 100
Of important storage buildings. } 100
Per cent. of above main buildings where sprinklers are still needed
Store Houses sprinkled No. 1

Minor Improvements suggested.

General remarks. At extreme low water in river fire pumps and condenser pumps could not be run together, but there is ample water for fire pumps alone.
Yarn in cases and cotton stored together in Section E Storehouse (undesirable)

Other important unsprinkled rooms not mentioned above.

Recent changes in sprinklers, protective apparatus, or buildings. Connection just completed to fire system of A---- Mills, making pump of A---- Mills and pumps of W----Woolen Co. available in this yard.

Extent and amount of night work. None

PUBLIC WATER PRIV. RESV. OR LARGE TANK.....6...... 1⅛ inch streams reduced pressure from ....83...lbs. to ..70..lbs. ..1686..gallons. | 2....streams to ....80 lbs. Tests made by Thomas 8/2/10

FIRE PUMPS

LOCATION.	MAKE OF PUMP.	H. P. available for Pumps from Water Wheel or Boilers.	SIZE.	RATED CAPACITY. Gallons per Min.	GREATEST SPEED TRIED Revs. per Min.	NO. OF STRMS.	SIZE STREAM.	WATER PRESSURE. Lbs. per Sq. In. At Pump	At Hyd't	LENGTH OF HOSE. Feet.	SIZE OF HOSE.	KIND OF HOSE.	APPROX. GALLONS DELIV'D.	SMOOTHNESS OF ACTION.	GENERAL CONDITION.
Pump Ho.	Deane W.	Ample	20x12x16	1500	70	6	1⅛	90	85	50	2-5/8	C R L	1860	Exc.	Exc.
Pump Ho.	Deane E.	Ample	20x12x16	1500	65	6	1⅛	85	79	50	2-5/8	C R L	1793	Exc.	Exc.

Rotary Pumps.........Well located, Inside, outside main bldgs. Can be run indepen't of sh'ft'g & belt'g?............ Driven by Friction, Sliding gear.
Steam Pumps.........Well located. Steam plant cut off from main bldgs.?...Yes.. Steam pipe safe?...Yes... All steam properly contr'l'd in Boiler R'm?..Yes..... Boiler feed reliable?...Yes
Suction from......Well from river.........under....4 to 9 ft. lift..............ft. head.....................Not liable to obstruction. Suction...is....reliabl
Pump Cistern.............Gallons.............Full..................Independent priming tank for pumps?.......Yes..................Chk. Vlv...........on Discharge.........inside..........outsid

Always test, if possible, with 1⅛-inch smooth nozzles. If ring nozzle is used, deduct ⅛ inch from bore in recording size of stream. In Public Water Trials give larger number of streams tested first. Generally avoid raising pressure above 80 lbs., but determine greatest number of streams pump can throw without pounding violently. Avoid responsibility for accidents yourself by having pump run by mill men.

Regular Inspection Report on Mill with Good Conditions

About two-thirds original size

This is full copy presented by Inspector and duplicated to insurance offices.

INSPECTION DEPARTMENT Assoc. Factory Mutual Fire Insurance Companies, Long Distance Tel. Main 8214. 31 MILK ST., BOSTON, MASS.

OFFICE COPY.
REGULAR INSPECTION.

Hours Time in Mill Yard 5½

After Insp'n conferred with Mr. Toby, Mgr.

Factory of S--------- Paper Company Index No. 20020

Inspected by C S Johnson

At A---------------, N. Y. on July 9, 1910.

GENERAL ORDER and NEATNESS—Neglected. Fair. Good. Excellent.
Combus'le Waste Stock is removed before night. Floors—oil soaked.
OILY WASTE—Neglected. Well cared for. Receptacles—Scant. Poor. Good.
CLOSETS, Etc.—Too many. Mostly disorderly. Neat.
STEAM PIPES—Examined. Combustibles in contact. All clear.
Heating pipes,—Mostly, all, at side, overhead. Hot air
FIRE DOORS—Pattern—Defective.....Fair.....Good....Self-closing.
..........More needed. Repairs needed. In good repair.
ELEVATORS, STAIRS, BELTS—Cut-offs at floors—Poor. Fair. Good.
FIRE PAILS—Supply scant, good. Neglected. Well filled,
SMALL HOSE—In None
2½" HOSE—Condition suspicious. Good. Supply—scant, ample.
Examined 950 tested 200 apparently good 650 ft. {300 Linen / 650 C R L
NOZZLES—Supply scant, good. Mostly, All, poor, good.
SPANNERS, Fire-axes, Bars, Ladders, Straps—Supply scant, good.
MILL FIRE BRIGADE—Unorganized. Undrilled. Org'zed. Drilled.
Probable Efficiency: Doubtful. Fair. Good.
WATCHMAN {Service & record}—None. Poor. Fair. Good. Rounds made. Hourly night
NIGHT MEN—In yard available for fire. 18 Sundays 125 week days. None Sundays
LANTERNS {Watch & repair}—Open. Risky. Fair. Good.
LIGHT—Kerosene. Gas,—retort, gasoline. Electric,—incand, arc.
ELECTRIC EQUIPMENT—Old style. Modern. Poor. Fair. Good.
FUEL OIL, Gasoline or None Well arranged. Dangerous.
TOWN STEAM FIRE ENGINES 0 in 10 min. 0 more in 30 min.

The condition is indicated by the word under which a line is drawn.

AUTOMATIC SPRINKLERS—Int'l and Mfrs. (Name)
Fed from: Tank. Pump,-Auto. gov'n'r. Priv. reserv. Public mains.
Pressure: on highest spr.........lbs. from Pub. Supply, Priv. Resv.
On highest sprinkler 15 lbs. from bottom of Tank or
Shut off in winter—None. Shut off in Nos. 3, 6, 10, 15, Monitor 17 & Passages
Valves shut in winter: Location poor. Doubtful. Convenient.
Dry Pipe System None in (Kind of Dry Pipe Valve.)
Arrangement of Pipes: Poor. Fair. Good. Improper circulation. some
VALVES—Examined All inside sealed. All found open except 4" for #11.
Inspection Records:—None. Poor. Fair. Good. (60 heads. Shut for repairs and forgotten).
TANK or Private Resv. 50,000 gals.........empty.........full.
Used for: M'f'g. Toilets. Spr. & only. Hyds., giving 43 lbs. at yd.
YARD SYSTEM—Outside shut-offs on all pipes over 2½" enter'g bldgs.
YARD HYDRANTS—Con. to Pub. Supply.....Old style dry...Frost-proof
All examined. Tested all All apparent good order. Except two.
FIRE PUMPS—Used objectionably for mfg. Power nights & Sundays.
Started how often? Weekly Turned over to-day.
PUBLIC WATER SUPPLY—Direct pump pres. only. Gravity delivery.
Not connected into yard. Gate kept shut. Obstructed by meter.
Diam. Main into Yard,..........Diam. street main..........
Special fire pres.........lbs. Ord. pres. by day.........lbs. Tested. } None
PROB. NO. GOOD 1⅛" STRMS. all sources (pmp. pblc. & res.) can simultaneously furnish at any point in yard (Include steamers first alarm only.) 4

Risk placed by Ark Ins. Co.

Class of Manufacture Pulp & Paper Specific kind of Work Newspaper (Gr. Wood & Sulphite)
Stock or Storage in mill, more than ordinary for class? No. Storehouses—None. All examined. Neat. Sub-division urgent.
Bldgs. Gen. type of constr. Slow burning and Non-combustible Height max. 2 Stos. mostly 2 Stos. Walls mostly Brick & Concrete Floors mostly Non-comb. & P on I B Roofs mostly P on Ir. Tr.

GRADING AS A WHOLE: Inspector's judgment present conditions at this risk.

Gen. Discipline (Mgt. & help) Lax Fair Good Excellent
Extent of Sprinklers None Scant Tolerable Ample nearly
Supply to Sprs. {Primary / Total} None Scant Tolerable Ample
Pump Service None Scant Tolerable Ample
Hydrants & Yard Pipes None Scant Tolerable Ample
Outside Aid {Public dep't or mill near by} None Dbtfl. Fair Good

Quality as a Fire Risk as a whole at present, compared with best of Pulp & Paper Class

EXPOSURE Bad. Consid'ble. Moderate. Slight. None.
CONSTR'C'N ......Poor......Fair......Good......Excellent.
OCCUPANCY ......Poor......Fair......Good......Excellent.
PROTECTION ......Poor......Fair......Good......Excellent.
AS A WHOLE ......Poor......Fair......Good......Excellent.

Special inspection needed regarding

These lines not copied on the sheets sent to mill.

APPROXIMATE PER CENT. FLOOR AREA SPRINKLED.
Of main manuf'g bldgs. including towers, foundries and wet-work, but not detached buildings of slight hazard or small value. 81
Of important storage buildings. 100
Per cent. of above main buildings where sprinklers are still needed 2
Store Houses sprinkled: A & B

Improvements urgently necessary.
1. Provide round iron hoops on sprinkler tank. Only six of old flat hoops remain and these badly rusted.
2. Put sprinklers in annex at Wood Rm., in monitor of Boiler Ho., in Dressing Rm. at Beaters, in ventilators and under hoods of machines. Repair broken sprinkler pipe in Digester Ho.
3. Repair bad Mach. Rm. roof - planking decayed - sprinkler lines fallen in places.

Minor Improvements suggested.
4. Thoroughly overhaul rotary pump and connections.
5. Provide 500-ft. C R L 2-5/8" hose.

General remarks.
6. Heat No. 10 and keep water on sprinklers. Provide dry-pipe valve for #6 & #15.
7. Oragnize simple fire brigade and a system of weekly valve inspections.
8. Overhaul fire doors.

Other important unsprinkled rooms not mentioned above.
a. Clean up around conveyor in chip loft.
b. Repair two leaky hydrants and one indicator post.

Recent changes in sprinklers, protective apparatus, or buildings.
Beater and Machine Rm. Basements except over shafting (non-comb.)

Extent and amount of night work. About 125 men 6 nights 10 to 15 men Sundays.

PUBLIC WATER PRIV. RESV. OR LARGE TANK 4 1⅛ inch streams reduced pressure from 43 lbs. to 40 lbs. 850 gallons. ......streams to ......lbs. Tests made by Johnson 7/9/10.

FIRE PUMPS Location.	Make of Pump.	H. P. available for Pumps from Water Wheel or Boilers.	Size.	Rated Capacity. Gallons per Min.	Greatest Speed Tried Revs per Min.	No. of Strms.	Size Stream.	Water Pressure Lbs. per Sq. In. At Pump	At Hyd't	Length of Hose. Feet.	Size of Hose.	Kind of Hose.	Approx. Gallons Deliv'd.	Smoothness of Action.	General Condition.
Pump Rm.	Warren	Ample	18x10x12	1000	78	4	1⅛	100	70	50	2-5/8	C R L	1125	Good	Good-Exc.
Beater Bsmt.	B-S Rot'y	300	No. 5	900	-	2	1⅛	45	-	50	"	"	450	Poor	Poor

No speed taken as connection blew off before I could obtain it
Pump of no practical use for fire purposes.

Rotary Pumps Not Well located, Inside, outside main bldgs. Can be run indepen't of sh'ft'g & belt'g? No Driven by Friction, Sliding gear.
Steam Pumps Well located. Steam plant cut off from main bldgs.? Yes Steam pipe safe? Yes All steam properly contr'l'd in Boiler R'm? Yes Boiler feed reliable? Yes
Suction from Tail race and flume under 20 ft. lift and 10 ft. head Not liable to obstruction. Suction is reliable.
Pump Cistern.........Gallons.........Full......... Independent priming tank for pumps? Yes Chk. Vlv. is on Discharge, inside, outside.

Always test, if possible, with 1⅛-inch smooth nozzles. If ring nozzle is used, deduct ⅛ inch from bore in recording size of stream. In Public Water Trials give larger number of streams tested first. Generally avoid raising pressure above 80 lbs., but determine greatest number of streams pump can throw without pounding violently. Avoid responsibility for accidents yourself by having pump run by mill men.

REGULAR INSPECTION REPORT ON MILL WITH POOR CONDITIONS

About two-thirds original size

owners and managers to combine safety against fire with full convenience in manufacturing.

The special inspectors make a detailed study of each problem and work out the solution which is believed to best fit the local conditions, making reports on what is advised, with sketches fully explaining their recommendations. In the following illustration a typical sketch for a special report is shown. In this a lay-out for extending and strengthening the yard-pipe system is given. A new fire pump is called for and provision made for a second future one. Much improvement is asked in fire cut-offs, and concealed roof and floor spaces are to be opened up. Weak sprinkler systems are to be reinforced, and various other points are covered. These reports and sketches are duplicated, and copies sent to the companies and the owners.

ELECTRICITY

BEFORE 1880 textile mills began to use electricity for lighting, largely by arc lamps. Twenty-three fires occurred within six months. This new danger was investigated by the Mutual Companies, and in cooperation with Dr. Charles F. Brush, Professor Elihu Thomson, Mr. Thomas A. Edison, and other pioneers in the electrical field, experiments were made, and from the information obtained preliminary rules were drawn up, this being practically the first set of rules dealing in detail with electrical problems.

As the use of electricity extended rapidly, rules were made by various insurance bureaus connected with the Stock Underwriters. Difference in standards and requirements naturally occurred, causing trouble and inconvenience, and later most of the rules were consolidated in one code. The Mutual Companies joined with many other insurance and electrical interests in efforts for uniformity,

TYPICAL SKETCH

SHOWING LAY-OUT OF FIRE PROTECTION AS RECOMMENDED BY A SPECIAL INSPECTOR AND ATTACHED TO HIS WRITTEN REPORT

This sketch about one-half original size owners and managers to combine safety against fire with full convenience in manufacturing.

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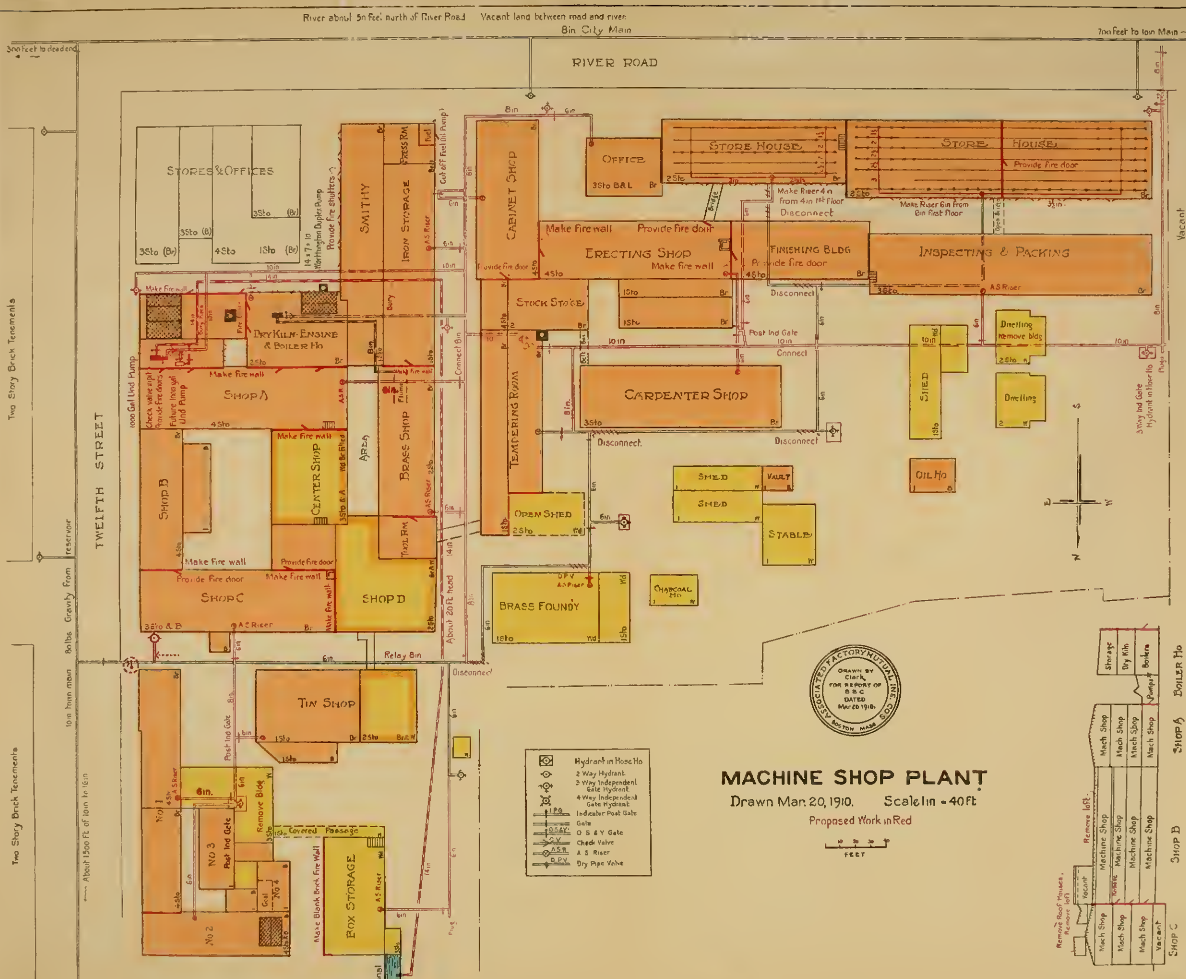


River about 50 feet north of River Road
Vacant land between road and river
8in City Main
300 feet to 10in Main
300 feet to dead end
RIVER ROAD
TWELFTH STREET
Two Story Brick Tenements
Two Story Brick Tenements
Stores & Offices
Smithy
Iron Storage
Cabinet Shop
Office
Store House
Store House
Provide fire door
Make Riser 4in from 4in 1st Floor
Make Riser 6in from 8in First Floor
Disconnect
Bridge
Make Fire wall
Provide fire door
Erecting Shop
Make fire wall
Finishing Bldg
Provide fire door
Inspecting & Packing
Vacant
Dry Kiln Engine & Boiler Ho
Stock Store
Dwelling
Remove bldg
Dwelling
Carpenter Shop
Shed
Shop A
Make fire wall
Shop B
Center Shop
Area
Brass Shop
Tempering Room
Open Shed
Tool Rm
Shed
Vault
Shed
Stable
Oil Ho
Make Fire wall
Provide fire door
Provide fire door
Make fire wall
Shop C
Shop D
Brass Foundry
Charcoal Ho
About 20 ft. head
Relay 8in
Disconnect
Tin Shop
No 1
No 3
No 2
No 4
Remove Bldg
Covered Passage
Box Storage
Make Blank Brick Fire Wall
Canal
Post Ind Gate
About 1500 Ft of 10in to 16in
10in Town main
Gravity from reservoir
Hydrant in Hose Ho
2 Way Hydrant
3 Way Independent Gate Hydrant
4 Way Independent Gate Hydrant
Indicator Post Gate
Gate
O S & Y Gate
Check Valve
A. S. Riser
Dry Pipe Valve
ASSOCIATED FACTORY MUTUAL INS. COS.
BOSTON MASS
DRAWN BY Clark FOR REPORT OF B B C DATED Mar 20 1910.
MACHINE SHOP PLANT
Drawn Mar. 20, 1910.
Scale 1in = 40 ft
Proposed Work in Red
FEET
Boiler Ho
Storage
Dry Kiln
Boilers
Pumps
Shop A
Mach Shop
Shop B
Machine Shop
Remove loft
Remove Roof Monitors Remove loft
Shop C
Vacant

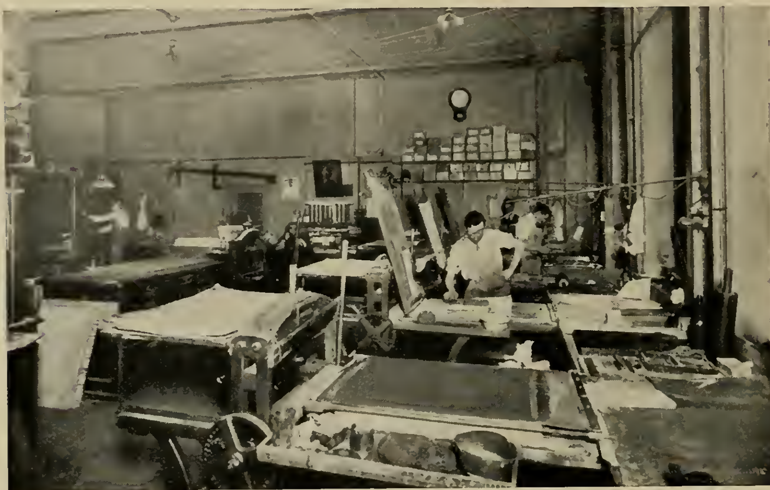
especially urged a broad recodifying of the rules, and took earnest part in the work which resulted in the present National Electric Code, which has proved so generally satisfactory.

The experiments made in the laboratories of the Mutual Companies on the old type open fuse exerted important influence in bringing about the modern, safe, enclosed type of cartridge fuse, now common. In the same way tests were made on switches, establishing standard spacing and aiding in putting the whole question of switch design on a permanent basis. In many other directions similar original investigations were carried on, contributing to the development of the art.

It was found that the fires originally occurring were due to crudeness in installation, and this was easily overcome. Later experience has shown that electric lighting and power in the average Mutual mill, with its open construction, accessible wiring, and generally dry condition, introduce no material hazard, so that with even less perfect installations than are now possible, fires have been few, and no large loss has ever occurred from the use of electricity in the Mutual field.

As electricity came into greater use, electrical inspections became necessary, and are now a part of the regular work of the companies. From the first the policy has been to have all new work installed according to the best practice, but to use much discretion in requiring the immediate removal of older systems which, under the special conditions, experience had shown to contain little hazard. This policy has been fully justified by the results, and in the natural process of development the old work soon disappears in this rapidly advancing art. Thus the whole electrical problem has been handled without special burden upon mutual members, while at the same time the standard of work in mutual risks has been kept at a high point.

In all of this, as in handling the older hazards, the aim has been first to learn the facts, investigating deeply where necessary, and then make requirements. To this end Mutual engineers have kept in close touch with the electric companies, visiting their factories, studying new devices, and working out with the leading electrical engineers the various problems as they develop.



Lithograph Room — Where Reports and Plans are Duplicated

PLANS

AT first simple sketches of the mills were made as they were inspected, and written descriptions kept in note-books, each man following his own method. Later, ground plans of the mills were made, showing the main pipes, and these plans were duplicated and copies used by the different companies interested.

In the late eighties a plan department was organized and more complete plans were drawn. Sections of the different buildings were added, showing the occupancy, and an isometric view included, to give a general idea of the property, the relative height of buildings, and their relation to one another. This work can best be shown by

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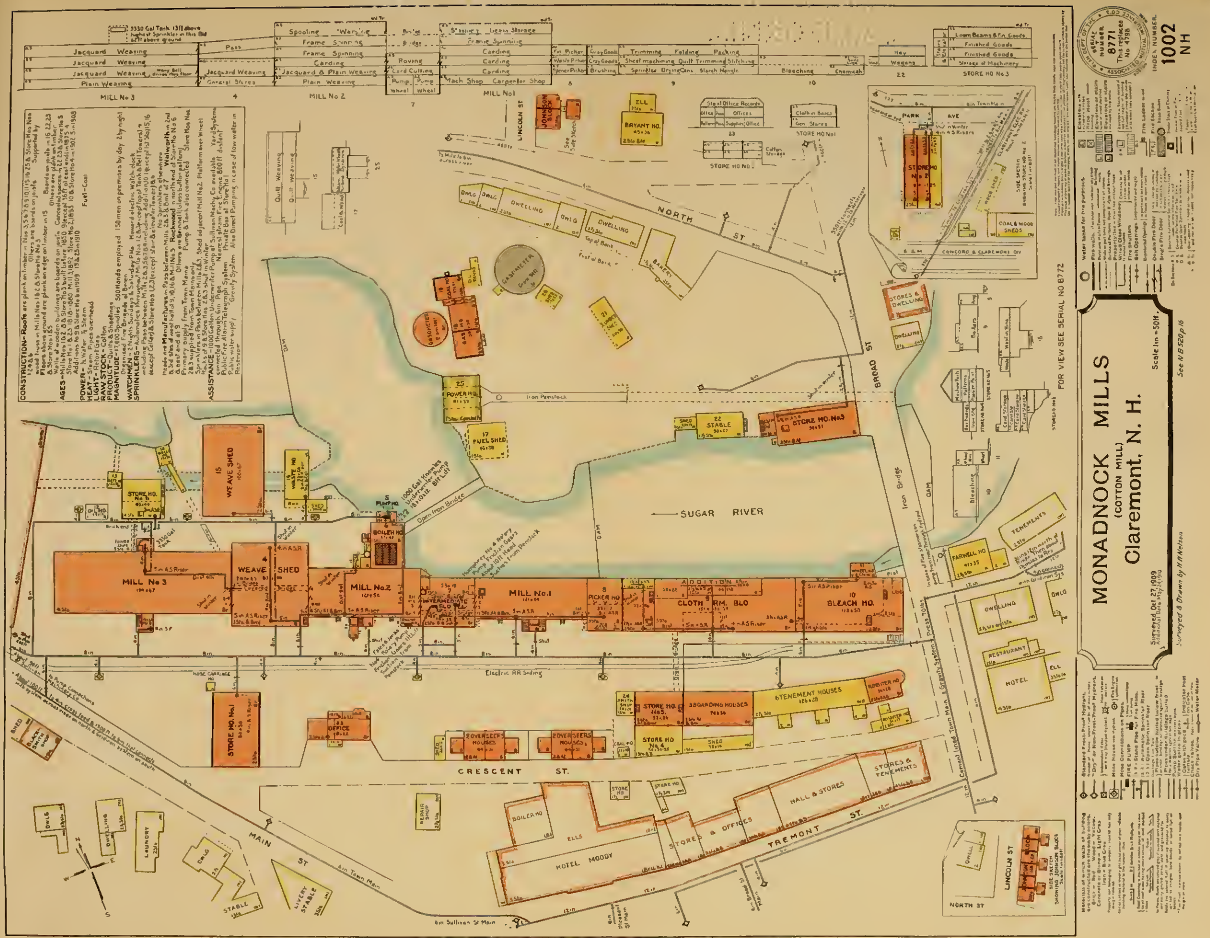
Monadnock Mills.
Claremont, N.H.
December, 1887 Scale 1 in = 40 ft

1025



MONADNOCK MILLS
(COTTON MILL)
Claremont, N. H.
Surveyed Oct 27, 1909
Scale 1 in = 50 ft.
1002
NH
MILL No 3
WEAVE SHED
MILL No 2
MILL No 1
PICKER HO
CLOTH RM. BLD
BLEACH HO.
STORE HO. No 5
STORE HO. No 1
STORE HO. No 6
BOILER HO.
POWER HO.
FUEL SHED
STABLE
OFFICE
GASOMETER
SUGAR RIVER
NORTH ST
BROAD ST
CRESCENT ST.
MAIN ST
TREMONT ST.
LINCOLN ST
BOARDING HOUSES
TENEMENT HOUSES
HOTEL MOODY
HALL & STORES
STORES & OFFICES
STORES & TENEMENTS
RESTAURANT
HOTEL
DWELLING
TENEMENTS
FARWELL HO
BRYANT HO.
JOHNSON BLOCK
Electric RR Siding
Iron Bridge
Open Iron Bridge
Iron Penstock
FOR VIEW SEE SERIAL NO 8772

exact reproductions of two plans of the same mill — one made in 1883 and the other in 1910. These show not only the development in plan making, but the growth of the mill, and the changes in its protective equipment.

The plans are made mainly by men who are either graduates from technical schools, or good practical

Plan Department with Men at Work

draftsmen. Beginning in this department, they gain knowledge of Mutual risks and methods, and those who prove to have ability and capacity for development go on into the inspection service and official positions in the Mutual system. Thus the Plan Department is the training school in which men are well grounded in the principles of fire-protection engineering. A period in the laboratory is also given, whenever possible, as a part of this training.

APPRAISALS

IT was necessary for equitable dealing that the amount of insurance to be carried on different risks be determined on the same general basis; therefore the Mutual

Companies established an appraisal department, and the men in this department are constantly engaged in appraising manufacturing properties, to determine the proper value for insurance purposes.

In new plants the values are well known, but in the older plants where many changes have been made, and where parts have been subject to long use and consequent depreciation, an appraisal is necessary from time to time to determine what amount truly represents the insurable value.

This work in no way aims to create fixed values, to be used for adjustment purposes in case of loss, but rather to make a fair estimate of the worth of the property insured at the time the appraisal is made. Machinery which has been in use for many years does not have the value of new equipment, though in some cases where there has been constant good management and repairs have kept machines in the best condition so they are still doing good work, the depreciation is much less than the mere age would suggest. All such points are carefully considered and a thoroughly equitable and business-like basis has been established upon which all the appraisal work is conducted.

This, like all other branches of Mutual activity, has developed and these appraisals are now made in considerable detail, and frequently the assured find them of much value beyond determining the proper amount of insurance to be carried. Appraisals are made at the request of the assured, without cost to him, or by desire of the insurance company, with the consent of the owner.

ADJUSTMENTS

WHEN a loss occurs an experienced adjuster is sent from the Inspection Department to advise with the owners as to the best way of making repairs and handling damaged materials, and finally to agree upon the proper payment to cover the loss in a satisfactory manner. The underlying principle in all adjustments is to ascertain the

A TYPICAL ISOMETRIC VIEW
TO ACCOMPANY PLAN OF 1910 AND SHOW
THE RELATIVE HEIGHT OF BUILDINGS,
STYLE OF ROOFS AND GENERAL
CHARACTER OF THE R.S.A.

[illegible]

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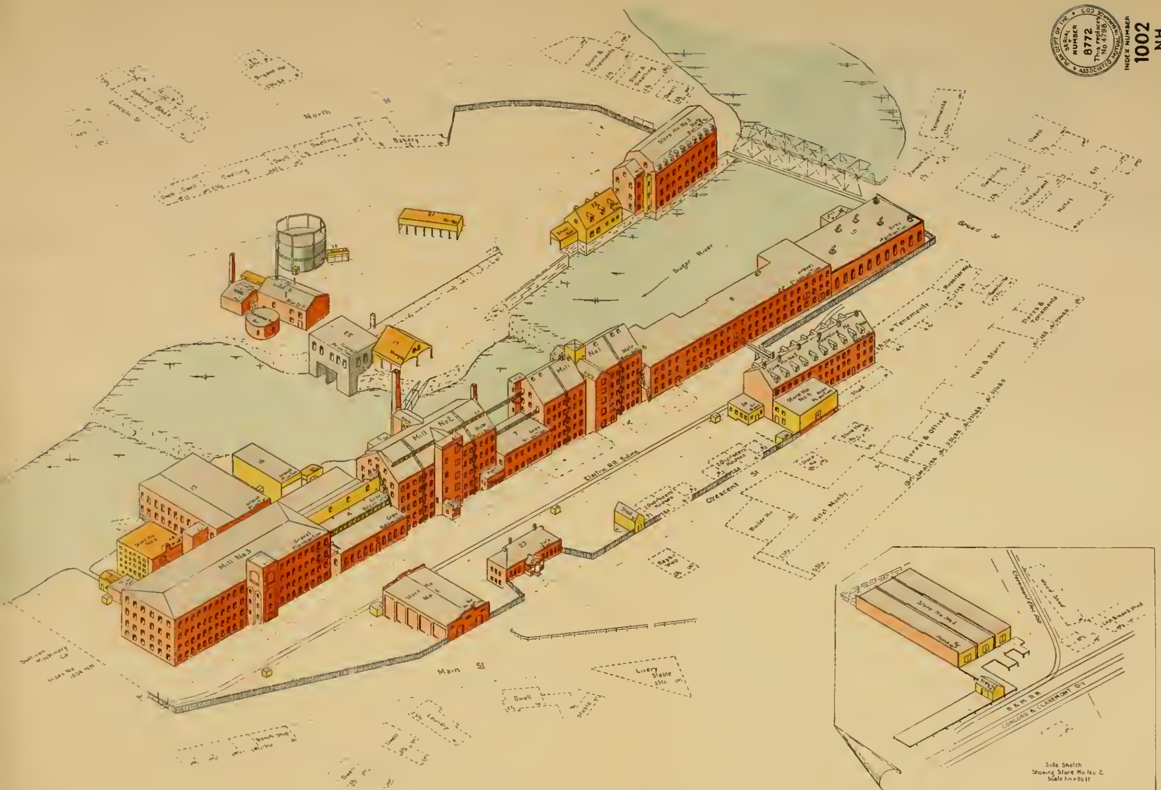


MONADNOCK MILLS

(COTTON MILL)

Claremont, N. H.

FOR PLAN SEE SERIAL NO 8771

Surveyed Oct 27, 1909
Additional Data May 24, 1910

Scale 1in = 50ft

Surveyed & Drawn by H H Nelson

loss sustained and pay it in full, or to the amount of the policy. The function of the adjuster is not to make a sharp trade, but to give the benefit of his experience in repairing damage and to see that the principle of equity is maintained. The adjuster acts for all of the companies interested, thus handling the loss in a simple direct manner.

In the case of a large loss or unusual conditions, the advice and experience of other Mutual members, or of special experts, may be obtained and the best adjustment under the circumstances determined. Recourse to the Courts in Mutual adjustments is unheard of. The basis of all adjustments is the value of the property damaged, on the day of the loss. This value is determined by deducting from the cost of new property, such depreciation as has occurred from use or age. Whatever value remains in the damaged materials after a loss is salvage, and this amount is deducted from the value as determined above, the difference being the loss.

Question often arises as to the connection between appraisals and adjustments. The same general principles apply in both, but the appraisals are not used as the basis of adjustment, for in settling loss it is necessary to work out values in much more detail than for a general appraisal, and to establish these strictly on the basis of the value at the time of the loss, which may be quite different from that existing when the last appraisal was made.

Much study has been given to the methods of handling damaged stock and goods so as to get the largest possible salvage, this being to the advantage of both underwriter and owner, as well as to all other members of the Mutual system. In the handling of raw cotton, for example, large amounts of which are insured by the Mutual Companies, and in which fire occurs with considerable frequency, methods have been fully developed, so that in many cases the percentage of loss is extremely small. Here again, as in the studies of loss prevention and fire control, the intelligent and friendly cooperation of manufacturer and underwriter brings most beneficial results.

SUCH has been the development of the Inspection Department. To-day there are twenty-five regular inspectors traveling over the territory between the Atlantic coast and the Mississippi River, and somewhat beyond, and including the manufacturing sections of Canada. These men move on regular tours and travel about three months apart, thus giving each mill a quarterly inspection at unannounced times. The special inspection work is done by eleven men who go to any place where there is call for their services. Appraisals are made by five men, and adjustments by two men regularly, with occasional assistance from inspectors, when losses come in rapid succession, or when, in more remote places, inspectors happen to be near when loss occurs. The small adjustment force is an excellent commentary on the result of fire-prevention work, when, in so great a field, the adjustment of losses is so small a feature.

In the Laboratory there are five men engaged in special investigations. There are twenty-eight men in the Plan Department surveying mills and making plans, and ten men are employed in lithographing plans and duplicating reports. A general force is engaged in copying regular inspection reports, writing special reports, coloring plans, caring for the general correspondence and clerical work, making with the few executive heads, a total force of one hundred and twenty-one men and women engaged in the prevention of fire loss, all in addition to engineers employed by the different companies direct. This Inspection Department handles all of the general work for the associated companies, and by doing it through one department in accordance with one standard, great economy results, and a high grade of work is done.

Much similar work in fire prevention is also done by the officers and engineers of the various companies, who use the work of the Inspection Department to its full extent, but go farther and arrange with owners for carrying out the recommendations made. They also consider the various business matters which arise in adjusting problems which arise in connection with the numerous branches of fire-protection work.

THE FACTORY MUTUAL LABORATORIES

AS has already been seen, it early became necessary to make tests of various devices, — automatic sprinklers, pumps, hose, oils, electrical apparatus, — and these were first carried on by men who devoted a fraction of

General Laboratory

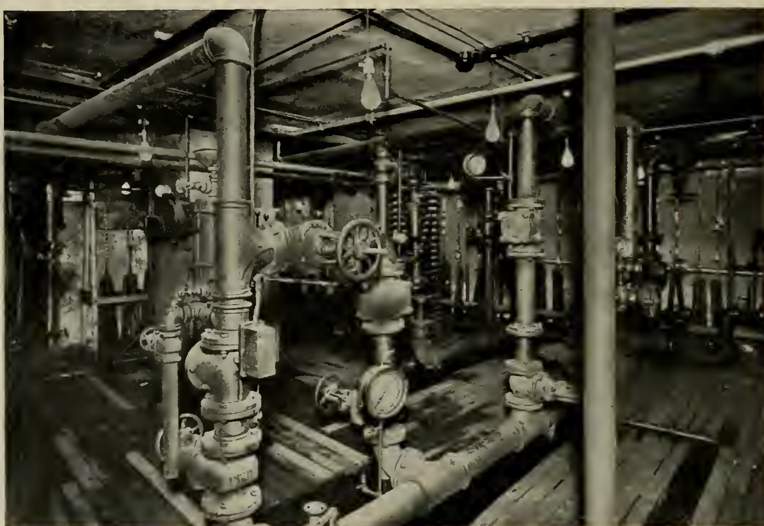
their time to this work, but were mainly employed with general inspection duties. At first experiments were especially arranged for as each problem arose and were made whenever a convenient opportunity offered. About 1890 a laboratory was established in the Inspection Department in Boston, and this was probably the first permanent laboratory to be specially devoted to fire-protection engineering problems. As the work increased, and became more specialized, it was found better to make a separate department to carry on such investigations, and this arrangement has proved very satisfactory. The laboratory work of the Mutual Companies has been a strong influence in the development of fire protection engineering.

The Laboratory now conducts tests on all sorts of new devices, determining the value of all important new ideas for extinguishing fire, or preventing loss. As an example of this work, much time has been spent in the study of automatic sprinklers. New sprinklers submitted have often appeared of merit, but frequently tests have shown vital faults; in some instances little defects in the process of man-

Chemical Laboratory

ufacture have resulted in a derangement of parts which would prevent a sprinkler from opening, in others some effect of time changed conditions so that sprinklers which were sensitive and reliable at the start entirely failed to open after years of use. Again, some faults resulted in a weakening of parts, after a few years of use, causing frequent breaking open of the sprinkler heads and heavy water loss. A careful research laboratory discovers these faults, and the consequent saving to Mutual members amounts to large sums.

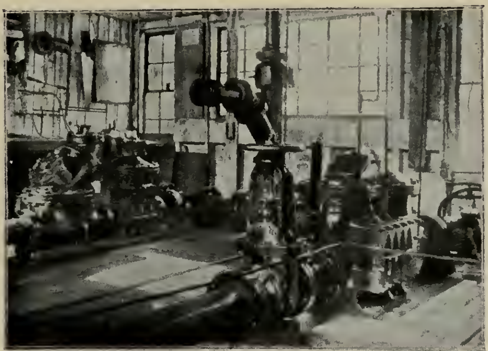
The dry-pipe valves used for controlling sprinklers in cold sections have required most careful study. Hose, pumps, and innumerable other appliances, including many electrical devices, are tested. Some are approved, some condemned, in others needed changes are pointed out. The total result is a general improvement in the quality of all such appliances and a material raising of the whole plane.



Valve Laboratory

As a part of this work, factories where approved devices are manufactured are visited from time to time and such general oversight given that the standard, once established, is maintained. For the information of members, lists of approved fire appliances and electrical fittings are regularly issued, and the first list of this kind, of comprehensive scope, was compiled by the Mutual Companies.

This work is not limited by the laboratory in Boston, but many of the more important experiments have been made through the willing cooperation of Mutual members, giving the facilities of their large mill yards for such use. The early testing of fire streams already mentioned is an excellent example of this. The pipe tests at Nashua another. The Laboratories now have an hydraulic testing station in the yard of the Proprietors of the Locks and Canals at Lowell where water in ample quantity, at good pressure, is available any time. This permits testing all sorts of devices for friction loss or any other feature where large flows of water are needed, and on a large and practical scale.


Lowell Hydraulic Testing Station

In many other ways experiments and investigations have been made through the courtesy and cooperation of Mutual members who have freely made available for this purpose the advantages of their great manufacturing plants.

LATER FIRES

1890 - 1910

IN these years twenty-two fires occurred where the loss in each case was over $100,000. Sixteen of these occurred in the first seven years and only six in the remaining thirteen years when automatic sprinklers and stronger general protection had been provided in practically all risks. While it is not always the large fire which gives the best lessons, these fires were vital experiences and those of special interest, with the losses to the Mutual Companies, are briefly described as follows:

1890 DUNNELL MANUFACTURING COMPANY. Loss, $279,000
Pawtucket, Rhode Island. Print Works.

Fire started at 6.15 A. M. in a pulley pit under the lower floor, probably from spontaneous combustion in rubbish, and spread to five other buildings. The buildings were equipped with perforated pipe sprinklers but the valves were in the tower at the first story and access to them was cut off by smoke before they were opened. Automatic sprinklers were to be put in, but on account of changes in buildings had been delayed. The mill apparatus and the public department finally extinguished the fire.

1891 RENFREW MANUFACTURING COMPANY. Loss, $471,000
Adams, Massachusetts. Cotton Weave Shed.

This was a one-story weaving mill, divided into two sections by brick walls. About 10.00 P. M. the watchman in the engine room heard a "roar like the sound of a great wind." His lantern was extinguished and the doors at both sides of the engine room blown open. The building was found to be thoroughly on fire, and though the help responded quickly and streams were used from the yard hydrants, the building was completely destroyed. There were no automatic sprinklers and the plant, being of the best construction, with sub-dividing walls, and very safe occupancy, had been considered an excellent risk. No satisfactory explanation was ever found for the origin and rapid spread of the fire.

1891 ELIZABETHPORT STEAM CORDAGE CO. Loss, $440,000
Elizabethport, New Jersey. Cordage Works.

Fire occurred in the afternoon from a hot bearing in the laying room, which had Parmelee automatic sprinklers, and these opened, but the water supply was evidently very weak and the fire spread to the adjoining engine and boiler house, crippling the steam pipe to the fire pumps. The city water pressure was only 20 pounds and the supply pipe 4-inch, making it worthless for fire fighting. The city fire alarm was out of order, causing delay in getting help. The plant was totally destroyed with loss to the owners of about $590,000. Plans were being made for a complete automatic sprinkler equipment. The Arkwright Company had no insurance on this property.

1893 CLINTON WIRE CLOTH COMPANY. Loss, $151,000
Clinton, Massachusetts. Woven Wire Mill.

Fire started in the forenoon, probably from friction, in the high brick tower where the woven wire netting made for window screens and other purposes, was painted and dried. The tower was one hundred and forty feet high with heavy overhanging wooden roof, and there were no sprinklers in it. The fire spread up through the tower, and the overhanging roof fell on other buildings near. Twelve strong hose streams were quickly available from the public water works, and steam fire engines. The fire was checked in the buildings to which it spread, by the excellent work of the employees, who formed complete lines at each main partition and drenched every spark as the fire tried to work in. Wooden, tin-clad fire-doors showed remarkable resistance and were strong factors in preventing the destruction of the entire plant.

RUINED PAINT TOWER OF CLINTON WIRE CLOTH COMPANY

1893 EXETER MANUFACTURING COMPANY. Loss, $137,000
Exeter, New Hampshire. Cotton Mill.

Fire started about 3.45 A. M. in the first story, where there were no sprinklers, and worked into the three upper stories, which had sprinklers, and these sprinklers retarded the spread of the fire enough to give opportunity to save the other buildings. The two mill pumps were rendered inaccessible by the fire which started near them. Public water and two steam fire engines extinguished the fire, and the new mill and adjoining buildings were saved, though the old mill was totally destroyed. The cause of the fire was uncertain.

1894 WILLIAM TINKHAM. Loss, $296,000
Harrisville, Rhode Island. Woolen Mill.

Fire discovered by watchman about midnight. He gave the alarm and attempted to start the rotary pump, but a coupling had been disconnected, probably for repairs, and there was delay in getting started for about ten minutes. There were automatic sprinklers in the carding room, supplied from a tank of 3,000 gallons capacity, and the sprinklers were seen to be working in the early part of the fire. There were some perforated sprinklers but the valve controlling their supply was not opened. The delay in starting the fire pump, the limited water supply, and the old-fashioned small yard pipe system permitted the fire to get beyond control and the mill was destroyed.

1895 CROCKER-WHEELER ELECTRIC COMPANY. Loss, $250,000
Ampere, New Jersey. Machine Shop.

This plant was one-story, brick, with joisted steep roofs, used for manufacturing electric generators and motors, being mainly of the machine-shop class. There were automatic sprinklers over about two-thirds of the plant, with weak water supply from the public mains. Additional sprinklers had been promised, and excellent public water was soon to be available. The plant was destroyed.

1895 TREMONT & SUFFOLK MILLS. Loss, $168,000
Lowell, Massachusetts. Cotton Storehouse.

Fire occurred in the afternoon in a large cotton storehouse and spread into two sections through some open fire-doors. There were no automatic sprinklers. Three hose streams were used by the mill operatives and about seventeen by the public department, and the fire was extinguished. This was before sprinklers had been largely installed in storehouses, and this fire exerted considerable influence in bringing about the universal protection of storage buildings, now practically accomplished.

1895 RIVER SPINNING COMPANY. Loss, $168,000
Woonsocket, Rhode Island. Dye House.

Fire started in an unsprinkled dye house. A mixing picker, handling at the time of the fire wool and some cotton, was in use temporarily, and fire was probably caused by some foreign substance going through the picker. The fire spread rapidly over about 2,000 pounds of stock. Hose streams were attached to the yard hydrants, but the engineer, who immediately started the thousand-gallon fire pump, did not open the discharge valve because he understood he must keep this closed until ordered to open it. The yard hydrants, therefore, had no pump service and, as the public water pressure was pulled down to a low point by the draft, the fire spread through the roof into an adjoining unsprinkled storehouse before the city steamers and streams taken direct from the fire pump checked it. Both buildings were practically destroyed. The fire showed the importance of a clear understanding of the fire apparatus.

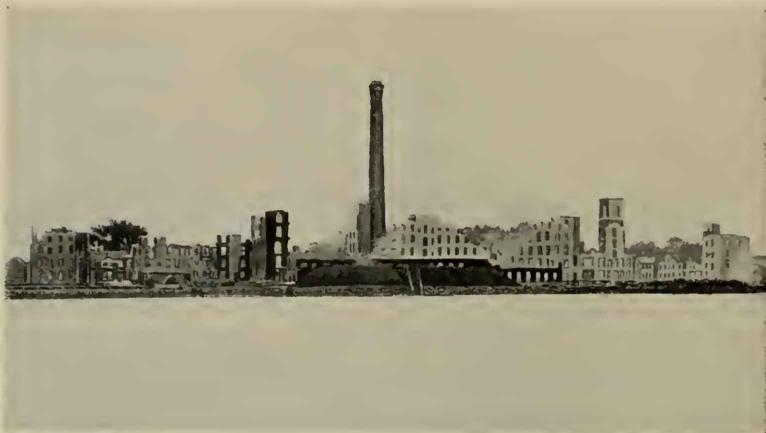
1895 WARREN MANUFACTURING CO. — Loss, $930,000
Warren, Rhode Island. — Cotton Mill.

This was the largest single loss ever paid by the Mutual Companies. The plant was of brick and mill construction, except No. 1 Mill, which had a steep shingled roof, and this at the time of the fire was being replaced by a modern type.

THE WARREN MILL BEFORE THE FIRE

Fire started in the engine room about 7 P. M., probably from ignition of the wooden lagging on the engine cylinders, there being an unusual amount of this woodwork, due to the large quadruple expansion engine with large cylinders and receivers. The mill had sprinklers, supplied by the public water system, small tanks in the towers, and the fire pump, but the public water was of very moderate capacity. The yard hydrants were supplied by the fire pump only, through pipes of good size. The public water had not been connected to these as, on account of its limited capacity, it was thought better to retain it exclusively for the sprinklers.

Better protection had been advised by the Mutual Companies. A new pump was soon to be installed and the engine and boiler house equipped with sprinklers. Pending the completion of the various improvements under way, steam was carried to the fire



View of Warren Ruins After Fire

pump by a pipe which ran through the engine room, and there was a valve on it in the engine room. This valve was kept open during the day, but due to an ill advised desire to save condensation, was closed by the watchman on his first round at night, as he had been instructed to do. The night fireman discovered the fire, called the watchman, and the alarm was given. Attempt was made to start the fire pump, but it moved slowly for only a few minutes, and then stopped. The closed valve in the engine room could not be reached on account of the fire all about it, but was found by Mutual inspectors in the ruins after the fire, open only a fraction of a turn.

Another View of the Ruins

With no sprinklers in the engine room, and no hose streams, the fire gained headway, worked into the mill, was checked for a time by the sprinklers there, but as the water from them could not reach the seat of the fire, so many were soon opened that the water pressure dropped below a serviceable point and the fire gradually extended through the whole mill, destroying it.

Had the fire occurred a month or two later, the increased protective equipment would undoubtedly have checked it, and the loss would have been small. It was a curious combination of circumstances which resulted in this great loss, and shows how a very small cause may have serious consequences. The unusual and needless closing of the one valve on the steam pump supply was the immediate cause of this loss, and was a typical example of:

> "For the lack of a nail the shoe was lost,
> For lack of a shoe the horse was lost,
> For lack of a horse the rider was lost,
> For lack of the rider the battle was lost,
> For lack of the battle the country was lost;
> And all for the lack of a horseshoe nail."

1896 WASHBURN & MOEN MFG. COMPANY. Loss, $151,000
Worcester, Massachusetts. Metal Works.

The building in which this fire occurred was of two stories with basement in part. It had a steel frame, steel floor beams, plank

INTERIOR VIEW OF RUINS OF WASHBURN & MOEN SPRING SHOP

second floor, plank and timber roof. The columns were of steel. The side walls were mainly of brick and glass with an end wall of wood for future extension. The building was occupied in the making and tempering of steel springs. Fuel oil supplied by a small gravity service tank was used in the furnaces, and fish oil in the tempering. A considerable part of the lower floor was of brick, which had become thoroughly saturated with fish oil, and the oil vapor from the tempering had formed an inflammable coating over the ceiling.

On Sunday morning repairs were being made to the fuel oil pipes and on disconnecting a pipe a considerable quantity of oil which had been trapped in the pipe ran out, falling upon furnaces which had not cooled down since Saturday; the oil ignited and fire spread with great rapidity throughout the whole building. There were sprinklers in the engine and shipping department at the end of the building farthest from where the fire started. A dozen hose streams were soon brought into service, but the hot fire quickly softened the steel columns, allowing floors and roof to fall in a tangled mass which burned with great rapidity, totally destroying the whole building.

Detail of Steel Work, Showing Result of Fire. Washburn & Moen Mfg. Co.

The fire showed the danger from overhead oil pipes fed by gravity; the great rapidity and fierceness of fire in oils; the danger of oil-soaked floors and the need of automatic sprinklers even if there is little in the structure of the building to burn, where the contents is of such inflammable nature. Further, the vulnerability of unprotected steel work which the fire showed is of special interest. Wooden beams which fell by the crippling of the steel supports were not charred more than one inch in depth and would not have been weakened to the breaking point. This all showed that unprotected steel must be avoided for all main members if a safe structure is to be secured.

The Exeter, Crocker-Wheeler, and Warren fires, as well as several lesser ones, were cases where, during the transition period from the protection of the early days to the stronger equipments which were being installed during these years, fire came first and heavy loss resulted. These fires also show the evolution of sprinkler protection, and how each step in the extension of this equipment over processes or into buildings which had originally been considered reasonably safe without it, was made on the basis of some hard lesson which showed that the loss would undoubtedly have been mainly avoided had sprinklers been present.

The Renfrew indicated the need of sprinklers in even the best class of weave sheds. The Crocker-Wheeler showed that metal working plants, in which many underwriters and manufacturers had felt sprinklers unnecessary, must be so protected. The Warren proved the necessity of automatic protection in engine rooms. The Tremont and Suffolk storehouse fire demonstrated the fact that storage must have sprinkler protection if losses in it were to be made comparable with those in protected mills.

A fire in the plant of the Gould Coupler Company showed in a similar way the need of sprinklers in iron foundries of good construction, with high roofs, which had been thought reasonably safe without them. In this case gas probably escaped from a furnace in some unknown manner, was ignited and the fire spread rapidly along the roof. The whole monitor, 620 feet long, was destroyed and a part of the main roof planking. The quick destruction of the long monitor evidently let out the heat so that most of the steel roof trusses were not seriously damaged.

Several of these fires showed the necessity of ample water supplies if sprinklers were to do their full work. This led to larger pipes, tanks and pumps. The Factory Mutual Companies have never had a fire get beyond control where there was a good sprinkler system, supplied with ample water at good pressure, and with the water on when the fire started.

The study of fires, to gain the full lesson from each case, developed along with all other features of fire pro-

Fire in Unsprinkled Foundry Roof, Extinguished by Hose Streams
Gould Coupler Co.

tection engineering. The next fire to be described may therefore be shown by a duplication of the report made at the time, slightly condensed. This well illustrates the growth of the idea that every important experience should be thoroughly investigated so that from each failure help may be obtained for the good of future fire prevention work. This fire occurred in a brick paper mill plant of generally good construction with results as follows.

This is copy of report presented by first inspector who reaches the place of the fire. To be immediately transmitted to Dept. to be manifolded and distributed to Insurance Offices.

Inspection Department Assoc. Factory Mutual Fire Insurance Companies. Long Distance Tel. Main 6514. 31 Milk St., Boston, Mass.

Fire Card No. 121

FIRE REPORT.

Hours time in Mill Yard 8

Factory of Hollingsworth & Vose Company Index No. 2322

Inspected by H. L. C----

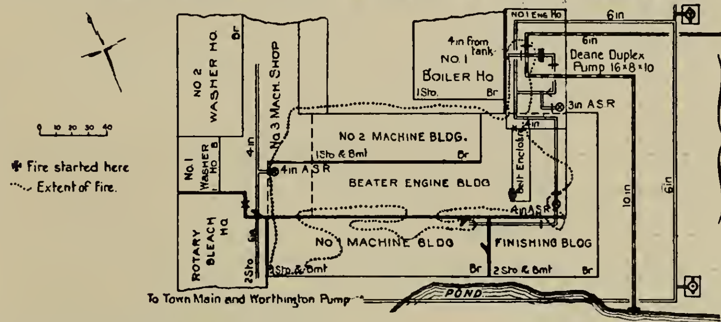
At East Walpole, Mass. Inspected on April 6,1904.

THIS FIRE occurred on date of Tuesday (Day of Week) April (Month) 5th, 1904 (Date) *at* 12:50 *hour* P. *M.*

Fire started in Beater Engine Building (Building) & Basement (Name of Room)

Extent of Fire, Confined to Mach.Rms. 1,2,3, Beater & Finishing Bldgs.,Engine Rm.#1, & Boiler Ho.

SKETCH. Give diagram or section, showing points of compass.



Construction.
Brick—Stone—Wood.
Mill Construction.
Joist Construction.
Special
Small part

Direction and force of wind, Practically no wind

By whom discovered, Men in Finishing Room *Public alarm given by* Whistle & Telephone *at* once

Apparatus used to extinguish, Sprinklers, hose from pumps, public Depts. from Walpole,Norwood & Dedham

Time required to bring apparatus into use. Mill, 2 or 3 minutes *Public Dept.* Not known *Duration of fire,* 4 hrs. before under control several more before ext'g'd.

LOSS ESTIMATED *not less than $* 75,000. *not over $*100,000. *Adjusted at $*

Sprinklers where fire started? No *Name of head,* Grinnell metal(D) and glass. (Name, type and date installed)

How many sprinklers opened? 307 *Dry-Pipe System?* ---- (Name and date installed)

Describe apparent action of sprinklers, (sensitiveness and distribution) Few metal disc failed to open.

Greatest number of Hose Streams used at one time 8 fr.yard system 4-5 fr. outside *Size of Nozzles,* 1-1/8" *Of Hose,* 2-5/8"

Did water supply prove all right? Scant for such a fire *Was any defect apparent in action of pumps or streams?* Steam pipe to 1 pump broke

Was any defect needing a remedy shown in supply of fire pails, extent of sprinklers or hydrant pipe, sizes or supply of hose? Lack of absolutely complete sprinkler protection

How was fire managed? Very well.

Cause of the fire, Hot bearing *As given by* Mr. Lewis Vose

In the judgment of the Inspector, Same

For a Fire in a Storehouse: Also fill out these blanks in addition to the foregoing.

Building open, *Closed,*
In Stock, *What kind,* *When put in,* *How piled,*
In what part of Storehouse,
Stock going in at time of fire, *Stock going out at time of fire,*
Distance of fire from any open door or window,
Men at work, *Where,*

GENERAL REMARKS. *What special lesson is taught by this fire? (As to hazard of process—improvement suggested for this risk or general information useful for the improvement of the insurance work.)*

The fire started in the beater engine basement, evidently at a bearing at the main belt, which was enclosed by a board partition extending from the floor to the joisted ceiling and tinned on the inside. There were no sprinklers inside nor in the second bay outside. The fire first appeared bursting from this enclosure, the inside of which was oily and greasy, making a very fierce fire so that when it broke out it opened a large number of sprinklers in the surrounding rooms because of the great

Signature of Inspector

OVER.

In obscure cases, special attention is to be given to any possible cause of spontaneous combustion.

4000 sheets of 4. January 1911.

A Typical Fire Report
About two-thirds original size

amount of heat generated out of reach of the water from the sprinklers which opened.

Fire streams were quickly brought into play, the Worthington pump was started at once and within ten minutes the engineer reached the Deane pump and started that also. The fire came into the engine room over the main belt and drove the men from this pump but with the assistance of sprinklers and hose streams the fire wse there extinguished and the pump, which had been left running, was again reached.

Eight streams were finally taken from the yard system, and the pressure at the Worthington pump dropped to 30-lbs. It was realized by the fire fighters that this was too low a pressure for efficient streams or good supply to sprinklere, but it was impossible, with the fire in the heart of the property, to withdraw a single line of hose, as it was necessary to keep the fire in check at so many places.

About an hour after the fire started the falling of a part of the Beater Building roof broke the steam pipe running to the Worthington pump, rendering the pump useless. The fight was about even when, at 3:30, a steamer from Dedham arrived with its two powerful streams, drawn from the pond, and with a stream from the Norwood supply and another from the Bird Paper Mill, the fire was finally extinguished. The fire walls and doors did excellent service. The greater part of the plant was saved.

During the fire it was seen that water from the east Beater Room sprinkler riser was being wasted and by great effort the inside valve in the basement was reached and closed Later the outside valve controlling the westerly riser was closed, but opened again by good judgment when the fire seemed to gain headway without the sprinklers.

LESSONS:

1st- Sprinkler protection should be complete inside and around all belt enclosures and throughout such paper mill basements. The fire contradicted the oft repeated statement that wet wood will not burn, for much of the construction destroyed in the basements was water soaked wood.

2nd- Steam pipes to fire pumps should not pass through buildings, but should run in a safe, direct way, from boilers to fire pumps.

3rd- Steam pumps should not be located in rooms connected by main belts or other openings to manufacturing buildings.

4th- This fire was not under control for four hours showing the need of a long continuing water supply for pumps. A pump cistern of ordinary size would have been exhausted before this time unless refilled from some source.

5th- Outside valves controlling sprinkler supplies are necessary. Had the inside valve, reached with great difficulty, been inaccessible, no servicable pressure could have been maintained at the hydrants.

6th- Good brick fire walls are of great value in checking fires. Lateral walls not fire walls like the wall between No. 2 Machine Room and the Beater Room let fire through but obstruct hose streams.

7th- Intelligent handling of fire apparatus is of vital importance and in this case excellent work was done and good judgment shown at all points. The fire was in the heart of the property surrounded on all sides by other buildings but was practically confined to the building where it started.

Respectfully submitted,

H. L. C ----------

Inspector.

1907 Cocheco Manufacturing Co. Loss, $480,000
Dover, New Hampshire. Cotton Mill.

About 6.20 A. M. a sprinkler on the fourth floor of the mill broke open from unknown cause and the water supply for sprinklers in one half of the mill was shut off by closing a valve in the first story of the tower. A few minutes later fire was seen around a belt box in the third story about under this sprinkler, and word was immediately sent to the watchman to open the closed valve. The fire spread very rapidly up through the greasy belt boxes, fanned by the moving belts, before the engine could be stopped, and ran over

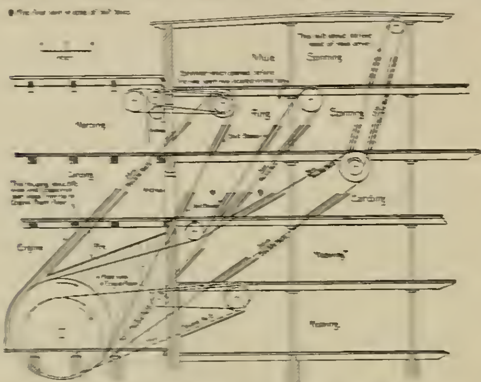
View of Cocheco Mill, Showing Fire in Progress

the loose stock in the rooms unchecked by sprinklers, as the watchman became confused by the operatives rushing from the mill, and the valve controlling the supply to sprinklers was not opened for ten to fifteen minutes.

The public water was of good pressure and capacity, there was ample pump service, and pumps and hose streams were quickly put in operation. A large number of sprinklers opened before the water was turned on and when the valve was opened the sprinklers took so much water that the pressure dropped too low to supply good hose streams. This valve was then closed and opened at about three-minute intervals for about two hours, to give the hose streams and the sprinklers water alternately.

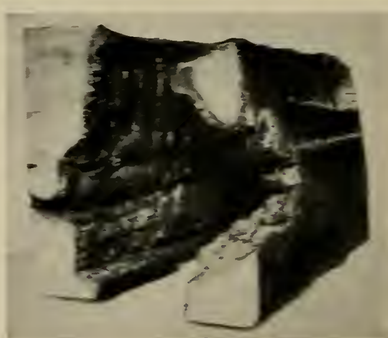
The public department was called at once and a steam fire engine came from Portsmouth. Twelve to eighteen hose streams were used. The thermometer was below zero, hose lines froze if water was shut off for a few minutes, and fire fighting was difficult.

The rapid spread of the fire at the start and the quick filling of the mill with smoke caught some of the operatives so that several jumped from windows and five were overcome and died. There were ample exits, but probably an attempt to get clothing caused some operatives to delay in starting out or tempted them to return, which proved fatal.



Cross Section Showing Arrangement of Belting, No. 1 Mill

About 8 A. M. the roof began to fall and was soon destroyed. Hose streams were used from the tower standpipes with good effect. The rapid spread of the fire was checked by noon, but it continued to break out until the next day, requiring ten to twelve hose streams. The fourth and fifth stories were badly burned, fire getting between the double beams proved very difficult to extinguish and the beams finally broke, letting down the floors. The burning was very serious around the main belt drive. The first, second and third stories were mainly saved and in the end the whole damage to the building was repaired for about $75,000 — the great loss coming on machinery and stock.



Section of Double Beam After the Fire

The fire was probably caused by the friction of a main belt rubbing against the boxing, the belt having possibly slipped on account of being wet with water from the sprinkler which first opened.

In the first twelve hours of the fire about four million gallons of water were used and before it was finally extinguished about eight million gallons were thrown on to it. There is little doubt but that the fire would have been confined to small limits had the water been on the sprinklers at the start. The lessons were:

1. The danger of large belt openings through floors. Again showing that slow burning construction means tight floors as well as solid plank and timber.
2. The danger in a large mill while sprinklers are shut off.
3. Unsprinklered wooden belt boxes and fly-wheel housings unavoidably somewhat greasy, are fire breeders.
4. The advantage of ample pumping capacity and water supply.
5. The disadvantage of double beams with space between.

Cocheco Mill and Wing, Showing Ice Coated Ruins

1907 Burnham, Williams & Co. — Loss, $140,000
Philadelphia, Pennsylvania. — Machine Shop.

Fire started about 5.30 P. M. in third story in a section recently partitioned off for drafting room with no sprinklers. It quickly broke out into main room, where sprinklers by unfortunate oversight were shut off. Pumps and public department were quickly brought into play, but the start gained in the unprotected areas allowed the fire to attain serious headway and large loss resulted. The fire probably came from smoking, as the draftsmen left the room. Its spread was due to the lack of sprinklers and to improperly closed valves.

1907 SHOVE MILLS. Loss, $131,000
Fall River, Massachusetts. Cotton Mill.

Some work was being done Sunday forenoon about the main engine fly-wheel. Fire started in a way not determined and ran rapidly up the main belt and through the third, fourth, and fifth stories. The mill was of stone and solid plank and timber construction, completely equipped with sprinklers supplied from public mains with forty-five pounds pressure, and several fire pumps.

In all about 650 sprinklers opened, twelve fire streams were used by the mill and city departments and the fire was extinguished. There being no holes through the fifth floor, fire did not get into the upper story. The throttle of the main fire pump was being repaired when the fire started, but was quickly put together and the pump operated.

This is a good example of the control of a fire under dangerous conditions due to beltways, where the sprinklers were in service at the start and there was ample pumping capacity.

The great danger of fire rapidly spreading from bottom to top of a mill through large belt openings, protected only by wooden boxes about head high, was most clearly shown by the Cocheco and Shove fires. The Cocheco fire showed the large loss which may result under such conditions if sprinklers happen to be temporarily out of commission. The Shove fire showed what sprinklers could do, but that with only fair primary water pressure a large loss was likely to result.

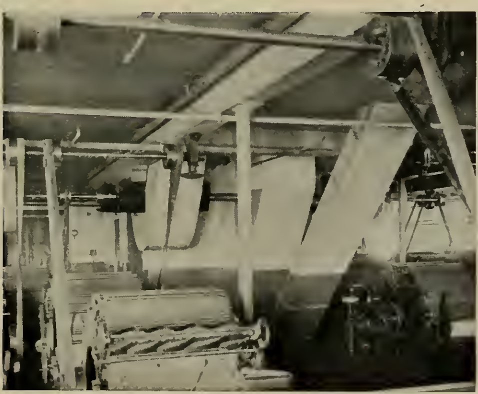
A similar fire at the Sagamore Mill in Fall River, in the same year, starting in the beltway on a Saturday afternoon, was extinguished by sprinklers and hose streams with a loss of about $7,300. In this case sprinklers were fed from public mains, from which 1,500 to 2,000 gallons per minute could be drawn at a pressure of 100 pounds, so that the sprinklers met the fire at the start with a deluge of water and controlled it.

These three fires perfectly illustrate the possibilities with high water pressure; with fair pressure; and with the water temporarily shut off.

A study of earlier fires shows that many of the heavy losses were largely due to these vertical openings made for the main belt, which allowed fire to gain headway quickly in several stories and so become uncontrollable. It was seen that the time had come when this danger should be eliminated.

Main Through Belts in Cement Enclosure
Drive for Room in Metal Boxing

Plans were devised for enclosing these old belt drives with partitions of metal lath and cement mortar, supported on angle iron frames, or with metal boxing for the less important cases. Provision is made for removable sections to permit easy access to bearings, pulleys, and belts, for repairs and changes. This work has been taken up during the last few years by engineers from the Inspection Department, especially detailed for this purpose, special inspections being made at all of the old mills having drives of this kind, and enclosures laid out in detail. The several cuts show various methods devised for protecting such drives as existed in the Cocheco and Shove Mills at the time of the fires in these plants.



Cement Enclosure for Main Drives. Metal Box for Side of Belt Coming Out into Room

A large part of the drives of this kind have been thus enclosed, and the experience so far with these enclosures has been very satisfactory. In general the gain in cleanliness and convenience is found very acceptable from the manufacturing standpoint, while the fire risk has been practically eliminated. These enclosures have the same general effect as brick belt and rope towers, now almost universally provided in first-class modern mills, driven in this way, but do not require heavy foundations or any considerable change in machinery. In some mills, where changes in power were desirable, belts have been removed and electric motors installed, rather than to provide belt enclosures.

Cement Enclosure, Showing Movable Section to Allow Removal of Main Pulley

This is another distinct advance in the removal of special hazards and shows how reasonable remedies can be worked out for almost any difficulty. It is expected that these enclosures will reduce the loss ratio materially in the large textile mills of the old type.

Sloping Cement Enclosure at Floor. Metal Boxing at Ceiling

LESSONS FROM THE FIRE LOSS RECORD

THE diagram on the following page shows graphically the great fires which have occurred during the past fifty years, the growth of the Mutual system, and the development of fire protection during this half century. In the first ten years the amount at risk was small and the chances for fires correspondingly small, then, as the system grew, bad fires constantly increased, culminating with the severe loss at Warren in 1895. After this time the whole condition was changed. The system continued to grow at a rapid rate, the seven hundred millions at risk in 1895 becoming twenty-two hundred millions in 1910, but, despite the greatly increased chances for loss, bad fires largely disappeared.

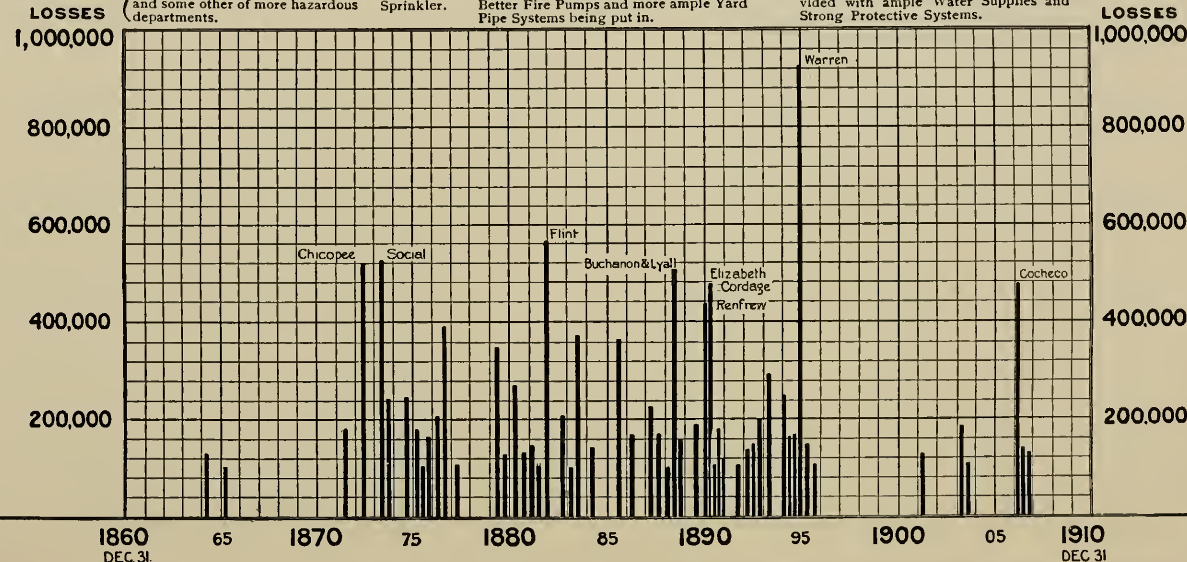
In the fifteen years, 1880-1895, there were thirty-one large losses and the average amount at risk was about five hundred and fifty million dollars. In the next fifteen years there were but eight large losses, only one a really severe one, while the average amount at risk was twelve hundred million dollars. Had the same ratio of fires continued after 1895 as before there would have been seventy great losses instead of eight, or over eight times as many.

The reason for this wonderful improvement was the fundamental change in conditions brought about by the automatic sprinkler and the general strengthening of all fire protective equipment. As has already been shown, the bad fires from 1880 to 1895 occurred under conditions where sprinklers could play no important part, as they were either entirely absent, or omitted in the places where the fire originated so that they could not act until the fire had gained uncontrollable headway. When modern pro-

FACTORY MUTUAL LOSSES OF OVER $100,000—50 YEARS

The Growth of the System and the Development of Fire Protection

	1860	65	1870	75	1880	85	1890	95	1900	05	1910
AMOUNT OF RISK IN ALL FACTORY MUTUAL CO'S			$100,000,000		$240,000,000		$552,000,000		$919,000,000		$2,200,000,000
KIND OF PROTECTION	Pumps, Yard Hydrants and Stand Pipes with Perforated Pipe Sprinklers in most Cotton Picker Rooms and some other of more hazardous departments.			First Automatic Sprinkler.	Automatic Sprinklers replacing Perforated Pipe Sprinklers and being extended to all parts of Factories and Storehouses. Better Fire Pumps and more ample Yard Pipe Systems being put in.				Automatic Sprinkler Protection rapidly nearing 100 per cent for Factories and Storehouses. Practically all Risks provided with ample Water Supplies and Strong Protective Systems.		



tection became general and complete there was an immense decrease in the number of bad fires.

Of the eight fires of this last period the largest (Cocheco) occurred when sprinklers were temporarily shut off for a few minutes to replace a sprinkler head which had accidentally opened; in another case (Washburn & Moen) there were practically no sprinklers; in a third (Burnham, Williams) there were none just where the fire started, and those which should have been next available were shut off by oversight. In the other five fires the sprinklers, with good pumps and hydrant systems, did excellent work and changed what would almost surely have been very heavy losses into relatively small ones.

When considering these results it should not be forgotten that before this great reduction in losses, which has resulted from the later developments of protection, the mutual method in the earlier days did bring about great improvements through its continued efforts for substantial construction, its insistence on the best protection of the times, its constant encouragement of the spirit of care and the personal desire to prevent loss. Though a number of severe fires occurred, many more were prevented, so that the losses were much less than in similar manufacturing properties not included in the mutual system. The cost of insurance consequently was much lower than for like properties insured under the ordinary methods.

It would be short-sighted and most unwise to assume that heavy losses may not occur again, for they undoubtedly will from time to time. After all reasonable precautions have been taken human fallibility is still a factor, and now and then that unfortunate combination of accidents which has been found as the cause of almost every great loss may again occur. However, the experience of fifteen years over a field so wide and varied, shows beyond question that the fire hazard is practically controllable. It is only necessary to follow these methods and the spirit which has built up this system to insure continued success.

In the fifty years since 1860 the Arkwright Mutual Fire Insurance Company has paid over five thousand six hundred losses, aggregating over three million dollars. The proportion of this loss caused by fires of different amounts is shown by the following table:

ANALYSIS OF ARKWRIGHT LOSS RECORD

PERIODS	1860—1880 20 Years			1881—1895 15 Years			1896—1910 15 Years			1860—1910 50 Years		
LOSSES	No. of Fires	Loss	Per Cent. of Loss	No. of Fires	Loss	Per Cent. of Loss	No. of Fires	Loss	Per Cent. of Loss	No. of Fires	Loss	Per Cent. of Loss
Under $1,000	232	$32,000	5	901	$105,000	7	4152	$342,000	35	5285	$479,000	15
$1,000-$5,000	38	78,000	13	92	216,000	14	101	215,000	22	231	509,000	17
$5,000-$10,000	16	118,000	19	27	199,000	13	18	123,000	13	61	440,000	14
			37			34			70			46
$10,000-$20,000	12	178,000	29	16	239,000	15	11	163,000	16	39	580,000	19
$20,000-$50,000	6	217,000	34	15	512,000	35	2	51,000	5	23	780,000	25
$50,000-$125,000	..	......	..	2	235,000	16	1	95,000	9	3	330,000	10
			63			66			30			54
TOTALS	304	$623,000	100	1053	$1,506,000	100	4285	$989,000	100	5642	$3,118,000	100

The record of these years has been divided into three periods: first, the days of the old protection; second, the time of transition to modern equipments with automatic sprinklers, strong pumps and ample yard pipes; and third, the last fifteen years during which the mills have had the advantage of practically complete protection. A summary for the whole fifty years is then added.

For the whole period it is seen that fires which cost the Arkwright Company less than $5,000 comprised nearly one-third of all the losses. Fires of medium size, between $5,000 and $20,000, make up another third, while the fires which cost over $20,000 make up the final third. Many of these large fires are the ones described in the preceding pages. The Arkwright Company often had, especially in the later times, from a fifth to a sixth of the total insurance on a risk, so that where the loss to this company was ten thousand dollars the total loss, very likely, was fifty to sixty thousand.

The first period shows the percentage of the aggregate loss constantly increasing with the size of the fires. Eighteen fires out of three hundred and four caused sixty-three per cent of the loss. In the second period the result was much the same and here thirty-three fires out of over a thousand caused sixty-six per cent. of the whole loss. In the third period the whole condition changed and out of over four thousand fires, there were but fourteen with loss of over ten thousand dollars, and these caused but thirty per cent. of the total loss. This all shows in another way the effect of modern protection in nearly eliminating the great fires which formed so large a percentage of the total loss in the earlier years. Although figures for fifty years covering all the Mutual Companies are not easily available, there is little doubt but that the main results would be the same as those for the Arkwright Company.

It is from the third period that lessons for the future must be drawn, for neither the first period with its primitive protection, nor the second period of transition from old to new, at all represents the conditions of the past ten or fifteen years, which in the main are the conditions existing to-day, and which will continue in a large measure for years to come.

Fires costing the Arkwright Company five thousand dollars, or twenty-five to thirty thousand for the total loss, are of moderate size. In the last fifteen years there were but thirty-two fires larger than this, or, less than one per cent. of the total number. These figures show that the automatic sprinkler, standing guard as it does over every square foot of protected area, catches nearly all fires at the start and confines them to small limits. In addition strong general protection and good construction have made it possible to keep the few fires, which for one reason or another got away from the first sprinkler, within restricted limits. Beyond the question of saving loss, this all means stability of business, and freedom from interruption of production, which is often more serious than the money value of that which a fire actually destroys.

As our manufacturing plants grow there is a tendency to greater areas and much larger concentration of value subject to one loss, while increased pressure for production and many new processes introduce new hazards. On the other hand, general construction is constantly improving. Complete sprinkler equipments and strong general protection with pumps, yard hydrants, and ample water supplies are now the standard of all first-class properties. Further, incombustible construction is increasing and this will surely tend to a reduction of losses. If the methods which have produced such excellent results for the past fifteen years are honestly and intelligently followed the future should give even better returns. So good, however, have been the results of the past that the margin for future improvement is a narrow one. The success of the past was obtained through constant vigilance and the willingness of owners to adopt the safeguards which study and experience showed necessary. Equal success in the future can be obtained at no lesser price.

BUSINESS ORGANIZATION

THE leading features of the work which the Factory Mutual Companies have done, and their general development during the past three quarters of a century have been shown in the preceding pages. The following table gives the names of these companies, all formed by manufacturers on the same general plan, with the dates of organization, and amounts at risk on December 31, 1910.

Organized	Name of Company	Amount at risk Dec. 31, 1910
1860	**Arkwright Mutual Fire Ins. Co.**	**$270,000,000**
1886	**Paper Mill Mutual Insurance Co.**	**29,000,000**
1850	Boston Mfrs. Mutual Fire Ins. Co.	$333,000,000
1855	State Mutual Fire Ins. Co.	221,000,000
1854	Firemen's Mutual Insurance Co.	186,000,000
1848	Rhode Island Mutual Fire Ins. Co.	154,000,000
1868	Blackstone Mutual Fire Ins. Co.	135,000,000
1835	Manufacturers Mutual Fire Ins. Co.	118,000,000
1855	Worcester Mfrs. Mutual Ins. Co.	111,000,000
1870	Fall River Mfrs. Mutual Ins. Co.	101,000,000
1871	Mechanics Mutual Fire Ins. Co.	82,000,000
1874	Merchants Mutual Fire Ins. Co.	70,000,000
1874	Enterprise Mutual Fire Ins. Co.	68,000,000
1877	American Mutual Fire Ins. Co.	68,000,000
1873	What Cheer Mutual Fire Ins. Co.	58,000,000
1875	Cotton & Woolen Mfrs. Mut. Ins. Co.	57,000,000
1875	Hope Mutual Fire Ins. Co.	55,000,000
1884	Rubber Mfrs. Mutual Ins. Co.	54,000,000
1880	Philadelphia Mfrs. Mut. Fire Ins. Co.	50,000,000
	Total	**$2,220,000,000**

These companies cooperate for the inspection of risks, adjustment of losses, and all work which can be done more economically and efficiently in common. There is a monthly Conference of officers, at which matters of general interest are considered. This body governs the Inspection Department, but its other actions are mainly advisory, each company being entirely independent in the conduct of its own business..

There is another smaller group of similar companies, sometimes called the "Junior" Mutuals to distinguish them from the "Senior" companies. They maintain a separate inspection department and have their own Conference of officers. The two groups therefore are independent of each other, but cooperate at points of common interest, and considerable insurance handled by the younger companies is placed in the older group.

The ordinary routine of business is well illustrated by assuming the case of a new risk. A manufacturer hears of the Mutual System, through an acquaintance who has a factory insured in it; he sees the excellent results and desires to obtain them for himself, and so makes application to some one company. The company ascertains the nature of the risk offered, and if it appears to be one which could conform to Mutual standards, it is generally visited by an officer of the company. If this examination, or other information, shows that the property can be made a good Mutual risk, requirements to bring it to the standard are laid out, if this is necessary. Where much study is needed a special inspector is usually sent from the Inspection Department to examine the plant thoroughly and make a detailed report. All such work is done entirely without cost to the applicant for insurance.

When the special report is completed, a copy is sent to the owner of the property, together with information regarding Mutual methods and probable cost of insurance. On receipt of this information, if the owner wishes to protect his plant against fire as advised, he goes ahead with the necessary work, and when sufficient protection is provided to make the risk reasonably safe, insurance can be written. In some cases this work of improving an old property goes on for several years, advice being freely given by the Mutual office with which negotiations are in progress, to the end that when insurance is finally written the plant may be in thoroughly satisfactory condition.

When the assumed new risk is ready for insurance the company which has been handling the preliminary details places the insurance among the associated companies. Each company writes its own policy and sends it to the company handling the business, or " placing the insurance " as it is commonly called; in this office all the policies are collected and reviewed for possible clerical errors. When all are ready they are sent to the manufacturer, who thus becomes a member of the Mutual system. The premium becomes due on receipt of the policies. If there is delay in writing the policies each company holds its amount of liability bound and, in case fire comes, this " binder " as it is called, has the full force of the written policy.

The policies of the Mutual Companies are generally written under a blanket form, covering buildings, machinery, and stock in one item. In earlier years it was the custom to divide the insurance, putting specific amounts on buildings, machinery and stock, and there was always a chance that there would be excess insurance on one part and insufficient on another, when fire came. The general use of the broad blanket form has proved of great advantage to Mutual members.

It is not the practice to make any co-insurance restrictions, but, that all may be on a common basis, it is required that the amount of insurance carried shall be at least ninety per cent. of the value of the property, above foundations, that is, the part commonly subject to destruction by fire. This freedom from co-insurance limitations is in itself a great advantage to a manufacturer, for though the desire is to keep fully insured, values often increase more than is appreciated or, by simple oversight, additional insurance may not be ordered. If fire occurs and there is a co-insurance restriction the assured becomes partly liable for the loss. In the few Factory Mutual policies which do contain a co-insurance clause, its significance is always explained fully to the owners, and it is used only under special conditions.

There is no wide difference in the rates on the main manufacturing properties carried by the Factory Mutual Companies, but of course slight variation is necessary to compensate for different kinds of factories, types of buildings, and general arrangements. As the whole plan of business is based on the idea that risks must be brought as nearly as possible to one standard, the aim is not to make the rate fit the risk, but to make the risk safe and truly entitled to membership in an association sharing losses mutually.

As previously mentioned, the general practice has been to write policies for one year, making them expire on the first of some month, but policies can be written for terms of three years. About thirty days previous to the expiration of policies the companies send notification of this expiration to the members, and renewals are ordered where desired. On the first of each month figures are compiled showing the business transacted in the preceding twelve months, or, in the case of three-year policies, for the preceding thirty-six months. From the total income all losses and expenses are deducted, and the balance is returned to holders of expiring policies in proportion to the amount of premium originally paid. This return to policy-holders has been commonly called a "dividend," but is in reality the unused premium which remains at the close of the transaction. When renewal is ordered the whole process is repeated just as if starting new.

If it is desired to cancel insurance during the year, this can be done at any time and premium is returned for the unexpired time. This arrangement makes it possible for manufacturers to carry additional amounts of insurance during periods when they have excess amounts of stock on hand, either in factory or storehouses, and provides insurance at the same pro rata cost as for a whole year. That is, three months cost one quarter what one year costs, and the higher cost of ordinary "short term policies" or cancellations is entirely avoided.

Notice that insurance has been assumed on a new risk is sent to the Inspection Department, and the first regular inspector passing through the district in which the property is located, makes an inspection and reports the conditions, and this is followed by quarterly inspections as long as the plant is insured in the Factory Mutual Companies.

It is customary for the company placing insurance for a plant to keep a general oversight of conditions, calling attention to any faults noted by inspectors, suggesting proper remedies, giving advice concerning new construction, alterations, or arrangement of hazardous processes, in fact, any matter which affects the fire hazard, and in a broad way supervise, not only the underwriting, but the safety of the entire plant as far as the fire hazard is concerned.

SPRINKLER INSURANCE

When automatic sprinkler protection became a general requirement some manufacturers objected on the ground that sprinklers might open accidentally, or pipes break, causing serious damage from water, for which the insurance companies would not be liable. The Mutual Companies believed the value of sprinkler protection was immensely greater than any possible trouble of this kind, and it was decided to issue policies covering this risk. After six years' experience in writing these policies separately, the sprinklers had proved their reliability so satisfactorily, that it was decided to include, with the fire insurance, full indemnity for loss due to leakage or breakage of sprinkler equipments. This is now done by all the Mutual Companies without additional premium. A good many losses from water damage occur in a year, but the total amount is small, and as all Mutual plants are protected by sprinklers, it is equitable to extend this indemnity to all.

USE AND OCCUPANCY INSURANCE

If a fire or water loss prevents the use of buildings or machinery the owner suffers distinct loss in addition to the damage actually done by the fire or water. This comes from the fact that for a time he is denied the use of his plant, and during this time interest, salaries, and other fixed charges continue, while his machinery is not earning anything to pay them. Use and Occupancy insurance pays this loss.

This insurance is furnished by the Mutual Companies at about three-fourths the rate on fire policies covering the same property, and is based on a daily payment for total interruption of product, until production is resumed, or the whole policy used up. If interruption of production is partial, payment is made in proportion.

The amount of Use and Occupancy insurance is usually from twenty to thirty per cent. of the total fire insurance. For example, a plant carrying $600,000 fire insurance might have $120,000 use and occupancy insurance. Assuming three hundred working days in a year, an interruption of production for one whole day would require a payment of $400; if the fire were serious so that many months were required to restore the plant, this payment would continue for three hundred days, or until the policy was exhausted.

WHEN A LOSS OCCURS

When any loss occurs the first duty of the manager of a plant is to make every effort to care for the property so as to save further damage, without waiting for a representative of the insurance companies. He should, however, send notice immediately to the company placing the insurance. The manager should use his special knowledge, gained from experience with the stock, goods, or machinery which may be damaged, and handle them so as to reduce the final loss as much as possible. In short, the manager should act just as he would if there were no insurance and the whole final loss to the plant depended entirely on his diligence and judgment.

LEGAL STATUS

The Mutual Companies from the beginning have considered that insurance business is done where the contract of insurance is made. For the Mutual Companies this would mean in their main offices, as no contracts are made outside of them, and all policies are written in the main offices. It has been a fundamental principle to keep the whole organization as simple in form as possible and thus avoid all needless cost. No paid agents have ever been appointed and no commissions are paid. Manufacturers in other states, becoming interested in mutual insurance and wishing to avail themselves of its benefits, from the legal standpoint, have come to the states where the companies reside and obtained insurance. This coming might be through the manufacturer, or his representative, calling at the office of the insurance company, or through correspondence. On this basis it was considered that a Mutual Company actually did business only in the state in which it resided, and no necessity existed for formally entering other states, as would have been the case had it been desired to do a general insurance business in different states.

Conforming strictly to the laws of their home states, these companies have sent their policies to manufacturers in many other states, working broadly under the Federal Constitution, which was considered to permit a citizen of any state to do business in any other state if he desires to go there for the purpose. The advantage of working on this broad ground has been the greatest simplicity in the machinery of business. Complex methods are not necessary in an association of manufacturers formed for the study of fire prevention, conservation of property, and mutual sharing of losses on a pure cost basis, working with no desire for profit from the business.

With the growing demand for closer supervision over all corporate work, several states in recent years have attempted by restrictive laws to prevent this method of conducting business. Undoubtedly in some cases these efforts have been inspired by agents of other forms of insurance, who have been disturbed by seeing large and *to them* profitable lines of insurance enter the mutual system, by the improvement of manufacturing plants. In other cases there has been ignorance of the real business and its benefits to all, and failure to distinguish between this mutual plan and local mutual companies, which, in some sections of the country, have been poorly managed and have resulted in disastrous failure.

Under the new conditions, and with the work of the Mutual Companies extending vigorously over a much wider field than in the past years, it has been concluded that, where the requirements for entering states can be made such that no material increase in complication results, or unnecessary cost is entailed, it probably will be desirable to enter, and thus avoid all possible question, with the added advantage of meeting such reasonable local demands as states may see fit to make, and giving the citizens a feeling that the mutual system is just as truly an institution of their state as of any other.

STABILITY

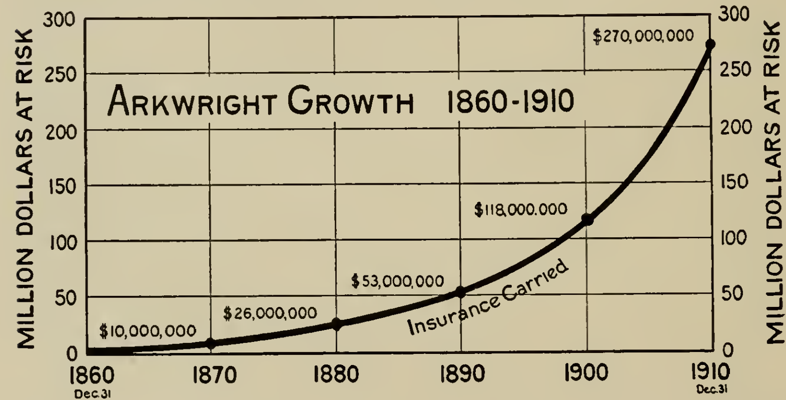
THE amount of insurance written on any single risk, subject, in the best judgment of the officers, to destruction by one fire, is limited to a fraction of a year's premium, so that there may be at all times an ample factor of safety in case severe losses occur in close succession.

An even better measure of safety is the excess of net cash assets over the losses. The State Insurance Departments usually have required for yearly policies that a mutual company have on hand at all times one-half of its premium. As the premium is paid in advance, this is about the amount which at any one time is unearned. Deducting this amount from the cash on hand, together with any unpaid losses or other bills due, the balance shows the net cash assets. On this basis for the year 1910 the net cash assets for the Arkwright Company were 15.6 times the losses for the year, which shows a large factor of safety. The average of these factors has been 12.9 for fourteen years past. Based on a good many years experience this shows a wide margin between the losses and the amount constantly on hand to pay them.

Beyond this, however, is the possibility of assessment, which would greatly increase the amount which could be made available. This possibility is frequently used as an objection to the Mutual method, and is sometimes held up to manufacturers who are considering Mutual insurance as a serious uncertainty which they will incur if they enter the system. Investigation of the facts would lead to just the opposite conclusion, for, as the above figures show, there is a large factor of safety before an assessment would ever be considered, and beyond this, since the system was fairly under way, no one of these companies has ever made an assessment. In the first years, by agreement, losses were paid by levying assessment on the members, rather than by depending on the collection of a sufficiently large initial premium. Complete protection and Mutual methods as a whole have given this stability and have made possible the broad blanket policies, free sprinkler policies and the general liberal provisions of Mutual insurance. If fires had not been brought largely under control these advantages could not have come. Therefore, these are further benefits from the Mutual plan in addition to reduction in the cost of insurance.

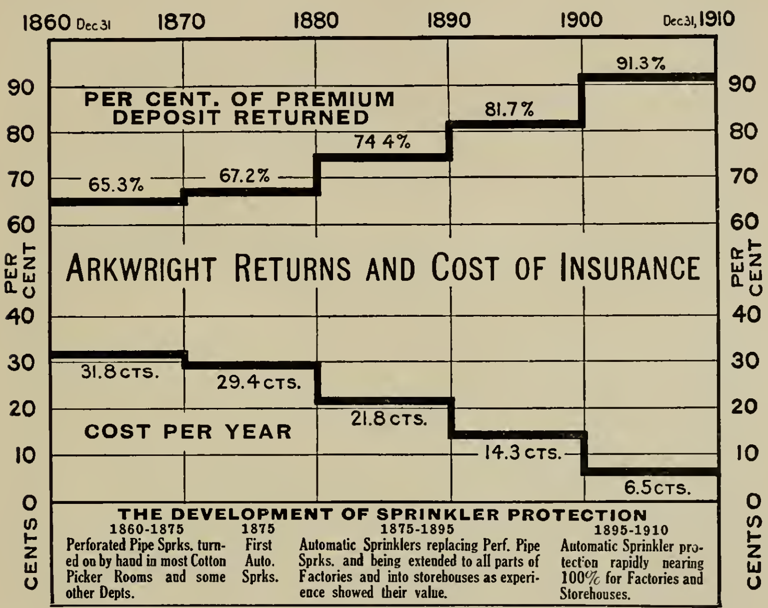
ARKWRIGHT DEVELOPMENT AND INFLUENCE

THE diagram below shows the growth of the Arkwright Company from its beginning to the present day. In the earlier times the growth was at a rather moderate rate, but steady from the beginning. In the later years, with the great development of manufacturing in the coun-



try, the growth has been at a very rapid rate. The Mutual System as a whole shows a generally similar growth, and the figures in the diagram on page 106 give the amount at risk from 1870 to the present time.

On the following page is a diagram showing by ten-year periods, the percentage of unused premium which the Arkwright Company has returned in fifty years, and the corresponding yearly cost of one hundred dollars insurance. The progressive increase in these returns and decrease in costs are the results of constant improvement in methods of fire prevention, all as the preceding pages have described. The development of automatic protection undoubtedly was the chief factor in the reduction of insurance costs, though other general improvements were contributory, so that the increase in the use of automatic sprinklers and the transition from the old protection to the new are also shown on the diagram, for ready compari-



son with the cost reduction, just as this was shown in the diagram on page 106, in comparison with the more severe fire losses.

The diagram shows that the average yearly cost for one hundred dollars insurance for all classes of risks was about thirty-two cents for the first period. It then dropped, slowly at first, but steadily, to less than seven cents for the last ten years. Storage, and risks less hazardous than the average of all classes, obtained insurance at an even lower cost.

The close connection between this great reduction in the cost of insurance and the improvements in protection is at once apparent from the diagram. The growth of the system, and the consequent broadening of its base undoubtedly was a factor in this result, while at the same time increasing the stability of the system as a whole. For exact figuring the interest charge on the premium which is paid in advance may be added to the net premium costs shown by the diagram.

The premium deposit returned by this Company in the whole fifty years averages eighty-four and one-half per cent., making the average net cost of one hundred dollars insurance for a year twelve and one-half cents. This includes the early years when only primitive protection was available. The general costs in the Mutual System as a whole would be slightly greater.

The Arkwright Company has stood for sound and conservative methods, and in the evolution of the Factory Mutual System has used its influence to encourage the best types of construction, ample protection, good business methods, and a high general standard. For many years the calm judgment of Mr. Higginson was often sought, and he exerted a quiet but strong influence on the side of stability and wise development, and it has been the aim to continue this policy to the present day. The Directors of the Arkwright Company have been, and are, men actively engaged in large manufacturing industries, and representatives of sound and progressive business enterprises. The contribution of the Arkwright to the building of the Mutual System therefore has been those things which make for solidity and high quality.

CONCLUSION

In these pages the attempt has not been to give a complete history of the Mutual System, but rather to show the development of the Mutual idea, and to make clear the fundamental principles upon which this system is founded.

Few individuals have been mentioned. The results are the work of many.

Beyond that which has been accomplished in this chosen field, there have been the broader results of creating the whole science of modern fire protection engineering, and bringing about practically all low cost insurance.

The Mutual System is an excellent example of the power of intelligent cooperation. It is a monument to the wisdom of the early manufacturers who dared to join in such a plan and to the discernment of those who, in all the later years, have loyally supported it as a power bringing great benefit to manufacturers, and incidentally to the community at large. It has drawn to its special field men of varied experiences and training who have labored earnestly and enthusiastically to make the system broad and progressive.

Future possibilities for good are equally great. With larger risks having more complex organization and equipment, cooperation for intelligent study of all problems can be of continuing benefit, and development and expansion can bring new advantages if the system is kept true to the fundamental principles. There must be the desire to prevent loss, the willingness to provide every necessary safeguard, and appreciation that membership in the Mutual Companies means more than an immediate gain in obtaining low cost insurance. Such membership is partnership in work which has strongly influenced the development of the highest class of manufacturing plants and the best known safeguards against the losses to property and to business enterprise which fire can cause.

The Arkwright Company stands firmly on these principles and believes it is a most useful work to make them known to all interested manufacturers, thus adding to the system such new members as will bring strength in its future development and aid in the constant broadening of its base.