The Locomotive

OF

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

VOL. XXXVI.

PUBLISHED BY
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.
1926-1927.

INDEX TO VOL. XXXVI.—1926-1927

THE LOCOMOTIVE

References Marked with a Star (*) are to Illustrated Articles.

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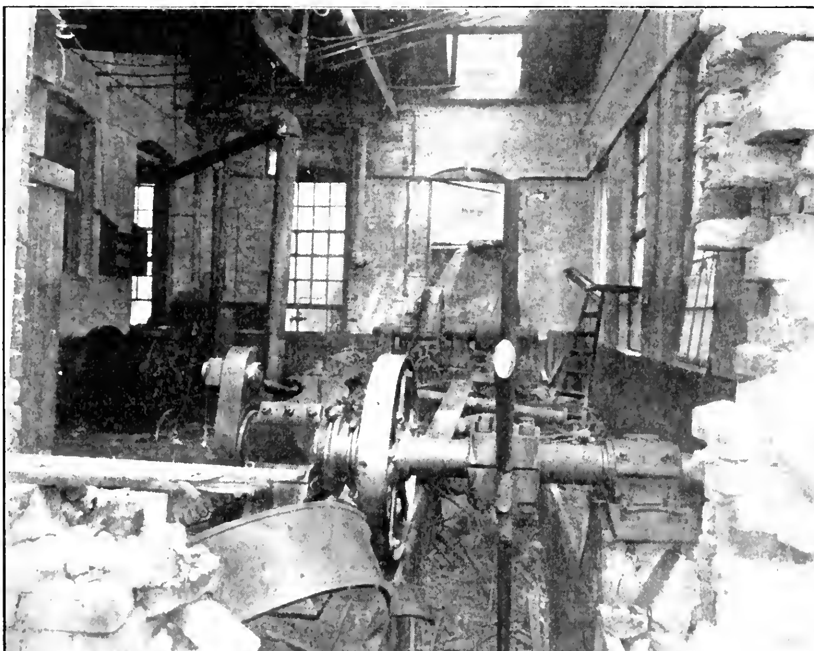
DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXVI. HARTFORD, CONN., JANUARY, 1926. No. 1.



FLY-WHEEL EXPLOSION AT NEWCASTLE, INDIANA.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Flywheel Explosion at Newcastle, Indiana.

A FLYWHEEL explosion of considerable violence occurred July 9th, 1925 at the factory of the Jesse French Piano Company, Newcastle, Indiana, and resulted in a property loss of $8,800. The engine overspeeded and the rim and five of the eight spokes of the wheel broke into many pieces which tore their way through the walls and roof of the engine room and scattered widely. A view of the engine room after the accident, is shown on our front cover.

One piece of the rim, about 3 ft. in length, flew over the three story main factory building and landed in a garden across the street. Another piece, about 2 ft. in length, was found in a field approximately 500 ft. from the plant. A man sitting on his front porch just across the street from the factory saw the flying fragments in the air and estimated that one piece ascended to a height of at least 200 ft. A hole 9 ft. by 50 ft. was torn in the roof of the engine room, and the windows and parts of the walls in line with the wheel were demolished. One arm of the wheel passed through the roof of the fire-pump house nearby and embedded itself 2 ft. in concrete. Several fragments of the wheel passed through the windows and south wall of the main factory building located 60 ft. from the engine room, breaking down some heating coils and two sprinkler pipes. Water from the sprinkler lines damaged finished pianos and materials in process of manufacture, and led to a newspaper estimate of the loss at $40,000. Prompt action by factory employees in moving pianos and other contents minimized the damage. In such a bombardment by large and small pieces of iron, it is remarkable that no one was injured.

The accident occurred at 1:50 P. M. when the plant was operating as usual. The engineer, A. B. Lanning, was at work on a pump in an adjacent room when he heard an unusual commotion in the engine room and went back to ascertain the cause. He saw that the engine was racing, and rushed to the throttle valve to close it. Just as he reached the throttle, the wheel exploded. The engineer's escape from serious injury or death was a miracle. One of the flying fragments passed across his back and cut his suspenders and shirt from his shoulders, yet did not even mark his skin. The throttle-valve wheel which he had grasped was smashed into eight pieces. Mr. Lanning displayed great courage in attempting to avert this catastrophe and his action is to be commended.

Another employee also had a narrow escape. He was walking along the third floor of the main building when a piece of the flywheel burst through the wall and flew past him, just grazing his shin.

After the accident one of the governor springs was found to be broken and it is thought that this failure might have occurred before the explosion and caused the governor to become inoperative. The engine frame was broken near the main bearing pedestal and the foundation was so cracked and broken as to necessitate rebuilding. In addition the connecting rod was badly sprung, the eccentric rod broken, the rocker arm cracked, and the governor completely ruined. Some of the coils of the generator were damaged and the generator pulley demolished.

The loss was covered by a Hartford policy.

The Trend in Modern Power Plant Design.

"NECESSITY is the mother of invention," and war with its insistent demand for more of everything — food, clothing, transportation, matériel — has always been a stimulus to invention. Probably no industry is exempt from such effects. Certainly the power industry is no exception for it has exhibited more fundamental improvements within the past six or eight years than it has ever known in a like period. Increased costs of labor and materials demanded either increased rates or greater efficiencies and the answer has been greater efficiencies. The cost of everything going into the production of power has been materially increased since before the war, yet the rates for electricity have remained the same or even been lowered. This has been made possible not by merely pushing existing installations a few notches higher in efficiency, but by a study of the theories upon which are based the conversion of the stored energy of coal into electrical energy and making new starts in untried fields.

Starting from the coal pile, the first innovation to be met is in the use of powdered fuel. In order to burn, coal must come in contact with air. Since the air can come in contact only with the surface of the lump, it takes an appreciable period of time to burn to the center of a lump. Pulverizing therefore results in a more intimate mixture of the fuel and air, and consequently expedites combustion. Greater economies have resulted from this system. In the first place more of the combustible matter is burned, thus reducing the loss from unburned fuel in the gases and ash. Also less excess air is required, and there is a considerable saving of coal during periods when the fire is banked. The improvement becomes most noticeable when the poorer grades of coal are burned. Of course the preparation of the coal is an additional expense and requires an investment for pulverizing machinery, but this is offset somewhat by the absence of stoker equipment. This system of firing has been in use for several years now and has proved its worth, although the furnace for burning powdered coal is still in process of evolution.

Furnace Walls Protected by Water Cooling.

Considerable trouble was at first experienced with the furnace walls when burning pulverized coal. Higher rates of combustion and consequent higher furnace temperatures were found to be more than the materials of the walls could stand. The coal burns while suspended in the air, and the molten ash sprayed against the wall seemed to act as a flux, melting the brickwork and running to the bottom of the furnace where, upon cooling, it would again harden. This at first led to a design of furnace along the line of the oil burning furnace — large volumes and the introduction of the fuel so that the flame would not impinge upon the walls — but the tendency in design now is toward the "well" type of furnaces. Ventilated or air cooled walls were next introduced to overcome the melting of the brick lining and proved singularly successful for this purpose, incidentally reacting favorably in an unexpected way as we shall see later.

The next step was from air cooled to water cooled walls and water screens in place of grates, all of these cooling tubes being connected to the boiler. This move was looked upon with some skepticism because it was felt that combustion would be checked by cool walls. Such has not proved to be the case, for on the contrary the reduction in temperature of the walls by water cooling is hailed as a decided step forward in furnace design. Protection of the walls and consequent reduction of the clinkering tendency permits higher rates of combustion to be employed, and in addition radiation from the setting is reduced. The heat absorbed by the water in the wall tubes is found to be considerable and advantage of this mode of heat transfer is taken to the fullest extent. The amount of cooling surface allowable, however, is a function of the kind of coal used, although the pulverized fuel furnace is not built, as are stoker furnaces, to burn a particular coal.

The latest type of furnace is one in which the fuel is injected somewhat tangentially to the sides and whirls around a small chamber or "well." A more turbulent flow and therefore better mixing and burning are thus obtained. After combustion, the gasses are expanded from the well to a larger chamber above it similar to the combustion space under an ordinary boiler. It is claimed that better results are obtained with this type of furnace and that the volume of the well and large chamber combined can be less than is provided in the ordinary stoker setting.

An innovation that has produced curious results is the use of pre-heated air for combustion. Pre-heating the air with heat from the furnace walls or flue gases was felt to be merely a conservation measure saving heat previously wasted. This it does and more, for the computed probable increase in thermal efficiency from this source has been exceeded due to better combustion. It is expected that the use of pre-heated air for combustion will become almost universal practice in larger power plants particularly with increasing steam pressures and temperatures, for more heat will be rejected to the stack gases to be reclaimed by either air preheaters or economizers, most likely the former since the economizers in turn will probably give way before stage heating of feedwater.

Heating Feedwater by Stages.

Stage feedwater heating is another recent efficiency booster in the boiler room from which much is expected. The method may be roughly compared to the counter flow principle of heat transmission. A certain amount of steam is bled from the low pressure stage of a turbine and used to bring the cold feedwater up to a given temperature. More steam is then bled from a higher pressure stage to raise the feed water temperature still higher. This could be continued in an indefinite number of steps and the gain would be in direct proportion to the number. Practical considerations, however, have so far restricted the number of stages in most cases to not more than four. Time may be expected to bring a simplification of the arrangement and an increase in the number of stages.

Along with the introduction of stage feedwater heating and probably as a direct result of the use of bleeder steam for such heating, we find the tendency toward electric driven auxiliaries. Current for these is usually obtained from a separate "house" generator.

One of the modern power plant developments that is attracting considerable attention is the tendency toward higher steam pressures. Only a few years ago 250 lbs. was spoken of as a high pressure. *Power* is authority for the statement that a Mollier chart was copyrighted the year the World War broke out, 1914, and included pressures up to 250 lbs. as a maximum, presumably considered the extreme limit of practice although steam tables were available up to 600 lbs. Yet today stations are operating at 400 lbs., 550 lbs., and 600 lbs., and in one case a station to operate at 1200 lbs. steam pressure is expected soon to be generating. Even this is not accepted as the limit and in

England experiments are being conducted on a laboratory scale to determine the possibility of generating steam at the critical pressure, 3200 lbs. At this pressure the latent heat, or heat of vaporization, is zero, and the transformation of water to steam would be instantaneous; there would be no ebullition or boiling action. But pressures are restricted by both physical and economic limits. The maximum temperature considered safe with the materials of construction available today is 750° Fahrenheit. Superheat of course is desirable, but the amount must be governed by the pressure since the temperature can not safely be raised much above 700° F. Undoubtedly this limit will soon be raised, for studies of the generation of steam indicate that greater gain may be expected from higher temperatures than from higher pressures. The economic limit upon steam pressure is set largely by the type of load the plant will be called upon to meet. The cost of high pressure plants is enormous, and the amount of equipment idle or running at poor efficiency for lack of load must be a minimum. Hence such plants are usually only designed for base load plants, that is, where a steady load averaging well up to the capacity of the station can be maintained. In the design of the Edgar Station of the Edison Electric Illuminating Company of Boston arrangements have been made so that the 1200 lb. unit will operate as a base load plant while the rest of the station, operating at 350 lbs., will take care of the fluctuating portion of the load.

It is interesting to note in connection with the 1200 lb. plant that the boiler drum is seamless, having been forged from a solid ingot, and that all fittings were subjected to an X-ray examination for possible latent flaws.

Reheating Steam Increases Thermal Efficiency.

Recent practice in modern power plants calls for the reheating of the steam after it has performed part of its work. The steam is taken off from the turbine at a designated pressure, reheated to approximately its original temperature and piped back to resume its work. The reheating is done sometimes by live steam but more often by the furnace gases direct just as in an ordinary superheater. Reheating the steam gives a perceptible increase in thermal efficiency but is somewhat complicated by the piping necessary to return the steam to the boiler. It is of interest to note that a new turbine hazard has been introduced by reheating; the reheater and its piping in some cases contain enough steam to overspeed the turbine even though the main governor cuts off additional steam. Of course, protection against this hazard is usually provided.

Modern power plants show a decided tendency toward larger generating units and stations. This has been brought about by the influence of many factors. Greater demand for power, improved materials and design, and necessity for cheaper production of current have all had their effect, but perhaps the real deciding factor has been interconnection. The interconnection of systems and stations has made larger generating units possible because each unit does not represent such a disproportionate percentage of the interconnected system as it does of a single station. Hence one of the large units can be shut down when necessary without interrupting the service, and this without carrying a large amount of idle standby equipment. The investment in reserve units is divided.

Interconnection has also in other ways reduced the cost of generating electricity. It has permitted greater use to be made of hydroelectric stations. At certain periods of the year more water enters the storage ponds than can be retained and therefore must waste over the spillway. By making a maximum load available to the hydroelectric plant during such seasons, use can be made of this water and recourse had to steam plants to tide over seasons when there is insufficient water. Interconnection also permits of greater use of the more efficient stations.

Other innovations in the field of power production are under consideration but have yet to be adopted for general use. The mercury boiler and turbine, for instance, has one installation operating successfully on a commercial basis. Low temperature carbonization of coal, advocated largely as a fuel conservation measure, has already proved its merits in Europe but it is still a matter of debate whether conditions in this country justify it. The wave of radical improvement has not yet subsided and other novel changes are to be expected, for when once stimulated, invention maintains its pace over quite a period of time before tapering off.

Boiler Explosion on the Steamship "Mackinac."

ON August 18th, 1925, one of the boilers exploded on the steamer "Mackinac" while in Narragansett Bay returning from Newport to Pawtucket, Rhode Island, and resulted in the death of fifty-two persons and the injury of over one hundred others. There have been boiler explosions that caused indirectly a greater number of fatalities through resulting fires or disasters incident to the explosions, but this is the largest recorded casualty list directly attributable to a boiler explosion in this country. Regularly a freight boat, the "Mackinac" had been put on an excursion route for the summer and at the time of the explosion was carrying nearly seven hundred excursionists, most of whom were members of either one of two groups holding annual outings. It was built in 1909 on the Great Lakes and was operated there until last year.

As shown by the illustration, the boilers on this vessel are of a rather unusual type said to be peculiar to lake boats. The upper part of the boiler is similar to a return tubular boiler, but in place of a setting,

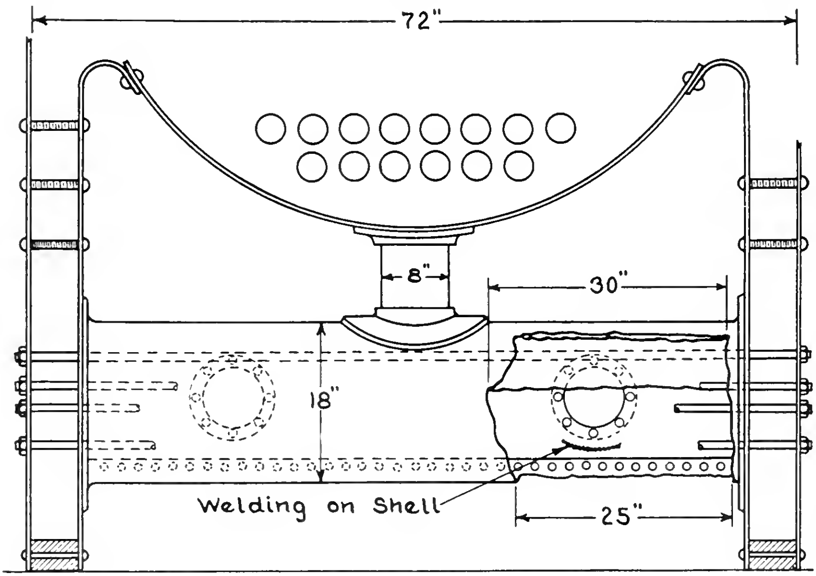


FIG. 1.

the fire box and combustion space are enclosed by water-legs which run along each side of the boiler for its full length. These water-legs are connected near the center by an 18 inch diameter circulating cross drum, which serves also as a bridge wall. This drum has an 8 inch diameter vertical connection to the boiler shell and two 6 inch diameter horizontal connections to the wet-back at the rear of the combustion chamber, as indicated in Fig. 1.

The failure was in the circulating cross drum of the forward boiler. Leakage in this drum had become evident and repair men from a local boiler shop were called in to weld the leak before the boat left Pawtucket on the morning of the accident. The welders reported a crack about 7 inches long near the longitudinal seam, which they were unable to repair because of lack of room and too much moisture from the leak; so that the boat set out for Newport, forty-five minutes late and with only the aft boiler, which had not been giving trouble, under steam.

A fire was later started under the forward boiler and the return trip begun about 5:30 P. M. with both of them in operation at reduced pressure. When but a short distance out from Newport the circulating cross drum of the forward boiler failed. The rupture began at a line about 25 inches long parallel and very close to the longitudinal seam — which was near the bottom of the drum on the side away from the grates — and tore a strip of this width circumferentially

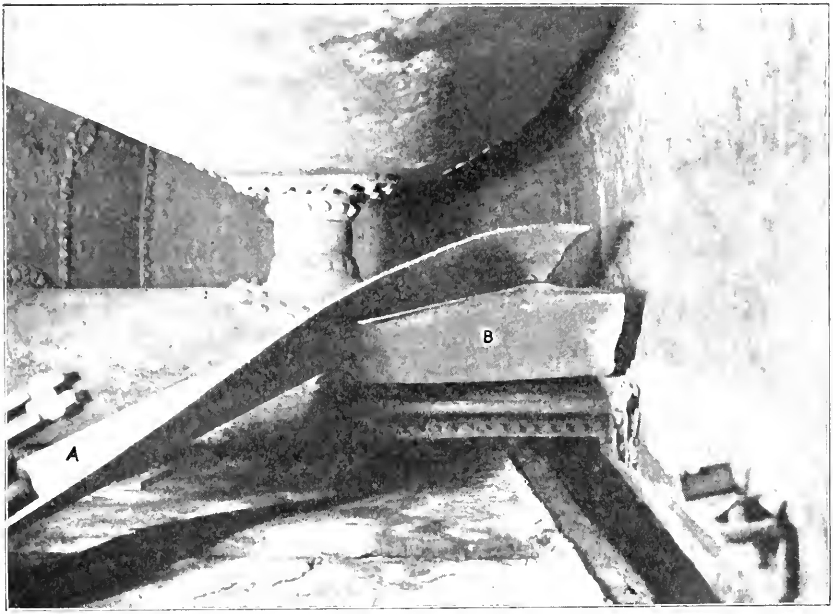


FIG. 2.

around more than one-quarter of the drum. The nature of the failure is clearly shown in Figs. 1 and 2. The piece marked "B" in Fig. 2 is the torn part of the drum shell. The piece marked "A" had no connection with the boiler.

Most of the killed and injured were on the main, or freight deck, where dancing was in progress, and were immediately enshrouded with live steam. The absence of a non-return valve on the steam line permitted the other boiler to continue to empty itself through the rupture. Although no parts of the boiler were violently projected about the boat, the pressure attained in the boiler room was sufficient to raise the steel main deck about 12 inches. The reaction of the escaping jet moved the boiler forward about one foot. The steam pressure allowed was 142 lbs., although only about 100 lbs. was being carried at the time of the accident.

The cause of the failure was external corrosion. External corrosion is a wasting away of the outside surface of the boiler, accelerated usually by the presence of moisture and soot. Sometimes the moisture comes from the boiler itself through a leak, and sometimes from other sources such as leaky valves or fittings in overhead pipings. Sometimes it may be produced by the sweating of a cold boiler, or perhaps by exposure to the elements. Deposits of soot, usually in comparatively inaccessible places which are likely to be slighted when cleaning the exterior of the boiler, retain this moisture and, by reason of the composition of soot, almost invariably result in corrosion of the plate which, if not checked, will soon become dangerous. The original thickness of the plate of the ruptured drum in this case was ⅜ inch, but it had been seriously reduced by the corrosion. The reduction in thickness of the shell began on a line running parallel to the axis along the lowest part of the drum and increased toward the seam, tapering off sharply to practically a knife edge at the line of initial failure. The defect — variously reported as "pin holes" and a "crack" — that prevented full use of the boiler just prior to the accident was evidently a place where the corrosion had penetrated through the plate. This wasting away of the place, however, had been so uniform and so free from signs of pitting or grooving that, except where it had actually penetrated through, there were practically no visible indications that the plate was dangerously thin.

Both of the boilers on this vessel had been inspected in April, 1925, by the government steamboat inspection service. While it would seem that the plate must have been seriously reduced at that time, yet we cannot attempt to say whether its condition could then have been detected as this depends entirely upon the nature of the inspection, a matter on which we are not informed. We do believe that if an experienced inspector examined this boiler when its latest defect developed just before the boat started on its fatal trip, the boiler would not have been approved either for temporary operation or for repair. It is hard to believe that anyone at all familiar with boiler construction would even consider repairing a boiler that had wasted away over a large area to the extent that there was an actual opening more or less continuous for a distance of approximately 7 inches. Yet the welders called in on the morning of the accident attempted to weld this opening, and undoubtedly would have done so had conditions permitted. Moisture and the inaccessible position of the opening were given as the reasons for not making the repair. There is no doubt that this leak would have been stopped by welding had conditions been more favorable for, about six weeks previous to the accident, an almost identical repair was made on the rear side of this same drum, and only a few inches from the final rupture. It too was apparently an opening about 7 inches long running approximately in a longitudinal direction and at a place where the metal was less than 1/16 inch thick.

A still further indication that the generally corroded condition of certain parts of the boiler had become evident is given by the fact that on the 6 inch diameter pipes connecting the ruptured drum with the wet-back, 75% of their external surfaces had been welded over. It might be well at this point to call attention to the apparent readiness of autogenous welders in general to apply their methods to boilers without giving any consideration whatever to the strength of the vessel. It is true that welds have been made which under test proved to be as strong and even stronger than the original plates joined; and it is perhaps with a knowledge of this fact that the welder undertakes to patch any opening in any vessel, placing sublime faith in his own work — done frequently under adverse circumstances — as being always the equal of the best. That so much of this work is imperfect and that there is no indication when such is the case is apparently lost sight of entirely. As a result, many repairs are made and defects covered over that should have had radically different attention. Until welders are frank to admit the limitations of their methods, it will be best to take your boiler troubles to a boiler inspector, — a man who is not interested in any one kind of cure, but only in the safety of the boiler.

This explosion is an outstanding one because of the number of casualties resulting from the explosion itself. Others have surpassed it although the number of killed and injured in each case was increased by accompanying disasters. One such instance is the explosion that occurred in March 1905 in a shoe factory at Brockton, Massachusetts in which the instantaneous collapse of the building and the ensuing fire resulted in the death of 58 and the injury of 117 persons. Another one, and one which undoubtedly will never be equaled, is the explosion of a boiler on the Mississippi River steamer "Sultana" in April 1865. The boat was packed beyond its capacity with Federal solders returning from prison camps. Fire followed the explosion and the boat was completely destroyed. Out of nearly 1900 soldiers on board, 1,101 perished, together with 137 of the civilian passengers and crew, a total of 1,238 killed.

Hartford Inspections à la Mode.

IF your boiler is located in Continental United States you can obtain "Hartford" inspections. No matter how remote or inaccessible the location, the inspector will find means of transportation and ferret it out. He may arrive by one of the usual methods of travel — train, automobile, or street railway — or if conditions require it he may travel by some less usual means. Inspector J. L. Wiant, for instance, has headquarters at Charleston, West Virginia, and covers considerable territory in the mountainous section of that state. The scattered population and infrequent train connections often prompt him to resort to hiking in order to save a day or two in journeying between plants. Of course the usual inspection kit must be taken along in addition to the regular traveling necessities, and so Inspector Wiant has a special carrying case to make easier the work of carrying his equipment. Traveling on foot in this territory is not as simple as one might think, for the road is not always in the open, but frequently leads through abandoned mines and even railroad tunnels. Bad weather also adds its disagreeable features. In spite of all this, Inspector Wiant does not consider portaging a pack for days at a time an irksome part of the work, but rather, dressed for the occasion, he derives much pleasure from these mountain hikes.

Inspector J. L. Wiant.

Inspector Wm. J. Betts.

Another inspector who occasionally resorts to a somewhat unusual means of travel is W. J. Betts of Ishpeming, Michigan. Ishpeming is located in the northern peninsula of Michigan and snows are frequent and heavy. Skiing is therefore a popular winter sport and it is not surprising that Inspector Betts should find it advantageous to make some inspection trips in this agreeable manner.

On the other hand, Inspector W. H. G. Slaymaker of Jackson, Mississippi shows a decided preference for more modern modes of travel. Inspector Slaymaker has had experience in aviation and his interest in the subject continues. While the automobile usually takes him on his rounds, he at times is fortunate enough to have an airplane at his disposal. This means of travel not only reduces the time spent in going and coming, but under certain conditions has expedited the work in another way. For instance, the inspector, in trying to keep track of portable boilers, often finds himself in a position to sympathize with the hen who "never finds things where she lays them." Portable sawmill boilers are seldom found where they were at the time of the last inspection, and sometimes are rather evasive. "In the woods" is often the only address. In such cases the advantages of an airplane observation are apparent. Of course the opportunity of flight holds no inducement for the inspector.

INSPECTOR WM. H. G. SLAYMAKER (RIGHT).

Riveting Pressures.*

THE pressure applied to rivets in the operation of riveting up and the length of time the pressure is sustained upon the rivets are two important factors which materially affect the efficiency of the riveted seams of boilers. In this country [England], these questions have received considerable attention, but there is a wide difference in the actual practice of various boiler makers. The following translation from a French contemporary expresses to some extent Continental opinion regarding riveting pressures, which it may be noted are appreciably less than is the practice in this country: —

*Extract from an article by V. Kammerer, in the *Bulletin of the French Association of Boiler Owners,* January, 1925. Reprinted from *Vulcan.*

" It is well known that in boiler shop work lines of rivets constitute weak points, not only in consequence of the reduction in strength due to the rivet holes, but also by reason of the stresses to which the edges of the plates are subjected in course of construction, all of which tend to set up stresses in the metal of the plates. Again, certain forms of riveted joints, notably lap joints, are subjected in the course of working to a bending action, and joints exposed to the fire are subjected to additional stresses in consequence of the differences of temperature which exist between the inner and outer surfaces of the plate.

Amongst the boiler shop operations which particularly affect the plates must be cited punching of the holes (a practice that every good shop will either forbid or render less harmful by subsequent drilling), bending of the plates, flattening of the edges and caulking. This latter operation cannot be avoided even when modern bending rolls are used and every care is taken in the construction.

These questions have been the subject of study for some years, and the opinions expressed have been that the operation of riveting was not likely to produce any serious alteration in the plates, neither through the heating of the rivet hole nor by the work of riveting itself. It is true that formerly a considerable proportion of the riveting was done either by hand or by a pneumatic hammer, and when hydraulic riveters were used the pressure rarely exceeded 50 tons. In more recent years, and particularly since the war, boiler shops have been furnished with more powerful tools to enable them to deal with thicker plates. These changes were already taking place in Germany before the war, as in that country higher pressures were more frequently used than in France, and also the Germans had a marked preference for the cylindrical boiler with internal furnaces, which for pressures of 180 lbs. per square inch require shell plates of considerable thickness. Due to the use of thicker plates the fitting of the ends is much more difficult, and in consequence boiler makers were tempted to make use of higher pressures in order to bring the plates together.

If plates fit well throughout the whole of the surface contact without any previous pressure, only a moderate pressure on the riveting machine is required to obtain a tight riveted joint, subject to the pressure being maintained for a sufficient period of time, as the close contact is assisted by the contraction of the rivet when cooling. The riveting machine must give a sufficient pressure to put a good head on the rivet, but this can readily be done if the rivet is properly heated. On the contrary, if the pressure is too high the contact of the plates at the joints may be unsatisfactory, due to their being stressed above the elastic limit.

This fact has already been noticed in the experiments made by Mons. F. Fremont in 1909. To determine the effect of the pressure during riveting upon the plate caused by the rivets, he used for rivets of 1 in. diameter pressures of 40, 70 and 100 tons, which corresponds approximately to 50, 90 and 125 tons per square inch of rivet area, and he found that in most of the cases the friction of the riveted joint diminished when pressures above 40 tons were used. He calculated that a pressure of 40 tons to 50 tons for 1 in. diameter was sufficient, and that any higher pressure would tend to crush the metal. A little later similar tests were undertaken at Stuttgart by Professors Bach and Baumann, and they arrived at similar conclusions, viz., that a riveting pressure of 42 tons to 52 tons per inch of the section of the rivet was sufficient to secure a good joint even with thick plates, and that if this latter pressure were exceeded there was a risk of injuring the metal around the rivet hole, and possibly setting up fractures.

The numerous failures that occurred in 1917 at a large chemical works in Germany of the riveting of almost new boilers (necessitating 22 boilers being put out of service), and a serious explosion at Reisholz* in 1920 causing 27 deaths, again drew attention to this question, as expert opinion attributed these failures to excessive riveting pressures. Professor Baumann undertook systematic tests to ascertain what was the effect of pressure and temperature upon the plates during riveting. Tests were made with heated iron rivets, the temperature of these being measured. When the rivet pressure exceeded a certain limit that Professor Baumann fixed at 52 tons per square inch on the area of the rivet, not only was the plate around the head of the rivet stressed beyond the elastic limit and deep depressions formed, but the pressure on the rivet was transmitted by the shank, which was in a plastic state, to the sides of the rivet hole, the temperature of the plate around the rivet hole being raised to about 900 deg. Fah., and this transmitted pressure caused crushing of the sides of the hole, the extent depending upon the riveting pressure used. As the shank of the rivet always has a tendency under pressure to take barrel form, it is near the middle of the hole — that is to say, the interior of the joint — that the metal is most severely stressed. It follows, then, that without considering any damage that may be done to the plates prior to riveting, cracks will be set up on the inner surfaces of the plates in contact, either at the time of riveting or at a later date, due to the stresses set up in

*See THE LOCOMOTIVE, January 1924, p. 11.

working acting upon the damaged parts. This fact, which is generally recognized, causes these failures to be particularly serious, as nothing can be detected by examination until the cracks have gone right through the plate.

But it is evident that if only a moderate riveting pressure is applied, other things being equal, the pressure must be kept on for a longer period if equal contact is desired. Mons. Fremont in his first experiments on riveting had drawn attention to the importance of the length of time pressure was applied, this time requiring to be increased if the fitting of the plates was poor, and that in no case should the time be less than 30 seconds. In England it is the practice in some cases to keep up the pressure for one minute. It must be remembered that the length of application of the pressure has an appreciable influence on the cost of riveting and the use of the plant, and it is therefore natural that boiler makers should, on their part, desire to reduce the time as far as possible. As contact is obtained chiefly by the contraction of the rivets and is affected by the fitting of the plates it does not seem that a minimum duration of time can be fixed suitable for all cases. The American Boiler Code includes a rule which states that pressure must be maintained so long as the rivet head shows red in daylight (another rule followed in certain boiler shops proportions the time of application of the pressure to the diameter of the rivet in millimetres). The American Boiler Code also states that the bolts holding the plates together must not be taken out until the rivet has been fixed on either side of the bolt. This precaution certainly tends to improve the contact of the plates and the tightness of the riveting.

An enquiry made in Germany in twelve of the most important boiler shops on the subject of pressures of riveting has shown that with two exceptions all these shops at the commencement of 1921 used pressures between 65 tons and 95 tons per square inch on the area of the rivet, whilst at the commencement of 1924 they had reduced the pressure to below 52 tons per square inch, and found that they were able to obtain the necessary contact of the plates and tightness of the joints which they had hitherto considered could only be obtained by the use of higher pressures."

From the *Zeitschrift* of the Steam Boiler Inspection and Insurance Company at Vienna, Austria, it is noted that nickel steel is being used in some cases for the shells of boilers built for very high pressures in Continental Europe. Furnaces and water tubes in such boilers, however, are without exception made of Siemens-Martin (mild) steel.

Harnessing Geysers in California.

By L. E. Grundell, Inspector, San Francisco Department.

SEVENTY-FIVE miles north of San Francisco in Sonoma County is Geyser Canyon, discovered in 1847 by W. B. Elliott, a hunter and trapper. This canyon is about one-half mile long and is full of boiling mineral springs and volcanic vents or fumaroles from which steam is constantly issuing. A meal can easily be prepared over one of these steam vents. About three years ago J. D. Grant of Healdsburg, a nearby town, conceived the idea of drilling out some of these vents and utilizing the natural steam for commercial use. The Geyser Development Company was organized and three wells were driven under unusual difficulties to depths from 150 to 300 ft. through ground from which steam was issuing in large quantities. Tests of the quantity, temperature, and pressure of the steam obtained indicated that about 1200 horse-power could be developed from these three wells.

Fig. 1.

During the past year four new experimental wells have been drilled by means of a rotary drill similar to the tool used in the oil fields. The last well opened up, No. 7, just before it was capped projected a jet of steam from an 8 inch diameter pipe fully 75 ft. into the air, as shown in Fig. 1. When capped it showed a pressure of 220 lbs. Well No. 6 only a hundred feet away developed a pressure in excess of 300 lbs. In order to limit it to this pressure, the safe working pressure for the casing valves and fittings, a 4 inch diameter escape pipe is provided as shown in Fig. 2. Well No. 5 showed a pressure of 250 lbs.

Utilization has not yet been made of this natural steam except to furnish power and light for furthering the work. A 12 kva. turbo-generator supplies electric power and light for the construction and drilling, and a 10 x 6 x 10 pump operating under 150 lbs. geyser steam pressure supplies water at a similar pressure for drilling. The experimental work is about completed and plans for a commercial electric generating plant are taking form.

Tests of this geyser steam reveal about 1½% of non-condensable gases, which, of course, is objectionable, and in addition a small amount of acid. This latter, however, is said to be so minute that no corrosive effect has been noticed on the casing, valves, or machinery. The quantity of this steam available is naturally an open qquestion, but it is said that no well has shown any falling off in production regardless of climatic changes or additional drillings. Preparations are now being made to sink two additional wells. A 16 inch diameter casing will be driven down for approximately 20 ft. and surrounded by a large concrete foundation. A 15 inch diameter casing will then be carried down the rest of the way and subsequently strengthened by an inside filling of concrete lined with a 12 inch diameter casing. To retain the drill in position and advance it, a giant hydraulic jack is used whose capacity is 300 tons.

FIG. 2.

Although this is the first development of the kind in America, Italy is reported to have in operation a plant utilizing 10,000 horsepower of geyser steam, 4,000 of which is furnished by a single well.

The Grave of John Fitch.

THE accompanying picture shows "the simple marker given by the government to the resting place of each Revolutionary soldier" which marks the grave of the inventor of the first successful steamboat. John Fitch was born January 21, 1743 in Windsor, Connecticut. He early showed an inclination for mechanical things and was in turn a watch repairer, brass founder, surveyor and engraver. This wide experience gave him an excellent grounding for the later development of his great invention.

In 1785 he designed and built a working model of a steamboat. A full size boat was next constructed, and in 1788 it traversed the Delaware River from Philadelphia to Burlington, a distance of 20 miles, at the rate of 6½ miles per hour. During the summer of 1790 his boat, capable of making 8 miles per hour, ran as a passenger boat over this route. The Philadelphia papers carried advertisements of the schedule, and the Federal Government granted him a patent on August 26, 1791.

As a protection of the invention, the state of New Jersey granted to Fitch for fourteen years the "sole and exclusive right of constructing, making, using and employing or navigating all and every species or kinds of boats or water craft which might be urged or impelled by the force of fire or steam in all the creeks, rivers, et cetera within the territory or jurisdiction of this state." This action was followed by similar action on the part of the states of Delaware, New York, Pennsylvania and Virginia. These rights were later transferred to Fulton and his financial backer, Livingstone. In this connection the following extract from "Public Statute Laws of the State of Connecticut May Session, 1822" is of interest:

"An Act to protect the citizens of Connecticut in their right to navigate boats or vessels moved by Fire or Steam.

> Whereas the Legislature of the State of New York, have passed, and continue to enforce, sundry acts giving to certain persons of that State, their associates and assigns, heirs and representatives, the sole and exclusive right of navigating all the waters claimed by that State, with boats or vessels moved by fire or steam, and have secured the observance of said laws by severe penalties and forfeitures; and whereas said laws operate to exclude the citizens of Connecticut from the free navigation of Long Island Sound, and the East River, communicating with the Atlantic ocean and our sister states —"

Then follows a section of the Act forbidding any person claiming rights under the above laws of the State of New York from operating any boat "moved by fire or steam" in the waters under the control of the State of Connecticut under penalty of $500 fine for the first offense, and $10,000 fine for the second offense. Another section pro-

(Continued on Page 22.)

The Locomotive

The Hartford Steam Boiler Inspection and Insurance Co.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS. Editor.

HARTFORD, JANUARY, 1926.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
Reprinting matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

PRESENT day civilization is a complex thing and there are many factors that have entered into its development and which are vital to its maintenance. Without any one of these factors, progress would be thrown back several generations at least. Look around, for instance at the many conveniences — automobiles, telephones, typewriters — necessities we will most likely call them today. How many would be within our price range without American mass-production methods. Or once produced, how many would still be available at any price without present day transportation facilities. And what a boon mechanical refrigeration has proven to all mankind. A varied assortment of fresh foods brought to our table in excellent condition the year round whether in city or country has meant perennial good health and the passing of the old fashioned spring tonic.

Yet all of these factors are in turn dependent upon one thing — power. With the development of more and cheaper power, particularly with the development of power in its most convenient form, as electricity, our highly organized civilization has advanced. Power is truly an Atlas upholding the world of present day civilization, and the recent growth of this mighty giant as outlined in the article on page 3 of this issue should therefore be of general interest.

Obituary.

WILLIAM T. WOODS, for nearly thirty-two years an employee of this Company, died suddenly on Thanksgiving Day, Thursday, November 26, 1925, at his home in Logan, Philadelphia, Pa. Apparently he had been in excellent health, but at midnight Wednesday he was stricken with apoplexy and died Thursday afternoon.

Mr. Woods was born at Newport, Pennsylvania, July 10, 1859, and entered the employ of our Philadelphia Department March 1, 1894. He had thus given nearly thirty-two years of faithful and efficient service to the Company. Mr. Woods was also an active and enthusiastic church worker.

The title page and index for Vol. XXXV of The Locomotive, covering the years 1924 and 1925, is now available and may be obtained upon application to the Hartford Office of the Company.

Autogenously Welded Tank Fails Under Air Test.

CONSIDERABLE interest was aroused by the article on page 239 of the October issue of The Locomotive describing the explosion of a new autogenously welded storage tank while it was being tested for tightness with compressed air. Another accident that occurred under strikingly similar circumstances was reported as follows in the *Albany Times-Union* of November 16, 1925:

> Two workmen were killed in the Ludlum steel plant, Colonie, [Watervliet, N. Y.] early today, when a new gas tank, which was being tested, through air-pressure exploded.
>
> The dead men are: John King, pipe fitter, 526 Sixth St., Watervliet. Salvis Corrato, pipe fitter's helper, 537 Broadway, Watervliet.
>
> The double fatality was purely accidental. It is customary at the big steel works to carefully test out all new apparatus. In accordance with this rule, the new gas tank was being tested today with air pressure. It was given a pressure up to its supposed capacity when the explosion occurred.
>
> The test was being made by the two men who were killed. The blast of the explosion hurled them several feet. First aid was administered promptly, but both victims were found to be beyond human help.

This tank was of 3/16 inch plate, 48 inches in diameter and 12 ft. long. The longitudinal seams were butt welded. The heads were 3/16 inch disks welded flat against the ends of the shell. The tank was intended for use as a gasoline storage tank and had a capacity of 1,000 gallons. At the time of the accident it was being tested for tightness by air and is said to have failed when the pressure reached 40 lbs. per square inch.

(Continued from page 19.)

vides that other boats shall not land or take off passengers from the proscribed steamboats on penalty of $100 fine per person. Still another section specifies that the Act shall remain in force so long as the objectionable New York laws remain in force. It is interesting to note that in 1824 the Supreme Court of the United States revoked and annulled these rights granted by the states.

Fitch continued his experiments with the steamboats until his death at Bardstown, Kentucky, July 2, 1798, nine years before Fulton's "Clermont" steamed up the Hudson River. Until a few years ago, Fitch's grave was entirely unmarked and unknown, but it is gratifying to note that Congress recently appropriated $15,000 for a monument to him to be erected at Bardstown.

Thinking Right Avoids Accidents.

WHEN a man is injured or loses his life through accident, the laws in the different states say what he or his depends shall receive in the way of compensation. That is, they say what a life is worth or a part of a life is worth. Statutes vary as to the amount to be paid the man or his dependents. Insurance companies will place such values on your life as you are able to pay for.

But who would attempt to place a value on a crippled man or a life? No one. The greatest fortune, doubled and trebled, could not induce you to become a cripple or part with your life needlessly; either is priceless. Obviously such an enormously important thing should be cherished and safeguarded in every way possible, yet injury and death are gambled with continually, in the shop, on the streets, and even in the home. Of course we don't deliberately defy Providence; we simply are thoughtless and careless.

The explanation of a great many accidents lies in failure to think. Yesterday, perhaps, or last week, we did really try to observe the principles of safety; but the safety of yesterday won't answer for today any more than will yesterday's dinner. We must keep on thinking about safety and what it means to us and to others.— *Gas & Electric News.*

BOILER EXPLOSIONS

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JANUARY, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
72	23	Section of heating boiler cracked			Wise, Smith & Co.	Business Block	Hartford, Conn.
73		Section of heating boiler cracked			John Malloy	Hotel & Restaurant	Hartford, Conn.
74		Five sections heating boiler cracked			First National Bank	Bank Bldg.	Helena, Ark.
75		Blow-off pipe fitting failed			The Stanwood Corp.	Boiler & Eng. Wks.	Covington, Ky.
76	24	Section of heating boiler cracked			Rebecca Edleson	Apt. House	Tarrytown, N. Y.
77		Section of heating boiler cracked			Standard Paper Co.	Stores & Lofts	Hartford, Conn.
78		Section of heating boiler cracked			Board of Pub. Education	School	Pittsburgh, Pa.
79		Section of heating boiler cracked			Daughters of Israel Home	Home for Aged	Newark, N. J.
80		Three sections heating boiler cracked			Marquis Lunch Co.	Restaurant	New York City
81	25	Four sections heating boiler cracked			Board of Public Education	School	Pittsburgh, Pa.
82		Section of heating boiler cracked			Millville Mfg. Co.	Cotton Mill	Philadelphia, Pa.
83	26	Two sections heating boiler cracked			Conroy's Auto Station	Garage	Torrington, Conn.
84		Manhole gasket blew out			Eagle Laundry	Laundry	Harlan, Ky.
85		Two tubes ruptured			Lederle Antitoxin Lab.	Laboratory	Pearl River, N. Y.
86		Tube failed			Bryant Paper Co.	Paper Mill	Kalamazoo, Mich.
87		Boiler ruptured			Sanitary Creamery	Creamery	Akron, Ohio
88	27	Rendering tank exploded			L. Scharff	Abattoir	Augusta, Ga.
89		Five sections heating boiler cracked			Arena Theatre	Theatre	New York, N. Y.
90		Boiler of locomotive exploded	2		C. & S. R. R. Co.	Railroad	Denver, Colo.
91	28	Section of heating boiler cracked			Consolidated School Dist.	School	Newell, Iowa.
92		Manifold and three sections heating boiler cracked			Eastman Kodak Co.	Kodak Factory	Rochester, N. Y.
93		Two sections heating boiler cracked			Buena Vista College	College	Storm Lake, Iowa.
94		Three sections heating boiler cracked			Wm. J. Hyland	Office Bldg.	Springfield, Mass.
95		Boiler exploded			Industrial Home	Home for Girls	Tipton, Mo.
96		Key cap blew out of header			Jessup & Moore Paper Co.	Pulp & Paper Mill	Wilmington, Del.
97		Vulcanizer exploded		1	Guenter Goodyear Service Sta.	Service Station	N.Little Rock, Ark.
98		Two sections heating. boiler cracked			Est. of Chas. N. James	Garage	Cambridge, Mass.
99		Three sections heating boiler cracked			Louis F. Breitenwisher	Apt. House	Lansing, Mich.

MONTH OF JANUARY, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
100	29	Section of heating boiler cracked			St. Joseph's Home	Home for Boys	Philadelphia, Pa.
101		Section of heating boiler cracked			Sam Bookstein	Furniture Store	Hamtranch, Mich.
102		Section of heating boiler cracked			Board of Trustees	Hendley School	Winchester, Va.
103		Boiler exploded			Frederick's Lease	Oil Well	Derrick City, Pa.
104		Hot water boiler exploded			Kirbyville Inn	Inn	Kirbyville, Pa.
105		Manifold and seven sections heating boiler cracked			Estate of Bencion Moskow	Apt. House	Dorchester, Mass.
106		Several sections heating boiler cracked			Louis F. Breitenwisher	Apt. House	Lansing, Mich.
107	30	Section of heating boiler cracked			Citizen's State Bank	Bank Bldg.	Bedford, Iowa.
108		Section of heating boiler cracked			Est. of A. L. Maxwell	Apts. & Stores	Lawrenceville, Ill.
109	31	Six sections heating boiler cracked			Waldorf System, Inc.	Restaurant	Salem, Mass.
110		Blow-off pipe fitting failed			R. X. DeGraw	Mercantile Bldg.	Kansas City, Mo.
111		Boiler ruptured			P. Goldsmith Sons Co.		Cincinnati, Ohio.
112		Boiler exploded	2	2	H. C. Milnor Sand & Lime Co.	Sand Dredge	Knoxville, Tenn.
113		Hot water supply boiler exploded		6	Palais d'Or	Restaurant	New York, N. Y.

MONTH OF FEBRUARY, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
114	1	Section of heating boiler cracked			Air Reduction Co., Inc.	Oxygen Plant	Dorchester, Mass.
115	2	Valve in feed water line ruptured			Charlottesville Woolen Mills	Woolen Mill	Charlottesville, Va.
116		Two tubes ruptured			Waddell Steel Co.	Steel Plant	Niles, Ohio
117		Boiler exploded	1	6	Walter Robey	Sawmill	Arkadelphia, Ark.
118	3	Superheater circulating tube pulled out			Penn Central Lt. & Power	Power Plant	Laurel, Del.
119		Section of heating boiler cracked			Air Reduction Co., Inc.	Oxygen Plant	Madison, Ill.
120	4	Flue plug blew out of locomotive			West Fork Logging Co.	Logging Camp	Tacoma, Wash.
121	5	Tube ruptured			Thomas Devlin Mfg. Co.	Iron Works	Burlington, N. J.
122		Boiler exploded		1	Crouch Lease	Oil well	Wortham, Texas
123		Boiler exploded			Byars-Hall High School	School	Covington, Tenn.
124		Several sections heating boiler cracked			Dworman Bros.	Apts. & Stores	Worcester, Mass.
125		Section of heating boiler cracked			Cosmopolitan Club	Club House	New York, N. Y.
126		Section of heating boiler cracked			Elizabeth C.. Graham	Apt. House	Omaha, Nebr.
127		Section of heating boiler cracked			Filbeck Hotel	Hotel	Terre Haute, Ind.

128	6	Two sections heating boiler cracked			Chas. P. Case	Store	Hartford, Conn.
129		Section of heating boiler cracked			Est. of M. Martin	Office Bldg.	Pittsburgh, Pa.
130	7	Section of heating boiler cracked			N. T. Hessell	Apt. House	Oakland, Calif.
131		Two sections heating boiler cracked			May Hosiery Mills	Hosiery Mill	Burlington, N. C.
132		Two sections heating boiler cracked			City of Cleveland	Police Station	Cleveland, O.
133		Four sections heating boiler cracked			Waldorf System, Inc.	Restaurant	Springfield, Mass.
134		Six tubes ruptured			Rensselear Polytechnic Institute	College	Troy, N. Y.
135		Ammonia tank exploded	1	19	Nat'l Evans Film Laboratory	Film Laboratory	Fort Lee, N. J.
136		Hot water heating boiler exploded			P. J. Bresnahan	Store & Apt.	Stevens Pt., Wis.
137	9	Boiler ruptured			B. & M. Lumber Co.	Planing Mill	Bay Minnette, Ala.
138	10	Blow-off pipe fitting failed			Polar Ware Co.	Enamelware Plant	Sheboygan, Wis.
139		Hosiery press exploded			York Knitting Mills	Knitting Mill	York, Pa.
140		Section of heating boiler cracked			Gordon & Wagman	Apt. Block	Hartford, Conn.
141	12	Section of heating boiler cracked			Kelly Realty Co.	Apt. House	Kansas City, Mo.
142		Blow-off pipe failed			National Candy Co.	Candy Factory	Louisville, Ky.
143		Section of heating boiler cracked			National Dept. Stores	Warehouse	Pittsburgh, Pa.
144		Two sections heating boiler cracked			Bershad Baths, Inc.	Turkish Baths	Philadelphia, Pa.
145		Boiler exploded	3	1	I. C. Lantrip	Sawmill	Pontotoc, Miss.
146	13	Six sections heating boiler cracked			Jacob Burwick	Stores & Apts.	Worcester, Mass.
147		Two sections heating boiler cracked			Board of Education	School	Amigo, W. Va.
148		Autogenously welded tank exploded	2		Coatesville Boiler Wks.	Boiler Wks.	Coatesville, Pa.
149		Boiler exploded			McDonald Public School	School	McDonald, Pa.
150	14	Section of heating boiler cracked			Belzer Corporation	Apt. House	New York, N. Y.
151		Crown sheet failed			Superior Coal Co.	Mine	Wheeling, W. Va.
152	15	Section of heating boiler cracked			Hubbell Auto Sales Co.	Automobile Sales	Saginaw, Mich.
153		Section of heating boiler cracked			Alabama State Normal School	School	Livingston, Ala.
154		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
155		Section of heating boiler cracked			Rose Arkin	Apt. House	Brooklyn, N. Y.
156	16	Two sections heating boiler cracked			The Kirk Co.	Store	Akron, Ohio
157		Section of heating boiler cracked			O'Bryan Bros.	Factory	Nashville, Tenn.
158		Boiler bulged and ruptured			Tindall-Gerling Furniture Co.	Furniture Factory	Shelbyville, Ind.
159	17	Section of heating boiler cracked			Knights of Columbus	Lodge Rooms	Louisville, Ky.
160	19	Three sections heating boiler cracked			German Workingmen's Assn.	Club House	Roxbury, Mass.
161		Two sections heating boiler cracked			East 105th Improvement Co.	Garage	Cleveland, O.
162		Boiler exploded			East Coast Oil Co.	Pumping Station	Vera Cruz, Mex.
163		Boiler exploded	1	1	J. E. Kicklighter	Sawmill	Daisy, Ga.
164		Accident to boiler		1	Pitt Mfg. Co.		Bath, N. Y.
165		Boiler exploded		1	East End Garage	Garage	Alameda, Calif.
166	20	Three tubes ruptured			Hower-Laughlin China Co.	Pottery	Newell, W. Va.

MONTH OF FEBRUARY, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
167		Tubes pulled out of read			Peoples' Gas Light & Coke Co.	Gas Plant	Chicago, Ill.
168		Steam pipe exploded	2	3	Canadian Pacific R. R. Co.	Railroad	Winnipeg, Can.
169		Four tubes pulled out of drum			Brown Paper Mill Co.	Paper Mill	Monroe, La.
170	21	Two sections heating boiler cracked			Est. of Wm. Davis	Apts. & Stores	Brooklyn, N. Y.
171	22	Hot water heater exploded		2	Charlestown Armory	Armory	Charlestown, Mass
172	23	Two sections heating boiler cracked			New Orleans Country Club	Club	New Orleans, La.
173	24	Boiler failed			Windmore Hotel	Hotel	St. Louis, Mo.
174		Tube ruptured, seven headers cracked			The Solvay Process Co.	Alkali Plant	Holt, Ala.
175		Arch tube of locomotive failed		3		Railroad	Langhorne, Pa.
176	25	Three sections heating boiler cracked			S. & J. Kohn	Warehouse	Hartford, Conn.
177		Six sections heating boiler cracked			Calumet Baking Co.	Bakery	Hammond, Ind.
178		Boiler exploded		7	S. S. Alaska	Steamship	Seattle, Wash.
179	26	Fitting on return line ruptured			American Printing Co.	Cotton Goods	Fall River, Mass.
180		Blow-off pipe fitting failed			Ohio Valley Pulley Co.	Pulley Works	Maysville, Ky.
181	27	Blow-off pipe failed			McLaurin-Jones Co.	Paper Mill	Ware, Mass.
182		Boiler bulged and ruptured			Model Laundry Co.	Laundry	Rockford, Ill.
183		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
184		Boiler exploded		2	J. E. Brown	Sawmill	Duncanville, Ala.
185		Boiler exploded			Charles Irwin	Reduction Plant	Petersburg, Ill.
186		Section of heating boiler cracked			School District No. 2	School	Bisbee, Ariz.
187		Five sections heating boiler cracked			Dworman Bros.	Apts. & Stores	Worcester, Mass.
188	28	Four sections heating boiler cracked			H. S. & B. N. Jelonak	Business Block	Chicago, Ill.
189		Boiler ruptured			Schwartz Apartments	Apt. House	Allentown, Pa.

MONTH OF MARCH, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
190	1	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
191		Boiler ruptured			Wisconsin Motor Mfg. Co.	Factory	West Allis, Wis.
192		Boiler exploded			Louisiana Cooperage Co.	Cooperage Plant	New Orleans, La.
193		Boiler of locomotive exploded	1	2	Lehigh & Hudson R. R. Co.	Raliroad	Monroe, N. J.
194		Four sections heating boiler cracked			Knights of Columbus	Lodge Rooms	Louisville, Ky.
195	2	Section of heating boiler cracked			Geo. B. Wuestefeld	Garage	New Haven, Conn.

196		Section of heating boiler cracked			Samuel Schlesinger	Apts. & Stores	Denver, Colo.
197		Boiler exploded			C. A. Donaldson	Tire Shop	Peoria, Ill.
198	3	Two sections heating boiler cracked			School Dist. No. 46	School	Sedgwick, Colo.
199		Two sections heating boiler cracked			Board of Education	School	Chickasha, Okla.
200		Section of heating boiler cracked			City of Laurel	City Hall	Laurel, Miss.
201		Tube ruptured		1	C. & O. R. R. Co.	Railroad	Huntington, W. V.
202		Heating boiler exploded			Joseph Naguszewski	Apt. House	Brooklyn, N. Y.
203		Boiler exploded			Levy Dept. Store	Dept. Store	Moberly, Mo.
204		Blow-off tank failed		1	Penna. Milk Products Co.	Milk Products	Harrisburg, Pa.
205	4	Blow-off pipe fitting failed			Ohio Hydrate & Supply Co.	Lime Plant	Woodville, O.
206		Blow-off pipe failed			W. W. Winship & Sons	Trunk Factory	Utica, N. Y.
207		Three sections heating boiler cracked			J. H. S. Jones	Carpenter Shop	Bridgeport, Conn.
208		Five sections heating boiler cracked			Board of Education	School	Mt. Hope, Kans.
209		Section of heating boiler cracked			Cuba-Conn Tobacco Co.	Warehouse	Feed'g Hills, Mass.
210	6	Section and two water-backs of heating boiler cracked			St. Nicholas Church	Church	Old Forge, Pa.
211		Three sections heating boiler cracked			Westminster School, Inc.	School	Simsbury, Conn.
212		Section of heating boiler cracked			D. L. Richman	Apt. House	San Fran., Cal.
213		Section of heating boiler cracked			Bartlett-Brainard Co.	Apt. House	Hartford, Conn.
214		Fitting on main steam line ruptured		1	Muse Tailoring Co.	Clothing Factory	Frederick, Md.
215	7	Three sections heating boiler cracked			Bray Hotel	Hotel	Kansas City, Mo.
216		Section of heating boiler cracked			Chas. S. Ashley & Sons	Office Bldg.	New Bedford, Ms.
217		Tube rutpured			Bryant Paper Co.	Paper Mill	Kalamazoo, Mich.
218	8	Non return valve ruptured			Hockanum Mills Co.	Woolen Mill	Rockville, Conn.
219		Tube pulled out			Litchfield Shuttle Co.	Shuttle Factory	Southbridge, Mass.
220	9	Section of heating boiler cracked			Hannie Murphy	Apt. House	Atlanta, Ga.
221	10	Crown sheet failed			J. P. O'Neil Co.	Sand Yard	Pittsburgh, Pa.
222		Section of heating boiler cracked			Hermes Hotel	Hotel	Denver, Colo.
223		Section of heating boiler cracked			Feinberg Bros.	Business Block	Hartford, Conn.
224		Three sections heating boiler cracked			Wexler & Goldberg	Business Block	New Britain, Ct.
225	11	Two sections heating boiler cracked			J. Lee Ryan	Residence	Cleveland Hts., O.
226	12	Five sections heating boiler cracked			Open Hearth Association	Church	Hartford, Conn.
227		Section of heating boiler cracked			Marie Chabanoff	Hotel Apts.	San Fran., Cal.
228	12	Tube ruptured and three headers cracked			Tide Water Oil Co.	Refinery	Bayonne, N. J.
229		Tube ruptured		2	Inland Empire Paper Co.	Paper Mill	Millwood, Wash.
230		Boiler bulged and ruptured			John C. Lewis	Store	Louisville, Ky.
231	13	Three sections heating boiler cracked			Lydia H. Roper Home	Apt. House	Norfolk, Va.
232		Boiler exploded			Hanford Cream Station	Milk Station	Sturgis, S. D.

MONTH OF MARCH, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
233	14	Tube ruptured			Proctor & Gamble Mfg. Co.	Soap Factory	Dallas, Texas
234		Manifold of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Charlotte, N. C.
235		Section of heating boiler cracked			Willys-Overland Co.	Auto Parts Fact'y	Brooklyn, N. Y.
236	15	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
237		Two tubes ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
238	16	Blow-off pipe fitting failed		1	Fales & Jenks Mach. Co.	Machine Shop	Pawtucket, R. I.
239		Blow-off pipe fitting failed			Ohio Hydrate & Supply Co.	Lime Plant	Woodville, O.
240		Boiler exploded	2	2	Shagnon & Bacle Co.	Sawmill	Grappes Bluff, Mo.
241		Manifold of heating boiler cracked			Alfred E. Buckler	Apt. House	Springfield, Mass.
242		Section of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Plainfield, N. J.
243	17	Four sections heating boiler cracked			Youngstown Sheet & Tube Co.	Steel Plant	Nemacolin, Pa.
244		Section of heating boiler cracked			Cuba-Conn. Tobacco Co.	Warehouse	Feed'g Hills,Mass
245	20	Blow-off pipe failed			Natick Box & Board Co.	Paper Mill	Natick, Mass.
246	21	Malt mixer exploded	4	5	Maltose Laboratories, Inc.	Malt Cannery	New Orleans, La.
247	22	Tube pulled out		2	American Can Co.	Can Factory	Maywood, Ill.
248	22	Boiler exploded			Howard C. Marshall	Restaurant	Detroit, Mich.
249	23	Steam separator ruptured			Wisconsin Chair Co.	Chair Factory	Grafton, Wis.
250		Three sections heating boiler cracked			Waldorf System, Inc.	Lunch Room	Boston, Mass.
251		Boiler exploded	1	1	Magnolia Well	Oil well	Chandler, Okla.
252	24	Three tubes failed			R. B. & R. Knight, Inc.	Cotton Mill	Centreville, R. I.
253		Header cracked & tubes pulled out			Lang Floral & Nursery Co.	Florist	Dallas, Texas.
254		Boiler ruptured			Rutherford Brick & Tile Co.	Brick Factory	Hamburg, S. C.
255	25	Tube ruptured			Bleecker Holding Corpn.	Factory	New York, N. Y.
256		Section of heating boiler cracked			The Country Club	Country Club	Brookline, Mass.
257	28	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
258		Boiler exploded	1	2	E. G. O'Bannon	Sawmill	Montauk, Mo.
259		Boiler exploded			Handy Robinson	Sawmill	Centreville, Md.
260	29	Tube ruptured			Western Colorado Power Co.	Power Plant	Durango, Colo.
261		Section of heating boiler cracked			Downey Hospital	Hospital	Gainesville, Ga.
262	30	Section of heating boiler cracked			S. M. Williams & Co	Office Bldg.	Memphis, Tenn.
263		Crown sheet of locomotive failed			Little River Redwood Co.	Sawmill	Crannell, Cal.

MONTH OF APRIL, 1925.

264	1	Fifteen headers cracked			Diamond Alkali Co.	Alkali Works	Fairport, Ohio
265		Section of heating boiler cracked			Rimes Lee Motor Co.	Sales Room	Ind. Harbor, Ind.
266	2	Section of heating boiler cracked			Sayles Finishing Plant, Inc.	Miscellaneous	E. Providence, R. I.
267		Section of heating boiler cracked			Philip Greenberg	Dept. Store	Omaha, Nebr.
268		Section of heating boiler cracked			Kiely Bros.	Garage	Amherst, Mass.
269	3	Main stop valve ruptured			Penn Worsted Co.	Worsted Mill	Philadelphia, Pa.
270	4	Section of heating boiler cracked			Schwoerer's Lunch Room	Lunch Room	Camden, N. J.
271		Hot water heater exploded			Samuel Gutstein	Residence & Store	Philadelphia, Pa.
272	5	Steam pipe burst	1		American Zinc & Chemical Co.	Chemical Plant	Pittsburgh, Pa.
273		Two sections heating boiler cracked			Loew's, Inc.	Theatre	Boston, Mass.
274	6	Section of heating boiler cracked			Board of Education	School	Piqua, Ohio
275		Tube failed			Texas Power & Light Co.	Power Plant	Olden, Texas
276	7	Five headers cracked			Pittsburgh Plate Glass Co.	Glass Factory	Kokomo, Ind.
277		Boiler exploded			Inner Rivers Refinery Co.	Refinery Co.	Scottsville, Ky.
278		Boiler of locomotive exploded		5	Pennsylvania R. R. Co.	Railroad	Indianapolis, Ind.
279	8	Ammonia pipe failed			Oswego-Netherland Co., Inc.	Cold Storage Plant	Oswego, N. Y.
280		Boiler exploded		1	Arkansas Drilling Co.	Oil Well	El Dorado, Ark.
281	9	Header cracked			Scoville Mfg. Co.	Brass Factory	Waterbury, Conn.
282		Boiler bulged and ruptured			Neches Canal Co.	Irrigation Plant	Beaumont, Texas
283	11	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
284		Two sections heating boiler cracked			Red Top Cab Co.	Garage	Cleveland, Ohio
285		Section of heating boiler cracked			Menig Investment Co.	Hotel	Denver, Colo.
286	12	Section of heating boiler cracked			Geo. A. Lewis Co.	Apts. & Stores	Danbury, Conn.
287	13	Boiler ruptured		1	Clermont Steam Laundry Co.	Laundry	Brooklyn, N. Y.
288	14	Hot water supply tank exploded			391 West Side Avenue	Residence	Jersey City, N. J.
289		Tube ruptured and three headers cracked			Vesta Knitting Mills	Textile Mill	Providence, R. I.
290		Two sections heating boiler cracked			Avedis Der Hovhanessian	Office & Stores	Boston, Mass.
291		Six sections heating boiler cracked			Shepley Land Co.	Office Bldg.	Providence, R. I.
292	15	Section of heating boiler cracked			Board of Public Educational	School	Pittsburgh, Pa.
293		Tube pulled out of drum			Brown Paper Mill Co.	Pulp & Paper Mill	W. Munroe, La.
294		Tubes pulled out of drums			Bloedel Donovan Lumber Mills	Lumber Mill	Bellingham, Wash.
295		Blow-off pipe failed			Manhattan Sponging Works	Pressers	St. Louis, Mo.
296	17	Tube failed			Hodenpyl, Hardy & Co.	Power Plant	Battle Creek, Mich.
297		Section of heating boiler cracked			Elders Lodge No. 11, I. O. O. F.	Lodge Room	Las Animas, Col.
298	18	Two sections heating boiler cracked			Williams College	College	Williamst'n, Mass.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1924

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks	$312,885.77
Real Estate	255,000.00
Mortgage and collateral loans	1,797,000.00
Bonds and stocks	9,830,809.50
Premiums in course of collection	1,114,552.34
Interest Accrued	145,614.56
Total assets	$13,455,862.17

LIABILITIES

Reserve for unearned premiums		$5,897,736.62
Reserve for losses		258,782.17
Reserve for taxes and other contingencies		559,988.34
Capital stock	$2,500,000.00	
Surplus over all liabilities	4,239,355.04	
Surplus to Policyholders,		**$6,739,355.04**
Total liabilites		$13,455,862.17

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
LOUIS F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
SHERWOOD F. JETER, Chief Engineer.
KENNETH A. REED, Electrical Engineer.
HARRY E. DART, Supt. Engineering Dept.

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Incorporated 1866 — THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. — Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

Department	Representatives
ATLANTA, Ga.,	W. M. Francis, Manager.
1103-1106 Atlanta Trust Bldg.	C. R. Summers, Chief Inspector.
BALTIMORE, Md.,	Lawford & McKim, General Agents.
13-14-15 Abell Bldg.	James G. Reid, Chief Inspector.
BOSTON, Mass.,	Ward I. Cornell, Manager.
4 Liberty Sq., Cor. Water St.	W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn.,	W. G. Lineburgh & Son, General Agents.
404-405 City Savings Bank Bldg.	A. E. Bonnet, Chief Inspector.
CHICAGO, Ill.,	P. M. Murray, Manager.
209 West Jackson B'l'v'd	J. P. Morrison, Chief Inspector.
	J. T. Coleman, Ass't Chief Inspector.
	C. W. Zimmer, Ass't Chief Inspector.
CINCINNATI, Ohio,	W. E. Gleason, Manager.
First National Bank Bldg.	W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio,	A. Paul Graham, Manager.
Leader Bldg.	L. T. Gregg, Chief Inspector.
DENVER, Colo.,	J. H. Chesnutt,
916-918 Gas & Electric Bldg.	Manager and Chief Inspector.
HARTFORD, Conn.,	F. H. Kenyon, General Agent.
56 Prospect St.	A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La.,	R. T. Burwell, Mgr. and Chief Inspector.
Hibernia Bank Bldg.	E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y.,	C. C. Gardiner, Manager.
80 Maiden Lane	E. Mason Parry, Chief Inspector.
	R. P. Guy, Ass't Chief Inspector.
PHILADELPHIA, Pa.,	A. S. Wickham, Manager.
429 Walnut St.	S. B. Adams, Chief Inspector.
PITTSBURGH, Pa.,	Geo. S. Reynolds, Manager.
1807-8-9-10 Arrott Bldg.	J. A. Snyder, Chief Inspector.
PORTLAND, Ore.,	Bates, Lively & Pearson, Gen'l Agents.
306 Yeon Bldg.	C. B. Paddock, Chief Inspector.
SEATTLE, Wash.,	C. B. Paddock, Chief Inspector.
415 Dexter-Horton Bldg.	
SAN FRANCISCO, Cal.,	H. R. Mann & Co., General Agents.
339-341 Sansome St.	J. B. Warner, Chief Inspector.
	L. J. Reed, Ass't Chief Inspector.
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Federal Bldg.	

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXVI HARTFORD, CONN., APRIL, 1926. No. 2.

HOT WATER SUPPLY TANK EXPLOSION AT WATERVILLE, CONN.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Hot Water Supply Tank Explosion at Waterville, Conn.

THE picture on the front cover page illustrates an accident that comes quite close home to practically everyone. A hot water supply tank failed apparently from overpressure and completely demolished the building in which it was housed. Fortunately no one was in the building at the time.

The building was a one story frame structure used as a public bath house and was the property of the town of Waterville, Connecticut. It was equipped with shower baths, a gas coil water heater, and a copper hot water supply tank. A steel mixing tank was formerly part of the system, but it had not been in use for some time and had been disconnected. This steel tank appears quite prominently in the picture though it had no part in the accident. The copper tank that exploded is said to have been about 10 years old, but showed no signs of weakness or distress.

The explosion was caused by overpressure, as shown by the violence attending it. Not only was the building demolished, but one portion of the tank passed over a two story building and over several large elm trees, landing about 500 ft. away in the yard of an old factory. The distance traveled and height attained by this section of the tank are remarkable inasmuch as it had been in a horizontal position in the bath house.

This accident is of particular interest because it happened to the type of hot water supply installation found in most residences and apartment houses. There was no relief valve on the tank. Overpressure was supposed to be prevented by the water backing into the city main. There was, of course, a valve where the feed line entered the building but this valve was found open after the accident. There was no meter in the line. What prevented the water from backing out and thus relieving the pressure is not apparent, but it is believed to have been due to scale or sediment loosened by the back flow of water. A relief valve of suitable size mounted on the tank would most likely have averted this explosion, which was directly due, it is thought, to the gas heater having been left on over night.

According to *The Valve World*, the new high school building at Pagosa Springs, Colorado is heated with natural hot water from an artesian well 350 ft. deep. The building contains about 7,000 ft. of radiation, which, owing to the lower temperature of the well water, is practically double the radiation that would be required for artificial heat.

Duplicate Boiler Explosions.

LIGHTNING is said never to strike twice in the same place, and although there is no such popular belief protecting the owners of boilers, the natural effect of a boiler explosion is to impress itself so vividly on the minds of the persons connected with the plant that the standard of safety is raised and the possibility of a repetition becomes more remote. A boiler explosion doesn't just happen, but instead is brought on by a definite cause. If the cause is not definitely determined and removed, a repetition of the accident is to be expected.

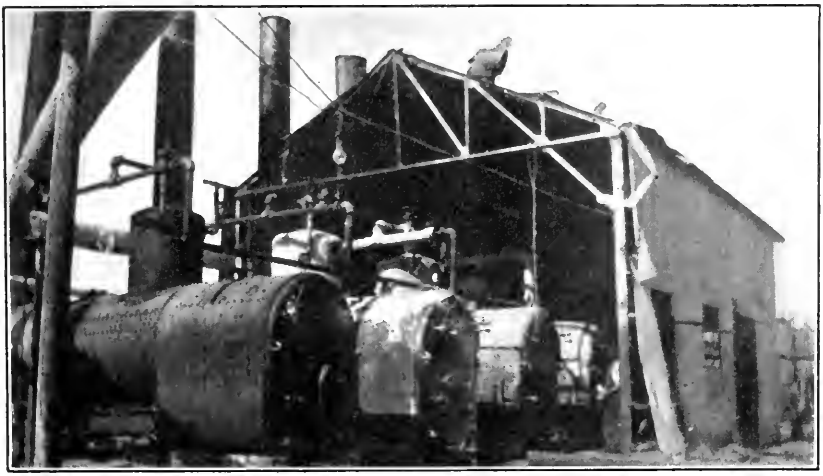


FIG. 1.

For instance, stop valves on steam lines are frequently ruptured by water-hammer. The water-hammer is most likely produced by an improperly drained pipe system or by faulty operation of the boilers. Unless the piping is redesigned or the boiler operation improved, further accidents are almost sure to occur.

The Waite Phillips Company of Rainbow Bend near Winfield, Kansas, suffered a boiler explosion in July 2, 1925, and on September 12, 1925 suffered a second explosion from exactly the same cause — low water. The installation consists of four locomotive type boilers, as shown in Fig. 1, that operate at 150 lbs. pressure. At the time of the first accident, which occurred about 2:40 A. M., the fireman was about 100 ft. away from the boiler house, returning from another building. The water level in boiler No. 1 became low and uncovered the crown sheet with the usual result. The crown sheet overheated and collapsed and ruptured, causing the boiler to be thrown forward about 50 ft. from its foundation. About half of the boiler house was wrecked. Fig. 1 shows the scene of the accident after a new boiler had been installed in place of boiler No. 1 but before the boiler house had been rebuilt. Fortunately no one was injured in this accident. The property loss was approximately $2,500.

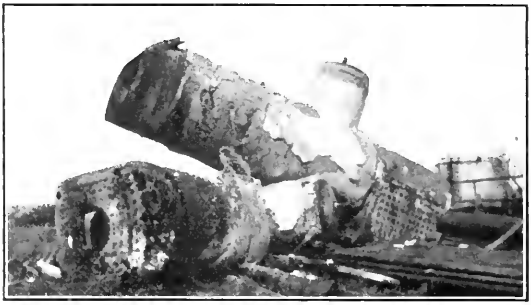


Fig. 2.

A little over two months later boiler No. 4 in this group exploded. As in the previous instance, the cause was low water. The crown sheet dropped and the boiler hurtled out of the house. By a peculiar twist of fate, it came to rest partly on top of the one that had exploded before. The two boilers are clearly shown in Figs. 2 and 3 just as they landed. Again no one was injured. The property loss amounted to $1,700.

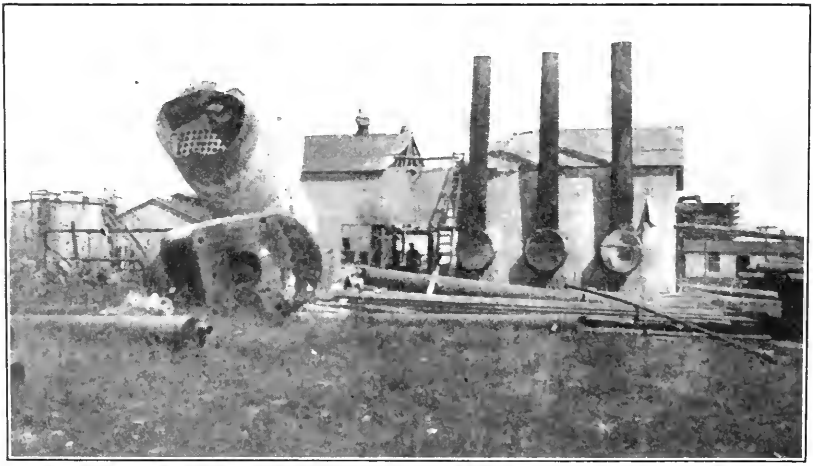


Fig. 3.

As previously stated, the direct cause of each accident was low water. This was quite apparent from an examination of the boilers after the explosions, but the cause of the low water is not so apparent. The boilers were subject to inspection and the gauges and appliances were found to be kept in good condition. The presence of a feed water regulator suggests the possibility that too much dependence was placed upon it, the operatives thus becoming lax in watching the water level. The fact that no one was killed or injured in either accident indicates that there was no one in the boiler room on either occasion.

Boiler and Power Plant Inspection Service an Aid in Acquiring Business.*

AN engineering insurance policy — specifically boiler, engine, flywheel or electrical machinery — carries with it an accident prevention service that should appeal to the agent, for it offers to the assured a tangible and immediate return on his investment. Insurance of this kind has two distinct features, inspection and insurance. The insurance feature indemnity for a loss sustained, is characteristic of all insurance and is of course understood by every agent. The inspection feature, however, is not so well known although it is this accident prevention service that is the principal attraction.

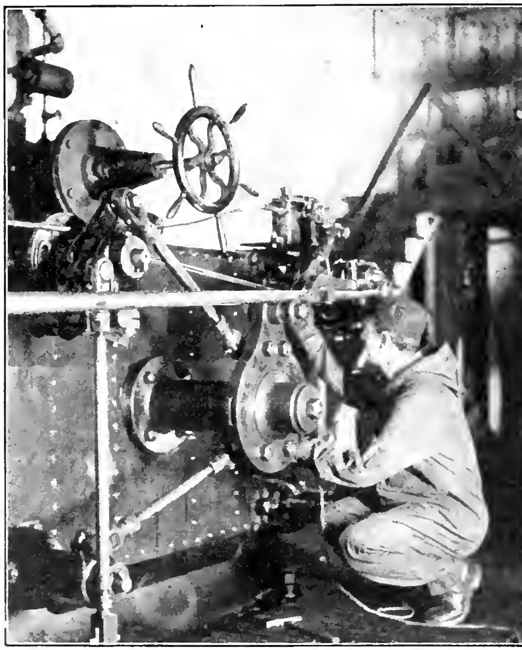
When steam boiler insurance was inaugurated in this country fifty-nine years ago by the The Hartford Steam Boiler Inspection and Insurance Company, the company in adopting a name placed the word " Inspection " before the word " Insurance " because it wished to impress upon everyone seeing the name that its business was primarily the inspection of boilers. This service is the foundation upon which the business is based for by it losses have been reduced and rates kept correspondingly low. In the early days of life insurance there was an old saying about the straight life policy that " one had to die to beat it," that is, to get any return on the premiums and many agents doubtless have somewhat the same feeling with regard to casualty insurance of this type. A little experience in selling it, however, will soon serve to remove any such feeling, for it will be found that those who have bought steam boiler, engine or electrical machinery insurance have done so primarily to avail themselves of this accident prevention service rather than the insurance feature; although the value of the latter is not under-estimated in view of the ever present hazard where machinery or pressure vessels are in use. Accidents can be reduced to a minimum but never entirely eliminated. The indemnity feature also serves as a stimulus to the inspection company to keep up an efficient inspection force.

Value of Inspections.

In a paper presented before a recent meeting of casualty underwriters Albert W. Whitney, Associate General Manager and Actuary

*This article was prepared by the Editor of The Locomotive especially for the November 1925 issue of *Rough Notes*.

of the National Bureau of Casualty and Surety Underwriters, said, "What I have in mind for insurance in general has been precisely carried out already in the field of steam boiler insurance. A boiler explosion is such a terrible catastrophe that human nature revolts at the idea of dealing with it merely as a cold-blooded, passive distribution of loss; insurance has, instinctively and inevitably, become inflamed with the active fervor of prevention and its machinery has been put to work upon the primary problem of keeping boilers from exploding and only secondarily upon paying losses, so that a steam boiler insurance company pays out for its preventive work four times as much as it pays out in losses."



Inspector Examining Engine Valve Gear.

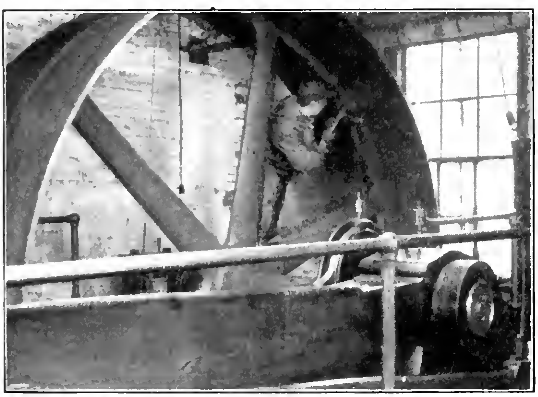
In an editorial comment upon a recent boiler explosion disaster, the *Syracuse Journal* said, in part, "Boiler explosions are not in the exact class of other accidents, hence the recognized necessity for boiler inspectors the world over."

Just a few days ago the papers announced that the Governor of Pennsylvania had discharged two state employes for responsibility in connection with a fatal boiler accident in the State Capitol which cost the lives of two men. It was found that the boiler, a new one, had been placed in operation "without a final inspection." Furthermore, the accident, a tube rupture, was the result of a scale accumulation in a tube directly over the fire, which should have been detected by inspection. The boiler, however, had been in constant operation for six months and therefore had not been internally inspected since its installation.

The boiler explosion on the steamer "Mackinac," which occurred near Newport, Rhode Island, and in which 52 persons were killed and approximately 100 injured, is still fresh in our minds and is an excellent illustration of a disaster that could probably have been averted by inspection. This accident was the result of the failure of a drum that had been thinned by corrosion. Just before the boat started on its fatal trip the boiler developed a serious leak. The evidence seems to indicate that, if an experienced inspector had examined it at that time, the boiler would not have been approved either for temporary operation or repair.

Methods of Inspection.

The inspector's principal duty is to examine, from the point of view of safety, the objects covered by the policy. Periodical calls are made at the plant to check up on the physical condition of the equipment and to observe the methods of operation. This is done by a general inspection at stated intervals supplemented by frequent inspections while under operation. On a visit of general inspection, better known in the case of boilers as an "internal," the boiler or machine is given a minute examination inside and out and all accessories are scrutinized and tested. The results are frequently surprising to the owner. A small leak along the seam that to the untrained eye may appear of no consequence may mean to the inspector a hidden defect that if neglected will lead to death and destruction. A freshly painted and well kept boiler front may give the owner the impression of an efficiently operated and well kept equipment, while a thorough examination of all the hidden parts may show conditions which mean the wasting of a large part of the fuel expended in the operation of the plant. The pipe lines may appear to be systematically laid out and by their symmetry leave the impression that they are well designed, while the trained eye of the inspector will detect a rigidity in the construction that will be fatal to safety if continued in operation.

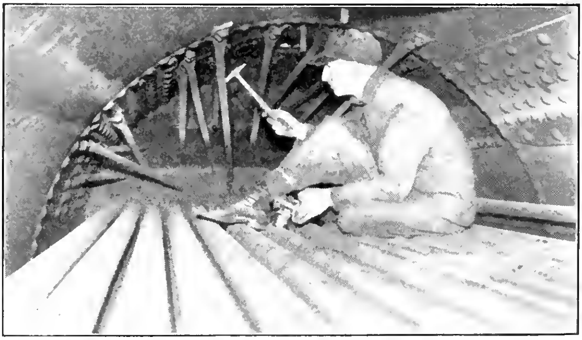


Inspecting a Flywheel.

The average plant operator has practically no knowledge of the safe pressure at which boilers under his care may be operated except that the manufacturer may have claimed their construction to be suitable for a given pressure or some former inspector had allowed a certain amount. The boiler inspector at the first inspection of a risk must carefully determine all the dimensions that are concerned with the ability of the boiler to withstand the pressure and fix a safe limit for pressure to govern its operation. While rules are supplied to guide him in reference to stresses that may be allowed for the material of which the boiler is constructed, if the vessel has seen service and is deteriorated as it necessarily will be in many cases, his judgment must be relied on entirely to determine whether such deterioration or the effects of age would warrant the full amount of stress that could be allowed on the part of a similiar structure when new. If the original pressure is to be reduced the inspector must decide how much.

The Work of Specialists.

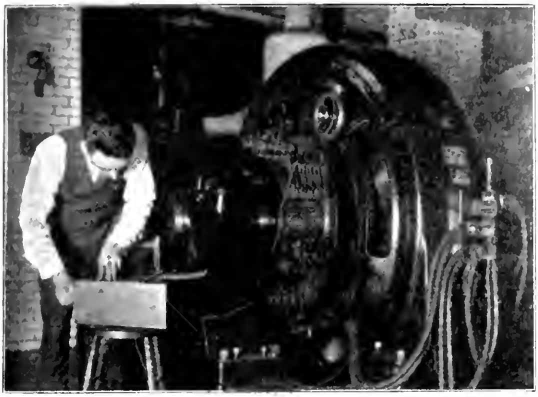
Likewise with fly-wheels. The initial strength of the wheel must be determined and a safe speed set. Sound wheels that explode from overspeed, like sound boilers that explode from overpressure, cause the greatest havoc. Therefore the speed limiting and automatic stop devices must be carefully passed on. The wheel and its shaft must be carefully examined for any defects that may reduce its strength. And so with turbines, engines, pumps, electrical machinery each in its own peculiar way calls for inspection by a specialist.



Examining the Inside of a Boiler.

As stated previously these general inspections are supplemented by frequent visits to observe the equipment "under operation." The working of the object and the care and attention it receives are functions of its safety and its probable life, and, as such, are of interest to the inspector. A written report on every inspection visit is invariably made to the assured.

The men who carry on this accident prevention service are former operating engineers who have been thoroughly trained for the work of inspection. They are therefore not only well versed in safety standards but also are entirely familiar with operating conditions. A man who visits hundreds of power plants and examines carefully the details of each must certainly have a fund of knowledge regarding good and bad practice and this is freely available to the operator. As a result the coming of the inspector is looked forward to, especially by the operators, and the visit considered very much in the light of a visit from the family physician.



Inspector Making Megger Test on D. C. Generator to Determine Condition of Insulation.

This inspection or accident prevention service is expensive and therefore can be most successfully carried on by a company with a large volume of such business. As pointed out before, a steam boiler insurance company pays out for its preventive work four times as much as it pays out in losses. Over one-half of its income is expended on this work. Hence, in power plant insurance, as distinguished from most other forms, even the assured who does not suffer an accident receives continuously, through this inspection service, direct returns on the investment. As a matter of fact the majority of power plant insurance buyers feel that the premium which they pay comes back to them many times during the policy term through economies and lower operating costs that result from inspection, to say nothing at all of the monetary loss prevented by reducing shut-down periods. When an agent delivers one of these policies to an assured, he is virtually passing the goods over the counter, for the inspection department has already started to function.

A man is relieved and gay when he has put his heart into his work and done his best; but what he has said or done otherwise shall give him no peace. — *Emerson.*

The Value of the Hammer Test.

By J. A. Snyder, Chief Inspector, Pittsburgh Department.

THE use of the inspector's hammer has brought to light many dangerous conditions in boilers and pressure vessels that would not otherwise have been found and that undoubtedly would have caused serious explosions within a short time had they not been discovered.

In certain parts of the country where corrosive water is used in steam boilers, the corrosion produces such uniform reduction of the plate or tube material that it is not perceptible to the eye. Where the material is wasted away so uniformly that it cannot be detected by visual inspection, it may become reduced to such extent that a rupture or crack may develop and cause a serious explosion. Recently an inspector found a dangerous condition in the mud drum of a bent tube type of water tube boiler. He was using his hammer freely on the plate surface, and the difference in sound to his ear and feeling to his hand when he struck certain spots attracted his attention. Upon removal of some brickwork, a careful investigation was made and a dangerously thin condition of the shell was found.

While hammer testing the tubes of a horizontal water tube boiler, an inspector noted a peculiar sound given out by one tube in the top row. It seemed to be entirely free at one end. He inquired of the engineer whether that tube was being cut out, but the engineer stated that he was not taking out any tubes as the boiler had been operated the day before and as far as he knew was in good order. Upon examination it was found the tube was cracked all the way around close to the header; it evidently had cracked while the boiler was cooling down. This condition would not have been found by mere observation as the tube end was in a difficult place to see.

The Interstate Commerce Commission rules require all rigid staybolts in locomotive boilers to be hammer tested every thirty days. It is a splendid rule for it has probably prevented many explosions and failures in fire boxes. In one case, with everything appearing sound and in good condition, an inspector discovered by means of the hammer test twenty-two broken staybolts. Cracked and broken braces are often detected by the use of the hammer. Loose hangers and supporting columns are also thus detected and show insufficient support of boilers or important steam pipes.

A common bolt was found projecting from a hole in the side of a boiler that was being used in a saw mill. Upon being asked why it was there, the engineer replied, " Why, a fool boiler inspector knocked a hole in the boiler." This boiler was not approved by the inspector, and as there were no inspection laws it was continued in operation. Later the boiler exploded. There would be much less sacrifice of human life and wasteful destruction of property if some sort of inspector could knock holes in certain boilers and then not permit closing the holes by bolts, welding, or any other process, but instead have such defective boilers discontinued from service or else repaired by safe and substantial methods.

A valuable adjunct of the hammer test, particularly where old boilers or pressure vessels are concerned, is the hydrostatic pressure test. Boilers that have been in service for any length of time are likely to have developed cracks. These cracks gradually get longer and deeper, and finally penetrate through the plate. Long before this stage has been reached, however, they are dangerous, yet exceedingly difficult to detect. If the hydrostatic pressure can be kept up while the hammer test is also applied, many incipient ruptures will be revealed.

If there is any reason whatever to suspect, as a result of internal or external examination, that a used boiler is liable to fail under ordinary working pressure, it is advisable to apply a hydrostatic test equal to one and one-half times the working pressure allowed by the inspector. If the boiler withstands this test without showing signs of distress, it may be taken as evidence, contributory but not conclusive, that the boiler is capable of handling the steam pressure which the inspector advises under the conditions.

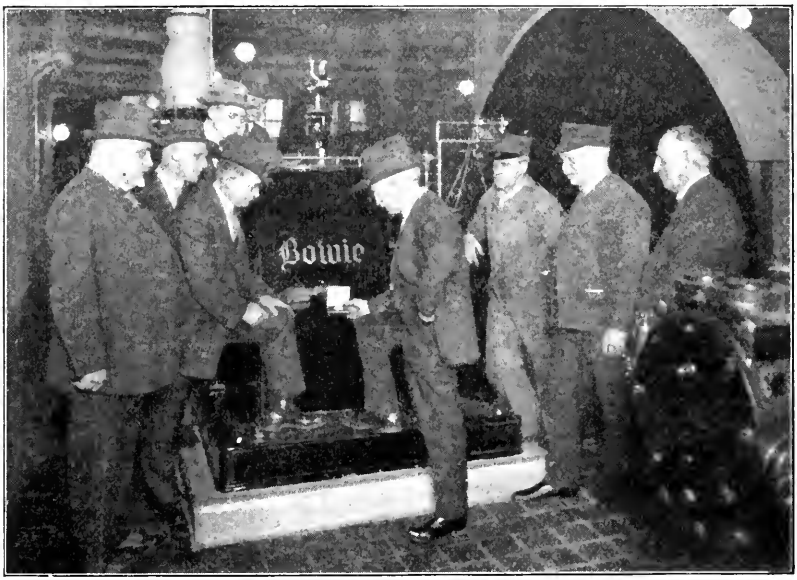
If major repairs are made on a boiler it is well to subject it to a hydrostatic pressure for the same reason that a new boiler is subjected to it on the testing floor in the shop — to show leakage at rivets and joints where these parts are not as tight as they should be. The hydrostatic test is of particular value for showing up minor leaks, particularly on new constructions.

Find Bomb Fuse in Boiler.

Ogdensburg, N. Y., Feb. 3 (AP)—An examination today of the boiler room in the City Hall, which was destroyed by an explosion and fire three weeks ago, with an estimated loss of $500,000, disclosed a timing device, wires and the fuse of a bomb, city officials said. First reports of the blast indicated that the boiler had exploded.—*New York Times.*

Hartford Inspector Honored.

THE Horlick's Malted Milk Corporation of Racine, Wisconsin, manufacturers of the universally known "malted milk," recently paid signal tribute to Inspector H. F. Bowie by naming one of their new engines after him. Mr. Bowie is attached to our Chicago Department and for over thirty years has inspected the boilers and engines at the Horlick plant. In fact, it appears that their original power plant, consisting of one boiler, was inspected by Mr. Bowie before



At the Unveiling of the Bowie Engine.

Inspector Bowie (Center), Chief Inspector Morrison (Left Center), and Vice President Wm. Horlick, Jr., of the Horlick's Malted Milk Corporation (Extreme Left).

it was purchased. Since then he has carried on the inspection work at this growing plant in such a thorough and conscientious manner as to make a lasting impression upon the officials of the Horlick Company. The recent acquisition of a new engine suggested a means of showing the esteem in which he was held.

Inspector Bowie's interest in this engine was increased when he was asked to select its name. His admiration for President Coolidge prompted him to suggest the name "Coolidge," and he assumed that his selection would be accepted. When the engine was ready to operate, it was decided to have a little informal unveiling ceremony on February 1st, and arrangements were made to have the inspector present on that date to make final inspection. Upon arrival at the plant he was received in the usual cordial manner and conducted to the engine room via the boiler room. Some changes being made in the latter place attracted the inspector's attention and it was with some difficulty that he was finally led into the presence of the new engine. Here were gathered a few officials of the Horlick Company and Mr. J. P. Morrison, Chief Inspector of our Chicago Department, representing the Hartford Company. One can imagine the surprise of the Inspector as the veil was withdrawn from the name plate to find the name "Bowie" instead of that of "Coolidge." All present congratulated Mr. Bowie and on behalf of the Hartford Company Mr. Morrison expressed appreciation for the honor he had brought to the Company. An informal reception in the office of President and General Manager William Horlick followed.

Some degree of appreciation of this testimonial to Inspector Bowie may be gleaned from the internationally prominent names borne by other engines in the plant, among which are:

William H.	Lincoln
James H.	Ziegler
Edison	Washington
Victoria	Christian IX
Gladstone	Amundsen

Bowie

Laying up the Heating Boiler for the Summer.

DURING the summer season a heating boiler does not run the risk of explosion, at least under ordinary conditions, but if not properly cared for corrosion may set in on a steel boiler and leave it in a serious, if not dangerous, condition. Corrosion may proceed on either the inside or the outside surfaces, hence attention to both is necessary to preserve the boiler when it is being laid up for an extended period.

On the outside, every vestige of soot and ash should be removed. These residuals of combustion contain certain ingredients which, when combined with moisture, are particularly corrosive. In fact this harmless appearing soot is held to be the cause of a skin disease known as soot-cancer which is found among chimney-sweeps. In the case of boilers, the moisture is readily absorbed from the air, or else it may be supplied by the sweating of the cold metal of a boiler. Hence all soot should be blown, scraped, and otherwise carefully removed, not only from the boiler but also from the whole inside of the setting. In addition, the surface of the boiler should be given a good cleaning with a stiff wire brush. By way of further precaution against external corrosion, care should be exercised to see that no water drips on the boiler from overhead sweating pipes or leaky valves, as such water is likely to seep through the insulation and attack the metal.

The inside surfaces should also be given particular attention as there is always a tendency to leave some water in the boiler. Whether this be much or little, corrosion is almost sure to ensue around the edge of the water because of the presence of both air or oxygen and moisture. Once started corrosion usually proceeds at a fairly rapid rate. Filling the boiler entirely full does not satisfactorily dispose of the trouble, first, because of the air dissolved in the water, and second, because such a body of water does not change its temperature readily to conform to atmospheric temperatures and hence the boiler is quite likely to sweat and induce external corrosion. The logical remedy is to completely empty the boiler and take off all manhole and handhole covers, thus allowing free access of air to the interior. Burning a few papers on the grate will assist in driving out the moisture, but under no circumstances should a wood or coal fire be built under a dry boiler nor should the metal be allowed to get too hot to touch. Quick or unslaked lime is sometimes placed in pans on the inside to remove the moisture and keep the air dry. When this is done, the boiler should, of course, be closed up to prevent the continual entrance of moist air. The safety valve ought to be propped open to prevent its sticking to its seat, and special attention given to feed and stop valves to see that they do not let leakage enter the boiler.

Cast iron boilers are not susceptible to corrosion and precautions in laying up need not be very elaborate. As a matter of convenience in inspection — and to this suggestion attention is particularly invited — it is advisable to thoroughly clean the boiler and fill it completely full of water.

A practice frequently followed in the summer is that of burning rubbish under a cold boiler. Such material usually burns with a quick and intensely hot fire, and is therefore destructive to boilers. This practice should be prohibited.

The engineer in charge of a heating system can save himself considerable trouble and annoyance in the fall by going over the system carefully before shutting down for the summer and marking leaky joints and valve stems, as these may be more readily packed or repaired during the off season. It is also well to note any leaks around the boiler and give them attention while shut down. Repairing vessels or pipes, while under pressure, is extremely dangerous.

Brass.

An Old Alloy That Every Now and Then is Being Rediscovered as a Great Servant of Mankind.

COPPER was first produced from ores probably 5,000 years before the Christian era. About this time bronze became known, not by melting copper and tin together, but rather because the ores available contained tin, nickel and small amounts of other metals and produced alloys harder and stronger than copper. The Bible mentions Tubal Cain as a worker in brass and refers to the alloy in several places. There is reason to believe that not brass but bronze is intended. In the first century Dioscorides makes the earliest unmistakable reference to brass (an alloy of copper and zinc); nevertheless, it was known to the Far East long before. Due to confusion in names no approximation of a definite time when brass came into use is possible.

Crucible furnaces were used for brass from the earliest times. Calamine (a zinc ore) was the primitive source of zinc. This practice continued to the eighteenth century, when metallic zinc was employed. No further great changes occurred until about ten years ago, when the electric furnace largely replaced the crucible furnace.

Brass was produced in the American Colonies first at the iron foundry of John Winthrop, Jr., Lynn, Massachusetts, in 1644. Cast brass was produced at Philadelphia also previous to the Revolution. The brass business developed from the manufacture of buttons. At Waterbury, Connecticut, in 1750, John Allen established a brass factory and in 1802 scrap copper and zinc from England were fused together and cast into ingots, subsequently rolled into brass sheets and used for buttons. From this humble start the brass industry of the United States, transplanted almost bodily from England, with the exception of brass spinning, has grown to be the greatest in the world. Connecticut now produces 60% of the world's brass.

As production of sheets, rods, wire and tubes increased, the use of brass was extended to other than button purposes. The attractive finish that may be given it, its strength, easy workability and rust resistance so encouraged possible users that consumption of copper by brass mills grew from less than 50 tons in 1820 to over 300,000 tons a century later.

Short brass pipes were used by the Romans as water-measuring devices. The copper pipes of ancient Egypt, however, are the forerunners of modern plumbing pipes. A piece of copper pipe in excellent condition, in the National Museum at Berlin, believed by

Egyptologists to be over 5400 years old, unearthed several years ago at Ghizeh, near the tomb of King Sahoure, undoubtedly was used to convey water to his palace and that of his successors. Between copper pipe in Egypt and brass pipe of today are many devious steps, — open troughs of stone and of wood, lead pipe, wooden pipe, iron pipe, steel pipe, tin pipe, concrete pipe. In 1838 the process of producing seamless brass tubing was invented in England and in 1850 was introduced in this country; it is giving fresh impetus to the brass industry.

Brass spinning invented by Hiram W. Hayden, of Waterbury, in 1851, was the first real forward step contributed by America. It quickly replaced the tedious method of producing cupped articles such as vases, pails, pots, other containers and many ornamental objects, by which a disc of metal was hand-hammered and otherwise worked until the desired shape was obtained. In spinning, the disc is mounted in a chuck, which is rotated at the proper speed. By holding suitable tools against the revolving metal it is thinned out over wooden or metal forms to the intended shape.

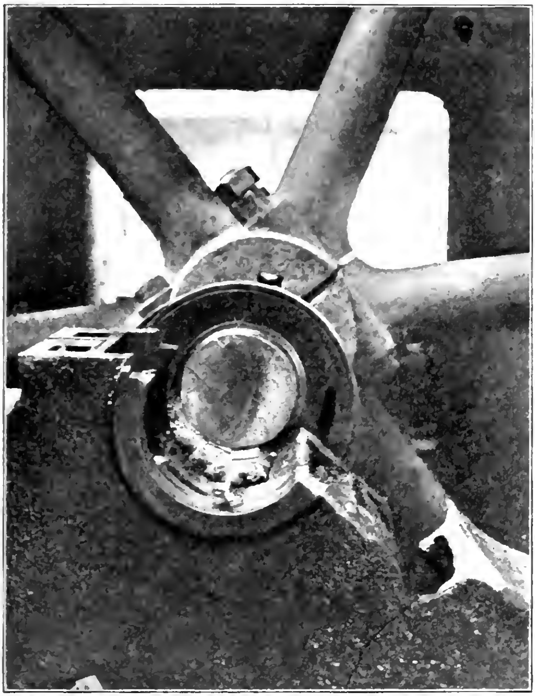
Hayden's first spinning was done at Wolcottville, now Torrington, Connecticut. According to two daughters who survive him, he invented as a pastime. Among his inventions were a process for color photography and a rifle, displaying wide diversity. He invented many things, but he kept no records. Just what experience or observation or line of thought suggested the method called spinning cannot now be ascertained. One of the largest uses for brass in his day was the manufacture of kettles and pails, originally cast and later hand-hammered from discs. The success of the hand-hammered kettle was short, because the first kettles so produced were manufactured from the wrong alloy and were unsatisfactory.

Brass pails made by methods in use in 1850 had thin bottoms. To overcome this fault Hayden devised the spinning process. He marked all of his pails as soon as he began manufacturing them by this method. Miss Hayden still has in her home one of the first pails produced by her father in 1851, bearing the date and his name. Hayden also used his process at one time in Waterbury for manufacturing lamps. It was in December 1851 that Hayden brought out the spinning process. In 1852 he sold it to the Waterbury Brass Company. Use of the process has grown so that it may be said to be universal today.

The world is again discovering copper and brass for a great variety of uses and may be said to be entering, on a grander scale, a second Bronze Age, using copper and its alloys much more extensively. — *Research Narrative No. 109, Engineering Foundation.*

A Timely Engine Inspection.

PROMPTED by a request for a special inspection, a Hartford inspector was detailed to examine a large rope-drive wheel which could not be made to operate smoothly. The master mechanic at the plant told the inspector that the wheel would not run true but wabbled, due, it was thought, to the shaft not being properly lined up. While the repairmen were preparing to line up the shaft, the inspector proceeded to examine the mammoth wheel.



Showing How an Old Crack Had Penetrated Approximately 70% of the Cross-Section of an Engine Shaft.

It was really a double wheel and weighed approximately 86,000 lbs., or 43 tons. It was 18 ft. in diameter, with a face width of 7½ ft., and was mounted on a shaft of 21⅝ inches diameter. The inspector carefully went over the wheel giving it a minute examination, frequently having it turned into different positions to permit of a close examination of every part.

The first defect noticed was a slight crumbling of the metal on the lugs or supports under the binding links of the hub. This in itself had not progressed far enough to be considered serious except that it was evidence of the distortion of the wheel. Later, while down on his knees examining the shaft, the inspector found a crack in the shaft about two inches from the hub. It was barely visible at first, but after cleaning the metal in the vicinity, he was able to insert the point of the blade of a pocket knife into the crack far enough so that the knife was supported in a horizontal position. It was decided to immediately discontinue the use of the shaft.

At a later date the inspector returned to the plant to examine the shaft after its removal, and found it in a much more accessible position, on blocks in the mill yard. This time a second crack was found which extended three-fourths of the way around the shaft. It was only a few inches from the first crack but had been under the hub and so could not have been found without removing the wheel.

The engine connected to the wheel was one of many in a large manufacturing plant employing thousands of men and containing acres of valuable machinery and buildings. The inspection was therefore timely as it undoubtedly averted a serious accident.

Method of Storing Coal to Eliminate Spontaneous Combustion.

IN order to eliminate spontaneous combustion of coal in storage, without the disadvantage of submerged storage, the Philadelphia Electric Company has devised a unique and effective method of storing coal. It is necessary to keep a large amount of coal in storage, principally as an insurance against strikes, having at present over 225,000 tons of bituminous coal in storage at several points of the system. This coal has been in storage over two years and has given no trouble.

"The ground is prepared by covering it with ash or dry earth and then rolling it hard. Over this the base of the coal pile is started by spreading a layer of coal, approximately two feet deep, over a width of from ninety to one hundred feet, and one thousand or even two thousand feet in length, depending on the length of the property on which the coal is to be stored. This coal is handled by a locomotive crane. A caterpillar tractor weighing approximately two tons then grades this first layer of coal with a drag and after the coal has been leveled a roller is drawn over the pile, thus packing the coal until it weighs approximately 65 pounds per cubic foot. The second layer is then started in precisely the same manner and after it is packed, the third layer, and so on up until the top of the pile is only as wide as the tractor and the roller.

"During the time that this pile is being built there is a certain amount of loose coal that will roll down the sides of the pile, and if left there will undoubtedly cause trouble in the form of small surface fires. To eliminate this, the operator on the crane trims the sides of the pile at the ground level the width of his bucket after the pile has been completed and in this manner gathers up the loose material and places it on the very top, thus forming the crown of the pile. The pile has now been thoroughly packed from top to bottom. The interesting feature of this is that coal which would weigh 45 and 50 pounds per cubic foot if piled normally without packing, now weighs 65 pounds per cubic foot. The surface of these piles is so closely packed that they readily shed water, and in all probability the circulation of air is entirely eliminated. Temperatures of this coal have been taken at least every six weeks from the time that the coal was placed in storage, using at each of our respective storage plants a portable protectometer.

"The temperatures indicate very clearly that there is a considerable lag of temperature within the coal pile compared with the external air, showing that there is no free circulation of air in the pile, but rather that the air is excluded and the temperature variation is governed more or less by contact connection. The various coal piles have been divided into sections and numbered, the records showing the analyses of the coal in the various piles as it was stored. This coal will be analyzed as it is removed from storage and it is hoped to obtain some definite figures on the losses which may be expected over a large storage of this kind. The coal storage piles average from 25 to 30 feet, in height, and from 90 to 100 feet in width at the base. It has been found necessary to crush the coal to insure success with this method. The average analysis of the coal as received is as follows:

Central Pennsylvania Coal.

Moisture	3.02	per	cent.
Volatile Matter	24.04	"	"
Fixed Carbon	65.77	"	"
Ash	7.17	"	"

"There are, of course, some kinds of coal which cannot be stored satisfactorily even under the best conditions, but even good coal stored improperly will develop fires.

"There seems to be some disagreement as to whether it is best to store coal that is wet, as from rain. A large amount of the storage mentioned was stored during wet weather and if anything this coal seems to pack harder and tighter than the coal that was stored during dry weather. There was, however, little or no variation between the two so far as temperature was concerned." — *Report of Prime Movers Committee, N.E.L.A*

Covered.

Jim — "George burned a hole in his trousers."
Bill — "Did he carry any insurance?"
Jim — "No! His coat tail covered the loss." — *Selected.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, APRIL, 1926.

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Recent bound volumes one dollar each. Earlier ones two dollars.
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

REMOVE the cause and you remove the effect. A boiler or fly-wheel explosion is an effect. There is nothing mysterious nor providential about such accidents as they result from something faulty in material, construction, or operation. Usually the cause becomes evident from an examination of the wreckage, and frequently the cause could have been detected by an inspection before the accident. This latter point is well brought out by a glance at the statistical table relating to the work of our inspectors as given on page 55 of this issue. The 35,696 dangerous defects and the 1,462 uninsurable boilers listed therein point to just so many potential explosions. In the majority of these cases, accidents were undoubtedly averted by timely repairs, the results of inspection. On rare occasions the recommendations of the inspector are not acted upon promptly and accidents result, as for instance the two accidents described in an editorial in our October 1925 issue. But stranger still there are times when accidents are allowed to repeat themselves for lack of removing the cause even though the cause is definitely known. An allustration of this is given in the article "Duplicate Boiler Explosions" appearing elsewhere in this issue.

Obituary.

JOSEPH JOHN LINAHAN, for many years identified with our Cincinnati Department as a special agent, died Saturday, September 26, 1925, at his home in Mt. Auburn, Cincinnati. He had been in ill health for over a year and his death was not unexpected.

Joseph J. Linahan

Mr. Linahan was born August 16, 1858, at Brooklyn, New York. He received a commercial education and became an expert accountant, later entering the insurance business. He came to this Company as a special agent in February 1900. In February of last year Mr. Linahan accordingly passed the twenty-five year service mark and was awarded a gold service medal in accordance with the custom inaugurated by the Company a few years ago for rewarding faithful employees.

Mr. Linahan was held in high esteem by his immediate associates and the officials of the Hartford Company. He was characterized by a loyalty and devotion to his work that was remarkable. Throughout his life he was guided by a desire to earn what he considered the highest tribute that could be paid to any man and it is said of him that "he was loving in his family, true to his friends, and faithful to his employers."

He is survived by his wife, two sons, and a brother, John J. Linahan, special agent in our Atlanta Department.

THOMAS F. GODFREY, formerly an inspector at the Minneapolis, Minnesota Branch and later a special agent connected with the Omaha Branch of our Chicago Department, died on Saturday, February 27, 1926, at his home in Seattle, Washington.

Mr. Godfrey was born on Christmas Day, December 25, 1849, at Philadelphia, Pennsylvania. After being trained as an engineer he entered the services of this Company as a boiler inspector and was first assigned to the Minneapolis Office on July 1, 1887. As Mr. Godfrey's experience and temperament fitted him for a position as special agent, he was accordingly assigned to the Underwriting Department with which he remained until his retirement about ten years ago. Having relatives in Seattle he then decided to make his home there, which he did until his death.

Mr. Godfrey was possessed of a very genial disposition and has left a host of friends. He is survived by his wife and an adopted son.

Personal.

AT a meeting of the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company, held on February 16th, 1926, C. Edgar Blake was elected Assistant Treasurer.

Mr. Blake came to the Company in December 1919 as Assistant Counsel. Previously he was a member of the law firm of Schutz and Edwards, of Hartford. He is a graduate of Yale College and Harvard Law School. Mr. Blake served with Troop B, 1st Separate Squadron, Connecticut Cavalry, in the Mexican Border Campaign of 1916, and during the World War served as a Lieutenant with the 302nd Field Artillery. After the armistice he attended Emmanuel College, Cambridge University, England, on detached service, being one of a group selected from the A. E. F. by the United States Government to study in British universities. In January 1923 he became Assistant to the Treasurer, and his present promotion is in recognition of his services in that position.

C. Edgar Blake

J. P. MORRISON, Chief Inspector of our Chicago Department, was "on the air" through station WOWO of Fort Wayne, Indiana, on the evening of January 13, 1926. He spoke on the "Care and Operation of Steam Heating and Power Boilers," and the radio audience that tuned in was treated to an interesting and instructive talk expressed in Mr. Morrison's characteristic style.

Summary of Inspectors' Work for 1925.

Number of visits of inspection made	246,520
Total number of boilers examined	478,099
Number inspected internally	180,933
Number tested by hydrostatic pressure	12,161
Number of boilers found to be uninsurable	1,462
Number of shop boilers inspected	14,902
Number of fly-wheels inspected	52,351
Number of premises where pipe lines were inspected	20,493

SUMMARY OF DEFECTS DISCOVERED.

Nature of Defects.	Whole Number.	Danger-ous.
Cases of sediment or loose scale	34,279	2,586
Cases of adhering scale	51,315	2,052
Cases of grooving	2,281	274
Cases of internal corrosion	27,564	1,072
Cases of external corrosion	14,312	1,852
Cases of defective bracing	890	229
Cases of defective staybolting	4,090	785
Settings defective	10,348	1,219
Fractured plates and heads	3,747	665
Burned plates	3,373	519
Laminated plates	292	37
Cases of defective riveting	1,839	424
Cases of leakage around tubes	14,497	2,565
Cases of defective tubes or flues	22,836	15,551
Cases of leakage at seams	5,783	571
Water gauges defective	4,897	1,120
Blow-offs defective	4,920	1,389
Cases of low water	451	169
Safety-valves overloaded	1,275	401
Safety-valves defective	2,279	591
Pressure gauges defective	7,999	652
Boilers without pressure gauges	672	58
Miscellaneous defects	8,331	915
Totals	228,270	35,696

GRAND TOTAL OF THE INSPECTORS' WORK ON BOILERS FROM THE TIME THE COMPANY BEGAN BUSINESS TO JANUARY 1, 1926.

Visits of inspection made	6,125,693
Whole number of inspections (both internal and external)	12,089,405
Complete internal inspections	4,701,885
Boilers tested by hydrostatic pressure	433,544
Total number of boilers condemned	34,546
Total number of defects discovered	6,615,126
Total number of dangerous defects discovered	745,502

FLYWHEEL EXPLOSIONS DURING 1925.

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	8	Flywheel exploded			Inland Paper Board Co.	Paper Mill	Versailles, Conn.
2		22	Flywheel exploded		1		Sawmill	Elk Creek, N. Y.
3			Flywheel on gasoline engine exploded		1	Marcellus Campbell Farm	Farm	Pleasant Hill, Mo.
4		26	Flywheel exploded			Durand Hoop Co.	Hoop Mill	Durand, Mich.
5		28	Flywheel exploded	1	1	Gulf Pipe Line Co.	Pumping Station	Mt. Vernon, Tex.
6	Feb.	16	Pulley ruptured			Sherman Paper Co.	Paper Mill	Felts Mills, N. Y.
7		23	Flywheel on gasoline engine exploded	1		Addis Phillips	Sawmill	Purvis, Mo.
8	Mar.	9	Flywheel exploded	1		National Farm School	Sawmill	Doylestown, Pa.
9		19	Pulley ruptured		1	Pynetree Paper Co.	Paper Mill	Gordon, Ga.
10	Apr.	1	Flywheel exploded			Anderson Cold Storage Co.	Refrigerating Plt.	Anderson, S. C.
11		4	Turbo-blower ruptured			N. Y. State Gas & Elec. Co.	Gas Plant	Oneonta, N. Y.
12		14	Flywheel failed			American Seating Co.	Cabinet Factory	Gd. Rapids, Mich.
13		15	Flywheel exploded	1		Noble Westerville Oil Co.	Oil Well	Chickasha, Okla.
14		16	Flywheel exploded			Diamond State Fibre Co.	Fibre Mill	Bridgeport, Pa.
15		20	Flywheel exploded	1		Bert Williamson Farm	Sawmill	Ball Mt., Mich.
16		27	Flywheel failed				Sawmill	Hobart Mills, Cal.
17	June	11	Turbine exploded			Pittsfield Electric Co.	Power Plant	Pittsfield, Mass.
18		13	Flywheel of Corliss engine exploded			Carlyle Paper Co.	Paper Mill	Carlyle, Ill.
19		26	Flywheel exploded			Rollstone Paper Co.	Paper Mill	Fitchburg, Mass.
20		30	Flywheel of Corliss engine exploded		1	Whitall Mfg. Co.	Textile Mill	Lowell, Mass.
21	July	13	Flywheel exploded			City of Fairfield	Power Plant	Fairfield, Ill.
22		22	Belt wheel exploded			Schmidt & Ault Paper Co.	Paper Mill	York, Pa.
23		23	Pulley exploded			Pacific Spruce Corp'n	Sawmill	Portland, Ore.
24		29	Turbine exploded			Standard Oil Co. of Ind.		Whiting, Ind.
25			Flywheel exploded			Jesse French & Sons Piano Co.	Piano Factory	Newcastle, Ind.
26	Aug.	7	Flywheel on fire engine exploded		4	City of Santa Monica	Fire Engine	Santa Monica, Cal.
27		11	Flywheel exploded			Blue River Power Co.	Power Plant	Milford, Nebr.
28		13	Pulley ruptured			R. B. McEwan & Sons	Paper Mill	Whippany, N. J.
29	Sept.	7	Flywheel exploded			Farmers Gin Co.	Cotton Gin	Winnsboro, Tex.
30		9	Flywheel exploded		2	Kuntz Farm	Farm	Turtle Lake, Wis.
31		10	Flywheel and two pulleys exploded			Hawthorne Paper Co.	Paper Mill	Kalamazoo, Mich.
32		14	Flywheel exploded		1	Giese Bros.	Garage	Schaller, Ia.

33			Flywheel exploded			City of Dawson	Power Plant	Dawson, Ga.
34		28	Flywheel exploded		3	Riceville Cooperage Co.	Cooperage Plant	Oneonta, Ala.
35	Oct.	10	Pulleys ruptured			Wilmington Oil & Fertilizer Co.	Oil Mill	Wilmington, S. C.
36		13	Flywheel exploded			H. P. Hood & Sons, Inc.	Dairy Products	W. Stew't'tn, N. H.
37		25	Flywheel exploded	1		Monroe Binder Board Co.	Paper Mill	Aurora, Ill.
38		26	Flywheel exploded		4	American Steel & Wire Co.	Wire Factory	Cleveland, Ohio
39		28	Flywheel of rolling-mill exploded		1	Carnegie Steel Co.	Steel Plant	Pittsburgh, Pa.
40	Nov.	7	Flywheel exploded	1		Tower Hill Connellsville Coke Co.	Coal Mine	Republic, Pa.
41		10	Flywheel of Corliss engine exploded			Bolinger-Franklin Lumb'r Co., Inc.	Lumber Mill	Zama, Miss.
42		26	Flywheel of Corliss engine exploded	1		Illinois Power & Light Co.	Power Plant	Atchison, Kans.
43		27	Flywheel exploded	1		Arthur Johnson Farm	Farm	Stockton, Ill.
44	Dec.	5	Centrifugal dryer exploded	2	1	Stephenson Dye Works	Dye House	Watertown, Mass.
45		30	Flywheel of gasoline tractor exploded		1	H. B. Strong	Farm	Seneca Falls, N. Y

BOILER EXPLOSIONS

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF APRIL, 1925 (Continued).

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
299	18	Tube ruptured			Tampa Electric Co.	Power Plant	Tampa, Fla.
300	19	Header cracked			Drake Holding Co.	Apt. House	Omaha, Nebr.
301	20	Two sections heating boiler cracked			Tarbell-Waters Co., Inc.	Office Bldg.	Springfield, Mass.
302		Section of heating boiler cracked			Kuttnauer Apron Specialties	Clothing Factory	Detroit, Mich.
303		Blow-off pipe failed		1	Chas. Nelson & Co.	Sawmill	S. Francisco, Cal.
304	21	Hot water boiler exploded		1	Joseph Angelotti	Residence	Revere, Mass.
305		Boiler exploded			W. H. Moore	Sawmill	Honesdale, Pa.
306		Separator flange cracked			American Printing Co.	Cotton Mill	Fall River, Mass.
307	22	Cooking tank exploded		3	Consolidated Beef Co.	Packing House	Philadelphia, Pa.
308		Fitting in main steam line ruptured			Consol. Gas-Elec. Lt. & Power Co.	Gas & Elec. Plant	Baltimore, Md.
309	23	Blow-off pipe failed			Fred Draper Lumber Co.	Lumber Mill	Colville, Wash.
310	24	Tubes pulled out of drum			Ottawa Silica Co.	Sand Quarry	Ottawa, Ill.
311		Boiler ruptured		1	C. R. R. of N. J.	Railroad Shops	Elizabeth, N. J.
312	25	Boiler exploded	1	1	Prarie Oil & Gas Co.	Oil Well	Wewoka, Okla.

MONTH OF APRIL, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
313		Section of heating boiler cracked			Consol. Amusement Enterprises	Offices & Stores	New York, N. Y.
314	27	Section of heating boiler cracked			Hamilton B. Wood	Factory	Worcester, Mass.
315		Crown sheet failed			Gulf States Steel Co.	Ore Mine	Altoona, Ala.
316	28	Ammonia tank exploded			Andronica Bldg.	Butcher Shop	Alameda, Cal.
317		Furnace flue collapsed			Crystal Steam Laundry	Laundry	Fayetteville, Tenn.
318		Two sections heating boiler cracked			Rt. Rev. S. B. Stritch	Rectory	Carey, Ohio
319		Section of heating boiler cracked			Jennie B. Joffee	Post Office	Rochester, N. Y.
320	29	Section of heating boiler cracked			Fenwick Club	Club	Cincinnati, Ohio
321		Boiler bulged and ruptured			Franklin Ice Co.	Ice Plant	Franklin, Tenn.
322	30	Blow-off tank exploded			Mattei Bldg.	Office Bldg.	Fresno, Cal.
323		Boiler exploded	3	1	Coffin's Sawmill	Sawmill	Clayton, Ala.
324		Tube ruptured			Woodward Iron Co.	Blast Furnace	Woodward, Ala.
325		Section of heating boiler cracked			J. & H. Stone Realty Corpn.	Apt. House	New York, N. Y.
326		Five sections heating boiler cracked			Saranac Lake General Hospital	Hospital	Saranac Lake, N.Y.
327		Five sections heating boiler cracked			Edward E. Saunier	Garage	Worcester, Mass.

MONTH OF MAY, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
328	1	Boiler ruptured			Lott Hotels, Inc.	Hotel	Chicago, Ill.
329		Six sections heating boiler cracked			Conron Bros. Co., Inc.	Apts. & Stores	New York, N. Y.
330		Three sections heating boiler cracked			White & Davis Investment Co.	Office Bldg.	Kansas City, Mo.
331		Section of heating boiler cracked			Independent School Dist.	School	Brooklyn, Iowa.
332	2	Two sections heating boiler cracked			Harwood J. Gilbert	Residence	Saginaw, Mich.
333		Section of heating boiler cracked			136 Eighty Second St. Corp.	Apt. House	New York, N. Y.
334		Tube pulled out of drum		3	Toxaway Tanning Co.	Tannery	Brevard, N. C.
335	3	Section of heating boiler cracked			Samuel N. Samuels	Apts. & Stores	New York, N. Y.
336	4	Boiler bulged and ruptured			C. W. Cochran	Sawmill	Falcon, Tenn.
337	5	Section of heating boiler cracked			Board of Education	School	Lancaster, Ohio.
338		Boiler bulged and ruptured			Campbellsville Ice & Ice Cream Co.	Ice Cream Plant	Campbellsville, Ky.
339	6	Boiler ruptured			National Pottery Co.	Pottery	Roseville, Ohio
340		Boiler bulged and ruptured			Terrell Cotton Oil & Refining Co.	Oil Mill & Gin	Terrell, Texas
341	7	Steam main exploded	2		S. S. Manchuria	Steamship	Balboa, C. Z.

342	8	Boiler bulged and ruptured			Davidson, Hicks & Green Co.	Coal Mine	Nashville, Tenn.
343		Two sections and manifold of heating boiler cracked			United Metal Spinning Co., Inc.	Metal Workers	Brooklyn, N. Y.
344	10	Section of heating boiler cracked			J. L. & A. V. Avery	Apt. House	Indianapolis, Ind
345	11	Section of heating boiler cracked			Children's Aid Society	School	Valhalla, N. Y.
346		Boiler ruptured			Trout Creek Lumber Co.	Lumber Mill	Kirbyville, Tex.
347	13	Valve burst		3	Conn. Light & Power Co.	Power Plant	Devon, Conn.
348		Head of deaerator cracked			Twin Branch Power Co.	Power Plant	Mishawaka, Ind.
349		Boiler ruptured			St. Mary's Academy	Hospital	Kansas City, Kans.
350	15	Mud drum of boiler exploded		1	Des Moines City Rwy. Co.	Power Plant	Des Moines, Iowa.
351		Section of heating boiler cracked			McCanna & Hubbell	Offices & Stores	Albuquerque, N. M
352		Section of heating boiler cracked			Louise Nadeau	Apts. & Stores	Holyoke, Mass.
353		Section of heating boiler cracked			O. B. & A. W. Stevens	Greenhouse	Shenandoah, Iowa
354	16	Boiler of locomotive ruptured			Grant Leather Corpn.	Tanning Plant	Cranberry, N. C.
355	17	Boiler of locomotive exploded	1	3	Missouri Pacific R. R. Co.	Railroad	Jerome, Ark.
356	19	Header cracked			Providence Gas Co.	Gas Plant	Providence, R. I.
357	20	Tube ruptured			Scranton Electric Co.	Power Plant	Scranton, Pa.
358		Two sections heating boiler cracked			Loew's Inc.	Theatre	New York, N. Y
359		Boiler exploded	2	3	Philip Tubbs	Sawmill	Elkland, Pa.
360		Hot water tank exploded			S. & S. Meat Market	Market	Philadelphia, Pa
361		Boiler on pressing machine exploded		2	McKinney Ave. Cleaners	Cleaners	Dallas, Texas.
362	21	Boiler bulged and ruptured			Marion Ice & Cold Storage Co.	Refrigerat'n Plant	Marion, Ind.
363	22	Boiler exploded	1	2	2110 Cornell Road	Apt. House	Cleveland, Ohio
364		Two sections heating boiler cracked			W. D. & G. Archibald	Hotel	Jackson, Ky.
365		Headers cracked			Omaha Ice & Cold Storage Co.	Refrigerat'n Plant	Omaha, Neb.
366		Manifold of heating boiler cracked			Minnie Rosenthal	Apt. House	Brooklyn, N. Y
367	24	Section of heating boiler cracked			Riverview Holding Co., Inc.	Apt. House	New York, N. Y
368	25	Main steam pipe fitting failed			Standard Paper Co.	Paper Mill	Kalamazoo, Mich
369		Ammonia tank exploded		1			Esparto, Cal
370	26	Boiler exploded		2	Falcon Steel Co.		Niles, Ohio
371		Boiler exploded		1	Sharp & Green	Sawmill	Nr. Winthrop, Ark.
372		Boiler exploded	1	3	Frank M. Lorick	Sawmill	Batesville, S. C.
373	27	Section of heating boiler cracked			J. L. & A. Avery	Apt. House	Indianapolis, Ind.
374		Nine sections heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg	Plainfield, N. J.
375		Tube ruptured			Marinette & Menominee Paper Co.	Paper Mill	Marinette, Wis.
376		Jacketed cooking tank exploded		2	Victor Ice Cream Co.	Ice Cream Factory	San Francisco, Cal
377	28	Boiler exploded	2	3	Hung Fong Lo	Restaurant	Chicago, Ill.
378	29	Boiler exploded		1	Chas. E. Knox Oil Co.	Oil Well	Enid, Okla.
379		Tube pulled out of header		2	Murry Iron Works Co.	Iron Works	Burlington, Iowa

MONTH OF MAY, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
380	30	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.
381		Boiler bulged and ruptured			A. P. Thurmond & Co.	Sawmill	Dyersburg, Tenn.
382	31	Boiler ruptured			Vaughn Construction Co.	Club Rms. & Stores	Omaha, Neb.
383		Tube ruptured			Michigan Alkali Co.	Alkali Plant	Wyandotte, Mich.

MONTH OF JUNE, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
384	1	Section of heating boiler cracked			Empire Loan & Trust Co.	Bank	Sheldon, Ia.
385		Fitting in feed water line burst		1	Tolman Laundry	Laundry	Washington, D. C.
386	2	Air receiver exploded	1	1	California Zinc Co.	Smelter	Winthrop, Cal.
387	3	Boiler exploded	1	2	V. M. Gammage	Sawmill	Howe, Ala.
388		Furnace collapsed			Lancaster Cotton Mills	Cotton Mill	Lancaster, S. C.
389	5	Air tank exploded			S. L. & E. F. Bowers	Garage	Fresno, Cal.
390		Tube rupture and four headers cracked			Diamond Alkali Co.	Alkali Plant	Fairport, Ohio
391		Section of heating boiler cracked			Regal Belting Co.	Belting Factory	Cincinnati, Ohio
392		Tube ruptured			Kalamazoo Veg. Parchment Co.	Parchment Mill	Kalamazoo, Mich.
393	6	Tubes pulled out of drum			General Motors Corp'n	Automobile Plant	Detroit, Mich.
394		Boiler exploded		1	Penn R. R. Co.	Railroad Shops	Renovo, Pa.
395		Boiler of locomotive exploded	2	1	Chicago-Key West Express	Railroad	Pigonkey, Fla.
396		Section of heating boiler cracked			Pittsburgh Hospital	Hospital	Pittsburgh, Pa.
397	8	Section of heating boiler cracked			Martha Rhode	Apt. House	San Francisco, Cal.
398		Manhole gasket blew out			Agar Manufacturing Corp'n	Paper Mill	Whippany, N. J.
399	9	Boiler ruptured			W. L. Milner Co.	Store	Toledo, Ohio
400	11	Tube ruptured			Hercules Cement Co.	Cement Plant	Stockertown, Pa.
401	12	Section of heating boiler cracked			Laura B. Waldo	Apt. House	Indianapolis, Ind.
402		Crown sheet of locomotive collapsed			East Side Logging Co.	Logging	Portland, Ore.
403		Hot water heater exploded			Irving Hotel	Hotel	Los Angeles, Cal.
404	14	Boiler bulged and ruptured			Watertown Gas Co.	Gas Plant	Watertown, S. D.
405	15	Section of heating boiler cracked			Westminster College	College	N.Wilmington, Pa
406	16	Plug blew out of tube sheet			Cuyahoga Asphalt & Paving Co.	Steam Roller	Cleveland, Ohio
407		Five tubes of locomotive ruptured		1	Suncrest Lumber Co.	Lumber Mill	Suncrest, N. C.
408	18	Tube ruptured		1	H. C. Aberle	Hosiery Mill	Philadelphia, Pa.

409	19	Section of heating boiler cracked			The Lunkenheimer Co.	Brass Works	Cincinnati, Ohio
410		Boiler bulged and ruptured			Plano Mill & Ice Co.	Mill & Elevator	Plano, Texas.
411	20	Three sections heating boiler cracked			Mason Davis & Co.	Stove Works	Chicago, Ill.
412		Section of heating boiler cracked			M. J. Connell	Factory Bldg.	Los Angeles, Cal.
413		Header failed			Pittsburgh Terminal Warehouse & Transfer Co.	Warehouse	Pittsburgh, Pa.
414		Main steam pipe fittings failed		2	J. L. Bushnell	Office Bldg.	Springfield, Ohio
415	21	Valve ruptured			Woodhaven Water Supply Co.	Pumping Station	New York, N. Y.
416	22	Eight headers cracked			William Mann Co.	Stationery	Philadelphia, Pa.
417		Boiler ruptured			Edw. B. Kingman Co.	Celluloid Plant	Leominster, Mass.
418		Section of heating boiler cracked			Kate Shapiro	Bath House	Baltimore, Md.
419		Section of hot water heater cracked			Wacht-Rose Holding Corp'n	Apt. House	New York, N. Y.
420	24	Section of heating boiler cracked			Klion Holding Corp'n	Apt. House	New York, N. Y.
421	26	Cross head-stays and blow-off pipe failed			Estuary Lumber Co.	Sawmill	Tampa, Fla.
422		Boiler exploded	1	1	A. Howard Farm	Farm	Mulvane, Kans.
423	29	Boiler exploded			Klever Kleaners	Cleaners	East Chicago, Ind
424		Header failed			Pittsburgh Terminal Warehouse & Transfer Co.	Term. Warehouse	Pittsburgh, Pa.
425		Boiler ruptured			Marysville & Northern Rwy. Co.	Logging	Bryant, Wash.
426		Tube ruptured			Northern Ohio Traction & Light Co.	Power Plant	Akron, Ohio
427	30	Expansion joint in steam main ruptured			New York Steam Co.	Steam Plant	New York, N. Y.
428		Tube ruptured			Woodward Iron Co.	Blast Furnace	Birmingham, Ala.

MONTH OF JULY, 1925.

429	1	Tube ruptured			City of Long Beach	Power Plant	Long Beach, N. Y.
430	2	Crown sheet collapsed			Waite Phillips Co.	Oil Refinery	Rainbow B'd, Kan.
431	3	Section of hot water supply boiler cracked			Hotel Matis	Hotel	Meriden, Conn.
432	4	Tube ruptured			Woodward Iron Co.	Blast Furnace	Birmingham, Ala.
433	8	Blow-off pipe fitting failed		1	Akron City Laundry Co.	Laundry	Akron, Ohio
434	9	Steam pipe burst	2		Lucas E. Moore	Stave Mill	Hornsby, Tenn.
435		Hot water supply tank exploded			L. R. Nesbit	Apt. House	Pittsfield, Mass.
436		Hot water supply tank exploded			City of Waterbury	Bath House	Waterville, Conn.
437		Gage glass on ammonia tank burst			Empire State Ice Co.	Ice Plant	New York, N. Y.
438		Two sections heating boiler cracked			Kingsport Grill	Restaurant	Kingsport, Tenn.
439	10	Air tank exploded			Mack's Garage	Garage	St. Louis, Mo.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACTS OF STATEMENT, DECEMBER 31, 1925

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks		$699,859.61
Real Estate		271,757.16
Mortgage and collateral loans		1,650,188.00
Bonds and stocks		11,233,196.67
Premiums in course of collection		1,341,102.96
Interest Accrued		141,983.25
Total Assets		$15,338,087.65

LIABILITIES

Reserve for unearned premiums		$6,433,164.02
Reserve for losses		283,273.98
Reserve for taxes and other contingencies		707,384.81
Capital Stock	$2,500,000.00	
Surplus over all liabilities	5,414,264.84	
Surplus to Policyholders,		**$7,914,264.84**
Total Liabilities		$15,338,087.65

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E. SIDNEY BERRY, Second Vice-President.
LOUIS F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
C. EDGAR BLAKE, Assistant Treasurer.
SHERWOOD F. JETER, Chief Engineer.
KENNETH A. REED, Electrical Engineer.
HARRY E. DART, Supt. Engineering Dept.

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The Hardest Way to Fire a Boiler

Question: Which method of firing is the hardest work for the fireman?

Answer: "The way they showed me when I started to work here. . . . It was hard work but I did not know any better way then. Many old firemen fire that way yet that have been on the job for 15 or 20 years."

The above answer was given by a fireman student in the

HARTFORD CORRESPONDENCE COURSE FOR FIREMEN

Another student, in commenting on the value of the Course, wrote—

"I have been firing for 14 years and carried a fireman's license for 5 years, and I can truly say I have learned more about firing since starting this course than I have in all my experience as a fireman."

Hundreds of firemen who have completed this course have had their work made easier and are saving a lot of money for their employers. For further information about the Course, fill out and mail the blank below.

THE HARTFORD STEAM BOILER
INSPECTION & INSURANCE CO.,
HARTFORD, CONN.

Please send me further details of your Correspondence Course for Firemen

Name ....

Address ....

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A-26.

The Locomotive

Devoted to Power Plant Protection

Published Quarterly

Vol. XXXVI. HARTFORD, CONN., JULY, 1926. No. 3

Hot Water Supply Tank Explosion At Worcester, Massachusetts

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Hot Water Supply Tank Explosion At Worcester, Massachusetts.

AN explosion of terrific violence occurred early in the morning of March 30th, 1925 at the Worcester Square and Compass Club, Worcester, Mass. when the hot water supply boiler exploded. No one was injured, due to the early hour of the explosion, but considerable property damage was done in the basement and on

FIG. 1.

the first floor, as indicated by Fig. 1 and the picture on the front cover. The boiler was located in the front part of the basement and the explosion blew down a brick wall that supported the large front porch. Doors and windows, including several decorative leaded glass windows, in the basement and on the first floor were blown out and the floor was raised several inches. Windows in neighboring buildings were also blown out. The property loss was estimated to be $10,000.

The tank that exploded was a copper hot water supply tank, 17 inches in diameter by 4 ft. 6 inches long, and was constructed of approximately 3/64 inch sheet copper. The top head seam was riveted but all other joints were brazed. The tank is said to have been tested hydrostatically to a pressure of 200 lbs. per square inch; the usual operating pressure was 100 lbs. It was fitted with a 1 inch A. S. M. E. lock-up pop safety valve. The water was heated by a coal burning heater.

The violence of the explosion would seem to indicate over-pressure produced by the generation of steam as the cause of the accident, though it is not clear what caused the pressure to build up to such a degree. The fireman in charge states that he banked the fire with hard coal in the usual manner about 9:40 P. M. and went home. In some way, perhaps due to misadjustment of dampers or perhaps to unusual weather conditions, the fire must have caught up brightly and heated the water to a steaming temperature, as the tank exploded about 3 A. M. The safety valve was afterwards recovered and tested by a state boiler inspector and found to be apparently in good operating condition in that it released at the specified pressure, 150 lbs. Slight corrosion, however, was noted and it is possible that this prevented the operation of the valve in time to avert the accident.

As far as we are able to learn there was no insurance on this installation.

Center-Crank Shafts.

By H. J. VanderEb, Supt., Engine Department

SHAFTS of reciprocating engines are of two general types, namely, side-crank shafts and center-crank shafts. As the name implies, a side-crank shaft (Fig. 1) is a plain shaft to which the engine crank is fastened at one end, or there may be a crank at either end. A center-crank shaft has the crank some distance away from its end, which makes its construction somewhat more complicated and usually involves a somewhat shorter useful life.

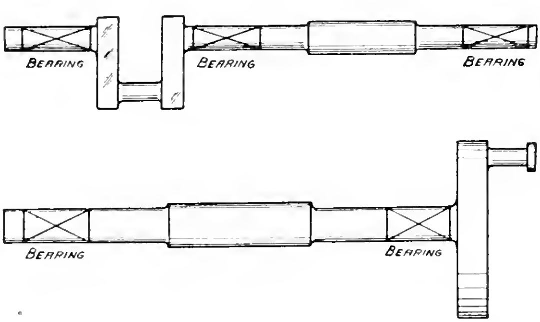


Fig. 1. Center Crank Shaft (above), Side Crank Shaft (below).

With a side-crank shaft of the usual design only two bearings are necessary. This makes the maintenance of bearing alignment a comparatively simple matter and no undue bending stresses will occur in a side-crank shaft when one bearing wears down a little more than the other.

The center-crank type of shaft as a rule requires for its support at least three bearings, which involves its own peculiar trouble. It is somewhat self evident that when more than two bearings are used it becomes harder to keep the bearings in proper alignment. When misalignment does occur, due to uneven wear in the three or more bearings supporting the shaft, there will be produced in the shaft structure certain extra bending stresses which may have a serious influence on the life of the shaft. It is with this feature of extraordinary bending stresses that this article is intended to deal.

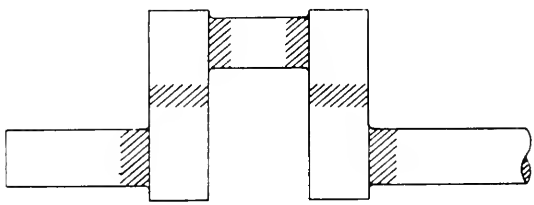


FIG. 2.
THE SHADING INDICATES THE REGIONS IN WHICH CRACKS MAY BE LOOKED FOR.

The bending stress in a shaft due to misalignment of the bearings is in addition to the normal bending stress produced by the load on the crank. The total stress thus created may in time be sufficiently high to cause gradual failure of the material. A shaft which has been subject for some time to excessive bending stress, if carefully inspected, is fairly certain to show surface cracks in certain critical portions. Such cracks generally occur in the shaded areas shown in Fig. 2.

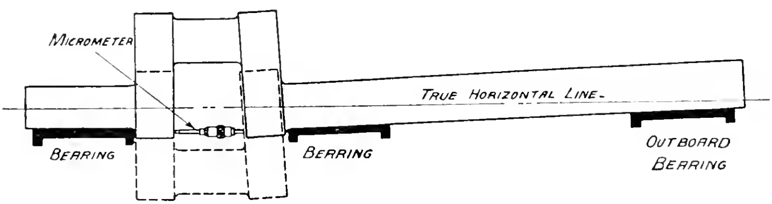


FIG. 3.
CRANK SHAFT DISTORTION DUE TO POOR BEARING ALIGNMENT (EXAGGERATED FOR PURPOSES OF ILLUSTRATION).

When, due to high bending stress, a surface crack has once started in a center-crank shaft, the shaft has practically reached the end of its useful life and can only be further used at the risk of a serious general engine wreck. The great importance, therefore, of maintaining correct bearing alignment with center-crank shafts has long been appreciated by engine manufacturers. It has been customary for many years on certain makes of large multiple center-crank engines to make special provision for conveniently checking up from time to time how much each bearing wears down. This is done by removing the bearing caps and taking accurate measurement between some fixed point on the engine frame and the top of each journal. If all the bearings show the same amount of downward wear, there is then fair certainty that no undue bending stresses take place in the shaft.

There is another method for checking the bearing alignment in engines with center-crank shafts which is more easily applied and is more adaptable to all types of engines, both vertical and horizontal. This is done by measuring directly the distortion of the cranks, which will occur when the bearings have worn unevenly and therefore are out of perfect alignment or if the bearings have been misadjusted. In Fig. 3 is shown a condition of bearing misalignment which is frequently met with. The outboard bearing is too high due to the fact that the main bearings have worn down while the outboard bearing has not been subject to as much wear, with the result that the crank travels through a slight distortion during every complete revolution of the shaft.

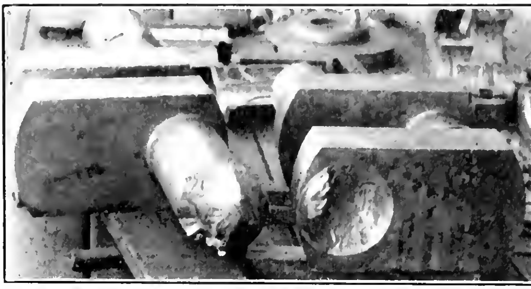


Fig. 4. Broken Crank Shaft.

When under these conditions the distance between the crank webs is measured by means of a micrometer in four different positions of the crank, an appreciable difference is found between the measurements in these four crank positions. If the engine is operated with this condition existing, it is reasonably certain that the shaft will develop surface cracks in the critical areas shown in Fig. 2. If the misalignment of the bearings is serious enough, failure of the shaft may be quite rapid. In some aggravated cases such shafts have broken in less than a year from the time that they were first used.

Fig. 5. Broken Crank Web.

Distortion of center-crank shafts from other causes than the mere misalignment of bearings is also clearly shown up by this method of measuring between crank webs. For instance, the bending action on the shaft due to a too heavy overhung flywheel or the influence of a tightening device on the driving belt (Figs. 6 and 7) can be traced in this way, and a suitable correction for these wrong conditions determined on so as to prolong the useful life of the shaft.

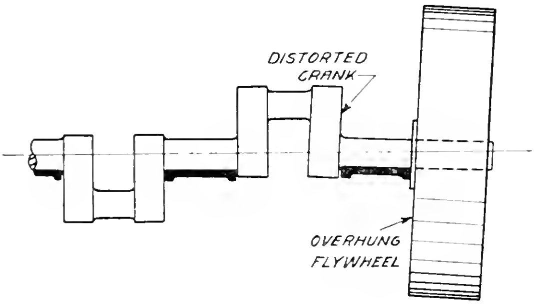


Fig. 6.
(Deflection Exaggerated for Purpose of Illustration.)

The difference in the micrometer measurements as found at two opposite positions of the crank may be a few thousandths of an inch and sometimes is as much as several hundredths of an inch. The extra bending stresses in the shaft material are of course proportional to this difference.

As an example, Fig. 8 is a graphical representation of conditions found in a 7-inch single-crank shaft. In this diagram the distances between concentric circles represent two one-thousandths of an inch and the heavy circle denoted by zero is taken as a reference circle. Four positions of the crank are denoted by Top, Back, Bottom and Front. The graph A was obtained by drawing a line through points a, b, c and d. If the first measurement between crank webs is taken with the crank in Top position and its position assumed to be on the reference (zero) circle, then the distance of .001 inch that point b lies outside of the reference circle denotes that the measurement between crank webs, when the crank was set in position Back, was .001 inch greater that that at crank position Top. At point c the distance between crank webs has become .004 inch greater and at point d the distance between crank webs is again the same as it was originally at

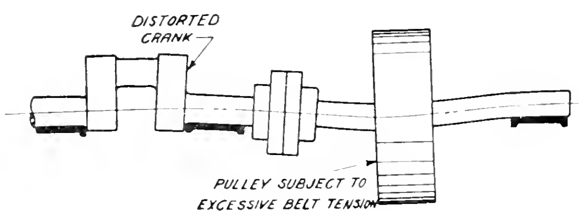


Fig. 7.
(Deflection Exaggerated for Purpose of Illustration.)

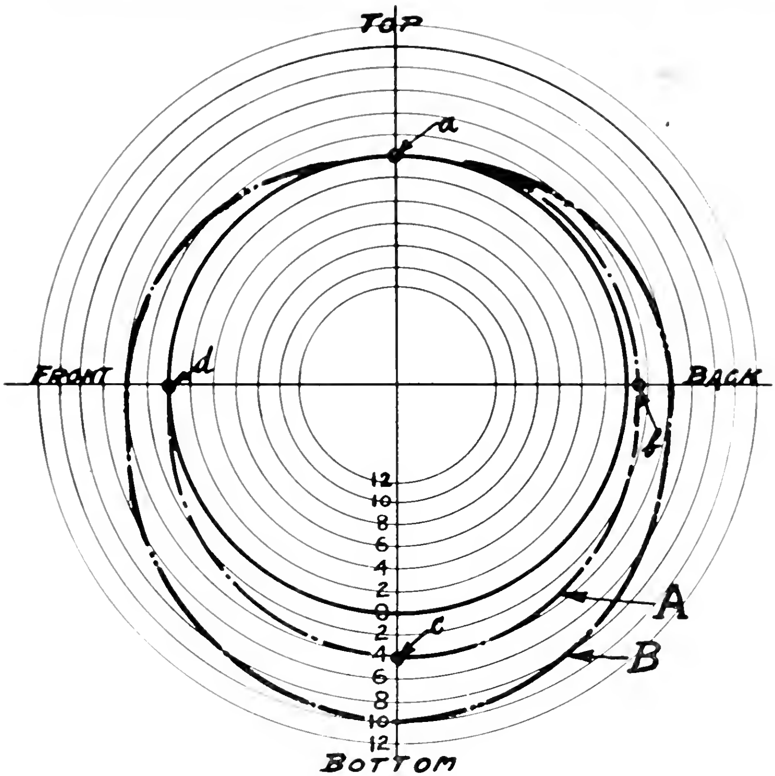


FIG. 8. GRAPHICAL REPRESENTATION OF CRANK DISTORTION.

point a, or TOP.

The graph B shows conditions of distortion of the same crank just one year later. It will be noted that the distortion of the crank, as measured between crank webs, has become much worse, it being .010 inch when the crank is in bottom position, whereas the year before in that position the crank distorted only .004 inch.

When the distortion, which of course is repeated during every revolution of the shaft, has reached such proportions, the surface stresses in the critical areas before mentioned become quite high and the formation of surface cracks is bound to occur.

It is obviously impossible to lay down a fixed limit for the measured distortion at which it becomes necessary to make correction in the bearing alignment, since the diameter of the shaft and the length of the crank must necessarily be taken into consideration. For average conditions of crank design, however, it is a fair assumption that when the distortion of the crank as measured between crank webs reaches

.005 inch the possibility for the formation of surface cracks in the shaft at the critical areas becomes quite great and it is then advisable to correct the bearing alignment. With stiff designs of cranks the amount of allowable distortion is necessarily less, and with long, flexible designs of cranks it is possible for a somewhat greater amount of distortion than .005 inch to do no serious harm.

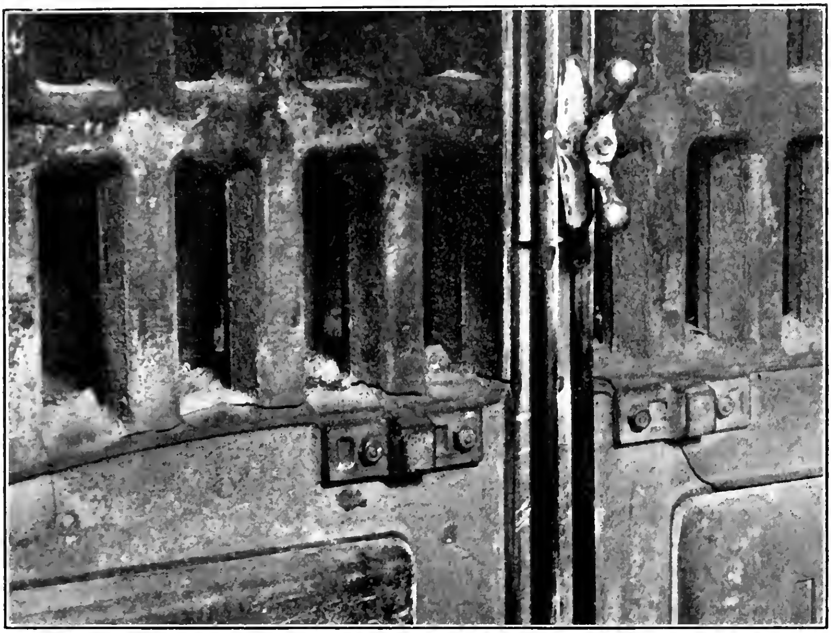
This method of keeping track of the distortion of center-crank shafts as outlined has proven to be of great value in getting the most possible use out of such shafts. Advice regarding it is one of the many important features of engine inspection visits by HARTFORD inspectors.

Pump Return Systems for Heating Boilers.

CAST iron heating boiler explosions occur occasionally, but not nearly so frequently as that other type of heating boiler accident, the cracking of sections. The explosions are usually the result of over pressure, but the cracking of sections in cast iron boilers may be due to any of several causes such as scale, localized or too intensive heating, uneven expansion due to building a hot fire too quickly, or occasionally to defective material, but by far the greatest number of such failures are due to low water. Causes of low water are likewise many, and range from careless operation to features of the design of the particular system. It is one of the latter that is to be considered here.

The usual type of steam heating installation is what is known as a gravity return system. The boiler is located in a part of the building that is lower than any of the radiators. The steam rises from the boiler to the various radiators where it is condensed and flows back by gravity. The amount of condensate returned is in proportion to the amount of steam going out, so the water level automatically remains approximately constant. When this arrangement cannot be obtained, that is, if some of the radiators are low or at a distance from the boiler so that the condensate does not drain back properly but remains in the heating system, it becomes necessary to install a pump for its return. In fact, it is becoming common practice now when designing new heating systems, especially large systems, to depend upon a pump for the return of the condensate to the boiler. This enables the use of smaller piping thus reducing the first cost, and in addition gives a more positive action particularly on large systems where long horizontal runs are inclined to make the action sluggish. The installation of a pump has rejuvenated many old gravity return systems that were not giving satisfactory results.

In the operation of a pump return system, the condensate returns to a receiving tank installed lower than any of the radiators and is then pumped into the boiler. The operation may be continuous or intermittent, that is, the pump may be running and a vacuum maintained on the return lines at all times, or the tank may be allowed to become filled to a certain height and the pump then started up to empty it. There would appear to be little difference in the operation whether all of the radiators are elevated above the level of the boiler



Cracked Section in Boiler Rated at 16,800 Square Feet. Boiler Was Red Hot When Oil Burner Was Shut Off.

or not, but the hazard of cracking of sections can be made less in the former case.

The use of a pump return introduces an uncertain element in the system in that it may at some time fail to operate. Usually these pumps are electrically driven, and it is well known that any one of a number of minor accidents, such as a loose connection or adjustment or a blown fuse, may happen to prevent or delay proper operation of electrical machinery, particularly automatic machinery. Electrical storms quite frequently interfere with the operation of generating stations, and heavy rain storms often flood conduits or otherwise interfere with transmission, thus shutting off power for periods varying from a few minutes to hours. If the attendant is not aware that the current is off — and he is not likely to give thought to it where dependence has been placed on automatic starting — the pump, of course, will not operate. Even where the pump does not start automatically but is controlled by an attendant, the element of carelessness or inattention enters. The failure of the return pump, of course, results in low water unless other provision is made for the return water to enter the boiler. Low water if not detected in time will in turn result in cracked sections, necessitating expensive repairs if not complete replacement.

When a steam heating boiler is located lower than the return line and there is a pump in the return line, it is usually advisable to provide an alternative way for the water to get back to the boiler by gravity through a by-pass in the event of failure of the pump. This by-pass carries the water around the pump and should be provided with a check valve but no stop valve, so that it will stand ready for operation at all times. Such an arrangement is not a sure safeguard for all systems against low water in case of failure of the return pump, for in many cases the pump has been installed because of real or anticipated difficulty with a gravity return, but it is an accident prevention measure that frequently comes to the rescue of the heating boiler. Insurance regulations formerly required the inclusion of such a by-pass around the pump before the boiler could be covered against the cracking of sections, and it is still recommended as good practice. It can be readily included when a new system is being installed at very little extra cost, and it would seem advisable for heating contractors to bring the matter to the attention of the owner of the premises, either when bidding on the job or at least before its completion, so that the plans may be altered to include a gravity return by-pass at little additional expense. Some manufacturers of pumps for heating returns furnish plans for the installation of their equipment and show the proper manner of making this connection so that it is a simple matter for the steam-fitter to incorporate it. Frequently in the past the matter has been brought to the owner's attention through applying for insurance against cracking. Changes necessary before placing a new system in operation have resulted in criticism being directed at the contractor and in considerable misunderstanding and an unfriendly feeling that could have been avoided.

Insurance against cracking of sections can now be obtained on any approved heating system whether the water is returned by gravity or pump. However, the greater hazard from low water with a pump return system necessitates a higher premium rate than does a gravity return system.

Brine Cooler Explosion At St. Louis, Mo.

A BRINE cooler exploded in the basement of the Valentino Apartments, St. Louis, Mo., on the afternoon of September 4th, 1925, killing one man and injuring six other persons. Five of the injured were overcome by fumes, and a woman was injured in jumping to the ground from a third floor window in a frantic effort to escape from the fumes.

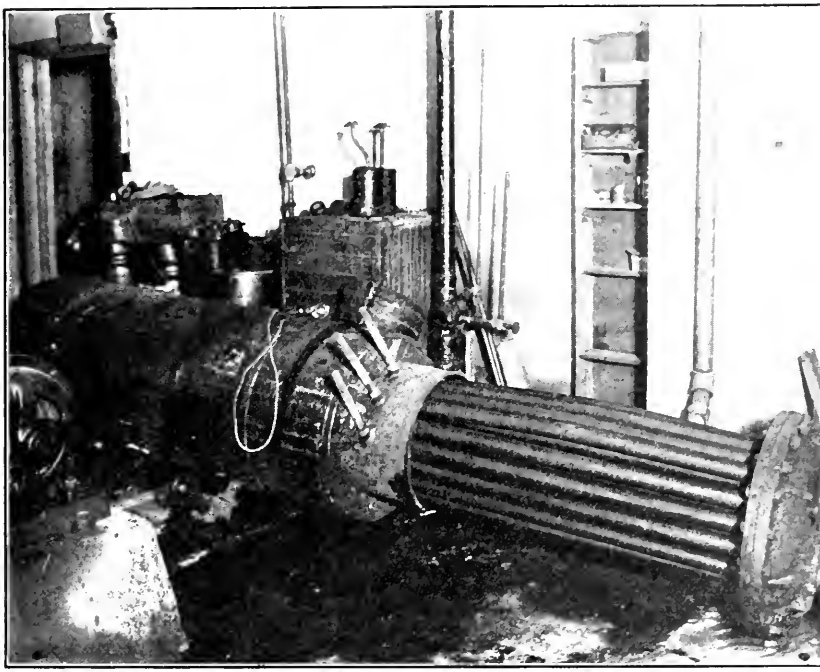


FIG. 1.

The brine cooler consisted of a shell 20 inches in diameter by 12 ft. long with tubes running through from end to end. Brine was circulated through the tubes for cooling, and ammonia surrounded the tubes. The shell was constructed in two courses of 5/16 inch plate, and all joints were autogenously welded.

The exact cause of the accident is not known because of the death of the operator, but it is believed to have resulted from improper operation. The brine is said to have become weak and froze in several of the tubes of the cooler, and in an endeavor to thaw it, hot gas from the high pressure side of the compressor was turned into the shell of the cooler. In this way it was possible to build up a pressure of 175 lbs. in the vessel, although the pressure attained at the time of the accident is unknown.

While the direct cause of the accident is thought to have been overpressure, yet it is significant, as so frequently is found to be the case, that some portions of the welding were very poor. The failure was entirely in one course, as shown by Fig. 1, and the rupture was confined to the welded seam. The course that failed was completely torn off and opened out flat, as shown in Fig. 2. Considerable damage was done to the piping and walls of the basement.

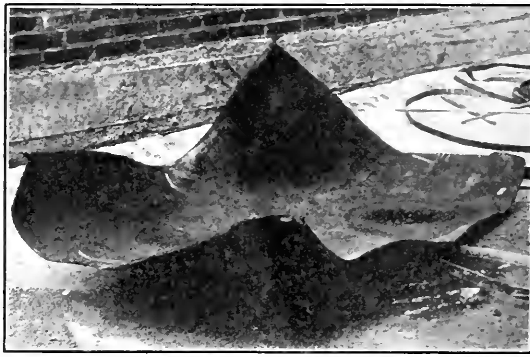


Fig. 2.

Boiler Explosions vs. Boiler Inspections.

An accident that particularly emphasizes the necessity of expert boiler inspection occurred October 19th, 1925, when the portable sawmill boiler owned by Messrs. Walker and Graw exploded at Roxbury, N. H. One man was killed and four others injured, and two horses were blinded. The sawmill was completely destroyed. The front end of the boiler was torn off and projected about 500 ft. away. The main portion of the boiler traveled about 200 ft. in the opposite direction but was retarded in its flight by three large trees which it broke off.

This boiler was of the locomotive firebox type, 48 inches in diameter and 17 ft. long. At the time of the explosion it had been in operation but one day after being completely overhauled and repaired. The studs securing the door frame had broken off and so the frame was spot welded to the front head. As the throat sheet had become thin at the blow-off connection, a 1½ inch standard flange coupling was welded to the sheet and the blow-off pipe screwed into this coupling. Likewise a ¾ inch flange coupling had been welded over the fusible plug opening in the crown sheet, thus leaving a small pocket for mud or sediment to collect over the end of the plug. In addition, several tubes had been renewed, a new fusible plug inserted, and the boiler painted so that it looked to be in good condition. It was evidently the intention of the owner to have the boiler placed in first class condition.

The failure of the boiler cannot be attributed to any of these repairs but rather to the failure of the staybolts. The staybolts in the boiler were originally of ¾ inch diameter, having a net cross-sectional area of .288 inch. They were spaced on 5 inch centers; hence the area supported by each bolt was 24.712 square inches. (Supported area minus area of staybolt.) The total stress allowed in a ¾ inch staybolt by the A. S. M. E. Boiler Construction Code is 2160 lbs., which when divided by the area 24.712 square inches, gives an allowable operating pressure of 87.5 lbs. At the time of the explosion the boiler is said to have had 110 lbs. pressure. The safety valve, which incidentally was too small, was set at 120 lbs. Under normal conditions, therefore, the staybolts were overloaded, and this condition was seriously aggravated by the fact that they had materially wasted away. As shown in Fig. 1, some of these staybolts had corroded to such an extent that not over one-third of the original diameter remained. This reduced the effective cross-sectional area to about one-sixth of normal and increased the unit stress in inverse proportion, thus effectually overcoming any reasonable factor of safety. During the overhauling, the hand-hole covers in the bottoms of the water legs are said to have been removed and the mud and sediment washed out, so it would seem as if these corroded staybolts must certainly have been seen at that time. However, the persons who did the work evidently failed to appreciate this to be a dangerous condition and so made no comment on it.

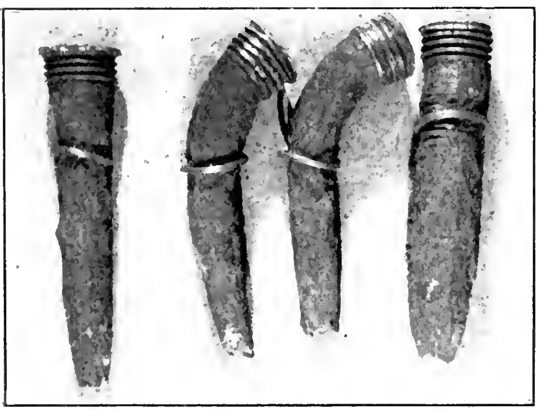
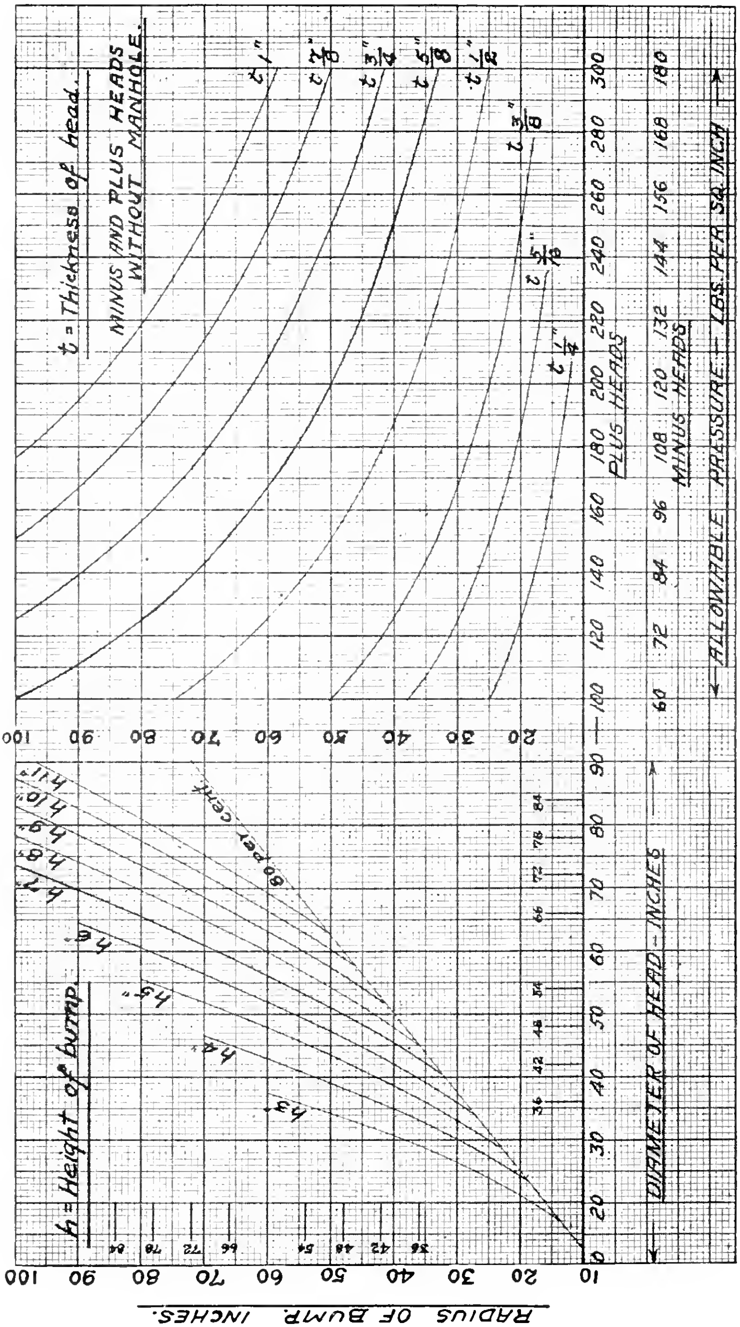


FIG. 1.

An examination by an expert boiler inspector would undoubtedly have revealed the overloading and wasting away of the staybolts and the insufficient size of the safety valve, and would have brought forth recommendations for suitable repairs to the throat and crown sheets. If there had been expert inspection it is very likely this accident would not have happened.



A Chart For Dished Head Computations.

A Chart For Dished Head Computations.

THE diagram on the opposite page was prepared by Inspectors Wm. H. Cannon and W. F. Reisch of our Pittsburgh Department primarily for use in computing allowable pressures for boilers as determined by the construction of the heads. The diagram is based upon the A. S. M. E. Boiler Construction Code formula for determining the thickness of plate required: —

$$t = \frac{5.5 \times P \times L}{2 \times TS} + 1/8$$

t = thickness of plate, inches.
P = maximum allowable working pressure, lbs. per square inch.
L = radius to which the head is dished, inches.
TS = tensile strength, lbs. per sq. inch.

This formula is for unstayed heads in which the head is a segment of a sphere with the pressure on the concave side, in other words a plus head. For minus heads — heads dished inward — the formula is modified so that the allowable pressure is but 60% of that allowed on a plus head of the same dimensions. This has been provided for in the accompanying diagram by separate pressure scales for plus and minus heads. The scale for minus heads is a great convenience but it should be noted, when reading intermediate pressures, that each division represents 1.2 lbs., a rather unusual value. It results, however, from taking 60% of 2 lbs., the value of each division on the scale for plus heads. The chart was designed for boiler steel using a value of 55,000 lbs. per square inch for the tensile strength.

The method of using the chart is simple. To obtain the maximum pressure allowed by the head construction of a boiler, start at the bottom of the chart on the left. Select a point on this scale representing the diameter of the head and follow up this vertical line until it intersects the curve corresponding to the height of the bump. (If the curve representing the height of bump is to the right of, and does not intersect, the vertical line, then stop at the intersection with the sloping line marked 80%). The horizontal line intersecting at this point gives the value which should be considered as the radius of the bump. Following this horizontal line to the right until it intersects the curve corresponding to the head thickness, and then following down the vertical line passing through this intersection point, the allowable pressure is given by the proper scale at the bottom on the right. There are two scales for allowable pressure, one for plus heads and one for minus heads, the latter giving values 60% of the former, as explained above.

For heads with a manhole, use the curve for thickness 1/8 inch less than the actual thickness.

The solution of a sample problem may make the use of the diagram more clear. Let us assume that a safe working pressure is to be determined for a boiler drum having a plus head 54 inches in diameter with an 8 inch bump and made of 5/8 inch plate. Figure 1 shows the course to be followed in solving this problem. Starting with point A at the bottom on the left, we follow up the 54 inch diameter line to point B, the intersection with the curve marked "h=8 inches." Following across the horizontal line through this point (which on the large diagram shows the radius of curvature of the head to be 50 inches) to point C, where it intersects the curve marked "t = 5/8 inch," then down the vertical line to point D we find the maximum allowable pressure based on the assumed head construction to be 200 lbs. per square inch.

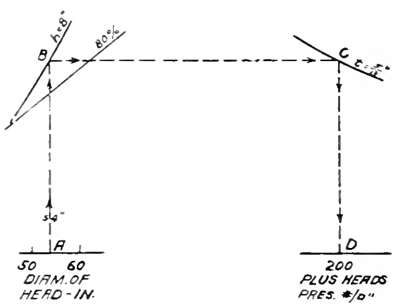


FIG. 1.

Had this been a minus head, we would have read the answer on the lower pressure line of the chart, which would give 120 lbs.

Had there been a manhole in this head, we would have stopped at the curve marked "t=1/2 inch" and followed down to find our answer to be 151 lbs. for a plus head.

The simplicity of this chart particularly recommends it, as the work of computation is expedited and made less irksome and the chance of error greatly reduced.

Labor Saving on the Locomotive.

THE locomotives of a few years ago, while much smaller than those of the present day, required far more physical labor to operate them than the large locomotives now in general use.

There was once a time when one of the big locomotives of any road needed a crew possessing tremendous physique to run it efficiently. The job of firing fuel as locomotives grew in size became more severe and the work of the fireman became almost continuous during the run.

So arduous was this job that on the big freight locomotives two firemen were often required to get enough fuel in the firebox to keep up steam pressure at the high rates of consumption on heavy freight runs.

Then too the labor of the engineer in "horsing over" the old Johnson bar when changing cut-off became greater with the increase in size of the locomotive and it could not be done safely at speed.

But the last few years have changed considerably the work of running a locomotive. Steam and air are made to do the physical jobs and as the crew has been relieved of manual labor, they have more opportunity to use their intelligence in getting the utmost out of the modern locomotive.

As the size of the locomotive increased additional equipment was installed to provide economies that were not considered on the older and smaller engines. With this additional equipment the railroads at the same time endeavored to provide other devices to off-set the new duties and relieve the engine crews of the unpleasant jobs which had formerly been theirs.

Among the most prominent devices of this character which relieved the fireman, were the stoker, pneumatic fire doors and the power grate shaker. The use of these devices materially lightened his duties and gave him time to aid the engineer, observe signals and to acquire more knowledge of locomotive operation.

Besides lightening the actual work of firing, Franklin Automatic Fire Doors make it easier for the fireman to keep up the steam pressure because they close between each scoop of coal, and thereby cut out a lot of fire-killing cold air that entered the fireboxes through the open hand swung door.

One of the hardest jobs of a fireman is using the slice bar on a fire that needs stirring while the locomotive is running. This work is now done by steam through the use of the Franklin Steam Grate Shaker, and all of the work the fireman is called upon to do is to operate two control handles. The danger of personal injury to back and hands is eliminated.

Among the other devices which benefit the engineer are the Franklin Power Reverse Gears and the Grease Lubricator for Driving Boxes. It is not so many years ago that the engineer had to be on the alert to keep driving boxes running cool. Today he hardly knows, as far as lubrication is concerned, that he has driving boxes on the engine.

The Precision Power Reverse Gear makes it possible for the engineer to secure just the proper cut-off for fuel economy at any speed without the danger involved in changing cut-off while running with the old form of hand reverse lever. And when the engine is to be reversed the task is a matter of only a moment and requires little exertion.

Not only has the labor of the engine crew been lightened, but the riding qualities of the large engines now in use have been considerably improved by the Lateral Motion Driving Box and the Radial Buffer. The Lateral Motion Driving Box eases the locomotive around curves and eliminates the sudden biting of the rails and side sway that constitute a real menace to safety and make the locomotive uncomfortable to ride.

The Radial Buffer provides the action of a cylinder rolling on a sphere between the engine and tender so that the buffer cannot possibly bind and lift the tender from the rails which used to happen in the old days.

The engine crews of today are fortunate. They are hauling heavier trains in less time and for better wages. The equipment that the railroads have provided on the large engines makes the work easier and leaves the crews in better condition physically and mentally when they leave their engines at the end of a run than the crews of the old time engine that pulled only a fraction of the tonnage now being hauled. — *New York Central Lines Magazine.*

Fatigue Tests on Welded Joints.

FATIGUE tests on butt-welded joints in steel tubes used in airplane construction were made by the Engineering Division of the Air Service at McCook Field, Dayton, Ohio, and the results, as reported in *Mechanical Engineering,* indicate such joints to be only about 50% as resistant to failure through fatigue as the original tubes. The rotating beam method was used. Results of static tension tests on like specimens indicate 80% as the dependable tensile strength.

The tests were made on both torch-welded and arc-welded specimens. No difference in strength between the two methods was shown, but the location of the fracture varied. With torch-welded specimens, the failure occurs in the tension tests about ½ to 1 inch from the weld due probably to the softening of the tube at this point by the heat of the flame, and in the repeated stress tests the failure is in the weld. With arc-welded specimens, the failure is at the edge of the weld in both tension and fatigue tests.

Coffee Boiler Explosions.

THE cheerful and companionable coffee urn such as one sees in every restaurant is an innocent looking piece of equipment, but it is nevertheless a pressure vessel and is subject to the hazards of such vessels. Four recent newspaper items tell of the failure of as many urns, one of which resulted in the death of the operator, two others resulted in cases of serious scalding, while the fourth caused a $3,000 fire.

On August 5, 1925, the coffee boiler in the kitchen of the Edward W. Sparrow Hospital, Detroit, Michigan, exploded and seriously scalded a woman employed as cook. The lower head of the boiler separated entirely from it. Leaks had been observed around one side of this head seam, and on the day of the explosion the opposite side started to leak. Just prior to the accident the cook became alarmed at a bubbling noise and stooped over to close the steam valve. While she was closing the valve, the vessel exploded.

On August 7, 1925, the coffee boiler in the County Alms House at Blackwood, N. J. exploded, scalding the cook so badly that he died the following day. This accident was evidently due to over pressure. The cook had left the tank full of water with the steam turned on in the heating coils. When he returned, water was squirting out of the safety valve. He was attempting to shut off the steam and water valves when the explosion occurred. The safety valves were probably inadequate.

The explosion of two coffee boilers in the Sam De Barri Restaurant, Los Angeles, California, on September 28, 1925 resulted in the complete destruction of the interior of the restaurant by fire. The two cooks on duty escaped injury. The cause of the explosion was not given.

On March 25, 1926 a coffee percolator exploded in the kitchen of a cafeteria on the eleventh floor of the American Bank Building, San Francisco, California, and seriously scalded the woman cook. Further details of the accident are lacking.

It would appear that these coffee urns or boilers are usually not very substantially built, are frequently not properly protected, and are operated by persons giving little thought to the dangers of a steam pressure vessel.

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Devoted to Power Plant Protection

Published Quarterly

Benj. C. Cruickshanks, Editor.

HARTFORD, JULY, 1926.

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Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
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The Locomotive of the Hartford Steam Boiler I. & I. Co.

THE possible breakdown of a large reciprocating engine is always a serious matter, for such accidents not only jeopardize the lives of persons in the vicinity but also result in large financial losses. However, by far the worst feature is the inconvenience and loss incident to a shutdown. Engines are used primarily in mills and mills do not as a rule have duplicate units. Hence, when an engine accident is experienced, the portion of the mill depending upon that engine is entirely at a standstill pending repairs. The employees are usually laid off and there is a 100 per cent loss in production.

Engine accidents are of many kinds but among the preventable ones is the failure of center crank-shafts. Such shafts usually have three or more bearings and any misalignment of these bearings, due either to wear or misadjustment, results in distortion. This bending action sets up stresses in certain critical parts of the shaft surface and these stresses are reversed at every revolution. Similar conditions are produced by deflection of the shaft from other causes such as heavy overhung flywheels, or pulleys with excessive belt tension. If these reversals of stress are allowed to go on unchecked, the useful life of the shaft is likely to be greatly shortened. Twenty-five years is said to be the maximum average life though some are known to have failed within 10 years. This subject is considered at some length in the article of page 67 and a method is given whereby the full possible length of life of a center-crank shaft may be obtained.

Obituary.

A. F. CHRISTIE, Inspector in our Cleveland department, died at his home in Cleveland, Ohio on Monday, March 22nd, 1926 after a brief illness. He was taken ill with pneumonia on Tuesday, the 16th, and died within a week.

Mr. Christie was born in Aberdeen, Scotland on September 5th, 1888. He had been in the service of the Hartford Company but a short time, having been employed as an inspector on June 1st, 1925. He had therefore completed less than ten months of service.

A New Cast Iron for Engine Cylinders.

A METAL attracting much attention abroad is Perlit, a cast iron invented and worked in the foundries of Heinrich Lanz, of Mannheim. According to *The Engineer,* London, by subjecting the metal to careful metallurgical control as to its composition and by preheating the mold and core so that the rate of cooling of the castings is correlated with the thickness and the mass of the casting, it has been found possible to produce a pearlitic structure throughout all sections. The casting is tough and malleable and shows a marked difference in fracture as compared with that of ordinary cast iron. The gray iron so produced is remarkably low in its silver contents and is largely immune from growth when exposed to high temperatures, which gives Perlit iron a particular importance for oil-engine work. A considerable amount of development work in connection with the production of standard castings of Perlit iron has been carried out in England and Germany.

The consistent qualities of Perlit iron are such as to render it to all intents and purposes a new metal. It is claimed that, for the first time in iron founding, a cast metal can be produced possessing properties that permit of the strength and weight of any casting being predetermined with an accuracy that up to now has been associated with mild-steel constructional work alone and lacking objectionable feature of growth encountered in cast irons under high-temperature conditions. — *Power.*

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JULY, 1925 (Continued).

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
440	10	Air tank exploded		2	Geneva Boiler Wks.	Boiler Works	Geneva, N. Y.
441		Tube ruptured			F. & M. Schaefer Brewing Co.	Brewery	New York, N. Y.
442	11	Tube ruptured		2	Bucyrus Co.	Steam Shovel Plt.	Evansville, Ind.
443	12	Tube pulled out of drum			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
444		Section of heating boiler cracked			Trinity Episcopal Church	Church	Rutland, Vt.
445		Two sections heating boiler cracked			Mary A. Fitzgerald	Office Bldg.	New York, N. Y.
446	13	Header cracked			Monsanto Chemical Works	Chemical Wks.	St. Louis, Mo.
447	14	Boiler exploded		1	So. Vernon Oil Field	Oil Well	Vernon, Texas
448	15	Six sections heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Charlotte, N. C.
449		Boiler exploded	1	2	Humphrey's Sawmill	Sawmill	Apison, Tenn.
450	16	Boiler of locomotive exploded	1		Rock Island Lines	Railroad	El Dorado, Ark.
451	17	Air tank exploded		3	Edw. G. Budd Mfg. Co.	Auto Body Fcty.	Philadelphia, Pa.
452	18	Air receiver exploded			City of Miami	Power Plant	Miami, Okla.
453	19	Boiler exploded		1	Trinity Drilling Co.	Oil Well	Wichita Falls, Tex.
454	20	Blow-off pipe failed			Manheim Laundry Co.	Laundry	Philadelphia, Pa.
455		Tube ruptured		1	Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
456	21	Ammonia tank exploded		1	Kroger Grocery & Baking Co.	Bakery	Cincinnati, Ohio
457		Tube ruptured			Kalamazoo Vegetable Parchment Co.	Parchment Mill	Kalamazoo, Mich.
458		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
459	22	Boiler exploded		2	Gulf Production Co.	Oil Well	Pierce Junc., Tex.
460	24	Crown sheet of locomotive failed			Spice Run Lumber Co.	Sawmill	Spice Run, W. Va.
461	25	Nipple on heating boiler ruptured			J. L. & A. V. Avery	Apt. House	Indianapolis, Ind.
462		Blow-off pipe failed			Hall Bros.	Cotton Gin	Beeville, Tex.
463		Section of heating boiler cracked			Los Angeles Industrial Clinic & Hospital	Hospital	Los Angeles, Cal
464	27	Furnace collapsed			Bergen Point Iron Wks.	Iron Works	Bayonne, N. J.
465		Tube ruptured			Lackawanna & Wyoming Valley Power Co.	Power Plant	Scranton, Pa.

466	28	Header cracked			Pittsburgh Terminal Warehouse & Transfer Co.	Term. Warehouse	Pittsburgh, Pa.
467		Boiler exploded	1		D. L. Carlton	Sawmill	Eufaula, Ala.
468	29	Boiler exploded		2	Echols Construction Co.	Contractors	Alderson, W. Va.
469		Blow-off pipe fitting failed			Farmers Gin Co.	Cotton Gin	Wallis, Texas
470	31	Section of heating boiler cracked			Fred Graves	Store	Beloit, Kans.
471		Section of heating boiler cracked			Albert Gordon	Hotel	Chicago, Ill.
472		Tube ruptured			Lorain Crystal Ice Co.	Ice Plant	Lorain, Ohio

MONTH OF AUGUST, 1925.

473	1	Blow-off pipe failed			Jacksonville Electric & Ice Co.	Ice Plant	Jacksonville, Tex.
474		Boiler exploded		3		Sawmill	Loachapoka, Ala.
475	2	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
476	4	Steam pipe burst	1		Mathis Yacht Bldg. Co.	Ship Yard	Camden, N. J.
477	5	Jacketed drier collapsed			C. W. Swingle & Co.	Rendering Plant	Lincoln, Neb.
478	6	Boiler exploded		3	Pennington & Wizgul Lumber Co.	Sawmill	Amory, Miss.
479	8	Air tank exploded	1	2	Pyntree Paper Co.	Paper Mill	Gordon, Ga.
480	9	Three sections heating boiler cracked			Janety Realty Co.	Apt. House	New York, N. Y.
481		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
482		Steam separator cracked			Continental Paper Co.	Board Mill	Bogota, N. Y.
483	10	Blow-off pipe failed			T. A. Foley	Sawmill	Paris, Ill.
484	11	Boiler exploded	1	2	H. M. Walker	Sawmill	Gold Rock, N. C.
485	12	Ammonia pipe burst			Sherry's Apartments	Apt. House	New York, N. Y.
486	13	Tube ruptured			Pinellas County Power Co.	Power Plant	St. Petersb'gh, Fla.
487	15	Three sections heating boiler cracked			Benjamin Feingold	Garage	New York, N. Y.
488	16	Section of hot water heater cracked			Klion Holding Corp'n	Apt. House	New York, N. Y.
489		Blow-off pipe failed			Esmeralda Canning Co.	Canning Fcty.	Circleville, Ohio
490	17	Throttle valve ruptured			North End Paper Co.	Paper Mill	Fulton, N. Y.
491		Crown sheet of locomotive ruptured			Swayne Lumber Co.	Sawmill	Oroville, Cal.
492		Feed-water heater coil ruptured			Union Leather Co.	Mill Supply Plant	Wilmington, Del.
493		Header cracked			Arrott Land Co.	Office Bldg.	Pittsburgh, Pa.
494		Ammonia coil exploded		3	Swift & Co.	Packing House	Los Angeles, Cal.
495	18	Manhole cover blew off	2		P. Sanford Ross Contracting Co.	Dredge	Island Park, L. I.
496		Boiler exploded	52	100	S. S. Mackinac	Steamer	Newport, R. I.
497	20	Section of heating boiler cracked			Air Reduction Co., Inc.	Chemical Plant	Emeryville, Cal.
498		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.

MONTH OF AUGUST, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
499	21	Hot water supply tank exploded			Theo. M. Barr	Plumbing Shop	Salem, Ore.
500	22	Boiler exploded		1	Belke Mfg. Co.		Chicago, Ill.
501		Boiler exploded			Old Spanish Trail	Gravel Pit	Slidell, La.
502		Boiler exploded	2	4	H. E. Talton	Cotton Gin	Kathleen, Ga.
503	23	Boiler bulged and ruptured			Alabama Water Co.	Ice & Power Pit	Oneonta, Ala.
504		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
505		Section of heating boiler cracked			Crockett Hotel	Hotel	San Antonio, Tex.
506	24	Boiler exploded		1	Geo. W. Foster Lease	Oil Well	Bully Hill, Pa.
507	25	Section of heating boiler cracked			Adolf Eckstein	Apt. House	New York, N. Y.
508		Blow-off pipe failed		1	Model Laundry Co.	Laundry	Durham, N. C.
509	26	Boiler ruptured			Fairmont Creamery Co.	Dairy	Omaha, Nebr.
510		Boiler exploded		1	Ashton Township	Stone Quarry	Ashton, Ill.
511	27	Boiler exploded	7		C. J. Buchanan	Cotton Gin	Dayton, Ala.
512	28	Header cracked			Lewis A. Park	Office Bldg.	Pittsburgh, Pa.
513		Header cracked			National Biscuit Co.	Bakery	Marsailles, Ill.
514		Blow-off pipe ruptured		1	Shand Builders Supply Co.	Planing Mill	Columbia, S. C.
515	29	Boiler ruptured			Fairmont Creamery Co.	Dairy	Omaha, Nebr.

MONTH OF SEPTEMBER, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
516	1	Tube ruptured			Western Ohio Railway Co.	Railroad	St. Mary's, Ohio.
517		Boiler bulged and ruptured			Alex Porter Lumber Co.	Saw Mill	Hope, Ind.
518		Header cracked			Shredded Wheat Co.	Wheat Products	Niagara F'lls, N.Y.
519	2	Header cracked			National Biscuit Co.	Baking Plant	Gr'd Rapids, Mich.
520		Boiler exploded				Oil Well	Abilene, Texas.
521	3	Tube ruptured		1	Quincy Mining Co.	Copper Mine	Mason, Mich.
522	4	Brine cooler exploded	1		Valentino Apartments	Apt. House	St. Louis, Mo.
523	5	Valve ruptured			H. J. Sontag	Stores & Offices	Chicago, Ill.
524	7	Boiler ruptured			Continental Eng. & Const. Co.	Contractors	W. Palm B'ch, Fla.
525		Blow-off pipe ruptured			Rider Packing Co.	Packing House	Medora, Ind.
526	9	Boiler ruptured			Yocum Ice Cream Co.	Ice Plant	Steubenville, O.
527		Boiler bulged and ruptured			Bowman-Hicks Lumber Co.	Lumber Mill	La Grande, Ore.

528		Section of heating boiler cracked			Est. of A. L. Maxwell	Apts. & Stores	Lawrenceville, Ill.
529		Section of heating boiler cracked			Board of Education	School	Lawrenceville, Ill.
530	10	Two sections heating boiler cracked			Keystone State Real Estate Co.	Light Mfg.	Philadelphia, Pa.
531		Crown sheet of locomotive failed		3	Shaw Bertram Lbr. Co.	Logging	Klamath F'lls, Ore.
532		Milk condenser dry pan collapsed			Harding Cream Co.	Creamery	Omaha, Nebr.
533	11	Boiler exploded			Russ Lumber Mill	Lumber Mill	Arcadia, Fla.
534		Boiler exploded	1		Randolph Gin	Cotton Gin	Greenville, N. C.
535		Boiler exploded		1		Stone Quarry	Union Twp., Ohio.
536	12	Section of heating boiler cracked			Atlantic Hospital Corp.	Hospital	Atlantic, Iowa.
537		Section of heating boiler cracked			Wallstein Industrial Corpn.	Loft Bldg.	Brooklyn, N. Y.
538		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
539		Blow-off pipe ruptured			Rider Packing Co.	Canning Plant	Freetown, Ind.
540		Crown sheet failed			Waite Phillips Co.	Oil Refinery	R'nb'w Bend, Kans.
541		Boiler ruptured		1	J. J. Newman Lumber Co.	Lumber Mill	Sumrall, Miss.
542		Hot water heating boiler exploded			Calvary Baptist Church	Church	Morristown, Pa.
543	13	Tube ruptured			Pinellas County Power Co.	Power Plant	St. Petersburg, Fla.
544	14	Stays pulled out of crown sheet of locomotive		1	Winton Lumber Co.	Lumber Mill	Gibbs, Idaho.
545		Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Charleroi, Pa.
546	15	Section of heating boiler cracked			W. J. Hyland	Business Block	Springfield, Mass.
547	17	Boiler bulged and ruptured			Bowman-Hicks Lumber Co.	Lumber Mill	La Grande, Ore.
548	18	Boiler bulged and ruptured			Houser Canning Co.	Gin & Cannery	Ft. Valley, Ga.
549	20	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
550	2	Tube ruptured			Sidney Blumenthal & Co.	Silk Mill	Shelton, Conn.
551		Header cracked			Eastman Kodak Co.	Photo Supplies	Rochester, N. Y.
552	22	Blow-off pipe ruptured			Wyoming Worsted Mills	Woolen Mill	Tunkhannock, Pa.
553		Air compressor exploded		3	Jenkins Glass Co.	Glass Factory	Kokomo, Ind.
554	23	Boiler bulged and ruptured			Bowman-Hicks Lumber Co.	Lumber Mill	La Grande, Ore.
555		Section of heating boiler cracked			S. & J. Kohn	Tob. Warehouse	Hartford, Conn.
556		Header ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
557	24	Heating boiler exploded	1		County Farm	Infirmary	Cassipolis, Mich.
558	25	Furnace collapsed			Cohn Bros.	Cotton Gin	Lorman Bros.
559		Two sections heating boiler cracked			B. G. Davis & Co., Inc.	Cigar Factory	Trenton, N. J.
560		Two sections heating boiler cracked			Est. of L. S. Starrett	Apt. House	Athol, Mass.
561		Two sections and manifold of heating boiler cracked			Gilmore & Gardner	Hotel & Stores	Springfield, Mass.
562		Milk condenser dry pan collapsed			Harding Cream Co.	Creamery	Omaha, Nebr.
563		Section of heating boiler cracked			Olympia Theatres, Inc.	Theatre	Allston, Mass.
564	27	Boiler bulged and ruptured			Bastrop Pulp & Paper Co.	Paper Mill	Bastrop, La.

MONTH OF SEPTEMBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
565	28	Tube ruptured		1	Jessup & Moore Paper Co.	Pulp & Paper Mill	Wilmington, Del.
566		Tubes ruptured			Anchor Planing Mill	Planing Mill	Meridian, Miss.
567	29	Tube ruptured	2		Commonwealth of Pa.	State Capitol	Harrisburg, Pa.
568		Blow-off pipe ruptured			South Chicago Sash & Door Co.	Lumber Mill	So. Chicago, Ill.
569		Crown sheet collapsed			Morgan M. Smith Farming Co.	Gin & Grist Mill	Forrester, Ala.
570		Section of heating boiler cracked			Katz Underwear Co.	Textile Mill	Honesdale, Pa.
571		Two sections heating boiler cracked			State of Connecticut	State Bldg.	Hartford, Conn.
572	30	Two sections heating boiler cracked			Mackie Worsted Yarn Co.	Textile Mill	Allendale, R. I.
573		Two sections heating boiler cracked			Cons. Amusement Enterprises	Miscellaneous	New York, N. Y.

MONTH OF OCTOBER, 1925.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
574	1	Section of heating boiler cracked			Ironwood Amusement Corpn.	Theatre	Ironwood, Mich.
575		Section of heating boiler cracked			Consolidated Cigar Corpn.	Cigar Factory	Allentown, Pa.
576		Two sections heating boiler cracked			Wm. Wunner & Geo. Snedecar	Apt. House	New York, N. Y.
577		Three sections heating boiler cracked			Rt. Rev. Alphouse J. Smith	Church	Memphis, Tenn.
578		Hot water heating boiler exploded			Trinity Social & Athletic Club	Club House	Brooklyn, N. Y.
579		Tube ruptured			Youngstown Sheet & Tube Co.	Steel Plant	Youngstown, Ohio.
580		Autogenously welded tank exploded	1	1	Aurora Welding Works	Tank Works	Stockton, Cal.
581	2	Ten sections heating boiler cracked			Wise, Smith & Co.	Business Block	Hartford, Conn.
582		Manifold of heating boiler cracked			J. F. & E. A. Kerley	Store & Apts.	Syracuse, N. Y.
583		Vulcanizer head blew off			Kokomo Rubber Co.	Rubber Works	Kokomo, Ind.
584	5	Section of heating boiler cracked			Children's Aid Society	Children's Institute	New York, N. Y.
585		Section of heating boiler cracked			Independent School District	School	Shenandoah, Iowa.
586		Manifold of heating boiler cracked			Loew's, Inc.	Theatre & Stores	New York, N. Y.
587	6	Crown sheet collapsed			Morgan M. Smith Farming Co.	Gin & Grist Mill	Forrester, Ala.
588		Section of heating boiler cracked			Romig Auto Garage	Garage	Akron, Ohio.
589		Section of heating boiler cracked			Veronica Herberich	Residence	Akron, Ohio.
590	6	Section of heating boiler cracked			The Inn Hotel	Hotel	Zanesville, Ohio.
591	8	Two sections heating boiler cracked			Monroe Hotel & Realty Co.	Cafe	St. Louis, Mo.
592		Section of heating boiler cracked			Samuel J. Rickman	Apt. House	Springfield, Mass.
593		Section of heating boiler cracked			Foster Foundation, Inc.	Home	Hunt'gton, W. Va.

594		Section of heating boiler cracked			Ed. C. Smith	Apt. House	Houston, Tex.
595	9	Section of heating boiler cracked			Ferrigno & Perrone	Apt. House	Hartford, Conn.
596		Section of heating boiler cracked			Conron Bros.	Market & Storage	New York, N. Y.
597		Section of heating boiler cracked			Air Reduction Co., Inc.	Chemical Plant	Jersey City, N. J.
598		Boiler bulged and ruptured			Lawrence Ice & Cold Storage Co.	Cold Storage Plt.	Newcastle, Pa.
599		Feed water pipe burst			American Furniture Co.	Furniture Factory	Martinsville, Va.
600	10	Manifold of heating boiler cracked			Luke Horsfall Co.	Mercantile	Hartford, Conn.
601		Tube ruptured			Pittsburgh Prov. & Pack. Co.	Packing House	Pittsburgh, Pa.
602		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
603		Sections of heating boiler cracked			Metropolitan Theatre	Theatre	Rochester, Minn.
604		Sections of heating boiler cracked			Catholic Bishop of Rockford, Inc.	Church	Aurora, Ill.
605		Section of heating boiler cracked			Samuels & Weinstein	Apt. House	New York, N. Y.
606		Sections of heating boiler cracked			Platt Bros. Co.	Rolling Mill	Waterbury, Conn.
607	11	Two sections heating boiler cracked			M. & E. Dunn	Stores	New Britain, Ct.
608		Section of heating boiler cracked			Cons. Amusement Enterprises	Miscellaneous	New York, N. Y.
609		Tube ruptured			West Penn Steel Co.	Rolling Mill	Brackenridge, Pa.
610		Boiler bulged and ruptured			Ebner Ice & Cold Storage Co.	Ice Plant	Seymore, Ind.
611		Boiler exploded		1	William Freihofer Baking Co.	Bakery	Reading, Pa.
612	12	Throttle valve failed			Tomahawk Kraft Paper Co.	Paper Mill	Tomahawk, Wis.
613		Section of heating boiler cracked			W. J. Ainsworth, Trustee	Business Block	Oelwein, Iowa.
614		Tube ruptured			Northern Paper Mills	Paper Mill	Green Bay, Wis.
615	13	Boiler ruptured			Cresent Enterprise Laundry Co.	Laundry	Connersville, Ind.
616		Oxygen pipe line exploded	1	2	Memphis Oxygen Co.	Oxygen Plant	Memphis, Tenn.
617		Two sections heating boiler cracked			Independent School District	Public School	Osage, Iowa.
618		Two sections heating boiler cracked			H. W. Trulson	Offices & Stores	Worcester, Mass.
619	14	Boiler of threshing machine exploded		2	Cassius Perrine	Farm	St. Louis, Mo.
620		Blow-off pipe failed			Arkansas Preservative Co.	Preservative Plant	N. Little Rock, Ark.
621	16	Three sections heating boiler cracked			Flanders, Twombly & Leslie	Garage	Denver, Colo.
622	17	Section of heating boiler cracked			St. John's Church	Church	N'thampton, Mass.
623		Tube ruptured		1	Floyd Adkisson Laundry	Laundry	Hickman, Ky.
624	18	Stop valve ruptured			Nekoosa-Edwards Paper Co.	Pulp & Paper Mill	Port Edwards, Wis.
625		Section of heating boiler cracked			Henry P. Silva	Residence	N. Bedford, Mass.
626		Two sections heating boiler cracked			Christ Davis	Offices & Apts.	Hazard, Ky.
627		Boiler exploded		1	954-45th St.	Residence	Brooklyn, N. Y.
628		Boiler bulged and ruptured			Perkins Oil Co., Inc.	Oil Mill	Memphis, Tenn.
629	19	Boiler bulged and ruptured			Lockwood Greene & Co.	Cotton Mills	Pelzer, S. C.
630		Boiler exploded	1	4	Walker & Graw	Sawmill	Roxbury, N. H.
631		Section of heating boiler cracked			General Motors Corpn.	Auto. Factory	Milford, Mich.
632		Ammonia coil failed			Diamond Ice & Coal Co.	Ice Plant	Charleston, W. Va.

MONTH OF OCTOBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
633	20	Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
634		Manifold of heating boiler cracked			Est. of Isabel A. Tolman	Printing Office	Brockton, Mass.
635		Section of heating boiler cracked			O. B. & A. J. Stevens	Green House	Shenandoah, Ia.
636		Section of heating boiler cracked			Consolidated Theatres, Inc.	Theatre	G'd Rapids, Mich.
637		Sections of heating boiler cracked			Adams Sales Co.	Garage	Kendallville, Ind.
638		Section of heating boiler cracked			W. J. Hyland	Business Block	Springfield, Mass.
639	21	Section of heating boiler cracked			Consolidated Realty Co.	Garage	Hartford, Conn.
640		Five sections heating boiler cracked			Rt. Rev. Alphonse J. Smith	Church	Memphis, Tenn.
641	22	Section of heating boiler cracked			Trustees of Schools	School	Shelbyville, Ind.
642		Section of heating boiler cracked			St. Louis Hotel Investment Co.	Hotel	St. Louis, Mo.
643		Mud drum ruptured			Lula Co., Inc.	Sugar House	Belle Rose, La.
644		Furnace collapsed			Daum Dairies Co.	Dairy	Connersville, Ind.
645		Boiler bulged and ruptured			J. R. Phillips	Planing Mill	Eupora, Miss.
646	23	Sections of heating boiler cracked			Lincoln Co., Bd. of Education	School	Stanford, Ky.
647		Tube ruptured			Public Service Corpn.	Power Plant	Jersey City, N. J.
648		Boiler bulged and ruptured			Village Board of Arcade, N. Y.	Power Plant	Arcade, N. Y.
649	24	Boiler exploded				Dredge	Mooreman, Ky.
650		Valve and fitting ruptured			Chevrolet Motor Co.	Auto Factory	St. Louis, Mo.
651		Five sections heating boiler cracked			Samuels & Weinstein	Apt. House	New York, N. Y.
652	25	Section of heating boiler cracked			Auto Call Co.	Factory	Shelby, Ohio.
653		Section of heating boiler cracked			School St. Trust	Office Bldg.	Boston, Mass.
654	26	Section of heating boiler cracked			Heber J. Grant	Church	Independence, Mo.
655		Section of heating boiler cracked			Fannie Perelman	Store	Cleveland, Ohio.
656		Section of heating boiler cracked			Capitol Theatre	Theatre	N. Britain, Conn.
657		Two tubes ruptured			Consumers Power Co.	Public Utility Plt.	Saginaw, Mich.
658		Return line fitting failed			Branson Bros. & Associates	Laundry	Dallas, Texas.
659		Blow-off pipe failed			Stevens & Thompson Paper Co.	Pulp & Paper Mill	No. Hoosick, N. Y.
660		Header cracked			Anderson Hotel	Hotel	Pittsburgh, Pa.
661	27	Tube ruptured		1	N. Y., N. H. & H. R. R. Co.	Railroad	Higganum, Conn.
662		Eight sections heating boiler cracked			E. Griffith Dodson	Apt. House	Norfolk, Va.
663	28	Section of heating boiler cracked			Soloman Citron	Apt. House	Boston, Mass.
664		Two sections heating boiler cracked			J. Howard Mitchell	Hotel	Hattiesburg, Miss.
665	29	Blow-off pipe failed			Pond Laundry Co.	Laundry	Wichita Falls, Tex.

666	30	Section of heating boiler cracked			Vincennes Township	School	Vincennes, Ind.
667		Section of heating boiler cracked			E. Caffey & F. C. Werner	Salesroom & Apts.	Pittsburg, Kans.
668		Boiler exploded	1	2	Lomax Lease	Oil Well	Archer City, Tex.
669	31	Boiler ruptured			Eureka Printing Co., Inc.	Print & Dye Wks.	Athenia, N. J.
670		Heating boiler exploded			Sadie Matson	Residence	Alexis, Ill.
671		Section and manifold of heating boiler cracked			Atlantic Basin Iron Works	Iron Works	Brooklyn, N. Y.
672		Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Pittsburgh, Pa.

MONTH OF NOVEMBER, 1925.

673	1	Section of heating boiler cracked			Hyman Kaplan	Apts. House	Hartford, Conn.
674		Section of heating boiler cracked			Himoff Tobacco Machine Co.	Machine Shop	L. I. City, N. Y.
675		Header failed			Pittsburgh Terminal Warehouse & Transfer Co.	Warehouse	Pittsburgh, Pa.
676	2	Blow-off pipe failed		1	Ballman Cabinet Co., Inc.	Furniture Factory	Covington, Ky.
677		Tube ruptured			American Sheet & Tin Plate Co.	Factory	Leechburg, Pa.
678		Seven sections heating boiler cracked			Louise G. Crabbe	Apt. House	New York, N. Y.
679		Section and manifold of heating boiler cracked			Twelfth & Filbert St. Realty Co.	Office Bldg.	Philadelphia, Pa.
680	3	Section of heating boiler cracked			Tri State Motors Corpn.	Garage	Evansville, Ind.
681		Boiler exploded			Franklin Millinery Co.	Store	Paterson, N. J.
682	4	Boiler exploded			Wells Creamery Co.	Creamery	Delphos, Ohio.
683		Blow-off pipe failed			Southern Cotton Oil Co.	Oil Mill	Sumter, S. C.
684		Steam pipe ruptured			Bristol, Myers Co.	Toothpaste Factory	Hillside, N. J.
685		Tube ruptured			Bureau of Canals & Waterways	Canal Boat	Albany, N. Y.
686		Tube bulged and ruptured			Victoria Mills	Woolen Mill	Thornton, R. I.
687		Tube failed			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
688	5	Four sections heating boiler cracked			Mayer & Schneider Enterprises	Theatre	New York, N. Y.
689	6	Section of heating boiler cracked			City of Newton	Public Property	W. Newton, Mass.
690		Section of heating boiler cracked			Peekskill Hospital	Hospital	Peekskill, N. Y.
691		Main steam pipe failed			Illinois Power & Light Co.	Power Plant	Danville, Ill.
692		Tube ruptured			Worthington Pump & Mchy. Corp.	Machinery Mfr.	Cincinnati, Ohio.
693	7	Tube ruptured			Oneida Craft, Inc.	Furniture Factory	Oneida, N. Y.
694		Cover blew off of rendering tank			Marion Packing Co.	Packing House	Marion, Ohio.
695	8	Three tubes pulled out of drum			Kullman Salz & Co.	Tannery	San Francisco, Cal
696	9	Boiler bulged and ruptured			Willingham Cotton Mill	Cotton Mill	Macon, Ga.
697		Section of hot water heater cracked			Adolph Eckstein	Apt. House	New York, N. Y.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1925

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks		$699,859.61
Real Estate		271,757.16
Mortgage and collateral loans		1,650,188.00
Bonds and stocks		11,233,196.67
Premiums in course of collection		1.341,102.96
Interest Accrued		141,983.25
Total Assets		15,338,087.65

LIABILITIES

Reserve for unearned premiums		6,433,164.02
Reserve for losses		283,273.98
Reserve for taxes and other contingencies		707,384.81
Capital Stock	2,500,000.00	
Surplus over all liabilities	5,414,264.84	
Surplus to Policyholders,		**$7,914,264.84**
Total Liabilities		15,338,087.65

CHARLES S. BLAKE, President.
WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
LOUIS F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
C. EDGAR BLAKE, Assistant Treasurer.
SHERWOOD F. JETER, Chief Engineer.
KENNETH A. REED, Electrical Engineer.
HARRY E. DART, Supt. Engineering Dept.

BOARD OF DIRECTORS

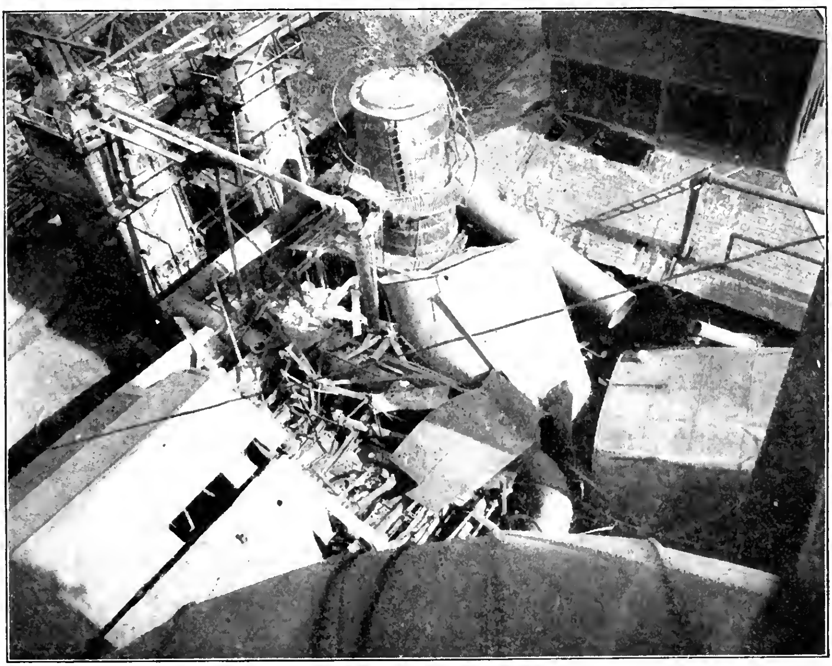
The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Devoted to Power Plant Protection

Published Quarterly

Vol. XXXVI. HARTFORD, CONN., OCTOBER, 1926. No. 4



A Recent Steam Pipe Explosion.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

A Recent Steam Pipe Explosion.

THE explosion of an 8 inch steam pipe might not ordinarily be thought of as a very devastating type of accident but the accompanying pictures show that such an accident may at times approach a boiler explosion in destructiveness. The explosion illustrated occurred July 25, 1926. The property loss amounted to $17,-

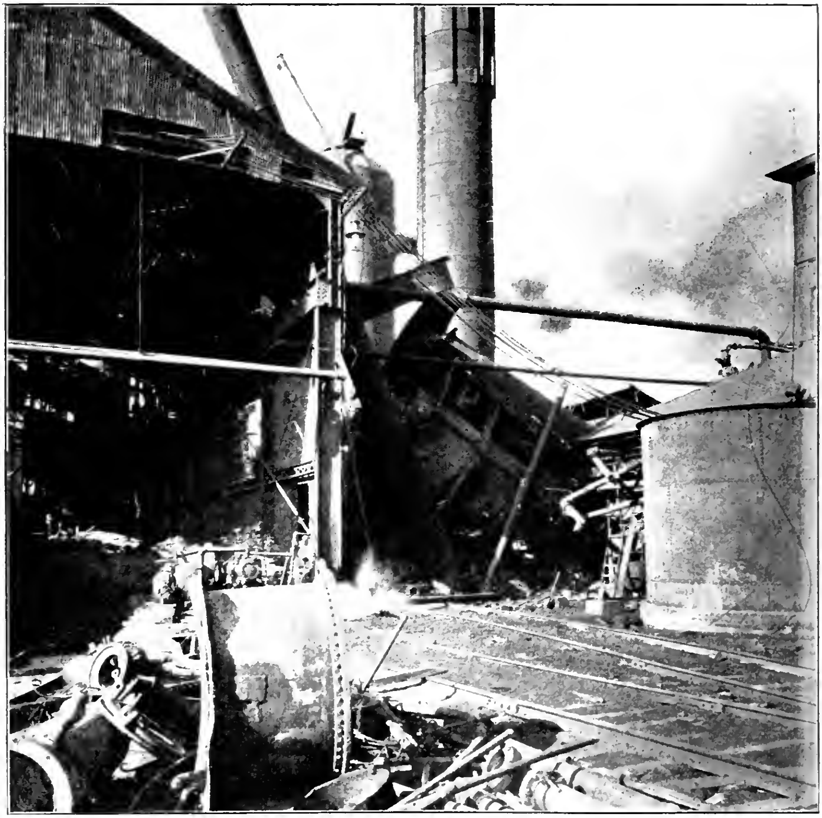


FIG. 1.

860. That no one was killed or seriously injured seems miraculous.

The initial rupture is thought to have been in an elbow on an 8 inch steam line connecting a vertical water tube boiler with a 14 inch steam header. The first break was followed, of course, by the general disruption of the steam piping. One piece of the pipe struck a water tank located in the rear of the boiler and knocked the tank over, at the same time tearing it through the middle. The tank, in falling, knocked over a Manning type boiler and the stacks of two other vertical boilers. Fortunately the Manning boiler was not in operation. The water tank was 17 ft. 6 inches in diameter and 67 ft. high, and was full of water.

The three boilers that were damaged were of the self-contained type and stood, with the water tank, in an open space between the boiler room and the engine room. The adjacent walls and also the roofs of these two buildings were badly damaged. The maze of steam, water, gas and air piping located in the area of the explosion was comparatively new. There were no employees in the immediate vicinity of the explosion but there were several in the boiler and engine rooms. Those in the boiler room were washed to one end of the room by the wave of water from the destroyed water tank. The men in the engine room were blown some distance but were not seriously injured. The closest to a fatality was a near drowning case in the boiler room.

The cause of the explosion is not clear. A subsequent examination of the ruptured pipe did not reveal any signs of a defect or of deterioration. It has been suggested that some dislocation of the supports might have thrown unusual stresses upon certain portions of the pipe and resulted in its failure. All of the outdoor piping was supported on standards with saddles under the pipe. About a month before this explosion considerable blasting had been done in excavating the site for a new furnace. In the absence of more definite evidence therefore the theory appears tenable that the blasting had disturbed the supports.

The loss was covered by a policy in The Hartford Steam Boiler Inspection and Insurance Company indemnifying against damage due to the explosion of main steam pipes.

Steam Pipe Explosion at New Britain, Conn.

Another steam pipe explosion, with results quite different from those described above, occurred August 16, 1926 at the factory of Landers, Frary and Clark, New Britain, Connecticut. Four men were burned. The property loss was small as the failure occurred in a pipe tunnel.

The failure was in a 5 inch flanged tee fitting which was used as an elbow. Early in the afternoon on the day of the accident the steam had been shut off and a new piece of pipe inserted in the line. The steam was then turned on. Later, it was shut off again and a new gasket put in at the flanged tee connection. The steam was once more turned on, and after nearly an hour had elapsed the tee exploded. A boiler room attendant noticed the unusual drop in pressure and assumed that something was wrong. He therefore shut off the steam and went in search of the break. This prompt action probably saved the lives of the injured men.

Examination of the ruptured tee after the accident showed it to have been a sound fitting. The possibility of water hammer having developed on this occasion is unlikely in that the installation was not new but had been in use for years; and furthermore, no one heard any sounds of water hammer preceding the failure. The accident was probably caused by strains from misalignment of the piping or by expansion strains.

Electric Motors — Kinds and Applications.

THERE are many types of electric motors, each type designed to meet some particular set of conditions, but all of them are broadly classed into either one of two classes, that is, alternating current motors or direct current motors. Of the two, direct current motors would probably be preferred in many cases because they are in general more easily adapted to various kinds of loads, but there are other conditions that operate in favor of the alternating current motor. The principal one is the matter of transmission losses. Direct current cannot be transmitted nearly so economically as alternating current because it cannot be readily changed to and from high voltage. Hence, where power is purchased, it is usually alternating current. Of course this can be readily converted to direct current but there is an unavoidable loss in the operation, as no energy change can take place with 100 per cent efficiency. In a plant that generates its own power, distances are usually not so great, so that transmission losses are not such a factor and direct current may be found the more acceptable. With alternating current power circuits, on the other hand, the problem of maintaining a high power factor is an ever present one.

Direct Current Motors.

Direct current motors are divided into three general classes — series, shunt and compound wound — each of which has characteristics particularly adapting it to certain kinds of work. The series motor for instance, is almost invariably used for traction and hoisting work where frequent starting under heavy loads is the rule, because it can exert a maximum torque or turning effort when starting. There is only one circuit to such motors, as the armature and field windings are connected in series. All of the armature current therefore passes through the field, and as the torque or turning effort in a motor is proportional to the armature current multiplied by the field current, the torque in the series motor is approximately proportional to the square of the current — within certain limits. When starting or when the motor is slowed down due to load, less counter-voltage — or counter-electromotive force* as it is usually called — is generated and hence more current is drawn from the line. The torque therefore increases with the load. On the other hand, as the load falls off, the motor speeds up due to the decrease in the field current, and if the speed is not checked it will race to destruction. Series motors ought, on this account, to be hand controlled.

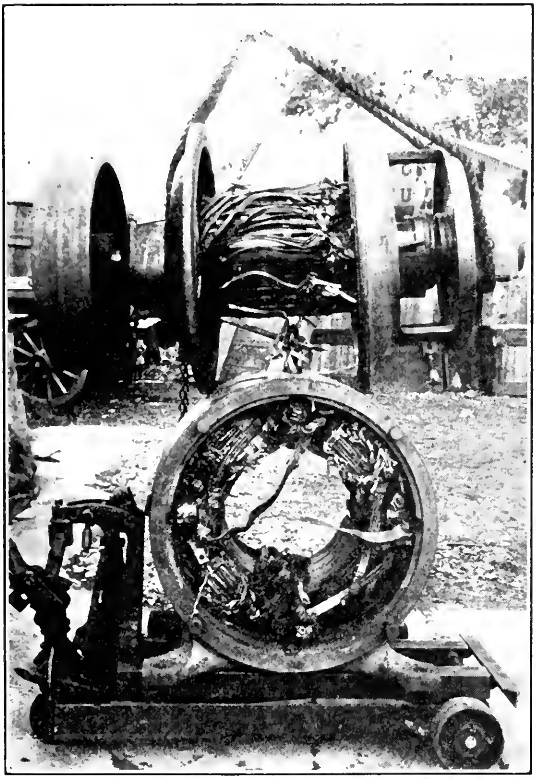


Fig. 1.

Fig. 1 is an illustration of what may happen to an automatically controlled series wound motor when the control fails to operate. This motor was used on a 10 ton hoist and over-speeded, with the result that the commutator flew to pieces, the armature wires were forced out of the slots and the field windings were completely destroyed. In fact the motor was so badly wrecked that it was not considered worth repairing and was replaced by a compound wound motor, which is not liable to this type of failure.

*It is, of course, generally understood that a direct current generator and motor are practically the same. With current in the field windings, if the machine is driven by mechanical power — say by a belt — it will be a generator and generate a voltage in the armature circuit. Conversely, if current from some outside source is caused to flow in the armature circuit, the machine will be a motor and drive the machine belted to it. In fact even when operating as a motor it is also creating a "counter-voltage." This is called counter-voltage because is opposes the line voltage, and the motor speed varies so that the load plus the counter-voltage always equals the impressed (line) voltage.

The shunt wound direct current motor is characterized as a constant speed machine. The field winding is connected directly across the line, or in parallel with the armature, and as the line maintains an approximately constant voltage, the field current remains constant. The variation in speed between no load and full load will not exceed 5 or 10 percent, the higher speed of course is at no load. In the shunt wound motor, since the field current remains constant regardless of the load, the torque or turning effort varies directly as the armature current. The shunt wound motor finds application wherever an approximately constant speed is desired.

It would be well at this point to say a word about the control of direct current motors. In general there are two methods, first, varying the armature current, and second, varying the field current. The action of electricity and magnetism in electrical machinery is rather complicated, but a few moments consideration will help make clear the effects of different methods of controlling the speed of a motor.

Control of Direct Current Motors.

When the armature of a motor is connected across a line of constant voltage, a certain current will flow through the armature depending upon its resistance and also upon the counter-voltage developed after the armature starts revolving. Since the armature resistance is low, the first rush of current will be large, and in passing through the armature conductors it creates a magnetic field which, acting in conjunction with the magnetic field created by the windings on the pole pieces, starts the armature revolving. As soon as the armature starts moving, the armature current decreases, due to the counter-voltage or-electromotive force generated, until the current is a minimum for the load.

The counter-e.m.f. depends on the speed of the motor and on the magnetic strength of its field. If resistance were placed in the armature circuit, this would be the equivalent of reducing the impressed voltage; the current flowing would be reduced and the motor would slow down in order to maintain the proper balance with the counter-e.m.f. It is readily apparent that the method of speed regulation by putting resistance in the armature circuit is uneconomical because of the large I^2R loss or the loss in heating the conductors, which increases as the square of the current. Thus doubling the current would increase the loss four times. Varying the armature resistance, however, is the only means of regulating series motors since the field winding consists of a relatively few turns of wire carrying the full armature current.

With the shunt motor, the field winding consists of many turns of fine wire carrying a small uniform current. If resistance is cut into this circuit, the strength of the magnetic field is decreased, which results in a small counter-e.m.f. because fewer lines of force will be cut by the armature conductors. Hence the armature will speed up to make up for this deficiency. Because of the small amount of current passing through the field coils, the I^2R loss will be small and this is therefore the most desirable mode of speed regulation. It has the objection, however, that the weakened field reduces the power of the motor so that one must be sure the motor is of sufficient capacity to operate at the higher speeds. In general it is most satisfactory to operate at the normal speed of the motor without external resistance in either the field or the armature circuits. Where variable speeds are required, the armature method of control is more economical when slow speeds are required only occasionally or where the power demand falls off rapidly with the speed as in ventilating fans, and the field method is more economical where high speeds are required only occasionally. For long periods above or below the normal speed, a combination of the two will probably prove most efficient.

We have said that the shunt wound motor is a constant speed machine but at the same time admitting that there is a slight variation with a change in the load. This change is unavoidable in a shunt-motor — let us see why. A line voltage " E " is applied to the terminals of a shunt motor. This applied voltage however is not all effective in driving current through the armature because the machine, as soon as it starts in motion, also acts as a generator and develops a counter-voltage " e " opposing " E," as explained in the footnote on page 101. Hence the effective voltage is really (E — e). Thus we have the equation (E — e) = IR, where " I " is the current flowing in the armature, and " R " is the resistance of the armature. When a heavier load comes on the motor, the " I " must increase to take care of it. This means that " e " must decrease. But " e " depends on the magnetic field and motor speed, so that since the field is constant the speed must decrease slightly.

Compound Wound Motors.

The shunt motor does not have the large starting torque that is characteristic of the series motor, and to meet heavy starting conditions with a uniform running speed under varying load, the compound wound motor was developed. This type of machine is very similar to the shunt machine except that a few extra turns of wire on the field coils are in series with the armature. The heavy starting current therefore strengthens the field and enables quicker starting. However, the variation in speed between no load and full load in the compound wound machine is slightly greater than in the shunt but not nearly so great as in the series wound machine.

It is possible to make the speed of compound wound motors increase with load up to a certain point by connecting the series field to oppose the shunt field windings. This is called differential winding, and the other method cumulative winding. Differentially wound motors have peculiar characteristics* and are seldom used.

The three kinds of direct current motors mentioned above may be called essential types, the others are really modifications of these. For instance, there is the commutating-pole motor. The commutating- or inter-pole is a small pole piece located between the main poles of the machine to assist in sparkless commutation. The brushes are placed at a neutral point on the commutator, that is, where the particular conductors are not cutting any magnetic lines of force. But these neutral points shift slightly with changes in load and cause sparking. The inter-pole, however, serves to hold the neutral points steady regardless of changes of load.

Where conditions are severe for good commutation, that is, where there is a wide variation in load combined with reversing, compensating windings are frequently used. These are in effect the same as inter-poles but with increased effect. The compensating windings are laid in slots in the face of the main pole pieces with one half of the coil in one pole face and the other half in the next pole piece, thus encircling the inter-pole. These coils are wound so as to be of the same polarity as the inter-poles, that is, opposing the magnetic field produced by the armature current.

Alternating Current Motors.

Alternating current motors are divided into two general classes — induction motors and synchronous motors. The induction motor is the more widely used particularly in smaller sizes. Its operating characteristics are very much the same as the direct current shunt machine. The squirrel cage induction motor is the simplest and cheapest and would usually be selected if adapted to the particular drive. In such motors the "armature" windings are in slots around the inner circumference of the stationary part, which is called the stator. The moving element, or rotor, is composed of copper bars laid in slots and short circuited at each end by a copper band. There are no electrical connections between this rotor and any outside circuit, in which respect the squirrel cage motor is unique.

The action of the squirrel cage motor can be readily understood

* The characteristics of a motor are the relations existing between speeds and loads. See Fig. 2.

if one visualizes a rotor of this type in a motor having but two poles and these poles permanent magnets. There will be magnetic lines of force passing from one pole to the other through the rotor. Now imagine that these poles are caused to revolve around the rotor. The magnetic lines of force will then be cut by the rotor conductors, thus inducing a current in the conductors which in turn sets up its own magnetic field. The reaction of these two magnetic fields causes the rotor to turn, literally dragged along, and it would turn at the same speed as the magnets if there were no load on the motor. The load, however, causes a certain lag in speed in order to produce the necessary pull.

The foregoing explanation contemplates the use of permanent rotating magnets but in an induction motor the stator winding, which produces the magnetic field, is stationary. The effect of the rotating field however may be produced by three phase alternating current. It is just as if we had three electro-magnets placed side by side, each connected to a separate source of electricity. With the current turned on the first one only, the center of magnetic force would be directly under that one. If the current is allowed to gradually die out in the first and increase at the same time in the second, the center of magnetic force will gradually shift to the second magnet. If the second is allowed to gradually die out while the third is increasing, it will shift to the third. A like procedure would gradually shift it to a fourth, and so on. A similar action takes place in the stationary windings of the induction motor. Current rises to a maximum in a small group of conductors in the first phase, then as this fades it rises in the adjacent second phase group, followed by fading in the second and increasing in the third. Thus a rotating magnetic field is produced in stationary windings, the rate of rotation depending upon the frequency of the alternating current.

Wound Rotor Motors.

Squirrel cage motors can be started by putting them directly across the line. However, if the motor is large or is started under load, this method causes an excessive rush of current which is objectionable. Various means of starting have been tried such as two sets of rotor windings, one with high resistance for starting and the other for running, or the use of autotransformers to cut down the voltage at starting. All of these methods however, reduce the starting torque.

The best way out of the difficulty has been by a modification of this type known as the wound rotor induction motor. The general construction is the same except that the rotor conductors are not bars short circuited by the end rings, but instead are insulated coils connected to collector rings and joined through some external resistance. By putting resistance in the rotor circuits the current is kept low during starting and the ability to start under load is greatly increased. This is well illustrated by the curves in Fig. 2. Examining curve 1, we see that beginning at zero speed the load (torque) is not very great, but it increases rapidly with increased speed. On the other hand, curve 4 representing conditions with a large resistance in the rotor circuit, shows heavy load at low speeds. Curves 3 and 2 represent similar conditions with decreasing resistance. Hence with a wound rotor it is possible to start under load with a large resistance in the circuit which can be cut out gradually as the speed increases, thus passing from curve 4 to 3 to 2 to 1. By working near the peaks of the curves, the maximum power of the motor is maintained.

There is one other interesting point that is well shown by this diagram and which applies either to a squirrel cage motor or to the wound rotor motor with resistance short circuited. Imagine the motor running idle. This condition is represented by the right hand end of curve 1. If a load is gradually placed on the machine, we would be traveling back along curve 1 from right to left, which shows very little drop in speed for greatly increased load. Hence the induction motor is practically a constant speed machine.

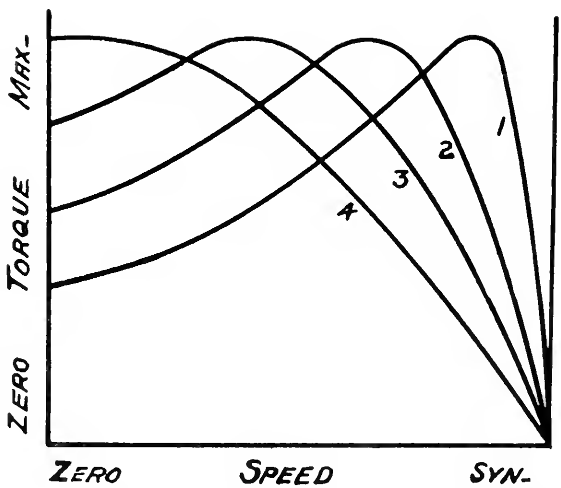


Fig. 2. Curves Showing Effect on Load of External Resistance in Rotor Circuit of Wound Rotor Motors.

The synchronous motor is a much more efficient type of alternating current motor because it operates with a much higher power factor than does the induction motor. In fact, by over exciting the synchronous motor it can be, and frequently is, run idle simply to improve a low power factor on a line. The one serious handicap to the synchronous motor, however, is its low starting torque. Such motors operate at exactly synchronous speed and until that speed is attained they will not carry a load. Hence the necessity of starting without load, and this restricts their use almost solely to the generation of direct current, either driving a generator or else as a converter, though clutches are sometimes utilized for other applications.

Even when starting light it is not often desirable to throw a large machine directly upon the line because of the enormous surge of current that would result. Starting must therefore be effected by autotransformers and by induction motor action. Autotransformers temporarily step down the line voltage. Induction motor action is brought about by dampering grids. These grids are heavy copper bars imbeded in the pole faces of the field (rotor) and short circuited at the ends very much like the squirrel cage rotor. We have said that synchronous motors operate at exactly synchronous speed, but sudden increases or decreases in load cause temporary variations which may become serious. Such variations in speed induce currents in the dampening grids which oppose these " hunting oscillations " and hence steady the turning of the rotor. Since the grids are exactly like induction motor conductors, by not exciting the field but putting line current through the stator the motor can be started by induction motor action.

Special Types of Synchronous Motors.

The synchronous converter is a type of synchronous motor in which the rotor windings are also connected to an armature from which direct current may be obtained. Because of the absence of a mechanically connected load, converters are particularly inclined to " hunt ". Dampening grids are therefore usually present and are used for starting. It is interesting to note however that if direct current is available the machine may be started as a direct current motor and brought up to speed. Then when the alternating current is switched on, the machine starts feeding direct current back into the line.

With every synchronous motor there is always a rheostat for regulating the field excitation because for each load there is a fixed value of the field current that requires a minimum line current. Hence, to obtain the greatest efficiency the field excitation must be adjusted for each change in load.

The super-synchronous motor is a recent unique design whose object is to overcome the handicap of the low starting torque of the synchronous motor. As usual the rotor carries the field, but the stator is also arranged so that it may rotate for starting. The load holds the rotor stationary and the motor, without field current and functioning as an induction motor, starts the stator turning. When it is up to synchronous speed a brake is gradually applied which slows down the stator and causes the rotor to pick up speed. Thus not only is starting under load effected but also the pick up of the load is executed with greater smoothness than where a clutch is used.

Removing Boiler Scale.

By J. A. Snyder, Chief Inspector, Pittsburgh Department.

IF boilers could be run with perfectly pure water — for example, with water that had previously been distilled — many of the difficulties encountered in actual practice would never arise, and the fireman's duties and responsibilities would be correspondingly lessened and simplified. Unfortunately, this ideal condition of things cannot often be realized. We cannot afford to use distilled water, and in most cases feed-water has to be taken in accordance with that mode of selection which is known to the world at large as "Hobson's choice," that is, we have to take what we can get. In cities and towns, good water may usually be had from the city mains, but in sparsely populated districts the manufacturer has to depend upon wells or upon running streams.

To remove the scale-forming matter from boiler feed water, there are to-day many systems, and to prevent scale forming on boilers and to remove that already formed, there are compounds, metal treatments, surface cleaners and appliances galore. Many are good, and some are better than others. Where the treatment is especially suited to the water conditions good results are obtained, especially so, as the old chief engineer said "if the engineer will use the proper amount of 'hoss' sense."

Some years ago a rolling mill plant was induced to try a boiler compound. The instructions were to use a certain amount daily and not blow down the boilers nor clean them for at least thirty days. There was considerable scale forming matter in the feed water and after four weeks trial as directed the boilers were cooled and emptied for examination. The installation consisted of a battery of four boilers connected to common steam and mud drums. It was with great difficulty that the large hand hole plate was removed from the mud drum, but when this was finally accomplished it revealed that the drum was filled almost solid with scale and stiff mud, leaving a very poor circulating connection between boilers. It was with great difficulty that the mud drum and other parts of the boilers were cleaned. If the compound was loosening the scale the boilers should have been blown down more frequently than was the usual practice. Another week of operation of these boilers would probably have resulted in burning them, to be followed by expensive repairs.

The water of the Monongahela River in the Pittsburgh district during the autumn season contains a high percentage of acid. One plant using water from this river in its steam boilers was troubled with considerable leakage during the fall season. Someone told the chief engineer to use lime in his boilers to prevent corrosion and leakage. He accordingly sent two barrels of lime to one of the boiler plants and told the water tender to use plenty of it as the water was bad. Three days later the plant was obliged to shut down, and parts of the bottoms of four boilers were cut out and patched by half sheets. Very large depressions had appeared on the bottoms of these boilers, and when the boilers were opened very heavy coatings of lime were found on the plates that were immediately over the fire. Entirely too much lime was used in this case.

Bagged Boiler Shell Result of Scale Deposit.

The accompanying photograph shows a depression on the first course of a horizontal return tubular boiler. This boiler was 78 inches in diameter and 20 ft. long. The shell plates were 9/32 inch thick, the longitudinal joints having eight rows of rivets. The depression was down 7 inches and was about 18 inches wide at one point. A fracture 1⅛ inches long had opened at the apex of the bulge and the metal was drawn down to a knife edge at the fracture, and was considerably reduced at other places.

There was scale in the boilers in this plant, and a scale solvent had been used for a short time to remove it. When the depression and leakage were noted the boiler was taken out of service and cooled; when opened, a heavy deposit of scale and sediment was found in the depression and on the lower plates. The indications were that scale was loosened from the tubes and shell plates too rapidly in comparison to the rate of removing it from the boilers by cleaning.

Nearly all boiler compounds, metal treatments and scale solvents are of some value when used in steam boilers, but care should be exercised when beginning the use of them. It should first be ascertained whether the one selected is suited to the boiler feed water, and further, if scale is removed rapidly from tubes or plates, it should likewise be removed from the boiler or overheating of plates and expensive repairs may result.

The Use Of Portable Electric Lights In Boilers.

ALTHOUGH entirely aware of the dangers of electricity at high voltages, nearly everyone has become so familiar with the usual 110 volt lighting circuits that little thought is ever given to the possibility of serious accidents from such circuits. Yet there are several cases on record in which shock from a 110 volt circuit has proved fatal. In the *Syracuse Bulletin* of May 14, 1926, there appeared an account of the death from electric shock of Ralph Merrill, a millwright at the Skaneateles Mill of the Oswego Falls Corporation. The man was working inside of a boiler preparing it for internal inspection, and was using a lamp and extension cord from a 110 volt circuit. In some way, probably through a faulty connection and contact with the brass socket, he received a shock that resulted in his death.

In the September 1925 issue of *The Boiler Maker* appeared a brief account of the death from electric shock of Michael O'Brien, while he was cleaning a boiler in the Administration Building, Montclair, N. J. Faulty insulation on the wire of a lamp which he held in his hand while in contact with the boiler is said to have allowed the current to pass through his body with fatal results.

About two years ago an inspector called at the plant of the Detroit Brass and Malleable Co., Detroit, to make an inspection. Upon inquiring for the engineer, a helper set out to find him. The inspector soon received a call to the top of one of the boilers, and there on top of the tubes inside of the boiler lay the engineer. He had been dead about a half hour. The charge from a 220 volt lamp on an extension cord which he had taken into the boiler with him had burned a hole about the size of a five cent piece near his heart.

Each of the above accidents happened with voltages such as one is likely to encounter in lighting circuits about an industrial plant.

Whether a test was made to ascertain what voltage actually existed in each of the above cases is not stated, but in other somewhat similar cases tests were made but failed to show more than the normal voltage. It would appear then that even a circuit of "only 110" volts may under certain circumstances be dangerous, and conditions under which boilers are inspected and cleaned are by no means the safest. In the first place the boiler has an excellent electrical connection with a feed water pipe and hence is well grounded. Furthermore the man working in a boiler is usually perspiring rather freely so that his moist hand or any part of his body that touches the metal makes a fairly good connection. It remains only for a short circuit through the brass lamp socket or a frayed cord to send a charge through the man.

Whether a shock from a 110 or 220 volt source will prove fatal depends likewise upon considerations other than merely good connections. For instance, the body resistance of different persons varies over quite a range, just as do all other physical characteristics. Hence, a man having a low electrical resistance would receive a heavier current than a man of higher resistance. Since the action of an electric shock is a paralyzing or tightening of the muscles, the condition of the heart is also a governing factor.

Still another factor is the matter of time or duration of the shock. If a person receiving a shock is in such a position that he immediately recoils or falls away and breaks the connection, serious injury is not likely to result from moderate voltages. However, if the paralyzing effect prevents voluntary action or causes the victim to fall in such a way as to maintain contact, then the prolonged action of the current, as would be expected, multiplies the effect. This is of particular importance to men working in boilers where much of the work is performed in tight places and in a recumbent position, sometimes even with the light resting on the body in order to free both hands for the work.

It is advisable therefore when using portable electric lights around boilers, first, to use only such as have the socket encased with some non-conducting material, and second, to examine the equipment beforehand to be sure it is safe for use.

Efforts to utilize the power of grain dust explosions in an internal combustion engine have been made by the U. S. Department of Agriculture. A modified Ford engine was used, according to *Power,* and although a continuous run was not made, as many as twelve successive explosions in one cylinder were obtained. The results are said to have been very encouraging.

Boiler Explosion at Chicago Heights, Illinois.

A BOILER explosion of considerable intensity occurred at the plant of the Albert David Chemical Company, Chicago Heights, Illinois, on the morning of June 15th, 1926. One man was killed and property destroyed to the extent of nearly $18,000. Greater loss of life was undoubtedly avoided because of the early hour, as the employees were just beginning to arrive and but few of them were on the premises. A few minutes later several men would have been at work in the immediate vicinity of the boiler room.

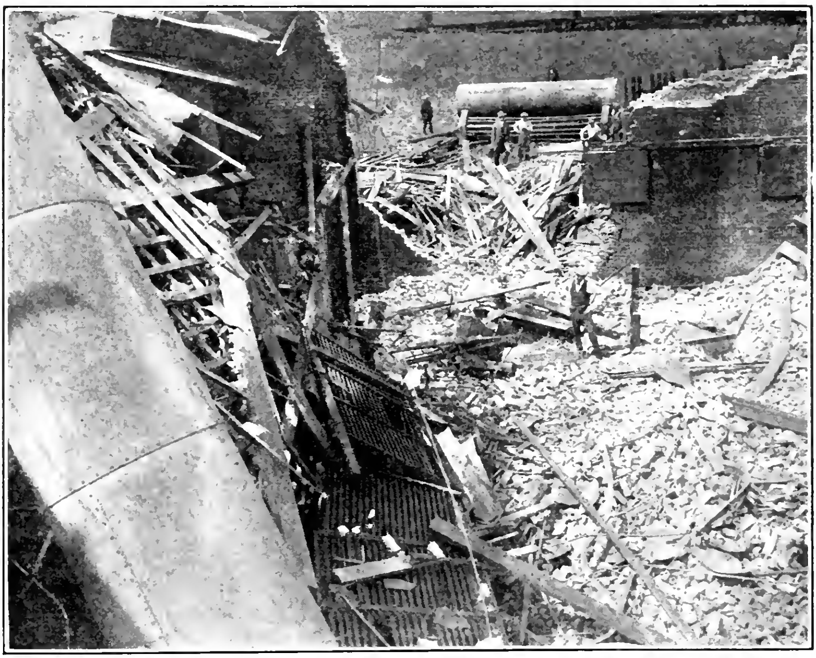


FIG. 1.

The boiler that exploded was of the water tube type and was located near the center of a large brick boiler room. This boiler house was situated in one corner of the plant with no buildings on two sides of it. On another side it was separated from a machine shop by a 13 inch brick fire wall. The boiler house was practically a complete loss. Only parts of the walls remained standing and some of these were so badly damaged as to necessitate tearing them down. One head of the boiler was blown through the brick fire wall, then across the engine room and through another 13 inch wall, coming to rest against the far wall of this room.

The rest of the boiler traveled almost intact through the opposite wall of the boiler house, ploughed across a railroad spur and through a fence, and came to rest about 75 feet away in a field. The boiler was somewhat battered by contact with the wall and railroad track, but the only rupture was in the head. The setting of an adjoining horizontal tubular boiler was damaged, and the stack and all of the piping in the boiler room were torn down when the building collapsed. An air compressor and a large drill press in the engine room were completely destroyed, and

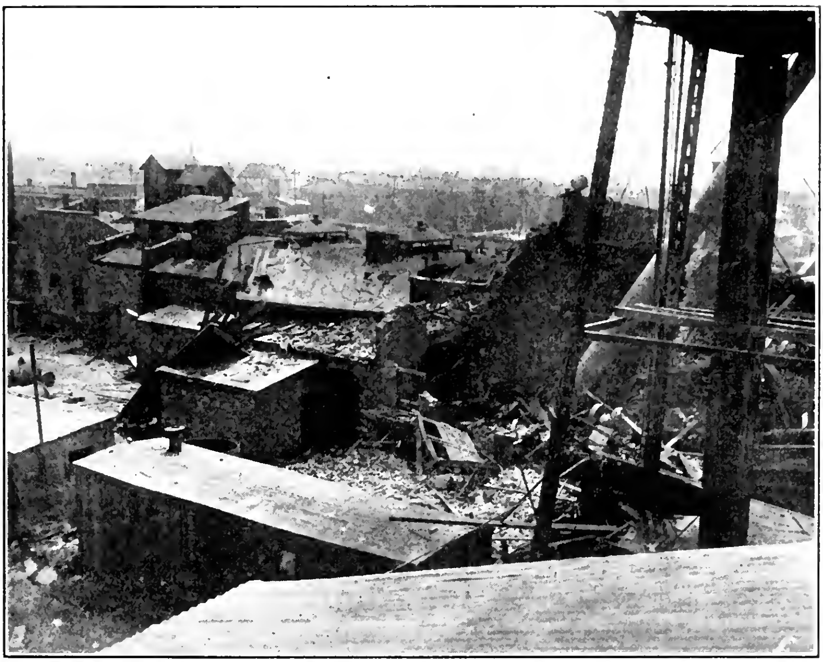


Fig. 2.

laundry machinery, motors and other machinery located there were damaged. Sight damage was done to the roofs of some neighboring buildings, but the damage in general was not so widespread as often is found to be the case. This was due, first, to the fact that the boiler did not separate into many fragments to be thrown about, the head being the only portion that was torn loose, and second, to the fact that the adjoining factory building of the plant had previously been destroyed by fire and had not been rebuilt.

Fig. 1 is a view of the boiler room with the exploded boiler in the background. Fig. 2 shows the engine room (behind the leaning stack) and adjourning buildings.

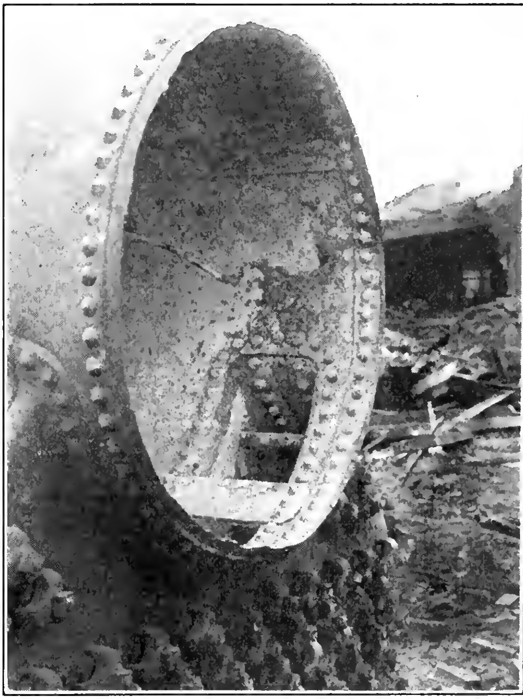


Fig. 3.

The cause of the explosion was a cracked head. As can be seen from Fig. 3, the head was severed completely around its circumference along a line about 2 inches from the row of rivets and just at the turn of the flange. Examination of the material along this line of rupture shows that a crack had developed extending almost completely around the head. Cracks such as this in the heel of a flange are generally regarded as fatigue failure of the metal. The exact pressure of steam at the time of the accident is not known.

The factory portion of this plant was totally destroyed by fire in December 1925, followed about two weeks later by a second fire in a pump house used in connection with a deep well water supply. Since then only a portion of the work has been carried on in the part of the plant that remained.

The property loss from this explosion was covered by a Hartford policy.

Rivetless Structural Steel Buildings.

Contracts have been let by the Westinghouse Electric and Manufacturing Co. for the erection of two arc-welded structural steel buildings on the company's property in Pittsburgh, according to the *Pittsburgh Gazette Times*. The two proposed structures consist of a one-story engineering laboratory building, and a five-story mill type building. Welding is expected to result in a considerable saving over riveting by the elimination of many plates and angles, and in some cases by the use of lighter structural numbers. The absence of the noisy riveting hammer is also a very desirable feature.

Explosion of a New Boiler That Had Never Been Fired.

A CAST iron hot water supply boiler exploded in Baltimore, Maryland, on December 28th, 1925, under peculiar circumstances in view of the fact that it had never been fired up since it was installed. The boiler, which was constructed for a maximum water pressure of 60 lbs., was connected to a steel supply tank and also to a pipe heating coil in the firebox of a cast iron steam heating boiler, as shown by the accompanying sketch.

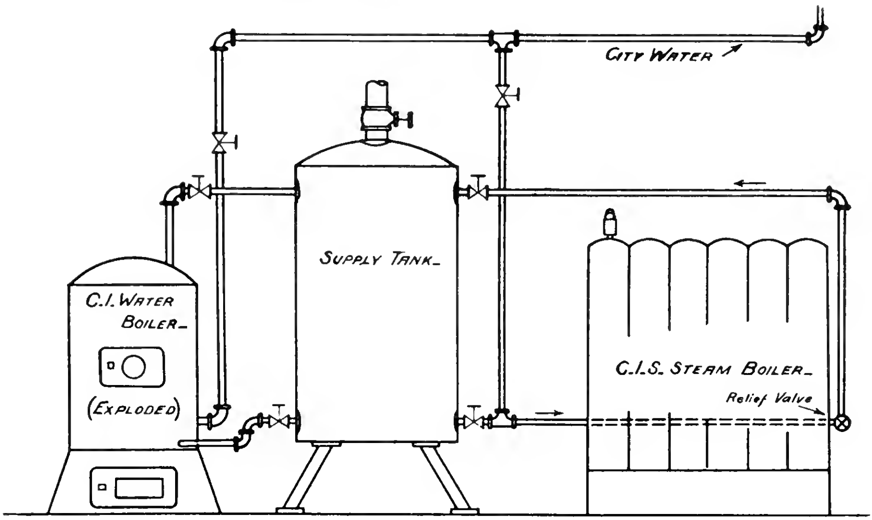


Fig. 1.

The heater was not equipped with the regulation water relief valve nor had it a pressure gauge, thermometer or temperature regulator. However, there was a relief valve fitted on the inlet pipe leading to the pipe coil in the firebox of the steam boiler. The relief valve was stamped to release at 125 lbs. pressure, while the normal city water pressure was 85 lbs. It will be observed that stop valves are fitted in all pipe connections between the boiler and the relief valve.

The hot water supply heater was installed during the fall of 1925 and, as previously stated, had never been fired up, for it was intended for use only during the summer months. During the winter months the water was to be heated by means of the coil in the firebox of the steam heating boiler.

The valve in the feed line from the city water main to the hot water heater was kept open so that the cold water circulated through the heater

(*Continued on page 118.*)

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, CONN., OCTOBER, 1926.

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Three Score Years of Boiler Insurance.

STEAM boiler insurance was inaugurated sixty years ago with the organization of The Hartford Steam Boiler Inspection and Insurance Company. The idea of steam boiler insurance was something entirely new at the time. A movement had already been started in England to prevent steam boiler explosions by inspections, and the organizers of the Hartford Company appreciated the sound principles upon which it was based. The idea of backing up the inspections by insurance, an indemnity in case of explosion, undoubtedly originated in Hartford which has long been termed "The Insurance City."

The formation of a business corporation is a matter that usually extends over quite a period of time so that the real birthday of such an organization is seldom as definite as that of an individual. The discussions that eventually resulted in the formation of The Hartford Steam Boiler Inspection and Insurance Company are said to have started about 1857, prompted no doubt by the rather numerous and disastrous boiler explosions resulting from a gradual increase in the working pressure of steam at that time. The Civil War is thought to have deferred the launching of the new organization, but the idea must have been fairly well developed for on May 2, 1866 a resolution incorporating the Hartford Company was passed at a session of the General Assembly, held at New Haven, Connecticut. The charter was approved June 30th. At a meeting of the organizers held in August it was voted that the stock subscription be set at $500,000. The month of October, however, really saw the Company come into being, for three meetings of the stockholders were held during the month. The minutes of the first meeting, on October 6, 1866, show that the stock had been fully subscribed for, and that a Board of Directors was elected. October 6, 1866 may thus be considered the birthday of the Hartford Company. October 6, 1926 is therefore the sixtieth anniversary of steam boiler insurance.

The Hartford Company has from the beginning maintained an inspection department which passes upon the construction and safety of all objects offered to the Company for insurance. It also investigates all explosions to which it has access and if possible determines the cause, with the object of preventing recurrence. It has given publicity to faulty constructions, advocated legislative action to insure safe standards of construction, and distributed thousands of blue prints showing approved methods of manufacture and installation. The experience of the Hartford organization and its researches into the causes of boiler failures gradually crystalized into standards that were the forerunner of the present day boiler codes. Today the phrase " must be acceptable to the Hartford Company " is of frequent occurrence in specifications, and the Company is often called upon by manufacturers for decisions as to the compliance of vessels of new design with a specified code. When explosions have occurred in spite of the best inspections, the Company has responded to its contract to indemnify the owner, frequently in such prompt and satisfactory manner as to create a record and draw unsolicited testimonials. In recent years the activities of the Company have been broadened so that insurance against the hazards incident to the operation of flywheels, engines and electrical machinery can now be obtained.

The success of the Hartford Company of course attracted other companies into the field, and although today it has several competitors, The Hartford Steam Boiler Inspection and Insurance Company remains the outstanding company devoted exclusively to this line of business. Sixty years of specialization in steam boiler inspection and insurance have brought to the Company a prestige that makes its name the synonym for excellence in power plant insurance.

Summary of Boiler Explosions For 1925.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	113	8	24	32
February . . .	76	10	37	47
March	74	9	20	29
April	64	5	15	20
May	56	9	32	41
June	45	5	11	16
July	44	5	18	23
August	43	66	122	188
September . . .	58	5	11	16
October	99	6	16	22
November . . .	98	8	24	32
December . . .	100	18	23	41
Total for 1925 .	870	154	353	507

Explosion of a New Boiler That Had Never Been Fired.

(Continued from page 115.)

to the supply tank and from there to the heating coil, thence returning to the supply tank. This valve was said to have been found open after the explosion.

The cause of the explosion is thought to have been the freezing of the water in the feed pipe where it passed through the stable floor above. About 5 o'clock on the morning of the accident a quantity of hot water was drawn from the system to replenish an automobile radiator, and at the same time the fire in the steam heating boiler was freshened up. This generated steam in the heating coil and increased the pressure to such an extent that the weakest part of the system, which was the cast iron boiler, exploded about 7:00 A. M., the relief valve failing to function at a pressure which would protect the hot water heater.

This accident emphasizes the importance of equipping hot water heating boilers, and in fact all low pressure heating boilers, with the necessary safety valve connected directly to the boiler independent of any other connection and without intervening valves. An altitude or pressure gauge, a thermometer and a temperature combustion regulator, are also necessary appliances for this type of boiler.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF NOVEMBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
698	9	Section of heating boiler cracked			Jackson Township	School	New Paris, Ind.
699		Seven sections heating boiler cracked			Board of Education	School	Logan, W. Va.
700	10	Tube ruptured		1	Quincy Mining Co.	Copper Mine	Hancock, Mich.
701	11	Tube failed			Gilbert Paper Co.	Paper Mill	Menasha, Wis.
702		Manifold of heating boiler cracked			Elizabeth C. Graham	Apt. House	Omaha, Neb.
703		Section of heating boiler cracked			Marks Hat Co.	Hat Factory	Des Moines, Iowa.
704		Section of heating boiler cracked			I. Nelson	Apt. House	Detroit, Mich.
705	12	Boiler ruptured			Barren Hill Consolidated School	School	Barren Hill, Pa.
706		Boiler ruptured			M. C. Fitzgerald	Paper Mill	Holyoke, Mass.
707		Hot water heater exploded			New Brunswick Country Club	Club House	N. Brunswick, N. J.
708	13	Section of heating boiler cracked (2nd accident)			I. Nelson	Apt. House	Detroit, Mich.
709	14	Boiler of locomotive exploded	2		Erie Railroad Co.	Railroad	Salamanca, N. Y.
710		Section of heating boiler cracked			Burton M. Reid	Residence	Springfield, Ill.
711	15	Section of heating boiler cracked			Ivan Allen	Store Bldg.	Atlanta, Ga.
712		Two sections heating boiler cracked			Diamond Holding Corpn.	Stores & Dwellings	New York, N. Y.
713		Boiler bulged and ruptured			Mulberry Ice Co.	Ice Plant	Mulberry, Fla.
714		Return pipe ruptured			Congregation Beth Israel	Synagogue	New Haven, Conn.
715	16	Boiler failed			Fred J. Kunkel	Service Bldg.	Baltimore, Md.
716		Autogenously welded tank exploded	2		Ludlum Steel Co.	Steel Plant	Watervliet, N. Y.
717		Section of heating boiler cracked			Molton Hotel Co.	Hotel	Birmingham, Ala.
718	17	Section of heating boiler cracked			Ronan Saw & Tool Works	Factory	Buffalo, N. Y.
719		Tube ruptured		1	Ed Kilgore	Farm	Powell, Wyo.
720	18	Boiler bulged and ruptured			Orr Cotton Mills	Cotton Mill	Anderson, S. C.
721		Header cracked			Ingersoll-Rand Co.	Factory	Easton, Pa.
722		Air tank exploded		1	Ohio Malleable Iron Co.	Iron Works	Columbus, Ohio.
723		Heating boiler exploded		2	Thompson's Restaurant	Restaurant	St. Louis, Mo.
724		Blow-off pipe failed			J. W. McDonald & Son	Cotton Gin	Wills Point, Tex.
725		Two sections heating boiler cracked			Pacific Telephone & Telegraph Co.	Tel. & Tel.	Glendale, Cal.

MONTH OF NOVEMBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
726	19	Section of heating boiler cracked			Air Reduction Co.	Chemical Plant	Elizabethport, N. J.
727		Boiler exploded			Dalziel Bldg.	Stores & Offices	San Francisco, Cal.
728	20	Boiler exploded			Hope Public School	School	Artesia, N. M.
729		Boiler of locomotive exploded	1	4	Virginian Railroad Co.	Railroad	Garwood, W. Va.
730		Boiler failed			City of Springfield	Municipal Bldg.	Springfield, Mass.
731		Main steam pipe failed			Miles Planting & Mfg. Co.	Sugar House	McCall, La.
732	21	Five sections heating boiler cracked			Mrs. J. F. Hicks	Stores & Offices	Kingsport, Tenn.
733		Section of heating boiler cracked and blow-off pipe ruptured			John S. Ames, Trustee	Apt. House	Boston, Mass.
734	22	Heating boiler exploded			Eunice Clark	Residence	Philadelphia, Pa.
735		Heating boiler exploded			Regal Shoe Store	Store	Philadelphia, Pa.
736		Section of hot water heater cracked			Wacht-Rose Holding Corpn.	Apt. House	New York, N. Y.
737	23	Header cracked			Shredded Wheat Co.	Wheat Products	Niagara F'lls, N. Y.
738		Header cracked			Pittsburgh Plate Glass Co.	Glass Factory	Crystal City, Mo.
739		Boiler of locomotive exploded	2	1		Railroad	Pataska, Ohio.
740		Air tank exploded			Pyramid Granite Co.	Granite Works	St. Cloud, Minn.
741		Boiler bulged and ruptured			Consumers Cotton Oil Co.	Oil Mill	Gadsden, Tenn.
742	24	Three tubes ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
743		Blow-off pipe failed			Wayne County Produce Co.	Apple Products	Marion, N. Y.
744		Section of heating boiler cracked			M. M. Gallagher	Apt. House	Norwood, Ohio.
745		Section of heating boiler cracked			Beaver Falls Boro School Dist.	School	Beaver Falls, Pa.
746		Three sections heating boiler cracked			Ban Shecket	Apt. House	New York, N. Y.
747		Seven sections heating boiler cracked			Marx & Haas Clothing Co.	Clothing Factory	Warsaw, Ill.
748		Three sections heating boiler cracked			Foster Foundation, Inc.	Ladies' Home	Hunt'gdon, W. Va.
749	25	Five sections heating boiler cracked			Estate of John L. Roper	Apt. House	Norfolk, Va.
750		Four sections heating boiler cracked			General Refractories Co.	Office Bldg.	Philadelphia, Pa.
751		Blow-off pipe failed			Town of Paris	School	So. Paris, Me.
752		Copper tank exploded		1	John Fravy	Residence	Goshen, Ind.
753		Boiler exploded	1		Garlett Mine	Mine	Clay City, Ind.
754	26	Boiler bulged and ruptured			Humphreys Coal & Coke Co.	Coal Mine	Humphreys, Pa.
755	27	Fitting in steam main ruptured			The Aeolian Co.	Factory	New York, N. Y.
756		Six sections heating boiler cracked			First National Bank	Bank	Connersville, Ind.

757		Section of hot water supply boiler cracked			Wausau Club Holding Co.	Club House	Wausaw, Wis.
758		Heating boiler exploded		5	Rockview Apartments	Apt. House	New York, N. Y.
759		Boiler exploded			A. J. Smith	Residence	Denver, Colo.
760		Tube ruptured			City of Grand Island	Power Plant	Grand Island, Neb.
761	28	Tube ruptured		1	Quincy Mining Co.	Copper Mine	Hancock, Mich.
762		Air tank exploded		4	Weidermann Brewing Co.	Brewery	Newport, Ky.
763		Boiler exploded			James Reed Mill	Sawmill	Mound City, Ill.
764		Boiler exploded		1	Edwardsville Creamery Co.	Creamery	Winnebago, Ill.
765		Blow-off pipe failed		1	Armour Grain Co.	Grain Elevator	Chicago, Ill.
766		Four sections heating boiler cracked			Waldorf System, Inc.	Restaurant	Boston, Mass.
767		Section of heating boiler cracked			E. L. Wilson Hardware Co.	Mercantile Bldg.	Beaumont, Texas.
768	29	Six sections heating boiler cracked			Orchard Paper Co.	Paper Mill	St. Louis, Mo.
769		Two sections heating boiler cracked			Luke Horsfall Co.	Store	Hartford, Conn.
770	30	Header failed			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.

MONTH OF DECEMBER, 1925.

771	1	Header ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Ford City, Pa.
772		Two sections heating boiler cracked			Township No. 43 No. Range	School	Lake County, Ill.
773		Section of heating boiler cracked			Marks Hat Co.	Hat Factory	Des Moines, Iowa.
774		Five sections heating boiler cracked			New Spruce Garage	Garage	Philadelphia, Pa.
775	2	Two sections heating boiler cracked			Mrs. Mathilda Sobol	Apt. House	New York, N. Y.
776	3	Boiler exploded	5	3	E. P. Creel	Sawmill	Ponce de Leon, Fla.
777		Boiler exploded		1	Continental Furniture Co.	Store	Council Bluffs, Ia.
778		Two tubes collapsed			Warner Collieries Co.	Coal Mine	Wolf Run, Ohio.
779		Blow-off pipe failed			Jenkins Machine Co.	Iron Works	Sh'b'yg'n F'lls, Wis.
780		Blow-off pipe failed			University of Utah	University	S. Lake City, Utah.
781		Section of hot water heater cracked			Charles Kovner	Apts. & Stores	Hartford, Conn.
782		Several sections heating boiler cracked			Louis Raphael	Offices & Stores	N. Britain, Conn.
783	4	Three sections heating boiler cracked			City of Hickory	Municipal Bldg.	Hickory, N. C.
784		Section of heating boiler cracked			L'Union St. J. B. D'Amerique	Fraternal Society	Southbridge, Mass.
785		Valve in main steam line failed			St. John's Guilds	Hospital	New Dorp, N. Y.
786	5	Section of heating boiler cracked			Hyman & Lena Krell	Apt. House	St. Louis, Mo.
787		Section of heating boiler ruptured			Emma C. Watson	Apt. House	Kansas City, Mo.
788	7	Hot water heater exploded			Annie Schwab	Residence	Philadelphia, Pa.
789		Boiler of locomotive exploded	2		B. & O. R. R. Co.	Railroad	Childs Station, Md
790		Boiler exploded	1		Harvey House	Hotel	Winslow, Ariz.

MONTH OF DECEMBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
791	8	Tube pulled out of header			Montefiore Hospital for Chronic Diseases	Hospital	New York, N. Y.
792		Four sections heating boiler cracked			Youngstown Sheet & Tube Co.	Steel Plant	Youngstown, Ohio.
793	9	Section of heating boiler cracked			John Hynes	Apt. House	Davenport, Iowa.
794		Section of heating boiler cracked			Board of Education	School	Frankfort, Ky.
795		Three sections heating boiler cracked			Lampkin Hotel Co.	Hotel	Frankfort, Ky.
796		Steel oil barrel exploded when subjected to air pressure	1		Chicago Belting Co.	Belting Works	Chicago, Ill.
797		Heating boiler ruptured			Hephzibah Baptist Church	Church	Hephzibah, Pa.
798	10	Blow-off pipe failed			Jenkins Machine Co.	Iron Works	Sh'b'yg'n F'lls, Wis.
799		Boiler exploded	2	3	Linden Wet Wash Laundry	Laundry	Fort Collins, Colo.
800		Section of heating boiler cracked			Mayer & Schneider Enterprises	Theatre	New York, N. Y.
801	11	Three sections heating boiler cracked			Minard Co.	Factory	Fram'gham, Mass.
802	12	Blow-off valve failed		1	Ingram Gin Co.	Cotton Gin	Maynard, Ark.
803		Tube ruptured			Whitney Mfg. Co.	Cotton Mill	Whitney, S. C.
804		Two sections heating boiler cracked			Universal Service Motors Co., Inc,	Service Station	Philadelphia, Pa.
805	14	Section of heating boiler cracked			Anna Moscovitz	Apt. House	New Haven, Conn.
806		Section of heating boiler cracked			American Packing & Provision Co.	Store & Warehouse	S't Lake City, Utah.
807		Tube ruptured		1	The Barrett Co. of W. Va.	Tar Products	Philadelphia, Pa.
808	15	Air tank exploded	1		American Salvage & Supply Co.	Machine Shop	Mexia, Texas.
809		Section of heating boiler cracked			Mayo Properties Association	Exp. Laboratories	Rochester, Minn.
810		Two sections heating boiler cracked			Pacific Tel. & Tel. Co.	Tel. Exchange	Oakland, Cal.
811	16	Four sections heating boiler cracked			Purdue University	College	La Fayette, Ind.
812		Two sections heating boiler cracked			William J. Riley, Trustee	Apts. & Stores	Hartford, Conn.
813		Tube ruptured			J. L. Huntzinger	Office Bldg.	Kansas City, Mo.
814	17	Boiler exploded		1	R. J. Bailey	Residence	Westmont, N. J.
815		Globe valve ruptured			Kimball Laundry Co., Inc.	Laundry	Omaha, Nebr.
816		Section of heating boiler cracked			W. C. H. Smith	Garage	N'w Bedf'd, Mass.
817		Section of heating boiler cracked			Madison Operating Co.	Hotel	New York, N. Y.
818	18	Section of heating boiler cracked			Burlington Graded Schools	School	Burlington, N. C.
819		Two sections heating boiler cracked			Chas. Kovner	Stores & Apts.	Hartford, Conn.
820		Four sections heating boiler cracked			Avoyelles Parish School Board	School	Marksville, La.
821		Five sections heating boiler cracked			Webster Furniture Co.	Furniture Factory	Rochester, N. Y.

822		Blow-off pipe failed			Jenkins Machine Co.	Iron Works	Sh'b'yg'n Falls, Wis.
823	19	Autogenously welded air tank failed	1		Grand Sausage Co.	Packing House	St. Louis, Mo.
824	20	Two sections heating boiler cracked			Riverview Holding Co.	Apt. House	New York, N. Y.
825		Two sections heating boiler cracked			B. & S. Hurst	Candy Kitchen	Kansas City, Mo.
826		Boiler exploded	1		Eichi Mayiba	Nursery	Oakland, Cal.
827	21	Tube ruptured			Atlantic City Elec. Co.	Power Plant	Atlantic City, N. J.
828		Two sections heating boiler cracked			Rose Goldberg	Lofts	Brooklyn, N. Y.
829		Thirteen sections and steam manifold of heating boiler cracked			Woolson Spice Co.	Spice Mill	Toledo, Ohio.
830		Ten sections heating boiler cracked (2nd accident)			Woolson Spice Co.	Spice Mill	Toledo, Ohio.
831	22	Three sections heating boiler cracked			Bemis Bag Co.	Bag Factory	Houston, Tex.
832		Five sections heating boiler cracked			American Awning & Tent Co.	Awning Factory	Boston, Mass.
833		Boiler exploded	1		Messing Planing Mill Co.	Planing Mill	St. Louis, Mo.
834		Boiler exploded	1		Crump & Beard Lease	Oil Well	Duncan, Okla.
835	23	Boiler ruptured			Globe Clothing Store	Store	Warsaw, Ind.
836		Tube ruptured			M. J. Whittall, Associates	Carpet Factory	Worcester, Mass.
837	24	Two tubes failed			Wellsboro Electric Co.	Power Plant	Wellsboro, Pa.
838	25	Three sections heating boiler cracked			Grand Theatre	Theatre	Norristown, Pa.
839		Boiler of locomotive exploded		3	Hocking Valley R. R. Co.	Railroad	Le Moyne, Ohio.
840		Tube failed			Atlas Plywood Corpn.	Wood Workers	Greenville, Me.
841	26	Three sections heating boiler cracked			Samuel M. Young	Hotel	Terre Haute, Ind.
842		Section of heating boiler cracked			David Goldberg Estate	Stores & Offices	Hartford, Conn.
843		Five sections heating boiler cracked			Two & Four W. 116th St. Corpn.	Apt. House	New York, N. Y.
844		Two sections heating boiler cracked			Dairymen's State Bank	Bank	Clintonville, Wis.
845		Heating boiler exploded		2	Akron-Alliance-Warren Interurban	Interurban Car	Wayland, Ohio.
846	27	Section of heating boiler cracked			White House Baking Co., Inc.	Bakery	Clark, W. Va.
847		Section of heating boiler cracked			School District No. 9	School	Belding, Mich.
848	28	Section of heating boiler cracked			Tinton Garage Co.	Garage	New York, N. Y.
849		Three sections heating boiler cracked			Arnold Schaak	Theatre	Chicago, Ill.
850		Four sections heating boiler cracked			Hayward Realty Trust	Office Bldg.	Boston, Mass.
851		Heating boiler exploded	1		Oscar Vinograd	Residence	Milwaukee, Wis.
852		Hot water heater exploded	1		Citizens Barber Shop	Barber Shop	Stuttgart, Ark.
853		Hot water heater exploded			Western Maryland Dairy, Inc.	Dairy	Baltimore, Md.
854		Boiler exploded			Louis Ringle		Omaha, Nebr.
855		Boiler exploded		1	McArdle Hat Shop	Store	Omaha, Nebr.
856	29	Crown sheet of locomotive collapsed			Pacific States Lumber Co.	Lumbering	Powers, Ore.
857		Boiler exploded		2	Kohler Bakery	Bakery	Niles, Mich.
858		Two sections heating boiler cracked			City of Springfield	School	Ind'n O'ch'd, Mass.

MONTH OF DECEMBER, 1925 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
859		Section of heating boiler cracked			Dalton Hotel Co.	Hotel	Dalton, Ga.
860	30	Two sections heating boiler cracked			State of Connecticut	Armory	Hartford, Conn.
861		Two sections heating boiler cracked			Clark Equipment Co.	Warehouse	Buchanan, Mich.
862		Jacketed vessel exploded		2	Walter Hunt Co., Ltd.	Jam Factory	Toronto, Ont.
863	31	Tube ruptured			Williamsburg Power Co.	Factory	Brooklyn, N. Y.
864		Boiler exploded		3	Superior Nickel Plating Works	Plating Works	Ft. Wayne, Ind.
865		Section of hot water heater cracked			Samuel Muscat	Residence	Gary, Ind.
866		Four sections heating boiler cracked			L. S. Ryan	Hotel	Lamar, Mo.
867		Three sections heating boiler cracked			First M. E. Church	Church	Chattanooga, Tenn.
868		Two sections heating boiler cracked			Universal Garage Co., Inc.	Garage	Fayetteville, N. C.
869		Five sections heating boiler cracked			Hotel La Salle	Hotel	New Orleans, La.
870		Two sections heating boiler cracked			Seeley & Co.	Office Bldg.	S. Francisco, Cal.

MONTH OF JANUARY, 1926

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	1	Five headers cracked			Commonwealth Water Co	Pumping Station	Canoe Brook, N. J.
2	3	Five headers & six tubes failed			Agasote Mill Board Co.	Board Mill	Fernwood, N. J.
3		Two sections & manifold of heating boiler cracked			67th St. Studio Bldg. Ass'n	Apt. House	New York, N. Y.
4		Two sections heating boiler cracked			Mrs. Mathilda Sobol	Apt. House	New York, N. Y.
5	4	Mud drum ruptured			B. & M. Rolling Mills Co.	Rolling Mill	S. Portland, Me.
6	7	Autogenously welded air tank exploded		1	Golden Rule Filling Sta.	Filling Station	Wichita, Kans.
7		Boiler exploded	1	2	Tipsord Farm	Sawmill	Oakwood, Ohio
8		Boiler exploded	1	4		Sawmill	Glen Allen, Ala.
9		Section of heating boiler cracked			Luliner & Trinz Theatres, Inc.	Theatre	Chicago, Ill.
10		Section of heating boiler cracked			Avoyelles Parish School Board	School	Bunkie, La.
11		Two sections heating boiler cracked			Zions Savings Bank & Trust Co.	Bank	Salt Lake City, Ut.
12		Three sections heating boiler cracked			Air Reduction Co.	Oxygen Plant	Emeryville, Cal.
13		Three sections heating boiler cracked			J. B. Nall & L. M. Neas	Municipal Bldg.	Kingsport, Tenn.
14	8	Two sections heating boiler cracked			Chicago Durant Co.	Manufacturing	Chicago, Ill.
15		Two tubes pulled out of drum			Indianapolis Abattoir Co.	Packing House	Indianapolis, Ind.
16	9	Boiler of locomotive exploded	2	3	C. & O. R. R. Co.	Railroad	Hurricane, W. Va.

17	10	Fitting on steam pipe failed			Crenshaw & Smailes	Offices & Stores	Los Angeles, Cal.
18	11	Nine headers cracked			Bedford Pulp & Paper Co. Inc.	Pulp & Paper Mill	Big Island, Va.
19		Furnace collapsed			Clardy Cleaning Plant	Cleaners	Ranger, Texas
20		Section of heating boiler cracked			Hotel Jerome	Hotel	Columbia, S. C.
21		Section of heating boiler cracked			School District No. 53	School	Julesburg, Colo.
22		Section of heating boiler cracked			Castlegate Realty Co.	Apt. House	Dorchester, Mass.
23		Section of heating boiler cracked			Penn. Co. for Insurance on Lives & Granting Annuities	Office & Stores	Philadelphia, Pa.
24		Three sections heating boiler cracked			Jamaica Motor Sales Co.	Garage	Somerville, Mass.
25	12	Boiler exploded			Central Hotel	Hotel	Sandstone, Minn.
26		Blow-off pipe failed			Fried-Osterman Co.	Glove Factory	Milwaukee, Wis.
27	13	Two sections heating boiler cracked			Air Reduction Co.	Chemical Plant	Jersey City, N. J.
28		Section of heating boiler cracked			Louise K. Slusher	Apt. House	San Francisco, Cal.
29		Tube ruptured			Dodge Bros.	Auto Factory	Hamtramck, Mich.
30	14	Boiler exploded	1		Michigan Farm Colony	State Home	Wahjamega, Mich.
31		Tube failed			William H. Hill	Creamery	Westover, N. Y.
32		Two sections heating boiler cracked			Universal Service Motors Co., Inc.	Garage	Philadelphia, Pa.
33	15	Section of heating boiler cracked			F. Elgorriago	Apt. House	San Francisco, Cal.
34		Section of heating boiler cracked			Fred J. Carey	Theatre	Hartford, Conn.
35		Boiler of pressing machine exploded				Pressing Shop	Hattiesburg, Miss.
36	16	Tube pulled out of header			Piedmont Mfg. Co.	Cotton Mill	Piedmont, S. C.
37		Section of heating boiler cracked			Pittsburgh Hospital	Hospital	Pittsburgh, Pa.
38		Six tubes pulled out of head			Western Ohio Creamery Co.	Creamery	Greenville, Ohio
39	18	Fitting in main steam pipe ruptured			Prescott Laundry Co.	Laundry	Springfield, Mo.
40		Three sections heating boiler cracked			Academy of the Sacred Heart	College	Hoboken, N. J.
41		Two sections heating boiler cracked			Walnut Construction Corp'n.	Apt. House	Philadelphia, Pa.
42	19	Two sections heating boiler cracked			Bernhard Greeff	Apt. House	New York, N. Y.
43		Two sections heating boiler cracked			J. C. T. Baldwin, Trustee	Office Bldg.	Boston, Mass.
44	20	Manifold of heating boiler cracked			F. D. Fisk & Jos. Sargent, Trustees	St'ge & Light Mfg.	Cambridge, Mass.
45		Blow-off pipe failed	1		Sawyer-Walker Lumber Co.	Lumber Mill	Norfolk, Va.
46		Valve ruptured			Consumers Power Co.	Power Plant	Flint, Mich.
47	21	Tube ruptured			A. S. Kreider Co.	Shoe Factory	Lebanon, Pa.
48		Sections of heating boiler cracked			Henschel Realty Corp'n	Apts. & Stores	N. Tonaw'da, N. Y.
49	22	Four sections heating boiler cracked			Ronan Saw & Tool Works	Tool Works	Buffalo, N. Y.
50		Two sections heating boiler cracked			Carhana Products Co.	Factory	New York, N. Y.

CORRECTION: We are informed that the air tank explosion reported in item 440 of the list for July, 1925 was at the Geneva Foundry Corporation, not at the Geneva Boiler Works.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1925

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks		$699,859.61
Real Estate		271,757.16
Mortgage and collateral loans		1,650,188.00
Bonds and stocks		11,233,196.67
Premiums in course of collection		1,341,102.96
Interest Accrued		141,983.25
Total Assets		15,338,087.65

LIABILITIES

Reserve for unearned premiums		6,433,164.02
Reserve for losses		283,273.98
Reserve for taxes and other contingencies		707,384.81
Capital Stock	2,500,000.00	
Surplus over all liabilities	5,414,264.84	
Surplus to Policyholders,		**$7,914,264.84**
Total Liabilities		15,338,087.65

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Incorporated 1866 — THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. — Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS, DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

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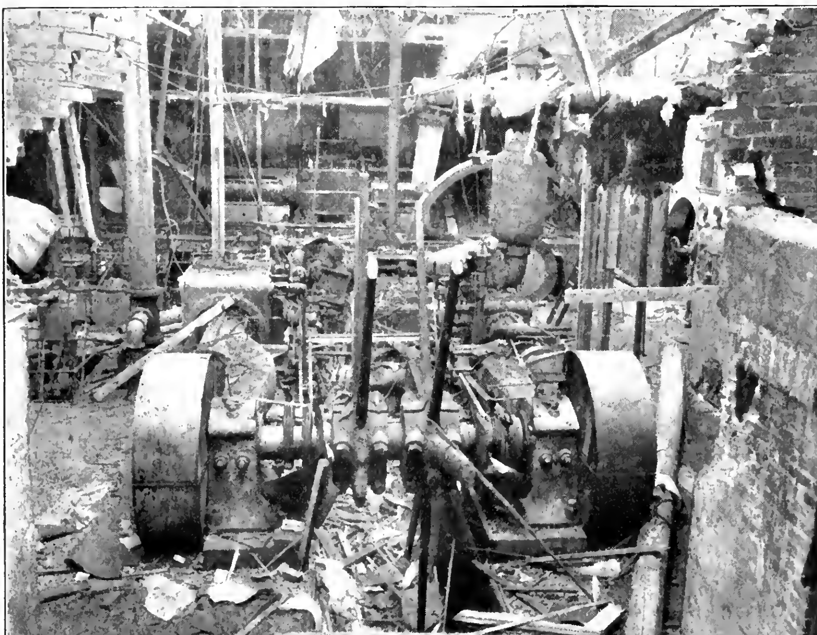
The Locomotive

Devoted to Power Plant Protection

Published Quarterly

Vol. XXXVI HARTFORD, CONN., JANUARY, 1927. No. 5



Flywheel Explosion at Kalamazoo, Michigan.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Flywheel Explosion at Kalamazoo, Michigan.

THE front cover picture and other accompanying illustrations show some of the results of a disastrous flywheel explosion that occurred July 21, 1926, at the plant of the King Paper Company Division of the Allied Paper Mills, Kalamazoo, Michigan. There was

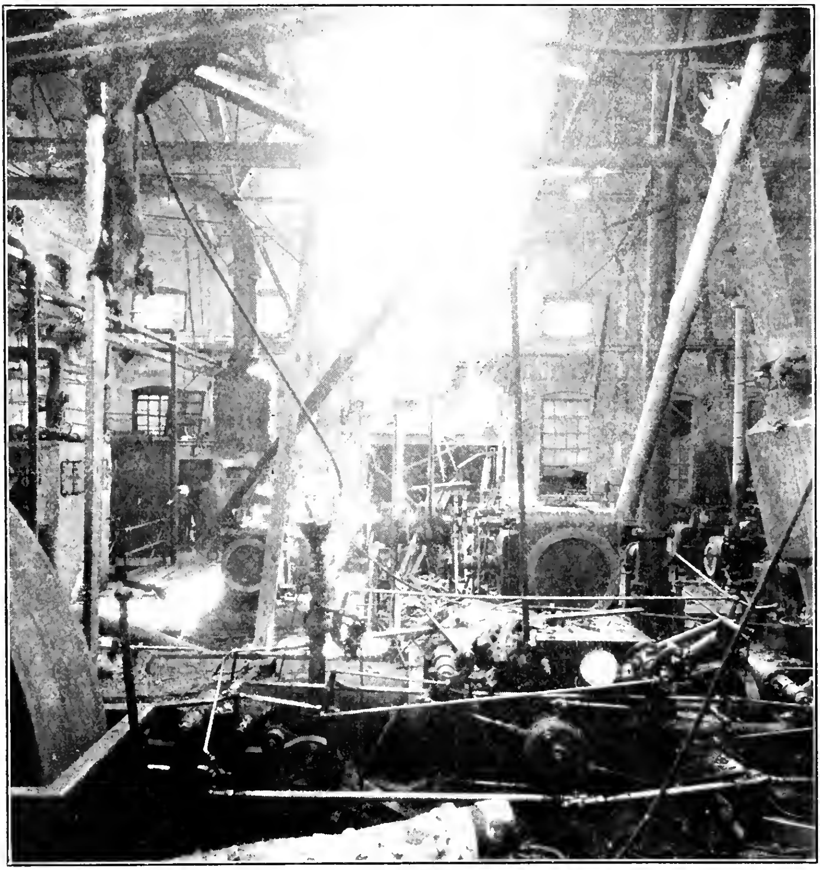


Fig. 1.

a property loss of $26,000, and a use and occupancy loss of more than $10,000. Six persons were injured, but fortunately all injuries were of a minor character.

The flywheel that exploded was really a double wheel, for it consisted of two wheels, each 18 feet in diameter and 26 inches wide, bolted together. The wheel was on the main shaft of a cross-compound Corliss engine which was set in the midst of four other engines and two turbines in the same engine room. The wheel was so situated that two of the engines were directly in line with it, and when the accident occurred flying pieces of the wheel damaged both of them considerably. The frame and low pressure cylinder of one of these engines were badly damaged; and the steam pipe and separator of the other were knocked down, and the governor and numerous parts of the valve mechanism were broken. The engine to which the exploded wheel belonged was, of course, the most seriously damaged. This was a 900 horsepower Corliss engine which drove 14 beaters, 2 Jordans, and numerous pumps, agitators and other auxiliaries. The low pressure frame of this engine was cracked in numerous places, and both high and low pressure frames were torn loose from their foundations. The main crank shaft was also bent. The receiver between the high and low pressure cylinders, and also exhaust piping, reach rods, rocker arms, and parts of the valve mechanism were destroyed. The main driving belt, a leather belt 48 inches wide and 160 feet long, was completely destroyed, as was also a leather belt 23 inches wide and 100 feet long on one of the other engines.

Fig. 2.

Pieces of the wheel in going through the roof tore down and badly damaged a steel roof truss 6 feet high by 65 feet long. Other damage by flying pieces was done to a Venturi meter, a condenser pump, piping for a sprinkler system, steam and water piping, and to a paper machine in an adjoining room. This latter was damaged by a piece of the wheel estimated to weigh 1800 lbs. which came down through the roof of the machine room.

In view of the extensive havoc wrought, evidence of the cause of the accident was not readily obtainable, but it is thought to have been due to a slipping governor belt. This engine furnished the power for all of the beaters in one beater room. A few minutes prior to the explosion the men in the beater room noticed a perceptible slowing down of their machines, and thinking it to be due to an overload on the engine they hurriedly relieved the individual loads of their several Jordans and beaters. The attention of the engine room operatives was first attracted by a noise which is thought to have been due to water in the cylinders. The engine then started to race and several attempts were made to shut it down by tripping the governor. It appears, therefore, that the engine first slowed down considerably and then speeded to destruction. The indications are that the slowing down was a result of the boilers priming, and the speeding up due to the sudden release of the load by the beater room attendants. The governor, of course, was depended upon to regulate the speed, but because of the oily condition of its belt it was unable to pick up speed with sufficient rapidity. Many flywheel explosions can be traced more or less directly to oily governor belts.

Fig. 3.

Fig. 2 shows a piece of the rim of the wheel as it landed near the Pennsylvania Railroad tracks 700 feet west of the engine room. This piece was estimated to weigh 2100 lbs. Fig. 3 shows portions of the rims of both wheels just as they landed on the right-of-way of the Grand Truck Railway approximately 800 feet east of the plant: and it is interesting to note that these portions of the two wheels are still joined by a small bolt, which would indicate that the wheels failed simultaneously. It is also to be noted that the flange joints shown are still intact.

The distances which pieces of the wheel traveled afford an opportunity to calculate the minimum speed of the engine at the instant of the explosion. The formula used is the usual projectile formula: —

$$\text{Range} = \frac{v^2}{g} \sin 2 \text{ (angle of elevation)}$$

where v = rim speed in ft. per second.
g = 32.2
range = horizontal distance travelled by flying piece, ft.

In using this formula the angle of elevation is assumed to be 45°, that is, the angle that will give greatest range or slowest rim speed as there was no way of measuring the actual angle. Rearranging and substituting the value of sin 90° (equal to unity), we have

$$v = \sqrt{\text{range} \times g}$$

$$= \sqrt{800 \times 32.2} = 160.5 \text{ ft. per sec.}$$

or=170 r.p.m. (for an 18 ft. wheel).

This speed necessarily must be somewhat below the actual speed at the instant when the wheel burst because no allowance is made in the calculation for the retardation of speed produced when the wheel fragment passed through the roof of the building.

Another reason why the speed was possibly greater than the calculated speed, plus any allowance for retardation by the roof structure, is that the calculation is based on the assumption that the wheel fragment started on its flight at the most favorable angle for maximum horizontal distance. The actual angle at which the segment flew off may, of course, have been greater or less than 45° which would require a higher speed of the wheel to produce a range of 800 feet.

The Hartford Steam Boiler Inspection and Insurance Company paid the limit of the direct policy ($20,000) for this accident, and paid a use and occupancy loss of $10,600.

Refrigerating Systems.

By Geo. H. Stickney, Supt. Boiler Department.

THE ordinary steam power equipment is very generally understood by the engineers who work with it, and as a rule they thoroughly appreciate the functions of the various pieces of machinery necessary to its operation. The process of mechanical refrigeration, however, is not always so clear, possibly because the installations are fewer in number and hence less opportunity is afforded to come in contact with them, but most likely because the temperature of the cycle is partly above and partly below normal, which is somewhat confusing. An article explaining the theory of mechanical refrigeration appeared in The Locomotive for July 1922. It is the purpose of the present article to consider the various vessels and machines essential to a practical system, having special reference to their safety and insurance.

Rating of the System.

In common with all other machines refrigerating systems are rated as to capacity in order that there may be some basis of comparison of different machines. They are susceptible to two ratings, that is, either their capacity is given in tons of ice they will produce in one day (24 hours) called ice *making* capacity, or they are rated equal to the cooling work done by one ton of ice *melting* per day (24 hours), called refrigerating capacity.

The relation of ice making capacity to refrigerating capacity is dependent to a great extent upon the temperature of the water from which the ice is made and also to the heat exchangers that may be a part of the plant equipment. In plants operating under the most favorable conditions the relation is sometimes as low as 1 to 1.5 and the general average is about 1 to 1.65. For the purpose of quoting insurance premiums it is arbitrarily taken as 1 to 2.

The commercial unit of capacity, or "ton of refrigeration," is defined as the cooling effect produced (or heat absorbed) by the melting of one ton (2000 lbs.) of ice per day (24 hours). The heat necesary to melt one pound of ice at 32°F into water at 32°F is 144 B. t. u. This value, 144 B. t. u., is the latent heat of ice. A ton of refrigeration, therefore, equals 2000 x 144 = 288,000 B. t. u. per 24 hours. The usual rating of refrigerating systems is the "refrigerating capacity" and is expressed in tons of refrigeration. It is, in other words, the number of B. t. u. which can be absorbed in 24 hours divided by 288,000 to reduce the value to tons.

In order to produce a ton refrigerating capacity it is necessary to compress (compression system) or generate (absorption system) an accepted amount of gas, and this is taken by the Joint Committee of the American Society of Mechanical Engineers and the American Society of Refrigerating Engineers as 5½ cubic feet per minute per ton of refrigeration in 24 hours with saturated gas at 5°F at the cooler and 86°F at the condenser. A 50 ton machine must therefore compress 5½ x 50 or 275 cubic feet of gas per minute.

The volume of gas to be pumped per ton is dependent upon the brine cooler pressure and the condenser pressure. The volumes for corresponding pressures and temperatures can be found in hand book tables.

Insurance premiums for refrigerating or ice making systems are based on the combined "ice making capacity" of all compressors or absorption generators connected with the system, such capacity to be determined from the manufacturer's rating stated on each machine. Where the rating is in refrigerating capacity it is of course to be converted into ice making capacity, the latter to be one half of the former. If the manufacturer's rating either in refrigerating capacity or ice making capacity cannot be ascertained the capacity of the system is determined for insurance rating purposes from the cylinder displacement of its compressors on the assumption that 15,000 cubic inches per minute equal one ton of ice making capacity.

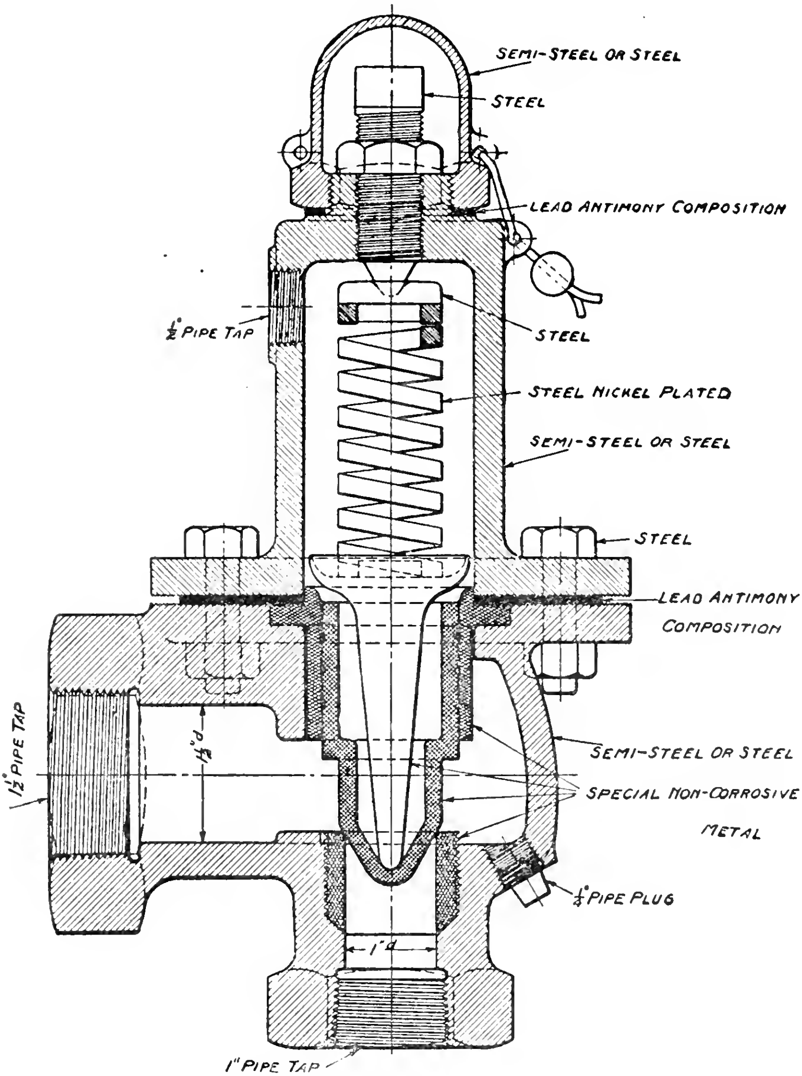
By the term "refrigerating system" is meant the pipes, coils and vessels of the system which contain ammonia, from the discharge end of the compressor to the suction end of the compressor, but excluding any compressor, and if the system is of the absorption type, the term shall include its generator. The compressor can be covered under an engine policy.

Compression System.

A compression system of mechanical refrigeration consists primarily of a compressor, condenser, receiver, expansion valve, and expansion coils. A driven **compressor** takes the low pressure anhydrous ammonia gas, compresses it to a higher pressure, and passes it on through an oil separator to the **condenser**. In the act of compressing, the temperature is increased, and the heat so generated is absorbed in the condenser by bringing the hot gas in contact with surfaces cooled usually with circulating water.

The ammonia changes from a gas to a liquid in the condenser because although the pressure is about the same as when leaving the discharge end of the compressor, the temperature has been brought down to nearly that of the condensing water. The change is due to the combination of high pressure and moderately low temperature. The liquid ammonia flows downward in the condenser to a tank known as a **receiver** located below the condenser. The receiver acts as a storage vessel and keeps the **expansion valve** supplied with a constant supply of liquid ammonia.

In the line from the receiver is an expansion valve which regulates the flow of ammonia to the **expansion coils**. Expansion valves may be either of the needle, disc or plug type and the disc and plug types are commonly used in large installations. When the liquid ammonia passes the expansion valve the pressure drops and the ammonia evaporates into a gas during the time it is in the expansion coil. It is at this point that a decrease in temperature occurs and production of cold created. Anhydrous ammonia has two principal qualities which



MASSACHUSETTS STANDARD AMMONIA SAFETY VALVE.

make it a desirable commercial refrigerant, first, its low temperature of evaporation (— 28°F at atmospheric pressure), and second, its high latent heat.

Before the liquid anhydrous ammonia can evaporate or boil into a gas it must be supplied with heat, and this heat must come from the brine, or air in the refrigerating rooms. If the expansion coils were under a gage pressure of 23 lbs. each pound (weight) of ammonia evaporated would require the absorption of about 564 B.t.u.

The expansion coils are either immersed in brine and the brine circulated in pipes in the cold storage rooms (indirect system), or else the coils are installed directly in the rooms to be cooled (direct system). After the ammonia has evaporated in the expansion coils it is pumped back into the suction side of the compressor and the cycle begun over again.

Protection of System.

The compressor should be protected from over pressure by an automatic by-pass from the discharge to the suction side, or by a spring loaded by-pass through or around the discharge stop valve, or else by a safety valve of proper size piped to discharge into the atmosphere at a safe place. These means of safeguard prevent the breakage of compressor parts in case an attempt were made to start the compressor with the discharge valve closed or in case of an abnormally high pressure during operation.

A great many compressors are provided with spring loaded or false heads beneath the main cylinder head. The purpose of such construction is to prevent broken compressor parts by furnishing a relief in case a considerable quantity of liquid anhydrous ammonia were taken into the cylinder.

It is desirable especially with high speed compressors that the discharge stop valve on compressors be so installed that the valve opens in the direction of the flow of the gas, in other words, that the pressure tends to open the valve. The object of this is to avoid sudden over pressure on the compressor cylinder and serious overstrain on other parts of the compressor which would occur if the valve should get loose from the stem and thereby act as a check valve.

When the automatic compressor by-pass valves discharge into the system the system should be protected from over pressure by a safety valve the size of which corresponds to the capacity of the machine. It should be set at a pressure not exceeding the safe working pressure of the vessels and should discharge into the atmosphere.

In determining the proper setting of such a safety valve it should be considered whether or not it is possible for the pressure in the discharge side of the system to act on top of the compressor safety valve so as to increase the pressure required on the lower side of the valve to make it operate. Due to the design of the Massachusetts Standard ammonia safety valve it is impossible for pressure from the discharge side to act on top of the valve disc in such a way as to increase the opening pressure. On the other hand, pressure from the discharge side would tend to lift the valve due to the shoulder of the valve disc. A number of other kinds of safety valves have this feature where pressure from the discharge side tends to lift the valve.

Receivers, shell type condensers and evaporators, which can be isolated by stop valves, should be protected by at least ½-inch safety valves set at pressures not exceeding the safe working pressures of the vessels protected, and these safety valves should discharge into the atmosphere.

Safety Valve Sizes.

The State of Massachusetts stipulates the size of safety valves for ammonia compressors based on 5 cubic feet of gas per minute per ton of refrigeration at a normal suction pressure of 10 lbs. gage and a discharge pressure of 275 lbs.

Size of Safety Valve	*Tons of Ref. Capacity*
¾	56
1	100
1¼	166
1½	240
2	424

If the suction pressure were less, it is obvious that smaller valves would be ample, and with a greater suction pressure larger valves would be required.

Within the last few years two-stage compressors and low pressure boosters have come into use, and for the booster and the low pressure side of the two stage compressors, particularly with higher suction pressures, the allowance of 5 cubic feet of gas is not considered sufficient for computing safety valve sizes. It is also felt that for by-pass valves, larger sizes should be used than those based on 5 cubic feet. Machines are now being built for as low as 75 lbs., whereas formerly 300 lbs. was the usual designed working pressure.

The ammonia compressor is subject to the complication of dealing with a suction pressure varying from 10 to 15 inches of vacuum, to 30 to 40 lbs. pressure, and the discharge pressure being a function of the condensing water temperature, may by anything from 70 lbs. in the winter to 275 lbs. in the summer; this may be further increased by air and uncondensable gases in the system.

Safety valves should be specially designed for ammonia service and in no case should a safety valve intended only for steam or water service be used. If any parts are of brass they will waste away rapidly due to the action of ammonia on metal of this kind. The Massachusetts Standard ammonia safety valve is as good a design as we know of.

It is always advisable to use a diffuser on the end of an escape pipe from a safety valve so that as much air as possible will mix with the ammonia fumes. The discharge from the safety valve escape pipe should be at a suitable location so that the fumes will not endanger life or become a public nuisance.

Absorption System.

An absorption system of mechanical refrigeration consists of a generator, analyzer, rectifier, condenser, receiver, expansion valve, expansion coils, absorber, pump and exchanger. The general principle upon which this system is based is the property of water to absorb ammonia gas, forming aqua ammonia. The colder the water the more gas it will absorb. After the water has absorbed as much gas as possible the gas can be driven from the water by application of heat. A simplified system is shown on page 140 and is described below.

Ammonia gas is driven from the strong aqua ammonia liquor in the **generator** by the heat of steam coils. The gas mixed with steam vapor rises under pressure and passes to an **analyzer.** The mixture passes upward through perforated trays over which strong liquor trickles downward to the generator. The descending strong liquor cools the rising vapor and partially condenses the steam. The final removal of steam and water vapor is completed in a vessel known as a **rectifier,** installed between the analyzer and condenser. All such condensation is returned to the generator.

Ammonia gas passes out of the top of the analyzer through the rectifier and into the **condenser** in which it strikes the cold surface of the pipe coil through which cold water is circulated. The ammonia is here condensed to a liquid and flows into a **receiver** and then to an **expansion valve,** passing thence to the **expansion coils** in the brine tank or refrigerating rooms where it vaporizes.

At this point, resemblance to the compression system ceases. The evaporated ammonia passes to a vessel known as an **absorber** where it mingles with and is absorbed by the weak ammonia liquor which is forced from the bottom of the generator. In the process of absorption heat is produced and in order that the weak liquor may readily absorb the gas, this heat together with some of the heat remaining in the weak liquor must be absorbed. This is done by a cooling coil through which cold water is circulated.

Due to pressure produced by the continuous evaporation in the

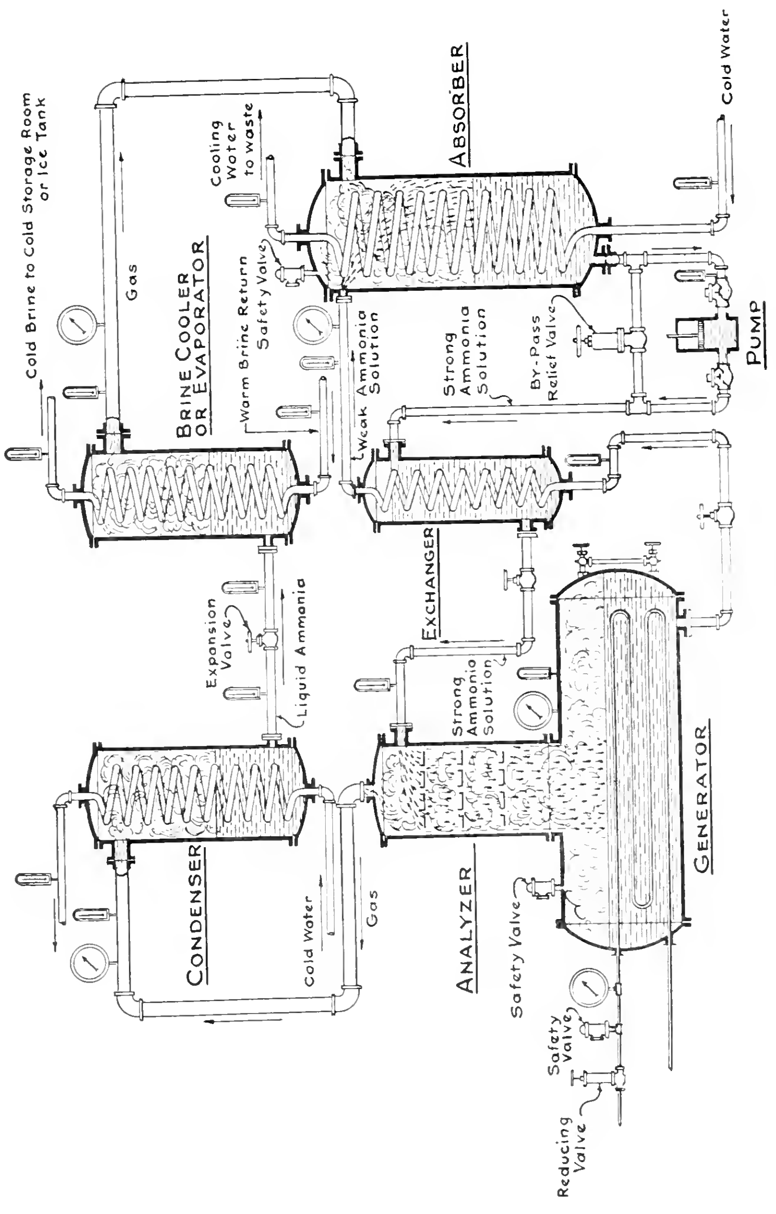


Diagram of Absorption System.

generator, the hot weak liquor is forced from the bottom of the generator and passes through a coil in the exchanger, after which it enters the top of the absorber. The cold strong liquor is pumped from the bottom of the absorber through the exchanger and into the top of the analyzer, where it falls to the generator. In the exchanger, the hot weak liquor gives up a large proportion of its heat to the cold strong liquor thus saving both cooling water in the absorber and steam in the generator.

The absorber and generator together with the parts lying between them take the place of the compressor of the compression system, without having any moving parts except the pump. It will be seen from the foregoing that there are two complete cycles, the course of the anhydrous gas and the liquid ammonia forming one, and the weak and strong aqua ammonia forming the other.

Protection of System.

Since the pressure and amount of ammonia gas driven from the generator are dependent on the steam coils in the generator it will be necessary to limit the pressure of steam by a reducing valve on the line to the coils and a safety valve between the reducing valve and coils. The pressure of steam or amount of heating surface of the coils should not exceed that necessary to obtain the designed capacity of the system.

The generator should be protected from over pressure by an ammonia safety valve of a size corresponding to the capacity of the system and set at a pressure not exceeding the safe working pressure of the vessel, and this safety valve should discharge into the atmosphere. The safety valve on the generator may discharge into the absorber provided the absorber is protected by a safety valve of proper size set at a pressure not above the safe working pressure of the absorber and discharging into the atmosphere.

In determining the proper setting of the safety valve on the generator, it should be considered that the pressure in the absorber acts on top of the safety valve and may increase the pressure required on the lower side of the valve or in the generator to make it operate. This condition may be somewhat different as previously explained.

If the remaining shell constructed vessels of the system can be isolated from the generator by stop valves they should be protected by at least ½-inch safety valves discharging into the atmosphere or into the absorber provided the absorber is properly protected.

In case all safety valves discharge into the atmosphere the absorber nevertheless should be protected from over pressure by an ammonia safety valve of a size corresponding to the capacity of the system and set to discharge into the atmosphere at a pressure not exceeding the safe working pressure of the vessel.

The best practice is to provide atmospheric relief for all ammonia vessels and compressors and where by-pass valves are used it is advisable to have them set at about 25 lbs. less than the valves relieving to the atmosphere. This enables excessive pressure to be relieved to the low pressure side, thus preventing the loss of ammonia, but the atmospheric relief valve is ready to function in case of failure of the by-pass valve.

Carbon Dioxide.

Carbon dioxide is a refrigerant frequently used in compression systems and the principles of operation are similar to the ammonia compression system except that the head pressure is much higher; usually about 1000 or 1200 lbs. The compressor is usually driven by an electric motor and the vessels of the system are of pipe construction. The compressor should have a safety valve installed on the discharge pipe between the stop valve and compressor and set to discharge into the atmosphere at a pressure not exceeding the safe working pressure of the system. An automatic pressure limiting device should be installed which will stop the compressor before the safety valve begins to lift.

If any of the vessels of the system are of the shell type and can be isolated by stop valves they should be protected by at least ½-inch safety valves of proper construction. Over pressure rupturing devices would be considered the equivalent of safety valves on shell type vessels.

Sulphur dioxide, ethyl and methyl chloride are other refrigerating mediums frequently used. Systems using these chemicals are insurable and they should be protected in about the same manner as carbon dioxide systems. The pressures in such systems are much lower than in the carbon dioxide systems.

Inspections

Owners should plan to let the insurance company know when vessels of shell type construction are to be opened for repairs and cleaning, and internal inspections at those times can be arranged for. Be certain that vessels are thoroughly ventilated and valves tightly closed when the vessels being inspected are connected with others under pressure. Ammonia gas has a specific gravity considerably less than air, and therefore it has a tendency to rise. Do not use an open flame light for inspection purposes. A hand flash light is advised.

Ammonia is generally not corrosive to iron or steel and although wasting away of metal is not common, the remaining defects as found in unfired pressure vessels can be looked for.

Test gage connections should be installed so that gages can be corrected.

No fires, open flames or flashing electric contacts should be allowed around ammonia apparatus, because a mixture of the proper proportions of air and ammonia gas may be inflammable and explosive.

Make sure the condensing water is cool, sufficient in quantity and from an unfailing source.

Broken fittings are often the cause of shut downs which usually are expensive due to the escape of large quantities of ammonia and the spoiling of brine, spoiling of material in storage, and loss of production, to say nothing of the possibility of the injury or death of persons. The engineer should investigate the possibility of ice cans striking ammonia pipes in the brine tank as this is a frequent cause of broken fittings. The practice of standing on ammonia pipes and fittings has been also frequently noted and such practice advised against.

European Rotary Economizer.

MAINLY from the standpoint of saving in floor space, according to the *Zeitschrift* of the Steam Boiler Inspection and Insurance Company of Vienna, Austria, a new piece of power plant apparatus has been designed which functions both as economizer and induced draft fan.

In outward appearance and size this fan-economizer looks like an ordinary fan, but the rotor consists of a circular nest of short tubes fastened in two hollow-disk headers through which the feed water is pumped by way of the hollow shaft. The tubes are provided on their outside surface with sheet metal fins similar to those on air-cooled compressor cylinders. No cast iron is used in the construction of the economizer as it is intended for high boiler pressures.

The results obtained with this apparatus are reported as remarkably good.

Learn to laugh. A good laugh is better than medicine. When you smile or laugh, your brain for a moment is freed from the load that it ordinarily carries. — *Selected.*

Explosion of a Steam Turbine Casing Due to Overpressure.

THE presence of a stop valve in the exhaust line of a turbine is in some cases a necessity as, for instance, when two or more turbines utilize the same condenser or exhaust into a common low

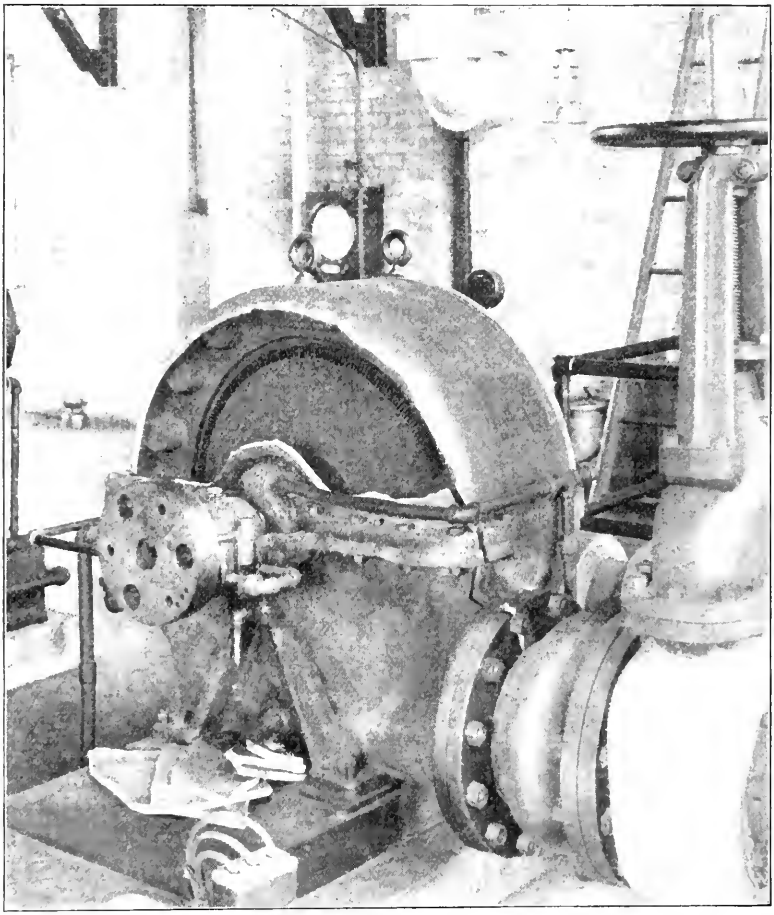


Fig. 1.

pressure supply line. Such a valve, however, introduces a hazard that is not always appreciated, for where there is a valve there is always the possibility of its being closed at the wrong time. The presence of this stop valve in the exhaust line presents the possibility of the low pressure end of the turbine being subjected to full boiler pressure. Since the low pressure casing is not designed to withstand high pressures, it should be protected against over pressure by an atmospheric relief valve.

The explosion of a 50 kw. turbine, the results of which are shown in the accompanying picture, was due to the closing of a valve in the exhaust line under rather unusual conditions. The turbine had been in operation as usual for several hours when it suddenly lost its load and was tripped out by an overspeed safety device. This occurred during the early hours of the morning, and the plant being in darkness due to the shut down, the fireman on duty made an effort to start up the turbine again. He first closed, or endeavored to close, the throttle valve, but apparently became confused in the dark and closed the exhaust valve instead. Upon opening the valve that had been closed by the overspeed mechanism, full boiler pressure was thrown upon the turbine casing because the throttle valve had remained open. The casing was so completely wrecked and the shaft so badly sprung that the turbine had to be replaced by a new one. The direct connected generator suffered damage to several coils. Greater damage would undoubtedly have resulted if the machine had been in motion.

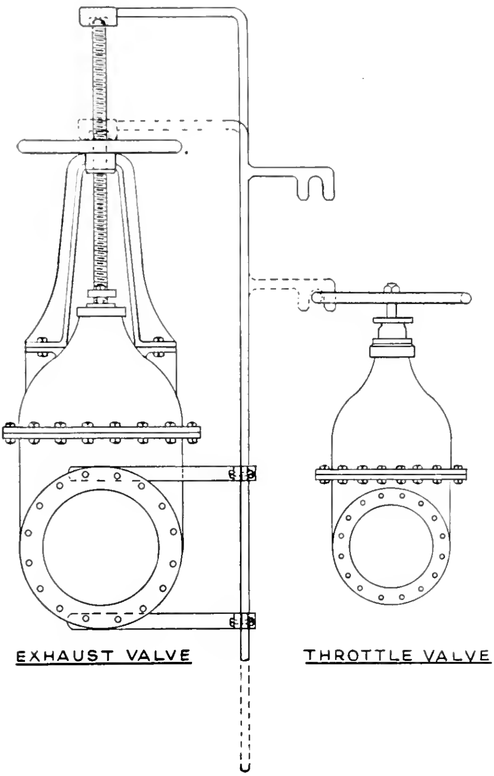


FIG. 2.

This turbine casing was not protected by an atmospheric relief valve but it did have an interlocking device connecting the steam and exhaust valves which it was thought made a relief valve unnecessary. The construction of this device is shown in the diagram, Fig. 2. A vertical sliding rod was supported by guides and contained two horizontal arms, one of which terminated in a downward projecting fork, and the other in a downward projecting cap. The cap fitted over the rising stem of the exhaust valve so that the whole arrangement moved up or down as the exhaust valve was opened or closed. When the valve was closed, the rod was in its lowest position and the fork projected between the spokes of the wheel on the throttle valve, thus preventing it from being opened. When the exhaust valve was opened the fork, of course, was withdrawn.

Such an arrangement at best is really only a reminder to the operator, for it is quite evident that the exhaust valve could be manipulated at will regardless of the position of the steam valve, and this completely nullified the arrangement as a safety device. To be really safe there is one feature that every safety device should have, — it should be completely automatic and not dependent upon thought or action of an attendant. An atmospheric relief valve on the exhaust connections without intervening stop-valve is a practical and safe means of preventing overpressure on a turbine casing. Such a relief valve would no doubt have prevented this explosion.

Steam-Boiler Development.

WITH the rapid developments in steam-boiler practice during the past few years, many problems have arisen that appear to give concern not only to the boiler manufacturer, but also to the inspection departments responsible for the safety of boilers and pressure vessels. The increasing demands for heat economy, particularly in connection with the large power stations now coming into use, have boosted operating steam pressures up from former maximums of 350 and 400 lb. to 600, 900, and 1200 lb. The critical pressure of steam, 3300 lb., is also suggested.

The grave questions concerning pipe connections and fittings, gaskets, packing, etc., for these higher pressures appear capable of satisfactory solution. The several installations operating at 1200 lb. or more have apparently overcome such problems with a reasonable degree of satisfaction, and research concerning the effect of the extremely high temperatures encountered at such pressures is developing a tremendous amount of valuable information concerning the characteristics of metals and alloys that are most suitable for the various classes of service.

One of the most striking features of this development is the fact that with drums of relatively small diameters these high pressures demand shell thicknesses that exceed the practical limits of riveting for the joints. This has influenced the use of forged seamless drums and here the valuable experience developed in heavy forging of large-bore rifles, hydraulic cylinders, etc. is turned to the advantage of the boiler manufacturer. This development has, it may be stated, revealed the necessity of introducing a new specification for the material required for such forgings, but the Boiler Code Committee in co-operation with the American Society for Testing Materials has been able to meet this need of industry. Such a specification has just been approved for publication as an addendum to the Material Specifications Section of the Code . . . .

With drums of such great shell thickness the attachments of nozzles or other fittings for outlet connections and the like have demanded treatment that is relatively new in steam-boiler practice. In some instances it has been found possible to forge down an end of the drum and machine directly upon it a pipe flange for connection to header or main stop valve. In others where a nozzle at the side is desired it is found more satisfactory to fasten the flange plate or nozzle fitting with studs instead of rivets, the thickness of the shell affording ample depth of thread. It has even been proposed to insert the end neck of a long-bodied nozzle through a drilled hole in the shell of such a thick drum and expand it at the inner end like a boiler tube, and it is of course generally recognized that such a plan has merit.

Not alone in the problem of shell construction are difficulties encountered in high pressure boiler design — all fittings and attachments require special treatment and in many instances different materials of construction. Feed connections and piping, blow-off piping and valves, and steam and water gages all require special design as well as special materials. Brass and bronze are frowned upon by the Boiler Code for use at pressures in excess of 200 lbs. per sq. in., as at the temperatures accompanying such pressures a pronounced weakening of the material is to be noted. Almost a new art has been developed in water-gage, steam-gage and safety-valve construction.

Broadly viewed, the art of boiler construction seems to be inclined to depart from its accustomed channels of practice for many years past, and it is indeed a study of the greatest interest to observe the tendencies toward which it is drifting. It is a general impression that important new developments are still to appear in this field.

— *Mechanical Engineering.*

S-Miles

He bought some tires that "smile at miles," but they burst out laughing. — *Selected.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, JANUARY, 1927.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. Co.

President Blake's Anniversary.

ON Saturday, November 20th, 1926, occurred the tenth anniversary of President Blake's election as the head of this Company. At the next meeting of the Board of Directors on November 24th, this event was noted by a review of the progress which the Company had made in the previous ten years. In recognition of this anniversary and of the wonderful growth and development shown by this review, the Board of Directors unanimously passed the following vote:

"At a meeting of the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company, of Hartford, Connecticut, held November twenty-fourth, nineteen hundred and twenty six, it was unanimously VOTED: That in commemoration of the tenth anniversary, — on November twentieth, nineteen hundred and twenty six, — of the election of Charles S. Blake to the presidency of this Company, the following minute be entered on our record, and that a suitable engrossed copy of it be prepared, signed by each Director, and presented to President Blake as a testimonial of our high regard for him.

"We deeply regret that the illness of President Blake prevents our expressing to him personally our hearty congratulations on the occasion of the tenth anniversary of his election as head of this

Company and on the wonderful progress the Company has made under his administration. But in his absence, perhaps with less embarrassment to him, we may record more freely and frankly our appreciation of him and of his service to the Company.

"During these last ten years the steady gain which our Company has made in business and financial strength has been a source of deep satisfaction to us, but the report which has been submitted today, comparing current business statistics with those of ten years ago, makes us realize more than ever how great has been our progress. The figures in it evidence the material prosperity our Company has attained and now enjoys under President Blake's leadership but they imply even more, for so substantial a growth must mean increasing public recognition of the usefulness of our institution. Other statistics of today's report confirm this and show that by broadening the field of its activities to meet the needs of industrial development The Hartford Steam Boiler Inspection and Insurance Company has maintained its paramount position in the face of growing competition as the largest insurer of those hazards which threaten the production of mechanical power.

"That the efforts of the officials and the employees of the Company and their loyal devotion to its interests have had an important part in this growth and prosperity we have no doubt, but we recognize that it is President Blake who has co-ordinated their work; directed their activity; inspired their enthusiasm, and whose character is reflected throughout the organization and that he, therefore, is primarily responsible for the splendid results attained.

"We desire to express our deep satisfaction that ten years ago we elected Mr. Blake our President. We extend to him our affectionate greetings and our earnest hope, encouraged by his already improved condition, that he will be speedily restored to complete health and strength."

SINCE our last issue, two new members have been added to the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company. At a meeting of the Board held October 25th, 1926, Shiras Morris, President of the Hart and Hegeman Manufacturing Company of Hartford, Connecticut, was elected to fill the vacancy caused by the death of the late Morgan G. Bulkeley, Jr.; and at a meeting held November 24th, 1926, His Excellency, John H. Trumbull, Governor of Connecticut and President of The Trumbull Electric Manufacturing Company of Plainville, Connecticut, was elected to fill the vacancy caused by the death of the late Atwood Collins.

Mechanical Refrigeration.

AT a popular lecture on the subject of refrigeration the speaker opened his talk with the statement that ice contains heat and that a stated number of pounds of ice contained enough heat to make the auditorium comfortable on a cold day. This, of course, is true, but unfortunately ice is at such a low temperature that its heat is not of any use to us at moderate temperatures. Hence we are not much interested in the heat content of ice, but we are very greatly interested in the fact that it will absorb heat from its surroundings. Heat flows down hill, that is, from a substance of higher temperature to one of lower temperature; and as ice is at a subnormal temperature and absorbs considerable heat in melting, it is the focus of heat flow from all objects near it. These objects are thus cooled or refrigerated.

At first all ice was natural ice and was harvested in winter from rivers and ice ponds and stored in special ice houses until needed. This method was, and still is, fairly satisfactory in the northerly latitudes where the production of natural ice is abundant, but it involved long hauls and repacking for use further south where refrigeration is required to a far greater extent. Under such conditions the development of mechanical refrigeration and the manufacture of artificial ice were inevitable, and the process has been so improved that artificial ice economically competes with natural ice even where the latter is abundant. Artificial ice can therefore be produced in any climate in quantities proportional to the local demand. Hauling even from nearby ice ponds is eliminated by the erection of manufacturing plants within cities, the centers of demand.

Not many years ago mechanical refrigerating systems were built only in fairly large units, but with the development of smaller units the market has expanded so that today the small store or soda fountain depending upon ice packs for its refrigeration is becoming the exception. The office building or industrial plant of fair size is almost certain sooner or later to have its own refrigerating system if only for cooling drinking water. The operating engineer will thus come more and more into contact with such equipment and will be expected to know how to operate and to care for it. The safety of the system is, of course, paramount, and this requires a thorough understanding of the manner in which each piece of equipment should function. An interesting and helpful discussion of the subject will be found in this issue.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

Month of January, 1926. (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
51		Boiler exploded			Potter Bros.	Grain Elevator	Morrison, Ill.
52		Boiler exploded	1	1	Wiggins Pressing Club	Pressing Shop	Greenville, S. C.
53	23	Boiler bulged & ruptured			The Mengel Co.	Sawmill	Louisville, Ky.
54		Boiler bulged & ruptured			T. G. Carek	Green House	Lorain, Ohio
55		Crown sheet pulled away from four stays			Batson & Hatten Lumber Co.	Lumber Mill	Lyman, Miss.
56		Section of heating boiler cracked			Durham Citizens Hotel Corp'n	Hotel	Durham, N. C.
57		Four sections heating boiler cracked			L. S. Knoek & Co.	Hdwe. Store	Hartford, Conn.
58		Two sections heating boiler cracked			Goodyear Yellow Pine Co.	Hotel	Picayune, Miss.
59		Section of heating boiler cracked			Western Reserve Academy	College	Hudson, Ohio
60	24	Four sections heating boiler cracked			Elks Home	Home	Norristown, Pa.
61	25	Gasket in main steam pipe blew out			The Pairpoint Corp'n	Factory	New Bedford, Ms.
62		Three sections heating boiler cracked			Atlanta Woman's Club	Club House	Atlanta, Ga.
63	26	Two sections heating boiler cracked			A. D. Steinbach	Mercantile Bldg.	New Haven, Conn.
64		Section of heating boiler cracked			Stafford Apartments	Apt. House	Norfolk, Va.
65		Sections of heating boiler cracked			Pittsburgh Assoc. for Improvement of Poor	Charitable Inst.	Pittsburgh, Pa.
66	27	Section of heating boiler cracked			Hyman Persky	Stores & Theatre	Holyoke, Mass.
67		Boiler bulged & ruptured			Virginian Gasoline & Oil Co.	Natural Gas Wells	Charleston, W. Va.
68	28	Boiler exploded	1		Ball Park Theatre	Theatre	Cleveland, Ohio
69		Boiler exploded		2	Pure Oil Co.	Oil Well	Camden, Ark.
70		Boiler of locomotive exploded		3	C. M. & St. P. R. R. Co.	Railroad	Danville, Ill.
71		Boiler ruptured			H. A. Reiling, Inc.	Silk Mill	Gouldsboro, Pa.
72		Section of heating boiler cracked			Pacific Tel. & Tel. Co.	Office Bdg.	San Francisco, Cal.
73		Section of heating boiler cracked			Domonic Mara	Apt. House	Hartford, Conn.
74	29	Two sections & manifold of heating boiler cracked			Union Trust Co.	Bank	Springfield, Mass.
75		Two sections heating boiler cracked			Thomas P. O'Connor	Garage	So. Boston, Mass.
76		Fitting in main steam pipe ruptured			Reeves Mfg. Co.	Sheet Metal Prod.	Dover, Ohio
77		Blow-off pipe failed			T. A. Foley	Sawmill	Paris, Ill.

MONTH OF JANUARY, 1926 (Continued).

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
78	30	Boiler exploded	1		St. Joseph's Hospital	Hospital	Ashland, Wis.
79		Section of heating boiler cracked			First Presbyterian Church	Church	Bellefontaine, O.
80		Section of heating boiler cracked			Gastonia Weaving Co.	Textile Mill	Gastonia, N. C.
81		Two sections heating boiler cracked			Ivan Allen	Office Bldg.	Atlanta, Ga.
82	31	Four sections heating boiler cracked			Pacific Tel. & Tel. Co.	Telephone Bldg.	San Diego, Cal.
83		Two sections heating boiler cracked			Waldorf System, Inc.	Lunch Room	Boston, Mass.
84		Section of hot water supply heater cracked			Wacht-Rose Holding Corp.	Apt. House	New York, N. Y.

Month of February, 1926.

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
85	1	Boiler exploded	1		Rose City Oil Co.	Oil Mill	Little Rock, Ark.
86		Section of heating boiler cracked			W. M. Waters	Furniture Store	Florence, S. C.
87		Section of heating boiler cracked			Lehigh Textile Co., Inc.	Silk Mill	Lehighton, Pa.
88		Section of heating boiler cracked			Samuel Boyarsky	Apt. House	Hoboken, N. J.
89		Section of hot water supply heater cracked			Forsyth Apartment Co.	Apt. Hotel	Savannah, Ga.
90	2	Tube burst		3	Penn. R. R. Co.	Railroad Shops	Altoona, Pa.
91		Section of heating boiler cracked			Sam Weisstein	Apt. House	Brooklyn, N. Y.
92		Section of heating boiler cracked			Madison Operating Co., Inc.	Hotel	New York, N. Y.
93		Section of hot water supply heater cracked			O. L. & E. A. Gruggel	Apt. House	San Francisco, Cal.
94		Section of hot water supply heater cracked			R. Safran & G. Gold	Apt. House	New York, N. Y.
95	4	Sections of heating boiler cracked			Lowell School	Public School	Shenandoah, Iowa.
96		Manifold and section of heating boiler cracked			Isaac Auerbach	Apt. House	Philadelphia, Pa.
97	5	Two sections and header of heating boiler cracked			Board of Education	School	Wickliffe, Ohio
98		Section of heating boiler cracked			Casino Mansions Co.	Apt. House	Brooklyn, N. Y.
99		Section of heating boiler cracked			Reed Realty Trust	Greenhouse	Springfield, Mass.
100		Two sections heating boiler cracked			Trident Development Corp'n	Garage	E. Boston, Mass.
101		Section of heating boiler cracked			St. Anthony of Padua Church	Church & School	Col'mb's Grove, O.

102		Boiler ruptured		1	Dayton Power & Light Co.	Power Plant	Dayton, Ohio.
103	6	Two tubes ruptured			Houlton Water Co.	Pumping Sta.	Houlton, Me.
104		Section of hot water supply heater cracked			Est. of W. W. Meyer	Apt. House	San Francisco, Cal.
105		Boiler bulged and ruptured			Elliott Knitting Mills	Knitting Mill	Hickory, N. C.
106		Boiler exploded			Jones Hardware Co.	Store Bldg.	Oceanside, Cal.
107		Hot water heater exploded			Rockford Electric Co.	Office Bldg.	Rockford, Ill.
108		Section of heating boiler cracked			Klots Throwing Co., Inc.	Silk Mill	Keyser, W. Va.
109	7	Manifold of heating boiler cracked			Hoffman Wagon Works	Garage	Cleveland, Ohio.
110		Manifold & section of heating boiler cracked (2nd accident)			Hoffman Wagon Works	Garage	Cleveland, Ohio.
111		Section of heating boiler cracked			Windsor Cement Co., Inc.	Factory	Hartford, Conn.
112		Section of heating boiler cracked			Purdue University	University	LaFayette, Ind.
113		Section of heating boiler cracked			Florence Amusement Ass'n	Theatre	Florence, Mass.
114		Section of heating boiler cracked			Middletown Silk Co.	Silk Mill	Middletown, Conn.
115	8	Section of hot water heater cracked			R. N. Filbeck	Hotel	Terre Haute, Ind.
116		Valve burst	1	3	Hammond Lumber Co.	Lumber Mill	Samoa, Cal.
117	9	Two sections heating boiler cracked			Oak Grove Seminary	School	Vassalboro, Me.
118		Section of heating boiler cracked			Village of Potsdam	Water Works	Potsdam, N. Y.
119	10	Boiler of fire engine collapsed			City of Scranton	Fire Engine	Scranton, Pa.
120		Steam pipe burst	1	1	Chicago Mill & Lumber Co.	Lumber Mill	Helena, Ark.
121		Tube ruptured			Vacuum Oil Co.	Oil Refinery	Paulsboro, N. J.
122		Section of heating boiler cracked			Louis Mooney	Apt. House	Bridgeport, Conn.
123	11	Section of heating boiler cracked			City of Hickory	School	Hickory, N. C.
124		Two sections heating boiler cracked			Wilmor, Inc.	Store	Hartford, Conn.
125		Header cracked			Providence Gas Co.	Gas Plant	Providence, R. I.
126		Boiler exploded		2	Capital Lunch	Lunch Room	New Haven, Conn.
127		Blow-off pipe ruptured			Ohio Valley Pulley Wks.	Pulley Works	Maysville, Ky.
128	12	Blow-off pipe failed			Shadhum Bros.	Tannery	Norcross, Ga.
129		Two sections heating boiler cracked			John Wesley Hotel	Hotel	Savannah, Ga.
130	13	Section of heating boiler cracked			Cleveland Furniture Mfg. Co.	Furniture Factory	Cleveland, Ohio
131		Section of heating boiler cracked			Jacob Wiener	Clothing Factory	Philadelphia, Pa.
132		Two sections heating boiler cracked			Yetta Katz	Apt. House	New York, N. Y.
133	14	Tube ruptured & three headers cracked			Marmon Motor Car Co.	Auto Factory	Indianapolis, Ind.
134		Furnace collapsed	1		Illinois Power & Light Co.	Gas Plant	Decatur, Ill.
135	15	Two sections heating boiler cracked			H. P. Hood & Sons, Inc.	Garage	Charlestown, Mass.
136		Section of heating boiler cracked			Thistle Investment Co.	Apt. House	Kansas City, Mo.
137		Blow-off pipe failed			Norman Kiln Drying Co.	Lumber	Louisville, Ky.
138		Tube failed & 5 headers cracked			Rivoli Silk Hosiery Co.	Hosiery Mill	Plainfield, N. J.

MONTH OF FEBRUARY, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
139	16	Tube pulled out of drum			Spicer Mfg. Corp'n	Auto Shafts Fact.	S. Plainfield, N. J.
140	17	Header cracked			Pittsburgh Terminal Warehouse Transfer Co.	Warehouse	Pittsburgh, Pa.
141		Ten sections heating boiler cracked			Rt. Rev. J. B. Schrenchs	Church	Cleveland, Ohio
142		Sixteen tubes pulled out of drum		1	Lehigh Portland Cement Co.	Cement Mill	Sandt's Eddy, Pa.
143		Section of heating boiler cracked			Arkansas College	College	Batesville, Ark.
144		Section of heating boiler cracked			Waldorf System, Inc.	Restaurant	S. Boston, Mass.
145	18	Sections of heating boiler cracked			Board of Commissioners	County Home	Wilmington, N. C.
146		Three sections heating boiler cracked			Carlton Hotel	Hotel	St. Louis, Mo.
147		Three sections heating boiler cracked			Gustave L. Morgenthau	Loft Bldg.	New York, N. Y.
148		Fitting in feed line ruptured			Henshall Bros., Inc.	Silk Mill	Paterson, N. J.
149		Blow-off pipe failed			Connon Floral Co.	Greenhouse	W'bst'r Gr'v's, Mo.
150	20	Section of heating boiler cracked			Estate of Stephen Blaney	Office Bldg.	Salem, Mass.
151		Sections of heating boiler cracked			County of Warren	Almshouse	Monmouth, Ill.
152		Sections of heating boiler cracked			Barlum Land Co.	Hotel & Apts.	Detroit, Mich.
153	21	Three sections heating boiler cracked			Mrs. A. R. Carter	Apt. House	Louisville, Ky.
154	22	Sections of heating boiler cracked			The Metal Products Co.	Machine Shop	New Haven, Conn.
155		Tube burst		1	Lincoln Paper Mill	Paper Mill	Elkhart, Ind.
156		Tube ruptured			Oneida Craft, Inc.	Furniture Fact'y	Oneida, N. Y.
157	23	Tube failed			Parker-Young Co.	Paper Mill	Lincoln, N. H.
158	24	Tube ruptured			Hudson Coal Co.	Coal Mine	Scranton, Pa.
159		Five sections heating boiler cracked			Perkins-Campbell Co.	Leather Goods	Cincinnati, Ohio
160	25	Two sections heating boiler cracked			Maryland Flint Co.	Garage	Baltimore, Md.
161		Section of heating boiler cracked			Contaras Bros. & Perakos	Theatre	New Britain, Ct.
162	26	Section of heating boiler cracked			Hanos, Demos & Kaldelis	Mercantile Bldg.	New Britain, Ct.
163		Sections of heating boiler cracked			Sam Hamburg, Jr.	Residence	St. Louis, Mo.
164		Fitting on return line ruptured			Western Tablet & Stationery Co.	Paper Supplies	St. Joseph, Mo.
165		Boiler ruptured			City of Mayville	Power Plant	Mayville, N. D.
166	27	Four sections heating boiler cracked			Lippman Schnurmacher	Garage	New York, N. Y.
167		Two sections heating boiler cracked			East St. Garage	Dwelling House	Chic'pee F'lls, Mass.
168		Sections of heating boiler cracked			Lincoln Theatre	Theatre	Chicago, Ill.
169		Section of heating boiler cracked			I. H. Bernstine	Garage	Chicago, Ill.

MONTH OF FEBRUARY, 1926 (Continued).

170		Water-column pipe ruptured			Little Rock Laundry	Laundry	Little Rock, Ark.
171	28	Four sections heating boiler cracked			County of Jackson	County Institution	Independence, Mo.
172		Tube ruptured			Detroit City Gas Co.	Gas Plant	Detroit, Mich.

MONTH OF MARCH, 1926.

173	1	Water supply pressure tank exploded	1		Jewell Poultry Farm	Farm House	Vineland, N. J.
174		Sections of heating boiler cracked			A. B. Harmon	Tobacco Wareh'se	Suffield, Conn.
175		Section of heating boiler cracked			Maine & N.H. Theater Co., Inc.	Theater	Concord, N. H.
176	2	Valve blew off of locomotive		1	So. Pacific R. R. Co.	Railroad	San Antonio, Tex
177		Steam pipe exploded		2	American Nut & Bolt Mfg. Co.	Factory	Philadelphia, Pa.
178		Fitting in steam main ruptured			General Hospital	Hospital	Syracuse, N. Y.
179		Manifold and 13 sections of heating boiler cracked			Binghamton Theater Co. Inc.	Theater	Binghamton, N. Y.
180		Two sections heating boiler cracked			Rose Dupler	Apt. House	Denver, Colorado
181		Section of heating boiler cracked			The Morris Van Buren Realty Co.	Apt. House	New York, N. Y.
182		Boiler exploded			W. M. Bainbridge	Residence	Rushville, Ind.
183	3	Boiler exploded			T. W. Riley Farm	Greenhouse	Germanville, Pa.
184	5	Boiler of locomotive exploded		2	New York Central R. R. Co.	Railroad	Watertown, N. Y.
185		Section of heating boiler cracked			L. B. Lorimer Co.	Service Station	Providence, R. I.
186		Section of heating boiler cracked			Peoples Outfitting Co.	Store	Toledo, Ohio
187	6	Tube ruptured			Packard Motor Car Co.	Auto Factory	Detroit, Mich.
188		Blow-off pipe ruptured			Daniels & Fisher Store Co.	Dept. Store	Denver, Colo.
189		Five sections heating boiler cracked			Loew's, Inc.	Theater	Brooklyn, N. Y.
190	7	Section of heating boiler cracked		1	First M. E. Church Society	Church	Holyoke, Mass.
191		Three sections heating boiler cracked			Harris Perilstein	Store	Philadelphia, Pa.
192	8	Boiler exploded			Walker's Garage	Garage	Oshawa, Ontario
193		Boiler exploded	5	3	E. H. Matthews	Sawmill	Melfa, Va.
194		Blow-off pipe failed		1	Boaz Barrel Co.	Barrell Plant	Palatka, Fla.
195		Section of hot water supply heater cracked			Harry Resnick	Apt. House	Hartford, Conn.
196		Four sections heating boiler cracked			Geller Co., Inc.	Theater	New York, N. Y.
197	9	Section of heating boiler cracked			Adams Sales Co.	Garage	Kendallville, Ind.
198		Section of heating boiler cracked			Chevrolet Motor Co.	Auto Factory	Detroit, Michigan
199		Three sections heating boiler cracked			F. W. Baesman	Dancing Academy	Portsmouth, O.
200		Four sections heating boiler cracked			Buhl Land Co.	Office Bldg.	Detroit, Michigan

MONTH OF MARCH, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
201	10	Tube ruptured			Pittsburgh Plate Glass Co.	Glass Factory	Creighton, Pa.
202	11	Four sections heating boiler cracked			K. R. H. Amusement Corp.	Theater	Richm'd Hill, N. Y.
203		Section of heating boiler cracked			Hudson View Construction Co.	Apt. House	New York, N. Y.
204		Section of hot water supply heater cracked			Klion Holding Corp.	Apt. House	New York, N. Y.
205	12	Boiler exploded		1	Jahncke Navigation Co.	Office Bldg.	New Orleans, La.
206		Five headers cracked			Campbell Soup Co.	Preserving Plant	Camden, N. J.
207	13	Two sections heating boiler cracked			Loews, Inc.	Theater	New York, N. Y.
208		Sections of heating boiler cracked			Tri State Motor Corp.	Garage	Evansville, Ind.
209	14	Section of heating boiler cracked			J. Abelio & N Lavin	Restaurant	Chicago, Ill.
210		Section of heating boiler cracked			Board of Education	School	Minneapolis, Kan.
211		Section of heating boiler cracked			Burlington Graded Schools	School	Burlington, N. C.
212	15	Heating boiler exploded			Rosenhayn School	School	Bridgeton, Pa.
213		Four sections heating boiler cracked			H. S. B. Berg	Store	Ripley, Tenn.
214		Five sections heating boiler cracked			C. A. Sanderson	Apt. House	Tulsa, Okla.
215		Two sections heating boiler cracked			Varner Co.	Store	San Antonio, Tex.
216		Two sections hot water supply heater cracked			Emby Realty & Holding Co	Apt. House	Brooklyn, N. Y.
217		Section of heating boiler cracked			L. W. Besse & G. E. Bryant	Garage	Springfield, Mass.
218		Section of heating boiler cracked			Orchard Paper Co.	Paper Mill	St. Louis, Mo.
219		Section of heating boiler cracked			Air Reduction Co., Inc.	Chemical Plant	West Allis, Wis.
220		Section of heating boiler cracked			G. F. Heublein	Offices & Stores	Hartford, Conn.
221	16	Three sections heating boiler cracked			H. A. Metz	Factory	New York, N. Y.
222		Tube ruptured			Mac Sim Bar Paper Co.	Paper Mill	Otsego, N. Y.
223	17	Boiler of locomotive exploded	1		Missouri Pacific R. R. Co.	Railroad	Jerome, Ark.
224		Boiler exploded	1	4	P. G. Gwin	Sawmill	Summit, Ga.
225		Boiler exploded	1		Gulf Refining Co.	Oil Well	Smackover, Ark.
226		Door strap on steam twist-setting tank failed			Klots Throwing Co., Inc.	Silk Mill	N'w Bedf'rd, Mass.
227		Section of heating boiler cracked			Salvation Army	Children's Home	Greenville, S. C.
228	17	Section of heating boiler cracked			Zarther & William	Apts. & Store	Boston, Mass.
229	18	Boiler failed			A. Rubin	Filling Station	Charlottesville, Va.
230		Valve ruptured			Florida Casket Co.	Casket Factory	Jacksonville, Fla.

231		Sections of heating boiler cracked			Ferdinand N. Monjo	Apt. House	New York, N. Y.
232		Six sections of heating boiler cracked			Berger Levy Co., Inc.	Glass Grinding	Brooklyn, N. Y.
233		Sections of heating boiler cracked			Ferrigo & Perrone	Apt. House	Hartford, Conn.
234	19	Section of heating boiler cracked			J. Lyon & Sons	Mercantile	Hartford, Conn.
235		Blow-off pipe failed			Muffets Corp.	Mfg. Foodstuff	Depew, N. Y.
236		Boiler ruptured			City of Mayville	Light, Heat Plant	Mayville, N. D.
237	20	Nine sections heating boiler cracked			Protestant Orphan Home	Orphans' Home	Pittsburgh, Pa.
238		Section of heating boiler cracked			Northwood Indep. School	School	Northwood, Iowa
239		Section of heating boiler cracked			City of Utica	School	Utica, N. Y.
240		Boiler exploded			Brooklyn Union Gas Co.	Pumping Station	New York, N. Y.
241	22	Pressing machine boiler exploded		1	Stewart Pressing Shop	Pressing Shop	Sylacauga, Ga.
242		Blow-off pipe ruptured			Hermitage Laundry Co.	Laundry	Nashville, Tenn.
243	23	Two sections heating boiler cracked			Samco Realty Co.	Office Bldg.	Philadelphia, Pa.
244	24	Four sections heating boiler cracked			Meriden Y. M. C. A.	Y. M. C. A. Bldg.	Meriden, Conn.
245		Sections of heating boiler cracked			J. Kaplan	Garage	Omaha, Neb.
246	24	Tube ruptured			Consolidated Paper Co.	Paper Mill	Monroe, Mich.
247		Boiler exploded		1	J. E. McCarroll	Farm	Poplar Bluff, Mo.
248	25	Main steam pipe ruptured		1	Forest Furniture Co.	Furniture Factory	N.Wilk'sb'ro, N. C.
249		Section of hot water heater cracked			C. C. Stroeck	Hotel & Garage	San Antonio, Tex.
250		Section of heating boiler cracked			Morris Tartikoff	Apt. House	Brooklyn, N. Y.
251		Section of heating boiler cracked			Citizens Bank of Oscela	Bank Bldg.	Oscela, Ark.
252		Four sections heating boiler cracked			Colt-Stewart Co., Inc.	Service Station	New York, N. Y.
253	26	Valve ruptured			Wisconsin Chair Co.	Chair Factory	Pt. Wash'gt'n, Wis.
254		Boiler exploded			Eighty-seven 42d St.	Dwelling house	Astoria, N. Y.
255	27	Carbonator exploded			Cowgill's Drug Store	Drug Store	Hickman, Ky.
256		Header cracked			Marmon Motor Car Co.	Auto Factory	Indianapolis, Ind.
257		Section of heating boiler cracked			Traub, Gaberman & Berman	Offices & Stores	Hartford, Conn.
258		Boiler bulged and ruptured			Purell Cotton Oil Co.	Oil Mill	Purell, Okla.
259		Boiler of locomotive ruptured			Calhoun Sawmill Co.	Sawmill	Lone Star, S. C.
260	28	Boiler exploded			Blessed Sacrement Parish	Dwelling House	N'w Roch'lle, N. Y
261		Section of heating boiler cracked			A. & L. Sablosky	Theater & Apts.	Norristown, Pa.
262		Section of heating boiler cracked			S. Stovin & A. L. Starin	Office Bldg.	N. Haven, Conn.
263	29	Section of heating boiler cracked			School Dist. No. 1, Laramie Co.	School	Cheyenne, Wyo.
264		Section of heating boiler cracked			Edw. E. Saunier	Garage	Worcester, Mass.
265	30	Hot water tank exploded			Worcester Square & Compass Club	Club House	Worcester, Mass.
266		Tube ruptured		1	American Woolen Co.	Woolen Mill	Lawrence, Mass.
267		Header cracked			Gardner Governor Co.	Iron Works	Quincy, Ill.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, DECEMBER 31, 1925

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks		$699,859.61
Real Estate		271,757.16
Mortgage and collateral loans		1,650,188.00
Bonds and stocks		11,233,196.67
Premiums in course of collection		1,341,102.96
Interest Accrued		141,983.25
Total Assets		15,338,087.65

LIABILITIES

Reserved for unearned premiums		6,433,164.02
Reserve for losses		283,273.98
Reserve for taxes and other contingencies		707,384.81
Capital Stock	2,500,000.00	
Surplus over all liabilities	5,414,264.84	
Surplus to Policyholders, ...		**$7,914,264.84**
Total Liabilities		15,338,087.65

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WM. R. C. CORSON, Vice-President and Treasurer.
E. SIDNEY BERRY, Second Vice-President.
LOUIS F. MIDDLEBROOK, Secretary.
J. J. GRAHAM, Assistant Secretary.
HALSEY STEVENS, Assistant Secretary.
C. EDGAR BLAKE, Assistant Treasurer.
SHERWOOD F. JETER, Chief Engineer.
KENNETH A. REED, Electrical Engineer.
HARRY E. DART, Supt. Engineering Dept.

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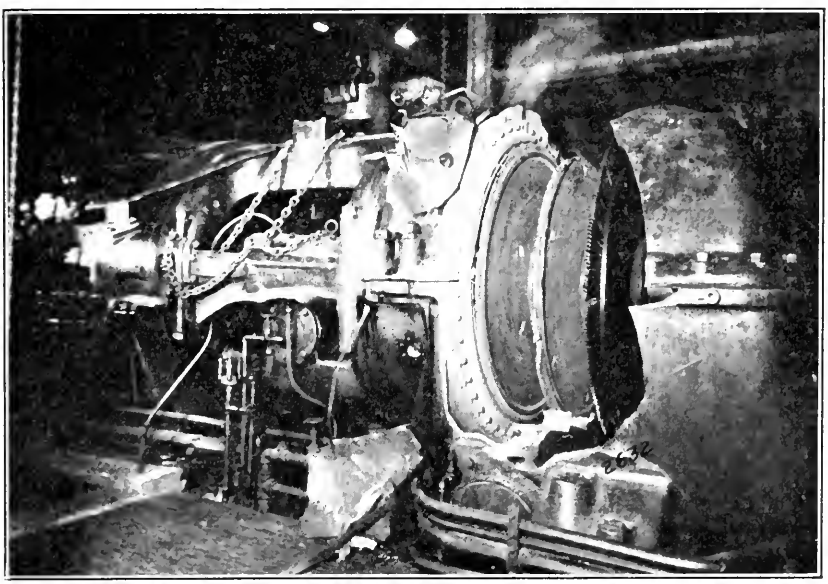
The Locomotive

Devoted to Power Plant Protection

Published Quarterly

Vol. XXXVI HARTFORD, CONN., APRIL, 1927. No. 6.



Steam Turbine Explosion at Chillicothe, Ohio.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Steam Turbine Explosion at Chillicothe, Ohio.

THE disruption of a disk in the third stage on the rotor of a 3,000 kw. turbine Friday morning, August 20th, 1926, at the plant of the Mead Pulp and Paper Company, Chillicothe, Ohio, resulted in a property loss of $43,000 not counting the use and occupancy loss. Two men were injured, but fortunately their injuries were not serious despite the fact that one of the men at the time of the accident was standing beside the machine that exploded. A view of the turbine after the explosion is shown on the front cover.

The property damage was heavy but was confined almost entirely to the turbo-generator unit itself. The steam end of the unit was a complete loss, and in addition considerable damage was done to the electric generator. The bell end of the generator casing was cracked, the shaft sprung, and the field winding damaged to such extent that it eventually had to be rewound. About three hundred condenser tubes were destroyed by pieces of metal falling into the condenser, and a 20 inch expansion joint for the extraction connection of the turbine and a 48 inch expansion joint for the exhaust connection were destroyed.

The ruptured disk separated into three pieces in addition to the portion that remained on the shaft. One piece that flew off could not be located, and another piece was found beside the machine. The third piece, weighing 117 lbs., went out through the roof of the turbine room. It made a big hole in the roof, partly wrecked a roof truss, and came down through the roof of the residence of a prominent physician approximately one half mile away, passed through the attic floor and a second story bedroom, and came to rest on an expensive davenport close to a grand piano in a music room on the first floor. Besides damage done to the building there was considerable damage to the Doctor's costly furniture. His loss was about $2,500.

The piece of the wheel that traveled this distance was heard in its flight by a number of people in the neighborhood. They all agree that it made a noise very similar to that of an airplane, so much so that they were sure an airplane had struck the house.

Nothing unusual had been observed in the operation of the machine just prior to the accident. It had been in continuous operation for several days, carrying little more than one half its rated load. Some difficulty had previously been experienced due to vibration such that the machine was not allowed to carry its full load, and arrangements had been made to have an inspection by a factory representative the following week-end. The inspector arrived the afternoon of the day of the accident in accordance with previous arrangements and without knowledge of the accident.

The failure occurred just after the operating engineer had made an entry in the log and had returned to the turbine, where he was standing performing some minor duty. He was slightly injured but retained his presence of mind. He immediately ran around to the throttle valve and shut off the steam. It later appeared, however, that this had been done by the automatic stop which was caused to operate by a piece of the disk striking it. Practically no steam escaped into the engine room.

The HARTFORD Company paid $49,500 for loss caused by this accident.

Steam Jacketed Kettles.*

By J. P. MORRISON, Chief Inspector, Chicago Department

ONE identified with The Hartford Steam Boiler Inspection and Insurance Company derives great pleasure from attending a meeting of this kind, for we have been engaged in "safety first" work for something over sixty years. In fact, I am sure we may confidently say that we were the pioneers in that field. Our first policy of insurance, issued about sixty years ago, and subsequent policies carry the provision that our inspectors have reasonable access to the boiler, steam jacketed kettle, or other insured object, for the purpose of making inspection, to prevent loss of life, injury to persons, and damage to property.

When the inspection work was inaugurated, the steam boiler was looked upon as the source of energy most likely to get beyond control and wreck the surrounding property, but as industries developed, and changing living conditions resulted in the establishment of immense food preparing plants in which the old fashioned preserving kettle, which the housewife had used on the kitchen range, was replaced by vessels of much greater capacity, using steam instead of the direct action of the fire as the heating element, the safety of such equipment naturally became one which concerned not only the owner of the establishment, but the public in general, as the explosion of a jacketed kettle or rendering tank was quite likely to be disastrous.

The things having a direct influence on the safety of steam jacketed kettles, retorts, rendering tanks, and pressure vessels of most

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*A paper presented before a meeting of the Food Section of the National Safety Council at Detroit, Michigan, October 26, 1926.

every description, may be grouped under the classification of material, design, construction, installation and operation.

The material should be suitable for the purpose intended. Many of the acids and gases which result from food preparing processes have a rapidly corrosive effect upon iron and iron alloys, while they may affect to a less extent such material as copper and aluminum. On the other hand, the vessel of copper and aluminum may not safely withstand the pressure which could be carried upon a similar vessel constructed of steel.

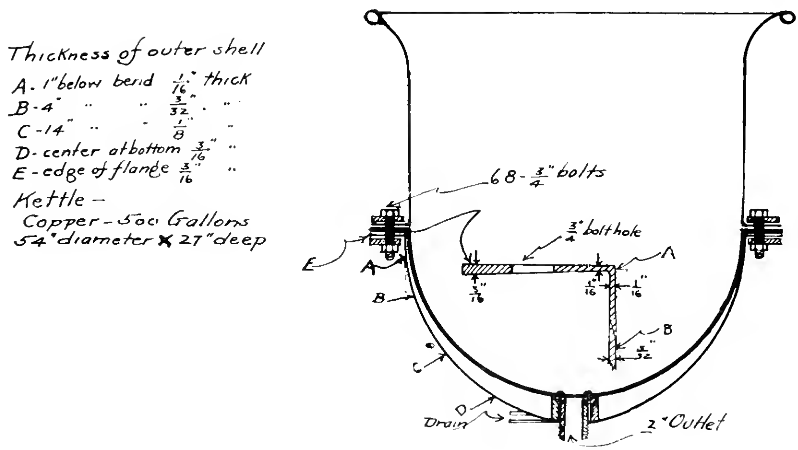


FIG. 1.

Assuming the material and design of the vessel is all that it should be, the methods of construction employed by the manufacturer may be such that the vessel is irreparably damaged, and does not possess a sufficient margin of safety when it reaches the purchaser. Such imperfections may be so concealed by other parts of the structure that they cannot be detected until failure takes place. A means of avoiding methods of that kind is to provide in the specifications for rigid shop inspection by an expert representing the purchaser. We frequently encounter the excuse — "That's good enough," when material or workmanship is criticised by the shop inspector. I know of nothing which will undermine and destroy the workman's judgment more rapidly. The man who is continuously being satisfied with inferior goods because it is "good enough," soon loses the power to judge and appreciate perfect work.

You will recognize this slide (Fig. 1) as representing a hemispherical, jacketed, copper kettle, such as is used in the majority of food preserving plants. The outside shell of the jacketed section is exposed to stresses tending to pull the copper sheet apart, while the inside shell is subjected to collapsing stresses, which copper, as a material, is poorly equipped to resist. The small cross section illustrated gives an idea of the manner in which the material was stretched during the process of manufacture. This reduction in thickness could not be detected after the parts were assembled, so the vessel continued in operation without its weakness being suspected, until it failed quite violently, causing the deaths of two men. The manufacturer of such equipment should know if his finished product possesses but one third the thickness and one third the strength the material had before fabrication was commenced.

We encounter a great variety of methods of connecting up food cooking equipment. In some cases there is a safety valve on one steam line leading to the kettle although there may be two or more such steam lines without any pressure regulating device. Again, the safety valve intended to protect the vessel from an overpressure may be located directly on the vessel, which, in the case of rendering tanks and objects used in kindred service, is prohibited, as the contents of the tank are quite likely to obstruct the safety valve if it has occasion to operate, so future operations will be seriously interfered with, if not absolutely prevented.

The food preparing plant should be equipped with a sufficient number of steam headers so that each vessel of a certain pressure classification may be connected to the header carrying that pressure, and the steam header should be provided with a stop valve, regulating valve, safety valve and pressure gauges of sufficient capacity to meet the requirements of all of the vessels connected to it. A jacketed kettle intended for but twenty pounds pressure should not be connected to a steam line carrying eighty or one hundred pounds pressure — with the thought that the attendant will regulate the steam flowing to the jacketed kettle with such precision that the twenty pounds pressure will not be exceeded — unless the branch line leading from the higher pressure header to the lower pressure object is equipped with the proper safety devices, consisting of a stop valve, pressure regulating valve, safety valve and steam gauge.

In our inspection work we are frequently confronted with the statement that a certain condition which has been criticised has existed for weeks, or months, or years, and an accident has not occurred. If such reasoning is carried to its logical conclusion, we might be just as sure that we will never die because we never have. I was impressed with a news item under a Washington, D. C., date line, which appeared in the daily press recently. A blacksmith — a horse shoer — is said to have had twenty-five years' experience at his trade, and during that time is estimated to have put on one hundred thousand horse shoes, which would correspond to shoeing three horses as an average day's work. He had been quite fortunate, and had never suffered injury. However, a few days preceding the date of the news item, the horse shoer entered his chicken yard. His Plymouth Rock rooster jumped up and kicked him. The spur entered the knee between the joint and the knee cap. The blacksmith is on crutches, with the probability of being a cripple for life. So do not let anyone tell you that because an undesirable condition has existed for a number of years, it should not be remedied.

There seems to be abroad in the land the idea that steam at eighty pounds pressure contains twice as much heat, and will do twice as much work in one half the time, as will steam at forty pounds pressure. So the plant superintendent, anxious to increase production and reduce production costs, is inclined to carry a higher pressure on the jacketed kettle than that for which it was intended. I have in mind the chef of a large kitchen which was equipped with quite a variety of food cooking vessels upon which one hundred pounds pressure was carried, although the margin of safety required by good practice would limit the pressure to forty pounds. In fact, one of the kettles was tested to disruption, and failed when the hydrostatic pressure exceeded one hundred pounds but slightly. The chef would not agree to a reduction in pressure, but when a pressure gauge was so adjusted that it traveled from zero to one hundred pounds while the pressure was increasing from zero to forty pounds, and the regulating devices were set to control the pressure at forty pounds, the chef was entirely satisfied. He could not tell the difference between forty pounds and one hundred pounds by results, but depended entirely upon the pressure gauge, which in this case had been purposely calibrated to deceive him.

Before considering seriously any plan to exceed the safe pressure on a jacketed kettle, tank or retort, try setting the pressure gauge a few pounds ahead, and see if the results are just as satisfactory. The increase in pressure from fifty pounds to one hundred pounds increases the stress in the material one hundred per cent and reduces the margin of safety by fifty percent, while the heat content of the steam at one hundred pounds pressure is but approximately one per cent greater than of steam at fifty pounds pressure. Just by way of emphasizing how little thought is given to even primary safety requirements by some people operating pressure vessels, I would mention a recent experience of one of our Michigan inspectors. He visited a food preparing plant. As a matter of fact, it was a cheese factory. He was to make the preliminary inspection of a boiler which had previously been uninspected and uninsured. Aside from a number of defects resulting from operating conditions, the boiler appeared to be an average risk. But the inspector could not locate the safety valve. Upon inquiring

Fig. 2.

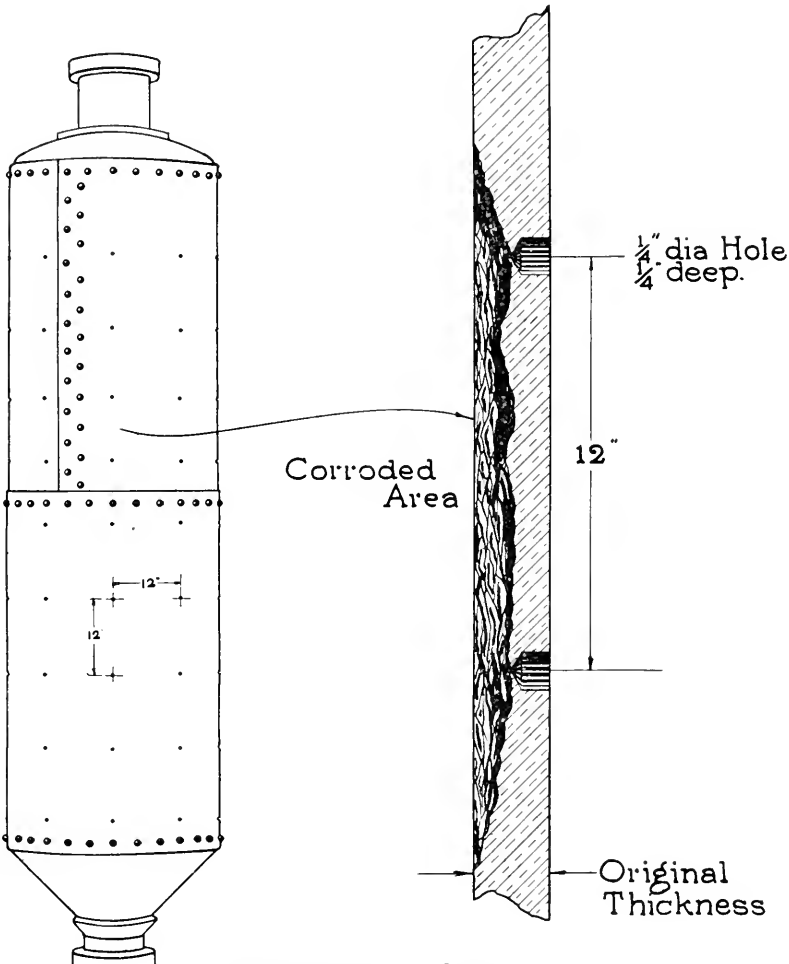
of the engineer he learned that the factory inspector had visited the premises but a short time before and that during the visit the safety valve of the boiler operated automatically. When it did so, a considerable cloud of soot was discharged from the boiler room into the cheese making department. Quite naturally the factory inspector objected to the preparation of food in just that way. Those in charge interpreted his objection as being directed at the safety valve, and proceeded to remove the offending member just as soon as the boiler could be taken from service. They explained to our inspector that the Factory Inspection Laws of Michigan do not permit the use of a safety valve on a boiler in a cheese factory. It had apparently not occurred to them that the safety valve could be adjusted to discharge in some other direction.

"Familiarity breeds contempt." The truth of this old saying appears to us quite frequently. The man who has observed a certain pressure on a certain vessel daily for a number of years soon becomes of the opinion that everything is safe and serene, and that there is no cause for uneasiness. Forty or fifty pounds pressure is quite low when compared to the twelve or thirteen hundred pounds pressure now being carried in some of the central stations, but those boilers and turbine casings subjected to that pressure possess a relatively larger margin of safety than does the ordinary jacketed kettle or rendering tank carrying forty pounds. This slide (Fig. 2) pictures the result of the explosion of a rendering tank when carrying forty pounds pressure. The failure resulted in damaging a considerable part of the plant, as well as in the death of one man, who was decapitated, and the serious injury of another. The investigation which followed developed the fact that the rendering tanks in the establishment had been examined thoroughly during the month of June. Several of them were found to be so badly corroded they were considered unserviceable, and accordingly were disconnected from the steam header. The tank which exploded, and the one adjoining it, were criticised, but it was estimated they could be continued in service until the first of the year, a term of possibly five or six months. The inspector understood that those tanks which were immediately removed from service would be replaced with new ones, but such was not the case. The balance of the tanks were continued in service approximately twenty-four hours a day, so the deterioration was twice as rapid as the inspector estimated it would be. The explosion occurred on November 13.

It is logical that some means be devised to detect the deterioration which takes place in cooking vessels so plans can be perfected for replacing the old ones with new before the point of failure is reached.

The next slide (Fig. 3) is intended to represent a vertical rendering tank with which our packing houses are equipped by the thousand. In the sectional view you will note the manner in which the internal surface has been corroded until the tell-tale holes have been reached, resulting in slight leakage, to be taken as a warning of the decrease in thickness which has taken place. Under ordinary operating conditions, the tell-tale hole may be closed by a wooden plug until the "cook" is completed, and after the tank has been emptied, may be permanently closed by the use of a one-quarter inch rivet driven cold.

These tell-tale holes are one-quarter inch in diameter, and drilled one-quarter inch deep from the outer surface of the shell of the average size vessel, say 72 inches in diameter, and are located opposite the region of greatest wear, which occurs on the inside surface of the tank. This plan, with certain modifications, can be applied to pressure vessels of all descriptions where the operation is likely to cause a reduction in thickness with corresponding weakening of the vessel. The operation of a pressure vessel, such as a jacketed kettle, rendering tank, retort or compressed air tank, may not in every case present a



RENDERING TANK

FIG. 3.

hazard equal to that encountered with the operation of a steam boiler, for the steam boiler has temperature stresses and is subjected to the changes which result from the use of impure feed water; but the cooking vessel is subjected to some temperature stresses, may be affected by acids and gases, and, in general, is operated by men having little or no mechanical training, undependable in an emergency, and properly enthusiastic in catering to the needs of the inner man. So I would urge that some competent authority be consulted when new equipment is purchased, and that you have a survey made of that now in use to determine if life and property are being needlessly exposed to danger.

Failure of a Water Wheel Generator.

THE accompanying picture shows some of the damage resulting from the failure of a 937 kw. generator at the plant of the Keith Paper Company, Turner's Falls, Mass., on June 11, 1926. The property loss amounted to $2,700, and the use and occupancy loss exceeded $16,300. No one was injured.

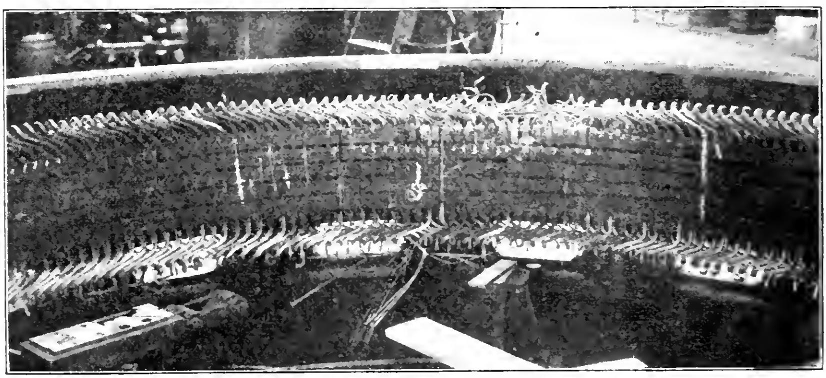


FIG. 1.

The accident occurred about 12:10 A. M. when this hydraulic turbo-generator and a steam turbo-generator were carrying jointly a load of 1200 kw. The initial trouble was a short circuit or ground in the stator winding which resulted in the destruction of approximately 47 coils. Fire resulted, and it was necessary to call the city fire department to extinguish it. As a result of the fire, all of the stator coils were ruined and a complete new stator winding was required. This rewinding was estimated to take six weeks time. Through inability to use this machine production at the mill was curtailed, other generating units not being of sufficient capacity to carry the total load.

The assured had "Hartford Steam Boiler" Electrical Machinery insurance, direct and use and occupancy, on the loss from the burning out and other electrical damage of this machine, in addition to fire insurance on the loss from the ensuing fire.

A Few Notable Discoveries by Hartford Inspectors.

IN response to an application for insurance on twelve water tube boilers in a traction company's plant, an inspector was detailed to make the first internal inspection. The boilers were of the two-drum horizontal type, and nothing unusual was observed in the first drum entered. Upon examining the second drum of this boiler, a slight rust streak was observed in the coating of scale along the turn of the flange at the bottom of the rear head. This led the inspector to suspect the presence of a crack.

The scale was removed and some light grooving was found to extend for about one third of the circumference of the head. Feeling confident that cracks existed at the bottom of the grooving, the inspector applied the alcohol and chalk test and found faint indications of their presence. The following day several slots ¼ inch deep were cut across the external surface of the turn of the flange and a hydrostatic test of 175 lbs. was applied, but no leaks were visible. Feeling, in spite of this test, that the head was dangerously cracked, the inspector advised the assured to replace it with a new one. The chief engineer, after some discussion, finally decided to have this done.

While the boiler makers were driving out the head after the rivets had been removed, the crack opened up for a distance of 76 inches around the flange of the head so that the defect was easily visible. The extent of the failure is clearly shown in Fig. 1, but it should be explained that the flange was struck a few blows with a sledge before the photographic exposure was made in order that the cracks would be visible in the picture. Later, with a few blows of the sledge, the flange was broken off around approximately one half of the circumference of the head, and the cracks were found to have penetrated half way through the plate for a good part of this distance. The fracture outside of the cracks had the usual crystalline cast iron appearance so familiar to fatigue failures.

Following this alarming discovery, the other heads in this boiler and another one of the same make and age were carefully examined, and as several of them showed indications of the presence of cracks, it was decided to replace all of the heads. Subsequent examination revealed one of these heads to be in an even worse condition than the one first discovered. Although the cracks extended around only 52 inches of the circumference, yet in several places they penetrated to within 1/16 inch of the full thickness of the plate. Three other heads had cracks extending for 32, 36 and 52 inches, respectively, in a circumferential direction. The remaining three heads, while showing slight grooving, seemed to be free from cracks. These drums were 48 inches in diameter, and previous to HARTFORD inspection, the boilers had been operated between 185 and 200 lbs. pressure although they were designed for but 175 lbs.

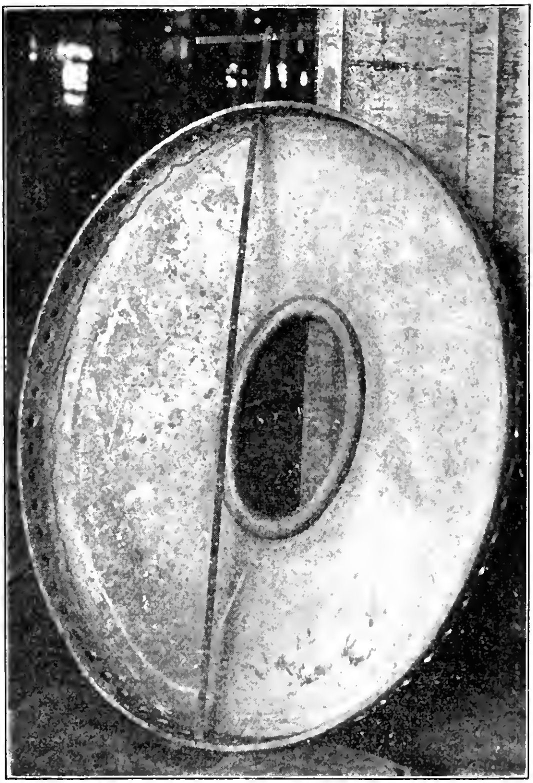


FIG. 1.

Upon another occasion an inspector called at a large central station for the purpose of taking data on such of the boilers as were available, at this was a new risk. These were water tube boilers of the inclined, bent tube type, and two of them were found available for internal inspection. While examining the mud drums, the inspector noticed some very fine lines which appeared to be hair line cracks in the front row of tube hole ligaments. The boilers were headed up and a hydrostatic test pressure applied, although the chief engineer jokingly told the inspector that the heat must be affecting him when he suggested the presence of cracks. The test resulted in the exposure of seven cracked ligaments in the mud drum of one boiler and five cracked ligaments in the other. The boilers were again emptied and the inside surface carefully scraped and re-examined. It was found that these hair line cracks extended almost the full length of the drum between the front row of tubes and the longitudinal seam. They varied in length between

½ inch and 4 inches, and the distance from the end of one crack to the beginning of the next varied between ½ inch and 3 inches with the majority of these intervals less than 1 inch. These boilers were well on their way to a most violent explosion, that is, such an accident as results where the shell fails along a longitudinal line. The defective drums were immediately discarded.

Another notable discovery of the approaching failure of an inclined, bent tube type of water tube boiler was made by an inspector under quite difficult conditions. The front side of the mud drum was inaccessible because of the close proximity of the bridge wall and the flooded condition of the pit. However, the inspector thought he saw signs of leakage and corrosion along the front side of the drum. He again entered the furnace and removed a few bricks from the bridge wall, but this was not very satisfactory. A request was made to have a sufficient amount of the bridge wall removed to expose the seam for its entire length and to then prepare the boiler for a hydrostatic test. Two days later the inspector returned and made the test, with the result that leakage was noted at several points along the seam. It was also observed that a majority of the rivet heads in this seam were almost completely wasted away. The rivets were removed and the rivet holes examined with a magnifying glass for cracks. Although no cracks were found it was easily seen that the plates were seriously reduced in thickness by corrosion. The plates were drilled and found to have wasted to a scant 7/32 inch, the orignal thickness having been 3/8 inch. Under the circumstances, the boiler was discontinued from service.

Each of the foregoing incidents happened to a water tube boiler of the type usually found in large modern power plants, but the horizontal return tubular boiler, which is found in so many industrial plants, is still a fertile field for latent defects. In a recent inspection of a lap seam boiler, the inspector had just finished his examination of the head and braces at one end of the boiler and was working along on top of the tubes examining the seams when he noticed an irregular mark showing against the scale. The cause of it was not clear, but after some of the scale had been chipped away, a crack approximately 10 inches long and running parallel to the axis of the drum was uncovered. The crack was just below the seam and immediately above the rivets of the supporting lug, and it was open wide enough to permit the insertion of part of the blade of a sharp pointed knife. The master mechanic of the plant satisfied himself of its presence by merely looking in through the manhole while the inspector held a lamp so as to make the crack visible. Removal of the brick work on the outside of the boiler failed to uncover the crack because it was behind the supporting lug. The boiler, of course, was discontinued from further use.

The portable locomotive firebox type of boiler is one that is usually badly mistreated and neglected, and it is not surprising that an inspector should occasionally discover a latent defect in one of this type. In this instance the inspector happened to be in the vicinity of a boiler that he was scheduled to make an internal examination of on the following day, so he stopped by to make sure that it would be available the next day. Looking over the boiler while it was under pressure, he observed a rust stain on the lagging under the boiler near the smoke box end. Prying open the lagging a little, further signs of leakage were noted. A considerable amount of lagging was then removed and the sheet cleaned, which resulted in the discovery of a longitudinal crack 5 inches long. The boiler was in operation under 115 lbs. pressure and so the inspector recommended that it be removed from service immediately and cooled for further examination. The inspector returned the following day and definitely established the presence of the crack.

The foregoing are merely a few of the numerous dangerous defects in boilers that inspectors are finding every day. Boiler inspection, the pioneer "safety first" movement, is still a vital factor in the saving of human life and of wealth.

Scale in Cast Iron Sectional Boilers.

SCALE is well known as a prolific source of trouble for the operator of power boilers as it usually results in overheating of the plates or tubes. Overheating is just as disastrous, and perhaps more so, to cast iron as to steel, but, fortunately, serious scale is not of frequent occurrence in heating boilers. This is due to the fact that heating boilers operate on a closed system and at low pressure. Hence there is little loss of steam or condensate and an extremely small amount of make-up water is required. Furthermore, water at low pressures is also at a temperature lower than that at which serious deposition of scale takes place. Such are the usual conditions found in connection with heating boilers.

Occasionally, however, an installation is found where there is some modification that is certain to cause trouble. For instance, there may be a return line with a serious leak, and if this leak is near a floor drain or if the water is absorbed by the ground or accumulates in some trench or pit from which it evaporates, the leak may go unnoticed for a long time; or water may be drawn off from the system at frequent intervals for domestic purposes. Water lost from the return lines of a steam system is distilled water, and although hot water drawn directly from the boiler or from the flow main of a hot water system is not distilled, yet it is considerably purer than the fresh feed water. Voiding water from the system requires continual addition of raw water which carries with it all of the natural scale and sludge forming

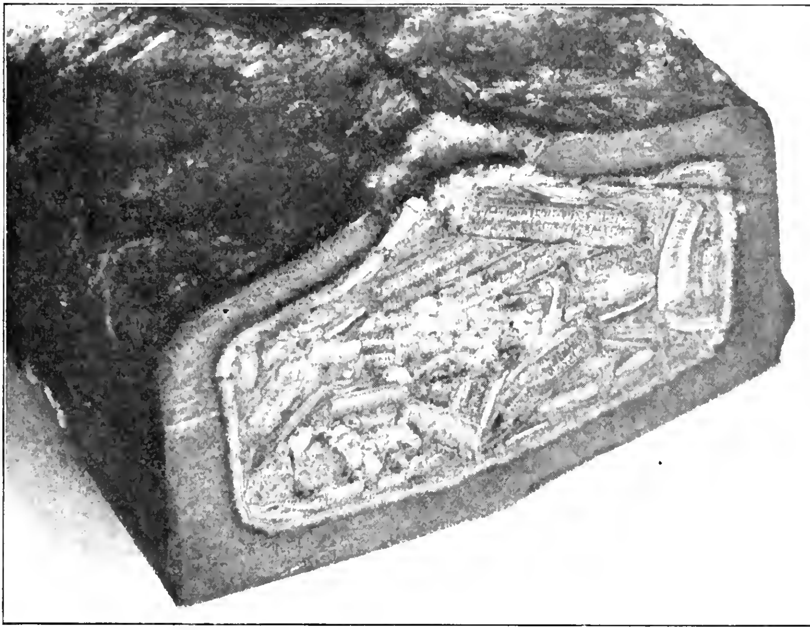


Fig. 1.

materials that may be in it. Operators of heating equipment seldom give this a thought usually because of lack of appreciation of the cause and effect of scale formation.

The accompanying picture shows an extreme case of scale deposit in a sectional cast iron boiler. This boiler had been installed in a restaurant in Columbus, Ohio, for heating purposes, but it had been the practice for some time to draw off water from the system whenever hot water was needed for scrubbing or general cleaning. As a result it was necessary to add raw water at frequent intervals, with the resulting deposition of scale shown. It is remarkable that this deposit could attain such a degree of development before causing trouble.

An Epidemic of Bulged Boilers.

THE accompanying pictures show the progress toward destruction of several boilers under conditions that appeared at first to justify the use of the word "mysterious." The installation consisted of a battery of four horizontal two-drum water tube boilers. One drum ruptured, followed shortly by the rupture of a drum in another boiler. Examination of all of the boilers then revealed that five of the eight drums were badly bulged, as shown in the photographs.

It was quickly realized, of course, that the trouble was the result of overheating due to the peculiar design of the setting of the boilers. The brick arch did not close in on the sides of the drum at about the

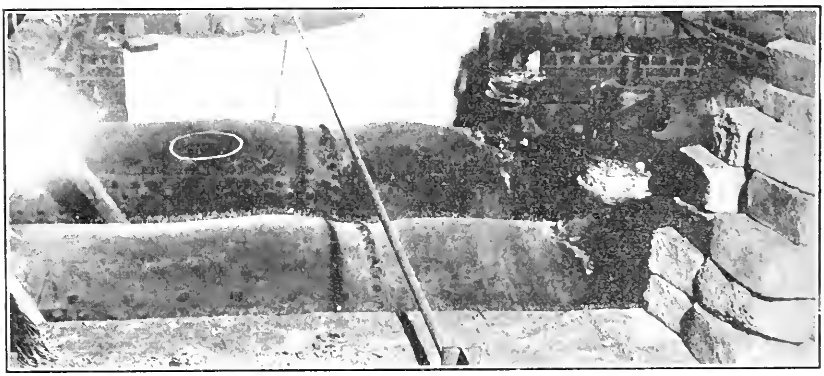


Fig. 1.

lowest safe water level, as customarily is the case, but instead was carried above and suspended entirely clear of the drums, leaving a space of about 12 inches between the tops of the drums and the arch. The hot gases direct from the fire went upward among the tubes of the first pass and then surrounded the drums before going downward in the second pass. This was probably designed to provide drier steam. The heat from the gases in contact with the drums caused overheating of the plates in the steam space of the boilers, as would be expected.

The peculiar feature of this case is that the boilers had been operated for years with this same arrangement and had not given any previous trouble except that a slight bulge had been observed in one drum. This bulge had been carefully watched and had not appeared to grow worse. The rupture of two of the drums in rapid succession then led to the discovery of the bulged condition of the other drums.

Investigation brought out that the stokers on these boilers had been changed shortly before the development of this trouble and the new stokers increased the rate of combustion. This, of course, meant hotter furnace gases and caused overheating of the plates which were not in direct contact with water.

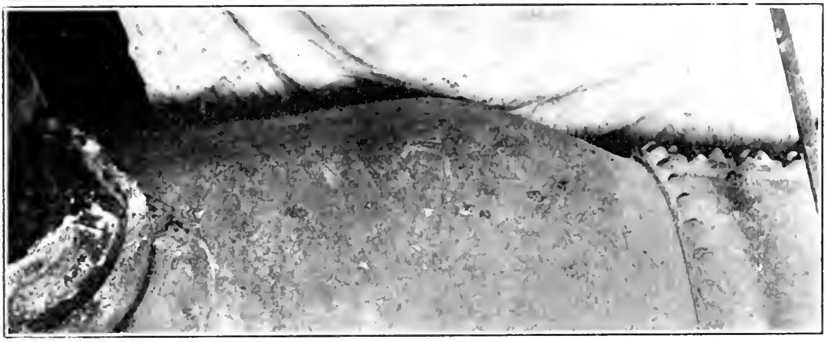


FIG. 2.

The pictures are also of interest from another point of view in that they well illustrate the reinforcing effect of the girth seams of a boiler shell. Although in this case the seams were overheated equally with the immediately adjacent plates, and perhaps even to a greater degree because of the greater mass of metal concentrated here, yet it can be seen that the seams did not yield to the pressure as did the plates.

Hot Water Boiler Explosion.

A HOT water boiler exploded in the basement of the Powers Theatre Building, Grand Rapids, Michigan, on October 18th, 1926, and resulted in the death of one man. Considerable property damage was done to the basement of the building and to a concrete paved arcade beneath which the boiler had been located and through which it was blown, so violent was the force of the blast. The accident was investigated by the State Chief Inspector of Michigan, and in his report to the State Commissioner of Labor he points out the necessity of a water relief valve on all hot water heaters. In this case it appears that the relief valve was of insufficient size, and furthermore was inoperative because the spring had been compressed so that the coils were too close together. This report in full is given below:

"I wish to report that I have made an investigation into the cause of the explosion of a hot water boiler in the basement of the Powers Theatre building at 133 Pearl St., Grand Rapids, Mich., on the morning of October 18, 1926, and find as follows:

"The boiler which failed by the collapse of the furnace of the boiler, killing a man named Michael Wirth, an employee of the building management, said to be ——— Company, was bought from the ——— Company of Chicago by the ——— Company of Grand Rapids, Mich., on January 29th, 1921, and installed by them in the Powers Building.

"The boiler was 29 in. diameter and 40 in. high and had an unstayed furnace 25″ diameter by about 36″ high. All plates were 3/16 inch thick, joints single riveted and lapped. The trade name of the heater was 'No. 30 Tobasco Surface Burning Water Heater,' and was rated as having a capacity for heating 500 gallons of water per hour.

"The valve used for relief of pressure was a Crane 'Snifter' type of relief valve and not a regular safety valve. The failure occurred by the collapse of the furnace sheet of 3/16 inch plate due to excessive pressure.

"A calculation shows that the outer plate or shell would fail at the riveted joint at about 400 pounds, while the furnace would fail at a pressure of about 200 lbs. This pressure depending on how close the furnace was to a true circle. The lap joint, of course, was source of weakness because of the low crushing strength in front of the rivets and inherent deformation due to the lap of plates.

"The relief valve was taken to Detroit and tested and found to be inoperative at a pressure of 400 lbs. It would be impossible for this valve to operate because the coils of the spring were forced together.

"The boiler is built in violation of the A. S. M. E. boiler code which limits plates to not less than ¼ inch for either steam or hot water boilers. See Section IV, H-11 of A. S. M. E. Code relating to low pressure heating boilers.

"The relief valve used was an unsafe type and not approved by the code.

"Section H-44 reads: Water relief valves shall be connected to all hot water boilers. The valve shall be the diaphragm operating type, without guide wings below the seat, set to open at or below the maximum allowable working pressure. No water relief valve shall be smaller than one half inch standard pipe size. The outlets of water relief valves shall have open discharges in plain sight.

"This boiler could not be lawfully sold or used in Michigan because of its thin plates. In any event a pressure over 35 lbs. could not be allowed on such a boiler under engineering practice.

"The immediate cause of the accident was the use of the boiler with a defective and improper relief valve.

"The dead man, Michael Wirth, 69 years old, lived at 716 Sixth St., N. W., Grand Rapids."

Big Engine Goes Out at Power Plant.

WITH a crash and a roar of defiance in its last hour on this earth, the big Atlas engine that pulls the generator at the Power House, slipped a pin last night, pushed the piston through the cylinder head and then died.

The end came unexpectedly while the engineer, Guy Banks was in the boiler room looking after his fires.

The engine had been in poor health for some time and had only recovered from a severe attack of a burnt out bearing suffered a week ago and it was thought that it had fully gotten over its troubles.

According to Banks the accident occurred without warning. All at once he heard an explosion and the roar of escaping steam and immediately the plant was plunged in darkness.

Going into the engine room was out of the question and he was forced to climb to the top of the boiler before he could shut off the steam, which was swiftly getting away from him.

By this time a crowd, which had heard the noise, began to gather and in a few moments the auxiliary engine was started up returning electricity to the lines once more.

Parts of the cylinder were scattered all over the south side of the engine room. The piston, a massive steel rod had been bent, seemingly as easily as a hairpin could be bent and according to those who know, the machine is a total loss.

It was lucky for the engineer that he was absent from the vicinity when the blow up occurred as it most certainly would have killed him or at least dealt him some injuries.

Chairman Abecrombie and Superintendent Jack Treadwell left early this morning for Joplin in an effort to secure another engine immediately. In the meantime they are depending on the little machine to furnish the juice to the town but the people are warned that it also is liable to go up at any minute under the overload. — *The Daily Register,* Siloam Springs, Ark.

Diesel-Electric Ferryboats on the Hudson.

The first electrically operated ferryboats to ply across the Hudson River at New York City went into operation between Twenty-third Street, Manhattan, and Weehawken, N. J. These are the *Governor Moore* and *Charles W. Culkin,* for which Diesel engines generate electric motive power. They are operated by a private company, Electric Ferries, Inc., which hopes to hold its own against the Holland vehicular tunnel now under construction.— *Electrical World.*

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor

HARTFORD, APRIL, 1927.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Company Elects New Officers.

AT a meeting of the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company on February 8th, 1927, several important changes were made in the official staff of the Company with the view of lightening the duties of Charles S. Blake as its head, and with the view, too, of promoting to executive rank several of its personnel who are administering its departments. In accordance with this purpose, the positions of Chairman of the Board of Directors and three additional vice presidents were created and the following officers were elected:

Chairman of the Board of Directors	Charles S. Blake.
President and Treasurer	Wm. R. C. Corson.
Vice President and General Counsel	E. Sidney Berry.
Vice Presidents	Curtiss C. Gardiner.
	John J. Graham.
	Sherwood F. Jeter.
	Dale F. Reese.
Secretary	Louis F. Middlebrook.
Assistant Secretaries	Halsey Stevens.
	Harry E. Dart.
Assistant Treasurer	C. Edgar Blake.

As Chairman of the Board of Directors, Mr. Blake will continue to lead the Company and direct its policies as he has during the past ten years during which, under his administration as president, the Company has enjoyed such a large measure of growth and prosperity. Mr. Blake is now recovering from a long and serious illness and his return to his duties with the Company is looked for at an early date.

WM. R. C. Corson, who becomes president and treasurer of the corporation, has been with The HARTFORD Company since 1907 when he entered its Engineering Department. He has successively held positions of assistant secretary and secretary, and since 1921 has been vice president and treasurer of the Company.

E. Sidney Berry heads the list of vice presidents. Since 1922, as 2nd vice president and general counsel, he has had charge of the Claim and Legal Departments of the corporation and will continue in charge of them.

Curtiss C. Gardiner entered the employ of the Company in 1894 as an office boy in its St. Louis office. Six years later he became the Company's manager in that city, and in 1905 was transferred to be the manager of its New York Department. It has come about as a result of modern conditions that a large proportion of the business of the country is placed in New York and thus the New York Department has attained a position of great importance in the Company's structure. It is, in fact, in conformity with the practice of other insurance companies that the HARTFORD has made its metropolitan manager a vice president.

John J. Graham joined the Company's forces in its Cleveland Department in 1906. Later he was transferred to Pittsburgh as branch manager. In 1917 he came to the Home Office, assuming the duties of superintendent of agencies and in 1922 was elected assistant secretary of the Company. As vice president of the Company he will continue to have charge of business production and general supervision of the Company's field organization.

Sherwood F. Jeter came to the Company as an inspector in 1898. He advanced through positions of increasing responsibility in the Inspection Department and in 1915 was appointed chief engineer. As vice president he will have full charge of the Engineering and Inspection Departments of the Company. Mr. Jeter graduated from the Georgia School of Technology in 1893. He is a member of the American Society of Mechanical Engineers and has been a manager and vice president of that Society. He has continuously served on its Boiler Code Committee since 1913 and has had an important influence in establishing its standards of safe boiler construction now recognized throughout the country. Mr. Jeter is a past president of the Hartford Engineers Club and a member of several other technical associations.

Dale F. Reese comes as a new man to the HARTFORD organization. He was educated at Cornell University, from which he graduated in 1905 with the degree of mechanical engineer. In 1906 he entered the employ of The Ocean Accident and Guarantee Corporation as an assistant underwriter in its Steam Boiler Department. In 1909 he was given charge of the department and in 1918 became superintendent of the Ocean's Engineering Department, in which was combined the Boiler Underwriting and Inspection Department. He leaves this position to come to the HARTFORD where he will aid in developing and extending the underwriting activities of the Company.

Harry E. Dart graduated from the Massachusetts Institute of Technology in the class of 1901. After several years with the engineering firm of Buck and Sheldon of Hartford, in 1913 he was secured by the HARTFORD Company to head its Consulting Engineering Department with the title of superintendent. He has held that title until now though, due to changed conditions, his attention has been given less to engineering and more to underwriting matters, and for the past four years he has had general supervision of the Company's Statistical Department. It is in recognition of his changed responsibility and broader duties that the directors elected him assistant secretary.

Appointments.

Thomas P. Hetu, who has been connected with the Inspection Departments of the Hartford and Philadelphia offices for several years, has been appointed Assistant Chief Inspector at Philadelphia.

James P. Kerrigan, Jr., who has been connected with the Claim Department at the Home Office since 1922, has been appointed Chief Adjuster.

Steam Jacketed Kettles.

"THE hand that rocks the cradle rules the world," is a saying that might have been amended a few years ago to further read, "and also puts up the family preserves, pickles and ketchups, in addition to performing multitudinous duties about the home." But times have changed. The cradle is no longer in fashion. Its rockers have been removed in favor of wheels, perhaps to earlier accustom our children to life in this "nation on wheels;" and the household duties have been greatly lightened by the modern genii of the lamp socket, electricity. The preserving and pickling activities to a large extent have shown a trend toward that ideal set forth by students of our social problems, the removal of the kitchen from the home.

Not many years ago every family owned its large copper preserving kettle, but these are now taking their places in the list of antiques. Conserving fruits and vegetables during the season of plenty for use during the winter is now conducted upon a mammoth scale and to an increasing degree by large commercial kitchens. In the home the cooking was done usually by direct action of the fire, but in the commercial kitchen, steam under pressure is the source of heat. Jacketed kettles are used and the steam is circulated in the space between the inner and outer shells. A steam pressure vessel, however, retains its inherent hazards whether it is located in boiler room or kitchen, and a high standard of safety for these cooking vessels should be maintained at all times. In a paper on this subject printed elsewhere in this issue, J. P. Morrison, Chief Inspector of our Chicago Department, gives able consideration to the problems involved in the use of this type of vessel.

Three Score Years of Boiler Insurance.

IT IS with pleasure that we reprint below a very gracious tribute to the HARTFORD Company that appeared under the above heading in the editorial columns of a recent issue of *Power,* our well known contemporary.

> "Our congratulations to The Hartford Steam Boiler Inspection and Insurance Company which completed in October of this year sixty years of useful existence. The practice, already established in England, of avoiding boiler explosions by inspection was backed up by an indemnity in case of failure and boiler insurance became a fact.
>
> "The Hartford has, however, been much more than an underwriter of losses from boiler explosion. It has led in the establishment of safe practice in design, construction and operation. Its experience and practice are writteen into the codes of today and its requirements are controlling factors in boiler specification. Its inspections are accepted in lieu of those of government officials in most, if not all, of the states where boiler inspection is compulsory. We wish for it many years of continued prosperity."

Summary of Inspectors' Work for 1926.

Number of visits of inspection made (boilers and engines)	267,118
Total number of boilers examined	493,636
Number of boilers inspected internally	181,674
Number of boilers tested by hydrostatic pressure	12,080
Number of boilers found to be uninsurable	1,187
Number of shop boilers inspected	23,560
Number of premises where pipe lines were inspected	22,510
Total number of engines and wheels examined	55,266
Number of uninsurable engines and wheels	194

Summary of Defects Discovered.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale and adhering scale	80,480	3,817
Cases of grooving and internal and external corrosion	45,267	2,372
Cases of defective bracing	1,046	202
Cases of defective staybolting	3,712	769
Settings defective	9,194	837
Fractured plates and heads	3,372	592
Burned plates	3,367	492
Laminated plates	308	40
Cases of defective riveting	1,688	469
Cases of leakage around tubes, and defective tubes or flues	31,822	7,498
Cases of leakage at seams	6,108	480
Water gauges defective	3,679	700
Blow-offs defective	5,236	1,429
Cases of low water	490	205
Safety-valves overloaded or defective	2,934	711
Pressure gauges defective or missing	7,962	643
Miscellaneous defects in boilers	8,133	653
Flywheels found overspeeded	61	24
Cases of cracks found in engine parts and wheels	584	220
Defective governors	356	188
Miscellaneous defects in engines and wheels	56	20
Totals	215,855	22,361

Grand Total of the Inspectors' Work on Boilers from the Time the Company Began Business to January 1, 1927.

Visits of inspection made	6,381,009
Whole number of inspections (both internal and external)	12,583,041
Complete internal inspections	4,883,559
Boilers tested by hydrostatic pressure	445,624
Total number of boilers condemned	35,733
Total number of defects discovered	6,829,924
Total number of dangerous defects discovered	767,411

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF MARCH, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
268		Crown sheet of locomotive collapsed			Ash Grove Lime & Portland Cement Co., Inc.	Cement Plant	Chanute, Kansas
269	31	Section of heating boiler cracked			The Autocall Co	Factory	Shelby, Ohio
270		Section of heating boiler cracked			Avoyelles Parish School	School	Plaucheville, La.

MONTH OF APRIL, 1926.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
271	1	Section of heating boiler cracked			Anthony Symasko	Apt. & Stores	Holyoke, Mass.
272		Three sections heating boiler cracked			Handy Motor Co.	Service Station	Kansas City, Mo.
273		Two sections heating boiler cracked			Central N. Y. Amusement Co.	Theater	Herkimer, N. Y.
274		Fire pot of hot water heater cracked			Bertha Darr	Apt. House	St. Louis, Mo.
275		Section of hot water heater cracked			One Thirty Six 82d St. Corp'n.	Apt. House	New York, N. Y.
276		Section of hot water heater cracked			M. & L. Tartikoff Corp'n.	Apt. House	Brooklyn, N. Y.
277		Section of heating boiler cracked			University of Vermont	College	Burlington, Vt.
278		Section of heating boiler cracked			Old Fellows' Home	Home	Groton, Conn.
279		Section of heating boiler cracked			Morris Tantikoff	Apt. House	Brooklyn, N. Y.
280		Section of heating boiler cracked			Isaac Bernheimer Realty Co.	Office Bldg.	Stillwater, Minn.
281	2	Section of heating boiler cracked			Sowers Mfg. Co.	Foundry	Buffalo, N. Y.
282		Six sections heating boiler cracked			Hayward Realty Trust	Office Bldg.	Boston Mass.
283		Five sections heating boiler cracked			Wyandotte Furniture Co.	Office Bldg.	Kansas City, Mo.
284		Tube ruptured			Scoville Mfg. Co.	Factory	Waterbury, Conn.
285		Boiler bulged and ruptured			Pioneer Pole & Shaft Co.	Factory	Memphis, Tenn.
286		Crown sheet of locomotive failed		1	Southern Railway	Railroad	Bogue Chitto, Ala.
287	3	Boiler exploded			Windsor Hotel	Hotel	P'ghkeepsie, N. Y.
288		Tubes pulled out of drum		1	Jones & Laughlin Steel Co.	Steel Plant	Pittsburgh, Pa.
289		Four sections heating boiler cracked			Carbona Products Co.	Factory	New York, N. Y.
290		Two sections heating boiler cracked			Crebs Hotel Co.	Hotel	St. Louis, Mo.
291	4	Section of hot water heater cracked			B. G. & B. Realty Co.	Apt. House	Brooklyn, N. Y.

MONTH OF APRIL, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
292	5	Boiler exploded			Mrs. Rae Bateman	Residence	Bridgeton, N. J.
293		Section of heating boiler cracked			Academy of the Sacred Heart	School	Hoboken, N. J.
294	6	Boiler ruptured			H. P. Hood & Sons, Inc.	Creamery	Salem, Mass.
295		Tube ruptured			Consolidated Paper Co.	Paper Mill	Monroe, Mich.
296		Tube ruptured			Frost Mfg. Co.	Boiler Works	Galesburg, Ill.
297		Two tubes ruptured			Warren Furniture Co.	Furniture Factory	Warren, Pa.
298	7	Two sections heating boiler cracked			Tri State Motors Co.	Garage	Evansville, Ind.
299		Sections of heating boiler cracked			Public Schools	School	Highl'd Pk, Mich.
300	8	Section of heating boiler cracked			Wagner & Wurtzell, Inc.	Wholesalers	Perth Amboy, N. J.
301		Tube ruptured		1	H. C. Aberle Co.	Textile Mill	Philadelphia, Pa.
302		Main steam pipe ruptured			W. & K. Co.	Worsted Mill	Masonville, R. I.
303	9	Boiler exploded		1	Louis Popick	Tailor Shop	W. N. York, N. J
304		Boiler exploded	3	2	Wm. Newsome	Lumber Mill	Ligon, Ky.
305	10	Two sections heating boiler cracked			Waldorf System, Inc.	Restaurant	Rochester, N. Y.
306		Two sections heating boiler cracked			Sisters of the Good Shepherd	Convent	Louisville, Ky.
307		Section of heating boiler cracked			Art Works Shop	Accessories Shop	Buffalo, N. Y.
308		Section of heating boiler cracked			Edwin A. Boss	Hotel	Algona, Iowa
309	11	Fitting in main steam pipe ruptured			Fried, Osterman Co.	Glove Factory	Milwaukee, Wis.
310	12	Crown sheet failed			Great Lakes Dredge & Dock Co.	Dredging	Buffalo, N. Y.
311	13	Valve ruptured		2	No. 547 W. 23d St.	Factory	New York, N. Y.
312		Three sections heating boiler cracked			Feinberg Bros.	Stores	Hartford, Conn.
313		Section of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Winsted, Conn.
314	14	Boiler ruptured			Amarillo High School	School	Amarillo, Texas
315		Four sections heating boiler cracked			Garfield Court Realty Company	Apt. House	Indianapolis, Ind.
316		Sections of two heating boilers cracked			Ross Hunter	Apt. House	Atlanta, Ga.
317		Water column burst			Savage Mfg. Co.	Cotton Mill	Savage, Md.
318	15	Blow-off pipe failed			Eastern Malleable Iron Company	Foundry	Wilmington, Del.
319		Section of heating boiler cracked			Waldorf System, Inc.	Lunch Room	Boston, Mass.
320		Tube ruptured			Coonse & Caylor Ice Co.	Ice Factory	Indianapolis, Ind.
321	16	Boiler exploded	1	2	San Andreas Mining Co.	Gold Mine	San Andreas, Cal.
322		Hot water supply boiler exploded			No. 747 East 99th St.	Tenement House	New York, N. Y.
323		Tube failed			Atlas Drop Forge Co.	Drop Forge Plant	Lansing, Mich.

324		Firebox of vertical tubular boiler collapsed			Percy J. Brown	Saw Mill	Stafford, Cal.
325		Steam pipe failed			Marathon Paper Mills	Pulp & Paper Mill	Rothschild, Wis.
326		Tube ruptured			Algoma Panel Co.	Woodworking Pl.	Algoma, Wis.
327		Flue of locomotive failed at defective safe end weld		1	Delaware & Hudson Co.	Railroad	Pittston, Pa.
328		Sections of two boilers cracked			Ascher Theater Corp.	Theater	Chicago, Ill.
329	17	Hot water storage tank ruptured			Illinois Market Realty Co.	Business Block	Indianapolis, Ind.
330		Tube ruptured			Weyerhauser Timber Co.	Lumber Mill	Everett, Wash.
331		Two sections heating boiler cracked			Consolidated Realty Co.	Garage & Stores	Hartford, Conn.
332		Section of heating boiler cracked			Klion Holding Corp.	Apt. House	New York, N. Y.
333		Tube ruptured			Public Service Corp. of N. J.	Power Plant	Perth Amboy, N. J.
334	18	Boiler exploded			Durham Dairy	Dairy	Decatur, Ill.
335	20	Two sections heating boiler cracked			Clifford J. Lewis	Restaurant	Bridgeport, Conn.
336	21	Tube ruptured			Rivoli Silk Hosiery Co.	Hosiery Mill	Plainfield, N. J.
337	22	Tube ruptured			Consolidated Paper Co.	Paper Mill	Monroe, Mich.
338		Boiler exploded		2	Nelson's Farms	Drilling Rig.	Litchville, N. D.
339		Section of heating boiler cracked			Town of Watertown	High School	Watertown, Mass.
340		Section of heating boiler cracked			Chamberlain & Co., Inc.	Butchers	Boston, Mass.
341	23	Sections of heating boiler cracked			Chester Township	School	N. M'nchester, Ind.
342		Section of heating boiler cracked			Charles H. Black	Apt House	Atlanta, Ga.
343	24	Staybolts pulled out			Ohio Valley Water Co.	Pumping Station	Bellevue, Pa.
344		Section of two heating boiler cracked			City of Willard	School	Willard, Ohio
345		Section of heating boiler cracked			John Will Adams	Apartment	Kansas City, Mo.
346	26	Hot water supply boiler exploded			Morris Zap	Apt. & Stores	New York, N. Y
347		Tubes ruptured			Northern Paper Mills	Paper Mills	Green Bay, Wis.
348		Boiler bulged and ruptured			Ames-Rhymes Lumber Co.	Planing Mill	Macon, Miss.
349	27	Furnace of water heater collapsed			Stafford Hotel & Investment Co.	Hotel & Stores	St. Louis, Mo.
350		Five sections heating boiler cracked			City of Utica	School	Utica, N. Y.
351		Section of heating boiler cracked			School Dist. No. 1, Laramie Co.	School	Cheyenne, Wyo.
352	28	Sections of heating boiler cracked			Sisters of St. Joseph	School	Stamford, Conn.
353		Section of heating boiler cracked			Harris Bernstein	Apt. House	N. Haven, Conn.
354		Section of heating boiler cracked			Our Lady of Mt. Carmel School	Nursery	New York, N. Y.
355		Boiler ruptured			Clark and Kirklin	Elevator & Mill	Osgood, Ind.
356		Two tubes ruptured			Tennessee Paper Mills	Paper Mill	Chattanooga, Tenn
357	29	Tube failed			United Light & Power Co.	Power Plant	Cedar Rapids, Ia.
358		Two sections heating boiler cracked			Riverview Holding Co.	Apt. House	New York, N. Y.

MONTH OF MAY, 1926.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
359	1	Section of heating boiler cracked			Abraham Miller	Apt. House	Brooklyn, N. Y.
360		Section of heating boiler cracked			Loew's, Inc.	Theater	Brooklyn, N. Y.
361		Section of heating boiler cracked			N. Y. Guild for the Jewish Blind	Inst. for Blind	Yonkers, N. Y.
362	2	Two sections heating boiler cracked			U. S. Trust Co.	Rooming House	New York, N. Y.
363	3	Section of heating boiler cracked			Levi Strauss Realty Co.	Offices & Stores	San Francisco, Cal.
364	4	Section of heating boiler cracked			West 11th St. Corpn.	Apt. House	New York, N. Y.
365		Hot water supply boiler exploded		1	Whitmore Cleaning Co.	Cleaners	Springfield, Ill.
366	5	Boiler exploded		1	First National Bank Bldg.	Constr'ction Work	El Dorado, Ark.
367		Air tank exploded		1	Home Oil & Gas Co.		Caruthersville, Mo.
368		Tube pulled out of header			Pampa Land Co.	Lumber Mill	Winona, Mich.
369		Boiler bulged and ruptured			Sullivan Packing Co.	Packing House	Detroit, Mich.
370		Two sections of heating boiler cracked			Town of West Hartford	School	W. Hartford, Ct.
371	6	Section of heating boiler cracked			The Gross Mfg. Co.	Novelty Factory	Chicago, Ill.
372	7	Laundry mangle exploded		1	Medicine Lodge City Laundry	Laundry	Medicine Lodge, Kan.
373		Section of heating boiler cracked			City of Sharon	School	Sharon, Pa.
374		Section of heating boiler cracked			M. & L. Tartikoff	Apt. House	Brooklyn, N. Y.
375	8	Boiler exploded	1		Green Sea Lumber Co.	Lumber Mill	Howard, S. C.
376		Tube ruptured			Jack Daily	Cleaning Plant	Columbia, Mo.
377	9	Ammonia pipe burst			Hotel Ambassador	Hotel	New York, N. Y.
378	10	Section of heating boiler cracked			Rt. Rev. J. J. Hartley	School	Portsmouth, Ohio
379		Boiler bulged and ruptured			Holton & Hunkel Greenhouse Co.	Greenhouse	Brown Deer, Wis.
380		Blow-off pipe failed			North Fort Worth Ice Co.	Ice Plant	N. Ft. Worth, Tex.
381		Boiler ruptured			Saginaw Mfg. Co.	Woodworking Pl.	Saginaw, Mich.
382	11	Boiler exploded			Boston Bldg.	Office Bldg.	Ottawa, Kansas
383		Boiler exploded	1	1	Sherman Oil Co.	Oil Well	Tullos, La.
384		Valve ruptured			Fisk University	University	Nashville, Tenn.
385	12	Section of heating boiler cracked			Town of West Hartford	School	W. Hartford, Ct.
386		Section of heating boiler cracked			Standard Commercial Body Co.	Garage	New York, N. Y.
387		Tube ruptured			Susquehanna Collieries Co.	Coal Mine	Shamokin, Pa.
388	13	Tube pulled out of header			Joplin Water Works Co.	Water Works	Joplin, Mo.
389	14	Boiler exploded	1			Oil Well	Marietta, Ohio
390	15	Tube ruptured			Consolidated Paper Co.	Paper Mill	Monroe, Mich.

391	16	Boiler exploded		1		Bathhouse	Kerry, Oregon
392		Two tubes pulled out of drum			Chevrolet Motor Co.	Auto Factory	Detroit, Mich.
393		Sections of heating boiler cracked			Harry Yaverbaum	Apt. House	New York, N. Y.
394	17	Tube failed			Kelly Axe & Tool Co.	Saw Mill	Charleston, W. Va.
395		Section of hot water heater cracked			E. A. Clune & G. S. Fresher	Apt. House	Hartford, Conn.
396		Boiler exploded	1	2	State Prison	Prison	Joliet, Ill.
397		Boiler ruptured			Illinois China Company	China Factory	Lincoln, Ill.
398	19	Boiler ruptured			Colonial Hotel Co.	Hotel	Reno, Nevada
399		Boiler bulged and ruptured			Colorado Elgin Laundry	Laundry	Denver, Colo.
400		Superheater tube of locomotive failed at defective safe end weld		1	Penn Railroad	Railroad	Enola, Pa.
401		Tube ruptured			Indiana Power Co.	Power Plant	Edwardsport, Ind.
402		Tube ruptured			Penn Iron & Steel Co.	Iron Works	Creighton, Pa.
403	20	Tube ruptured			Chesapeake & Ohio R. R. Co.	Power Plant	Peach Cr'k, W. Va
404		Boiler exploded			J. B. Maurer & Sons	Store	Uhrichsville, O.
405		Air tank exploded			City of Louisville	Municip'l Light Pl.	Louisville, Ill.
406	21	Section of heating boiler cracked			Klion Holding Corpn.	Apt. House	New York, N. Y.
407	22	Air tank exploded		1	James Crawford	Farm	Stuttgart, Ark.
408	23	Stay bolt blew out of wrapper sheet of locomotive		1	Erie Railroad	Railroad	Honesdale, Pa.
409	24	Air compressor throttle valve bonnet blew out of locomotive		1	M., St. P. & S. Ste. M. R. R.	Railroad	No. Fond du Lac, Wis.
410	25	Hot water heater exploded			Martin Carado	Residence	Fortuna, Cal.
411		Section of heating boiler cracked			H. Schultz & S. I. Smith	Apt. House	Terre Haute, Ind.
412	26	Section of heating boiler cracked			Travelers Hotel	Hotel	San Antonio, Tex.
413	28	Section of heating boiler cracked			Trimble Bros.	Commission Mer.	Omaha, Neb.
414	29	Section of heating boiler cracked			St. Peter's Gen. Hospital	Hospital	N'w Br'nsw'k, N. J
415		Blow-off pipe ruptured		1	Beare Ice & Coal Company	Ice Plant	Jackson, Tenn.
416		Boiler bulged and ruptured			Luigo-Leeper Co.	Planing Mill	Denison, Texas
417	30	Boiler ruptured			Pace-Spencer Lumber Co.	Sawmill	Pace, Fla.
418		Tube ruptured			Sloss-Sheffield Steel & Iron Co.	Mines	Birmingham, Ala.
419		Separator in main steam pipe exploded			Union Bag & Paper Corp.	Paper Mill	Hudson F'lls, N. Y.
420	31	Tube ruptured			City of Claremore	Water, Light Plant	Claremore, Okla.
421		Section of heating boiler cracked			Harry Yaverbaum	Apt. House	Brooklyn, N. Y.

The Hartford Steam Boiler Inspection and Insurance Company

HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1926

Capital Stock, . . . $2,500,000 00

ASSETS

Cash in offices and banks	$684,103.09
Real Estate	267,631.53
Mortgage and collateral loans	1,523,106.20
Bonds and stocks	12,646,007.33
Premiums in course of collection	1,290,539.98
Interest Accrued	150,884.92
Total Assets	$16,562,273.05

LIABILITIES

Reserved for unearned premiums		$7,318,478.72
Reserve for losses		452,318.90
Reserve for taxes and other contingencies		770,028.22
Capital Stock	$2,500,000.00	
Surplus over all liabilities	5,521,447.21	
Surplus to Policyholders,		**$8,021,447.21**
Total Liabilities		$16,562,273.05

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WM. R. C. CORSON, President and Treasurer.

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Incorporated 1866 — Charter Perpetual

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND INJURY TO PERSONS DUE TO THE EXPLOSIONS OF BOILERS OR FLYWHEELS OR THE BREAKDOWN OF ENGINES OR ELECTRICAL MACHINERY

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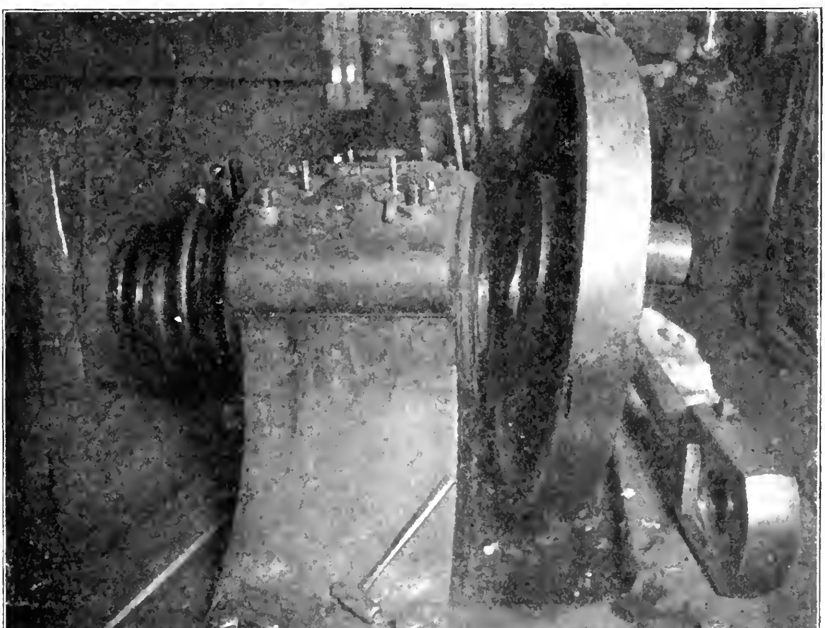
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

Vol. XXXVI HARTFORD, CONN., JULY, 1927. No. 7.



ENGINE ACCIDENT AT WILLIAMSPORT, PA.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE.
PLEASE LET HIM SEE IT.

Engine Accident at Williamsport, Pennsylvania.

THE accompanying pictures show the manner in which a large Corliss type engine was wrecked on February 7, 1927, at the plant of Sweet's Steel Company, Williamsport, Pa. The engine was practically a total loss, the direct property loss amounting to $10,000.

The failure occurred while the engine was operating at its normal speed of 100 r. p. m., and there were no advance indications of its imminence. Both cylinder heads were knocked out; the one from the head end traveled a distance of 65 feet and landed on the mill floor. All parts of the piston were broken, and the piston rod bent, two valve port bridges broken, the crosshead and shoes broken and bent, connecting rod bent, eccentric disks and governor belt pulley on shaft damaged, and the bed plate broken beyond repair. The engine was housed in a structure built closely about it, and further expense was incurred incident to the repair work because this structure had to be torn down, in order to install the large engine parts, and then rebuilt.

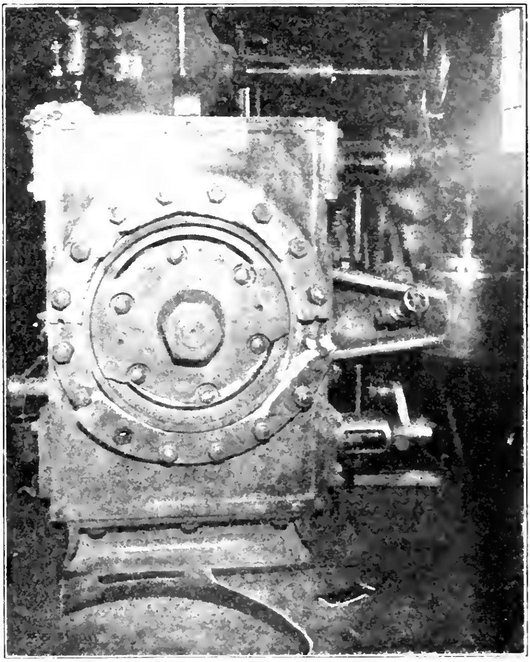


FIG. 1.

The cause of the accident was the gradual failure of the crank shaft due to continued reversals of internal stress. The failure occurred close to, and partly inside of, the face of the crank disk, at a place where a reduction in diameter of the shaft occurred. The absence of a fillet at this shoulder probably superinduced the break. The front cover picture is a view of the initial break in the shaft, and Fig. 1 is a view of the head end of the cylinder.

A HARTFORD engine policy indemnified the owners for the direct property damage $10,000.

Vapor Heating Systems.

IN recent years the use of "vapor" heating systems, sometimes called "modulation" systems, has become quite widespread, and several of these are now well recognized. Although often referred to as vapor systems, essentially they are merely low pressure steam systems, operating in some cases below atmospheric pressure. The advantages claimed for the vapor systems are better regulation of the heat in proportion to the requirements, lower operating pressure which enables regulation and apportionment of heat in moderate weather, and the absence of noise and the disagreeable results of discharging moisture and foul air from radiator air valves into the room.

There are two essential features that distinguish this type of installation from the ordinary steam system; first, the method of venting the air from the system through the return line instead of at each individual radiator, and second, the presence of a well designed steam valve on the inlet of each radiator, by means of which the heat can be modulated. These are the two features that really make for the success of the type, although there are other incidental differences.

Operation of the System

In explaining the operation of a vapor system it would perhaps be best to assume the ideal condition, that is, a constant difference in pressure between the steam and return mains, or what is really the same thing once the system is in operation, a constant pressure in the steam main. The steam is caused to enter the top of a radiator, and it then descends, forcing the air ahead of it out of the return connection, there being no atmospheric air vent on the radiator. The air thus forced into the return main is vented by various means from a point near the boiler. Sometimes there is a short vertical pipe giving access directly to the atmosphere; sometimes this pipe is connected into the chimney, the draft thus creating a slight decrease in pressure below that of the atmosphere; in perhaps a great majority of installations there is some form of vent trap. The water is returned to the boiler by gravity, assisted in some cases by a boiler return trap.

With a constant pressure on the steam main and the return line open to the atmosphere, it is a simple matter to adjust the valve on the radiator to obtain just the required degree of heat, particularly in moderate weather when very little heat is required. It is pointed out by advocates of this system that the graduated valve in the handy position at the top of the radiator is conducive of better attention. The radiators are usually designed with an excess of radiating surface so that even with the valve wide open the steam will all be condensed before reaching the outlet. In order to further insure no steam entering the return line, an orifice is often placed at the outlet to restrict the flow. Other systems use a thermostatic valve on the radiator outlet which will permit of the passage of air and the comparatively low temperature condensate, but which will close immediately upon the attempted issuance of steam. Where the return main has complete access to the atmosphere, it is, of course, essential that no steam enter the return, for this would be wasted.

Venting The Air

The air that has been forced into the return line from the radiators and other parts of the system must be eliminated, and this is frequently done by having the return line open to the air. The usual arrangement, however, is through the medium of a vent trap. This trap is placed in the return line in such a way that the water will ordinarily pass around it on the way back to the boiler, but the air goes to the trap and escapes through the vent in the vessel. Should the water in the return line rise abnormally high, it will then enter the vessel and cause a float therein to rise and close the vent, thus preventing the escape of water from the system. On many systems the vent trap is further equipped with a non-return mechanism which prevents the return of air to the system when the pressure drops below that of the atmosphere. It is in this type of system that a slight vacuum is usually maintained.

The difference in level between the normal water level in the boiler and the lowest point of the overhead return line is sometimes referred to as the "static head," as indicated in Fig. 1, and is the head of water that ordinarily returns the condensation to the boiler under normal conditions. If the static head at any time becomes insufficient to return the water to the boiler, a low water condition may be brought about with consequent cracking of sections. There are several conditions which may arise whereby the static head will be insufficient to return the condensation, and these may be summarized as either a rise of pressure in the boiler, or a reduction of pressure in the return line.

A rise in pressure above normal may be caused by the kind of fuel used. Highly inflammable fuel creating a sudden, intense heat, may be the cause; or perhaps the zeal of the attendant in getting up a quick heat may result in improper methods of firing, with similar results. At times, inexperienced operatives may attempt to force circulation by raising the pressure against some obstruction in the steam or return line, as, for instance, a dirty strainer or a damaged radiator valve or orifice.

If the size of supply mains has been skimped in the installation, or if additional radiators have been added, there is the possibility that a pressure in the boiler greater than the static head may be required at times to obtain the required flow of steam through the radiators. Such a condition might exist in almost any system in very severe weather.

When steam is drawn from the system for purposes other than heating, there is always the possibility of maintenance of a pressure greater than the static head in order to satisfy such demand. In cases where an arrangement of this kind has been in successful operation for some time, a dangerous condition may be brought about by a gradual increase in the outside demand.

A reduction of pressure in the return line below that which should exist may be brought about by the sudden closing off of a large amount of radiation. Under such a condition the abnormal vacuum produced may cause considerable condensation to accumulate in the return line before a sufficient head is acquired to force any water into the boiler.

Boiler Return Traps Aid in Returning Water

To overcome the possibility of an excessive pressure difference preventing the return of the water, a number of manufacturers have developed special boiler return traps which are designed to return the condensation to the boiler regardless of the boiler pressure, provided it is not in excess of 15 lbs. Fig. 1 shows an installation that is typical of vapor systems of the kind under consideration and illustrates how the vent trap and the return trap are connected to the system.

The boiler return trap contains a float which controls two valves within the trap, one for the steam supply from the boiler, and one for the vent or balance line to the return pipe. Assuming that the float in the return trap is down, the steam supply valve will be closed and the valve in the balance pipe to the return line will be open. The condensation can then flow by gravity through check valve A and up into the trap. As water accumulates in the trap, the float rises until it finally closes the valve in the balance line and opens the steam connection, thereby imposing boiler pressure on the water in the trap and releasing it to flow by gravity through check valve B into the boiler. When the trap has emptied itself, the float, of course, again reverses the valve positions and permits the trap to fill with another charge of returning condensation. It is to be noted that, when there is a low pressure in the boiler, the condensation may flow directly

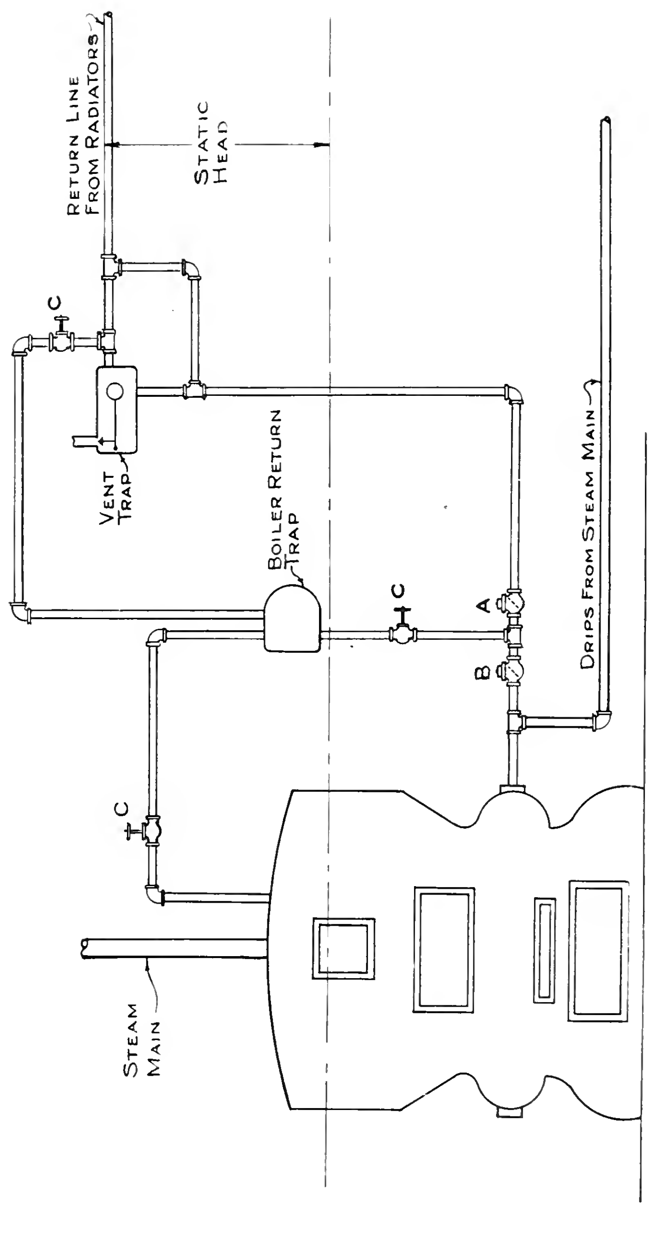

Return Line From Radiators
Static Head
C
Vent Trap
Boiler Return Trap
C
A
B
Drips From Steam Main
C
Steam Main

Fig. 1.

through the two check valves A and B without causing the return trap to function.

When a boiler return trap of this nature is used, the valves marked "C" in Fig. 1, are sometimes installed to facilitate removal of the trap in case it needs to be repaired. The closing of any one of these valves will prevent the operation of the return trap. Therefore, valves C, when used, should be locked or sealed open. It is considered advisable that the check valves shown in the diagram should be of the 45°, or swing, type rather than of the ordinary lift type.

Return traps should be installed at such a height that there will be sufficient head of water above the water line in the boiler to insure a positive and rapid flow of water from the trap into the boiler. The recommended minimum distance between the normal water line in the boiler and the bottom of the trap varies with the different makes. In all cases it is advisable to occasionally check up on the operation of the trap to see that it does promptly return the water to the boiler.

Height of Vent Trap Important

The height of the vent trap above the water line of the boiler is also an important item, more especially so in those systems which do not have a return trap than in those that do. It is always advisable to have the end of the discharge line from such a vent in a conspicuous place so that should any flooding of the trap or other faulty operation occur, the fact will be promptly brought to the attention of the operative by the overflow.

Oftentimes automatic feed water devices are used in connection with systems of this kind. In such cases means should always be provided for feeding the boiler should the automatic feeder become inoperative.

When a stop valve is installed in the steam main from the boiler in multiple boiler installations, there is the possibility of a low water condition occurring in the boiler by reason of the water being forced out through the pipe marked in Fig. 1, "drips from steam main," sometimes referred to as the "wet return line." In such cases a check valve should always be required in this line.

The water line return connection* can be used on all vapor systems of which we have knowledge, and, in fact, is recommended by some manufacturers. Whereas such a connection will not overcome the difficulty of water being held out of the boiler by an unduly high steam pressure, it does prevent the forcing out of the water below a safe level.

*See The Locomotive, July 1920.

Boiler Explosion at Ninety Six, S. C.

THE approximately simultaneous explosion of two boilers occurred August 14, 1926, at the plant of the J. H. Self Lumber Company, Ninety Six, S. C. Seven persons were killed and three were injured. The property loss was estimated to be $15,000. A general view of the scene is given in Fig. 1.

The circumstances leading up to the explosion are interesting. The mill had started up in the morning as usual, but had to shut down temporarily, after running for about an hour, in order to make some

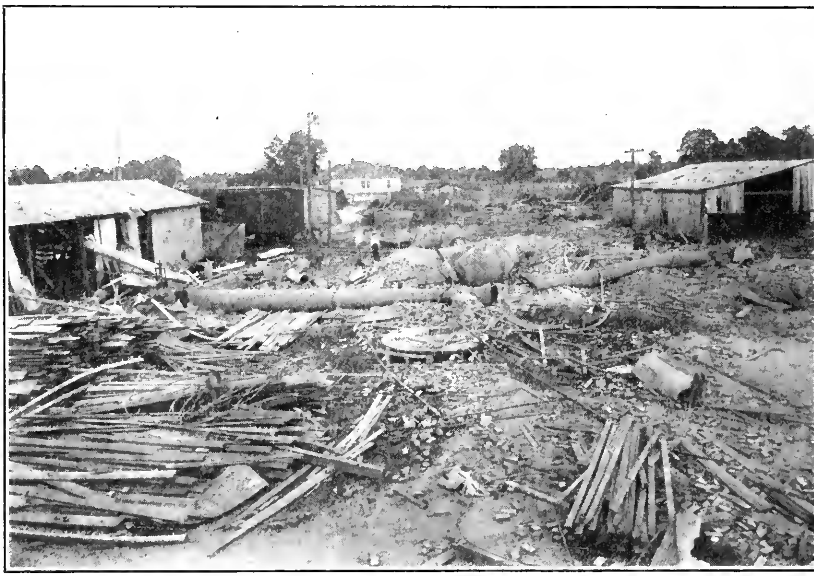


Fig. 1.

minor repair. With practically no load on the boilers during this interval, it is stated the firemen continued to pile on wood waste fuel with the result that the safety valves soon began to blow. These valves were said to have been set to relieve the pressure at 110 lbs. In spite of the relief afforded by the safety valves, the pressure on the boilers continued to rise, 140 lbs. having been noted shortly before the explosion by one of the survivors. A few moments after this observation both boilers exploded. The foregoing evidence, together with the violence of the explosion, would seem to indicate over-pressure, resulting from insufficient safety valve capacity, as the cause of the accident. As all of the mill employees were at work at the time, the casualties were heavy. Four men were practically instantly killed, one of them a minor son of the superintendent of the mill and another a 12 year old negro boy, and six men were injured, three of them so seriously that they died later.

The boilers that exploded were of the horizontal return tubular type, 60 inches in diameter and, respectively, 14 and 16 ft. long, of

FIG. 2.

double riveted lap seam construction. One of them was said to have been 43 years old and the other one 25 years old, although they had been in the present location but three years. The 43 years boiler failed along a row of rivets in the longitudinal seams of the rear and middle courses, much the same as in the case of a lap seam crack failure. In this instance, however, there was no sign of a crack, the entire break being fresh. These two courses opened out flat and, together with the rear head, moved only a few feet from the site of the boiler room. They are shown in Fig. 2. The rear course and head, intact, traveled about 100 feet in the opposite direction. The dome of this boiler was blown a distance of approximately one-half mile.

Boiler number 2, said to have been 25 years old, failed by shearing all of the rivets in the girth seam between the middle and rear courses. The front and middle courses and front head, with most of the tubes, moved about 100 feet forward, while the rear course and head were blown about 600 feet to the rear. There was no dome on this boiler, and the boiler itself did not suffer general disruption. The boiler room, of course, was leveled, but the nearby engine room fortunately suffered little damage. The property loss might very easily have reached a far greater figure had any of the projected parts of these boilers gone in the direction of a nearby cotton mill, as the machinery of such mills is delicate and expensive. So far as could be learned, there was no insurance on this installation.

The accident calls to mind a boiler explosion that occurred about three years previously at Greenwood, S. C., which is only nine miles from Ninety Six. The explosion at Greenwood was in the plant of a cotton mill, and considerable additional damage to the cotton machinery and products was done by a rain storm in progress at the time. The rain entered holes made in the roof of the main mill building by flying grate bars and tubes. The property damage resulting from that explosion, which was reported in THE LOCOMOTIVE for October 1923, exceeded $53,000.

Cooling Boilers for Cleaning, Repairs, or Inspection.

By J. A. SNYDER, Chief Inspector, Pittsburgh Department

ALL steam boilers should be periodically cleaned and inspected, the frequency depending upon the condition of the feed water and the usage of the boiler. Owing to changes in personnel from time to time, with new engineers and firemen taking charge of the steam boilers, some instructions regarding the best methods of cooling and otherwise preparing a boiler should be of value.

The ideal method of cooling any type of boiler, especially those with brick settings, is to close all openings to the setting and allow the boiler to stand several days after drawing the fires without emptying it. By thus giving ample time, the cooling is very slow and uniform, the material contracts uniformly, and the riveted joints and tube ends accommodate themselves to the change without distress. Unfortunately, industrial conditions seldom permit of sufficient time for this ideal way of cooling, and so some modification of it must be adopted. But it should be remembered that boilers are abused when emptied immediately after having the fires drawn, especially when under steam pressure. The heat of the setting is quite likely to burn the boiler, but even if this should not occur, the sudden, unequal cooling of different parts, and consequent non-uniform contraction, causes a decided shock to the structure, particularly the joints and tube ends.

When the fires have been burned out and drawn or dumped, all hot ashes should be removed from the grate, ash pit, and combustion chamber. Hot ashes in the ash pit and hot soot in the combustion chamber cause the boiler to hold its heat for a longer time. Furthermore, supposedly cool soot in combustion chambers has been known to cause severe, and even fatal, burns to workmen. The soot should also be cleaned from the tubes and plates while the boiler is being cooled. This cleaning is essential if the boiler is being shut down for inspection or repairs, and it is advisable to perform it immediately upon shutting down because the soot delays cooling by acting as heat insulation between the tubes and the cool air which later may be drawn through the gas passages. After removal of the fire, the steam valve may be closed, and the boiler should then be blown down several times for the purpose of clearing the blow-off passages to avoid difficulty in emptying the boiler by gravity when cold and not under pressure. If it becomes necessary to add any water to the boiler while it is still hot, this should not be cold water. Cold water in a hot boiler is never helpful, although moderate amounts likewise may not be very harmful, but in shutting down a boiler there is always the possibility of becoming too enthusiastic in this respect in an endeavor to expedite cooling.

Special care should be taken to see that cold water is not thrown or splashed on hot furnace brickwork, as it will cause the refractory to crack and spall.

Draft Effects Rapid Cooling

When the temperature of the boiler and setting becomes fairly low, cooling may be safely expedited by letting air pass through the gas passages. In order to do this, the damper is opened and all openings to the setting closed except the ash pit doors. Cool air thus takes the place of hot gases and further safely reduces the temperature of boiler and furnace. The mistake is frequently made of opening the door at the base of the stack, but this kills the draft through the boiler and, therefore, has a reverse effect from that desired. It is during this period of cooling that a coating of dust or soot on the boiler surfaces will have a retarding effect, as mentioned previously.

In opening a boiler, the top manhole cover should be removed first and then a lower manhole or handhole cover. If this order is reversed, the moment the top opening is cracked there will be a current of air set up from the lower opening to the upper, and this will carry hot vapor about the hands and face of the person removing the top manhole cover, thus seriously handicapping him in the work. Attention to this detail will lighten an otherwise disagreeable task.

Before entering a boiler for any purpose, one should make sure that the vessel is well ventilated so that the air will be fit to breathe. Working in an atmosphere deficient in oxygen may, in extreme cases, be dangerous, but it is always uncomfortable and distressing and greatly reduces the efficiency of the workman. A boiler can readily be ventilated by taking off manhole or handhold covers, such that there will be openings inside and outside of the setting, and then closing all doors or openings to the setting. In horizontal tubular boilers, for instance, there is usually a manhole above the tubes in the shell plate and one below the tubes in the front head. The upper one is accessible from outside of the setting and the lower one must be reached from inside the setting. There are certain types of water tube boilers that can be ventilated by having the manhole plate removed from the stream drum and also several of the lower tube-hole plates or caps at the rear end. With the damper open, the stack will draw air into the setting by way of the boiler, thus introducing a continuous current of fresh air into that vessel.

Often it is necessary to work in a boiler before it can be brought to a comfortable temperature. Under such conditions a workman can never do his best work, but electric fans and air hose can be used to good advantage to make conditions more endurable.

Suggestions Apply to All Types

Locomotive, firebox, and vertical tubular boilers, large or small, should have approximately the same treatment as far as may be applicable. The soot should be blown from the tubes and all ashes and dust removed from the grate and ashpit. When the boiler has sufficiently cooled for safety, it may be further cooled to a comfortable working temperature by opening the damper and the ashpit door and allowing cool air to be drawn through the tubes.

When boilers are emptied they should be immediately washed out with a hose under strong pressure for the purpose of removing sludge and soft scale before it hardens on the boiler surface. Incidentally it may be pointed out that when boilers are emptied while still hot, much of the scale is baked onto the surfaces so that it is much more difficult to remove than it would have been had the boiler cooled before being emptied.

Briefly, regardless of the type of boiler, take as much time as possible in cooling it, and expedite cooling only by drawing air through the gas passes from the ashpit. All other openings to setting or stack should be closed.

Over the Chief Inspector's Phone: "This is the Engineer at the Slippery Elm Soap Company. In the inspection report just received your inspector reports finding a hair line crack at the turn of the head flange, and recommends that the head be slotted and the boiler tested hydrostatically. What I want to know, 'Is this a *serious* matter or just a funny crack?'"

Why Metals Fail Under Influence of Steam Once Superheated.*

THE history of all power-plant equipment that comes in contact with superheated steam indicates that a serious problem still confronts us, even though certain metals have been developed that will greatly ameliorate the deterioration that formerly took place, particularly in cast-iron fittings.

There is great need at the present time for throwing more light on the cause and nature of metal failure where the metal has been subjected to superheated steam on a commercial scale in power plants. The purpose of this article is to present some deductions on the cause of metal failures, from observations extending over a period of thirty years of power-plant practice combined with some recent observations of the nature of superheated steam as produced in modern power plants.

Many failures have been attributed to high temperature, but failures of the same nature in turbine blades, valves and valve fittings do not occur under saturated steam conditions regardless of temperature; therefore one must look for some condition in the superheated steam that caused the prevalent failures.

Some Free Hydrogen Probably Produced by Catalytic Action

Tests made on the air exhausted from turbine condensers clearly indicate the presence of hydrogen, the amount varying from 1 to 2 per cent by volume of the air removed. The effect of free hydrogen on metals will be discussed later; first let us see where it comes from. Steam dissociates at temperatures of from 1,500 to 1,800 deg. C. This is, of course, much higher than the maximum temperature possible in power-plant practice. If some outside agent or catalyst were present with the steam, the dissociation temperature could be lowered well within the range of power-plant temperatures. For instance, steam will dissociate quite rapidly when brought into contact with red-hot iron at, say, 1,100 deg. F. While superheater tubes do not ordinarily attain such a temperature, it is not at all an uncommon phenomenon for superheater tubes to be red hot, nor is it reasonable to suppose that if steam dissociates rapidly in contact with red iron it will not dissociate at all at slightly lower temperaures.

The steam temperatures in the plants will average 500 to 700 deg. F. In consideration of the comparatively low critical velocity of steam, it is hardly to be doubted that there is turbulent flow rather

*By Bert Houghton and D. C. Weeks in *Power*.

than well defined stratification through the superheater tube. However, there are two facts concerning superheaters and the steam flowing through them that indicate that average steam temperature does not represent the maximum temperature that any small portion of the steam may attain. A recent investigation has shown that some of the steam of an indicated average superheat of 200 deg. F. had a quality of only 98.6 per cent at its superheater tube outlet. In such a case, with an average steam temperature of over 600 deg. F. and 200 deg. F. superheat, a maximum temperature of well over 600 deg. must have been attained by a portion of the steam. With the present design of several of the widely used types of superheaters, it is well known that the flow of steam through the tubes is not equalized. Some tubes carry much more than their share of the steam, while others carry correspondingly less.

Free Gases Act Upon Intercrystalline Cement

A great many investigations have been made in recent years as to the causes of intercrystalline fractures, and it has been abundantly shown by various investigators that if a metal is permeated with a gas that will react with the intercrystalline cement along the crystal boundary lines, the bond is weakened and the resulting fracture is along the boundaries and not through the cleavage planes. Many gases will act in this way, among the most common of which are hydrogen, oxygen and nitrogen. Should a portion of the steam dissociate or should the steam react with the iron of the piping, thereby releasing hydrogen, a gas or gases would be present which would cause the deterioration of the character found. This has been shown to be the case.

Miscroscopic photographs of some metals that had long contact with superheated steam verify the fact that the intercrystalline structure of bronze reaction turbine blades, a cast-iron pipe flange, a cast-iron valve flange, a cast-brass valve bushing, and a bronze seat of a turbine throttle pilot valve were all subjected to the reactions mentioned in the preceding paragraph. The failures in each case appeared as cracks. In the case of the turbine blades they, as a whole, were not brittle. However, there was a brittle case around each blade. . . .

The polished and etched specimens showed under the microscope a well defined intercrystalline weakness. In some of the bronze turbine blades, the deterioration of the intercrystalline cement was so pronounced near the surface of the blade that it was surprising that the crystals held together.

In the case of the cast iron the failure of the grain boundaries was not as pronounced as in the turbine blades. The widening of the grain boundaries was sufficient to indicate clearly that intercrystalline weakness was the cause of failure. We have two cases in the cast iron, one of a pearlitic iron (iron and carbon) and one of a ferritic iron (pure iron.) The failure in one case was from the bolt hole out; in the other, through the entire cross-section. The intercrystalline weakness in each case was apparent through the entire cross-section. The cracking from the bolt hole out simply meant that the weakened metal broke where the greatest stress was applied. In determining the cause of each failure, we considered the most likely causes of intercrystalline weakness. The usual types of failure are accompanied by trans-crystalline fractures.

Other than as a statement of observed facts in power plants in combination with the reports of metallurgists' investigations, no attempt is made to present the foregoing comments as a finished solution for some of our most urgent power-plant problems, but at the same time the remarks focus attention on a condition in commercial superheated steam and the metals associated with it which must be overcome before further advances in the art of power plant practice can be made with complete assurance of the elimination of trouble.

A Fatal Diesel Engine Accident.

A rather unusual accident to a Diesel engine occurred Sunday, April 10, 1927, at the plant of the Louisiana Shell Isle Products Company, Happy Jack, La., of which, however, we have indefinite information. The engine, it appears, was new and was being tested or demonstrated in the presence of company officials when the accident occurred. A cylinder exploded, and a portion of it weighing nearly a ton was projected through the roof. The occupants of the room were uninjured and made a hurried escape, but the engineer, realizing that the explosion was over, returned to the vicinity of the engine just in time to be crushed by the descending cylinder. He was killed almost instantly.

The cause of the explosion could not be learned, nor is it likely that more information will be forthcoming in view of the death of the operator and the fact that the engine was shortly afterwards submerged in six feet of water by the unprecedented floods in the Mississippi River basin.

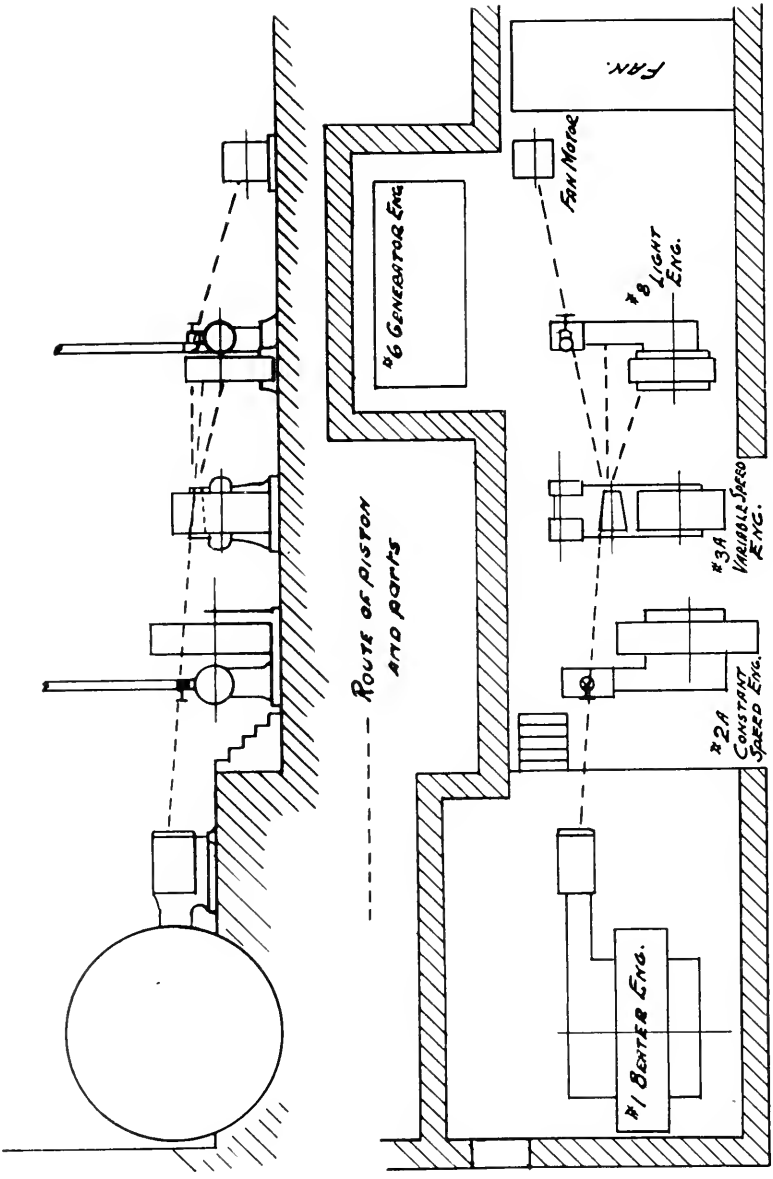


Fig. 1. Diagram of Engine Accident at Bogota, N. J.

Engine Accident at Bogota, N. J.

BOILER and flywheel explosions are characterized by the widespread havoc which they create, whereas damage from engine accidents is usually confined to the engine itself and its immediate surroundings. An engine accident that departs from the usual, however, occurred March 30, 1927, at the plant of the Federal Paper Board Company, Inc., Bogota, N. J. Fragments of a piston and cylinder head of one engine flew around the engine room and damaged three other engines and two electrical machines.

The accident is thought to have been due to the absence of a cotter pin from the crosshead key, as the pin would have retained the key in its proper position. In the absence of a cotter, the key worked from its proper position and was sheared off. The piston and piston rod thus released were driven through the cylinder head, and flying particles of the piston and cylinder head damaged three other engines, an electric generator, and a motor. The widespread damage seems all the more remarkable when it is noted that the damaged units were not distributed around the engine that failed, but were located one behind the other so that each one partly shielded those beyond it. The apparent paths of the various pieces are indicated by the dotted lines in the accompanying sketch.

The engine that failed first was a constant speed engine known as No. 1. It furnished power for the beater room. The next adjacent engine was No. 2, also a constant speed engine. Its valve gear was damaged, the 5 inch throttle valve fractured, and a portion of the 5 inch steam pipe flattened. Beyond engine No. 2 was a variable speed engine, No. 3. The frame of its speed-changing mechanism was destroyed, also a chain by which the speed changes are effected. The lubricating lines of this engine were also damaged.

Beyond engine No. 3 was engine No. 8, directly connected to an electric generator. One flying fragment broke the frame of this engine, another fragment struck and destroyed a fitting in the main steam line just ahead of the throttle valve, and a third piece did slight damage to the lubricating equipment. Still another fragment damaged five coils in the electric generator. A fan motor, in the farthest corner from the engine that first failed, had its commutator junction bars slightly damaged.

An engine breakdown policy relieved the owners of the direct property loss incident to this accident.

Fatigue of Welds.

IN the July 1926 issue of THE LOCOMOTIVE brief mention was made of the results of fatigue tests on welded joints in steel tubes such as are used in the construction of airplanes. In a recent issue of *Power* appeared an abstract of a report on similar tests presented by R. R. Moore at the annual meeting in April of the American Welding Society. The tests in this investigation were also made on 1 inch and ½ inch steel tubes such as are used in airplane construction, but the results of the tests are nevertheless of general interest. Gas, metal arc, and atomic hydrogen processes were used, likewise various kinds of filler rods. Test specimen bars were also made up by depositing filler rod material by the several methods of welding. The rotating-beam type of testing machine was used for the fatigue tests.

Tensile tests were made of all welded tubes, the fracture in every case being outside of the weld, approximately 1 inch distant. The location of the fracture is thought to be due to softening of the adjacent metal by the heat of the torch, and to the increased cross-section at the weld. The tubes showed a tensile strength of 50,500 to 62,500 lbs. per square inch.

The endurance limit was determined by plotting stress-cycles curves, the stress determined by the regular beam formula, and the cycles by counting the revolutions of the specimen. The endurance limit was taken as the stress at which the curve became flat, that is, the specimens failed to break under an infinite number of reversals of stress. In the endurance tests the fracture occurred either in the middle of the weld or very close to it. The location of the break in both the tensile strength and fatigue tests bears out the results previously reported.

It would be expected that the deposited metal, which is cast and not worked, would be more brittle than the mild steel tube and hence would be the weak spot in the endurance tests. Of particular interest, therefore, are the tests on specimen bars made from filler rod material deposited by the torch. The Norway iron sample deposited with a gas torch showed a tensile strength of 50,500 lbs. per sq. inch with 26 percent elongation, and a fatigue test of 24,000 lbs. per sq. inch. The latter is about 48 percent of the tensile strength, a ratio said to be exceeded by only a few steels. The endurance limit on these filler rod bars exceeded that on any of the welded tubes.

The gas welded specimens using chromium molybdenum filler rods gave the very low endurance limit of 8,000 lbs. per inch, due to poor welding. Tension tests on these samples, however, gave results equally as high as others, and the rupture did not occur in the weld. The poor fusion, therefore, was not detected by tensile tests but became readily apparent in the endurance tests.

Arc welded samples of the tubes showed similar results to the torch welded samples, but tests on the bars of deposited metal gave a tensile strength of 62,500 lbs. per sq. inch and only 1.5 percent elongation.

The atomic hydrogen process of welding, in which fusion takes place in an atmosphere of hydrogen and thus prevents formation of metallic oxides and in which strips of the original tube metal were used for filler rods, gave results not essentially different from the others except that the tube seemed to be softened to a greater extent, which resulted in a lower tensile strength.

The author points out that the tensile efficiency of the welded tubes was better than 75 percent, but the fatigue strength was as low as 13 percent and never higher than 35 percent of the tensile strength of the weld. Furthermore, poor fusion will show up much more quickly in fatigue endurance tests than in the tensile strength tests.

Caught In the Separator.

WHO'S GOT MINE?

The rain though raining every day
Upon the just and unjust fella,
Falls chiefly on the just because
The unjust has the just's umbrella.

The Eagle

"Sorry," said the constable, "but I'll have to arrest you — you were speedin' along at a 50 mile clip."

"You are wrong, my friend," said the motorist. "I say I wasn't, and here's a ten dollar bill says I wasn't."

"All right," returned the constable, as he folded up the money, "with eleven against me I ain't a-goin' to subject the county to the expense of a trial."

— *Selected*

Magistrate — And did you strike the policeman?
Prisoner — The answer is in the infirmary. — *Selected*

Diner — Waiter, there's a button in my soup.
Waiter (ex-printer)—Typographical error, sir; it should be mutton.

— *Selected*

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor

HARTFORD, JULY, 1927.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

KNOWLEDGE arouses interest and creates enthusiasm. A man may work at some task for years and give little thought to the whys and wherefores, simply contenting himself with a faithful performance. But explain to him the reasons for certain things and his interest is usually aroused. Questions invariably follow and, perceiving the real object of his work, aimless methods give way to more efficient ones.

Excellent illustrations of this are frequently found in the cases of certain students enrolled in the HARTFORD Correspondence Course for Firemen. There are many engineers and firemen who enroll because previous study has accustomed them to seek further knowledge, but there are also a great many who are persuaded to enroll yet who have never taken up any particular line of study since leaving off with the "three R's." Interest in study is at an ebb. However, a few interesting explanations of phenomena already observed about combustion are given in the first few lessons of the course, and these stimulate interest and cause the work to proceed more satisfactorily and more rapidly. Often a request for additional lessons is made in order to expedite the work. Questions pertaining to the particular installation show that the man is thinking about his work and applying what he has learned. It is then only reasonable to assume that with a clear understanding of what he is doing and how it is best done, definite results in the way of better firing will ensue.

THE matter of a heating system for a building is a subject that should receive full consideration before installation for it is one that bears considerable inertia. Once a system is in operation and is found to be ample for cold weather, there is little likelihood of any changes being made except when necessary. Yet the simple steam-heating system is open to the criticism that satisfactory control of the amount of heat in accordance with the need, particularly in moderate weather, is practically impossible. Rather than have insufficient heat under such conditions, too much is supplied, which means poor economy. The vapor system of heating, really an adaptation of the simple steam system, is a type that lends itself admirably to such regulation. How it is done is told briefly in an article elsewhere in this issue.

No Man is Indispensable.

I care not what your place may be —
  A job that's most laborious
With a mightly little salary,
  Or one that's fat and glorious;
But, be your labor great or small,
  Of this you must be sensible —
Some other chap can do it all;
  No man is indispensable!

When you begin to swell with pride
  And cater to the gallery,
And put on lots of "dogs" and "side"
  Because they've raised your salary;
Why then's the time you'll tumble quick,
  Such ways are indefensible;
Some other chap can do your trick:
  No man is indispensable!

It's well enough to know your worth
  And know just what to do with it,
But don't imagine that the earth
  Will quit when you are through with it:
No, it will roll upon its way,
  And — what seems reprehensible —
Some other chap will draw your pay:
  No man is indispensable!

— *New York Central Lines Magazine.*

FLYWHEEL EXPLOSIONS DURING 1926.

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	1	Flywheel exploded		3	Carnegie Steel Co.	Steel Plant	Pittsburgh, Pa.
2		2	Band-saw wheel ruptured			Bowman Hicks Lumber Co.	Lumber Mill	La Grande, Ore.
3		6	Flywheel exploded	1		C. L. Hadley	Farm	Bridgeport, Ind.
4		12	Turbine exploded		1	Beacon Oil Co.	Oil Refinery	Everett, Mass.
5		30	Flywheel exploded	1			Sprayer Factory	Winter Haven, Fla.
6		31	Turbine exploded			American Mfg. Co.		Albany, N. Y.
7	Feb.	3	Flywheel exploded	1		Northern Oil Co.	Oil Well	Kane, Pa.
8		6	Flywheel exploded		1	W. G. Prather	Farm	Eureka, Kan.
9		7	Turbine exploded			Kewanee Public Service Co.	Power Plant	Kewanee, Ill.
10		12	Flywheel exploded				Blast Furnace	New Castle, Pa.
11		16	Flywheel exploded			Midwestern Box Board Co.	Board Mill	Circleville, O.
12		17	Flywheel exploded			Wilson Bros.	Sawmill	Aberdeen, Wash.
13			Flywheel exploded			Macon, Dublin & Sav'h Ry. Co.	Railroad Shops	Macon, Ga.
14		24	Flywheel exploded		1	American Woolen Co.	Textile Mill	Webster, Mass.
15	March	8	Flywheel exploded	1		John Green	Farm	Guilford Ctr., N. Y.
16		11	Flywheel exploded			Asheboro Chair Factory	Chair Factory	Charlotte, N. C.
17		12	Flywheel exploded	1		Elmer Loefer	Farm	Forest Junct., Wis.
18		20	Flywheel exploded			Nassau Gas Light Co.	Pump House	Brooklyn, N. Y.
19		30	Belt wheel ruptured			B. B. & R. Knight Inc.	Bleachery	Pontiac, R. I.
20	April	5	Flywheel exploded		1	Carl Anderson	Farm	Shields, Minn.
21		19	Pulley exploded			Northern Paper Mills	Paper Mill	Green Bay, Wis.
22		20	Flywheel exploded	1		Chicago Mill & Lbr. Co.	Lumber Mill	West Helena, Ark.
23	May	10	Flywheel exploded	1		Ford Garage	Garage	Farina, Ill.
24		17	Belt wheel exploded			Est. of J. W. Gaddis	Ice Plant	Van Wert, Ohio
25	June	21	Pulley exploded			Bell Laundry & Cleaning Co.	Laundry	Knoxville, Tenn.
26		23	Belt wheel exploded			Pacific Spruce Corp.	Lumber Mill	Toledo, Ore.
27			Turbine ruptured			R. B. McEwan & Son	Paper Mill	Whippany, N. J.
28			Flywheel exploded			Cleveland-Oconee Lbr. Co.	Lumber Mill	Oconee, Ga.
29		24	Flywheel exploded			D. W. Flint	Launch	New London, Conn.
30		27	Flywheel exploded			Schuylkill Iron Works	Iron Works	Conshohocken, Pa.

31	July	12	Flywheel of Corliss engine exploded	1	2	Lafayette Box Board & Paper Co.	Paper Mill	Lafayette, Ind.
32		21	Flywheel of Corliss engine exploded			King Paper Company	Paper Mill	Kalamazoo, Mich.
33		29	Pulley exploded	1		Bogalusa Paper Co.	Paper Mill	Bogalusa, La.
34	Aug.	20	Turbine exploded		2	Mead Pulp & Paper Co.	Pulp & Paper Mill	Chillicothe, O.
35		29	Turbine exploded			American Seating Co.	Wood W'k'g Plant	Grand Rapids, Mich
36	Sept.	8	Flywheel of Uniflow engine exploded		1	Village of Greenfield	Power Plant	Greenfield, Ohio
37		15	Belt wheel exploded			Harbison-Walker Refractories Co.		Woodland, Pa.
38		20	Pulley ruptured			Casino Ice Co.	Ice Plant	Belmar, N. J.
39		21	Pulley ruptured	1		Fisher-Grossman Stave Co.	Stave Mill	Wynne, Ark.
40		28	Flywheel of Corliss engine exploded	1	1	Helena Cotton Oil Co.	Cotton Oil Mill	Helena, Ark.
41			Flywheel exploded		1	Bolles Oil Lease	Oil Well	Fullerton, Pa.
42	Oct.	2	Flywheel exploded				Prison	Jefferson, Mo.
43		4	Flywheel exploded			Cutsinger Elevator	Grain Elevator	Edinburg, Ind.
44		12	Flywheel exploded		1	Tube City Brewing Co.	Brewery	McKeesport, Pa.
45		22	Flywheel of oil engine exploded			Atkins Elec. Light & Power Co.	Power Plant	Atkins, Ark.
46	Nov.	5	Flywheel exploded	1		Muenster Oil Field	Oil Well	Gainesville, Texas
47		15	Flywheel exploded			Welch Grain Co.	Grain Elevator	Welch, Okla.
48		18	Centrifugal extractor exploded		3	Herbert W. Topp	Leather Factory	Johnstown, N. Y.
49		22	Flywheel exploded			Norman Oil Mill	Oil Mill	Norman, Okla.
50	Dec.	15	Flywheel exploded	1			Sawmill	Powell Butte, Ore

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JUNE, 1926.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
422	1	Section of heating boiler cracked			F. & L. Realty Corp.	Store & Dwelling	Brooklyn, N. Y.
423		Main steam pipe failed			So. Bend Dowel Wks., Inc.	Wood W'k'g Plant	So. Bend, Ind.
424		Boiler ruptured			J. M. Leach Mfg. Co.	Ice Plant	Kokomo, Ind.
425		Tube ruptured			Pittsburgh Crucible Steel Co.	Steel Plant	Midland, Pa.
426		Steam pipe on locomotive failed		1	Southern Oregon Lumber Co.	Lumber Mill	Gazelle, Calif.
427		Section of heating boiler cracked			St. Joseph's Seminary	Church	Grand Rapids, Mich.

MONTH OF JUNE, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
428		Section of heating boiler cracked			Loews, Inc.	Theatre	New York, N. Y.
429		Section of heating boiler cracked			York Hotel	Hotel	Pittsburgh, Pa.
430		Section of heating boiler cracked			Burdeau Real Estate Co.	Offices & Stores	St. Louis, Mo.
431	2	Boiler bulged and ruptured			Campbell-Towle Lumber Co.	Lumber Mill	Klamath Falls, Ore.
432		Main stop valve ruptured			Cafiero Ice Works, Inc.	Ice Plant	Algiers, La.
433		Section of heating boiler cracked			Onondaga Happy Hour Th'tre Co.	Theatre	Syracuse, N. Y.
434	3	Section of heating boiler cracked			Charles Kooner	Apts. and Stores	Hartford, Conn.
435		Crown sheet of locomotive failed		1	A. B. & A. Rwy.	Railroad	Fitzgerald, Ga.
436	4	Six sections heating boiler cracked			Pacific Tel. & Tel. Co.	Tel. Exch. Bldg.	San Francisco, Cal.
437		Flue of locomotive failed at defective safe end weld		1	Penn. Railroad	Railroad	Holland, N. Y.
438	5	Crown sheet of locomotive failed		1	Gulf Coast Lines	Railroad	Mercedes, Texas
439	6	Tube ruptured		1	Peoples Gas & Electric Co.	Power Plant	Savanna, Ill.
440		Boiler ruptured			Sloss-Sheffield Steel & Iron Co.	Ore Mine	Irondale, Ala.
441		Boiler exploded			Relief Oil Co.	Oil Well	Amarillo, Texas
442	7	Boilers (2) exploded	1	6	Magnolia Petroleum Co.	Machine Shop	Electra, Texas
443	8	Hot water supply heater ruptured			Thirty-Sixth St. Grill	Grill	New York, N. Y.
444		Two tubes ruptured			St. Paul & Tacoma Lumber Co.	Lumber Mill	Tacoma, Wash.
445		Tube failed			Central Paper Co.	Paper Mill	Muskegon, Mich.
446	9	Tube ruptured			Hanna Furnace Co.	Steel Plant	River Rouge, Mich.
447	13	Two sections heating boiler cracked			Miss Martha Rhode	Apt. House	San Francisco, Cal.
448		Flue of locomotive failed		1	B. & O. Railroad	Railroad	Eidenau, Pa.
449	14	Section of heating boiler cracked			Frederick O. Rackliffe	Apt. House	New Britain, Conn.
450	15	Boiler ruptured			Medical Society of So. Carolina	Hospital	Charleston, S. C.
451		Section of heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	Passaic, N. J.
452		Section of heating boiler cracked			University Club	Club House	Pittsburgh, Pa.
453		Boiler exploded	1		Albert David Chemical Co.	Chemical Plant	Chicago Hts., Ill.
454	16	Tube ruptured		1	King Paper Co.	Paper Mill	Kalamazoo, Mich.
455		Boiler bulged and ruptured			Conway Lumber Co.	Lumber Mill	Conway, S. C.
456		Flue of locomotive broke off at safe end weld		2	Southern Railway	Railroad	Clover, Va.
457		Hot water tank exploded			Presto Cafe	Cafe	El Dorado, Ark.
458	18	Boiler exploded	1	4	Macken Granite Co.	Quarry	Sparta, Ga.

459	19	Air container exploded		1	Wm. Sauers		San Francisco, Cal.
460	21	Section of heating boiler cracked			Academy of the Sacred Heart	Convent	Hoboken, N. J.
461	22	Crown sheet of locomotive failed		3	D. L. & W. R. R.	Railroad	Willow Point, N. Y.
462	23	Main steam pipe ruptured			Boott Mills	Cotton Mill	Lowell, Mass.
463		Tube ruptured			Robert Gair Co.	Paper Mill	Chicago, Ill.
464		Tube failed			Consolidated Paper Co.	Paper Mill	Monroe, Mich.
465		Tube failed			Monarch Paper Co.	Paper Mill	Kalamazoo, Mich.
466	24	Header cracked			White Sulphur Springs, Inc.	Hotel	White Sulph'r Spgs., W. Va.
467		Vulcanizer head failed			Ajax Rubber Co., Inc.	Rubber Works	Racine, Wis.
468		Boiler exploded	2	2	Albert Rains	Saw Mill	Williamsburg, Ky.
469	25	Blow-off pipe failed			North Ft. Worth Ice Co.	Ice Plant	No. Ft. Worth, Tex.
470		Jacketed vessel exploded		2	Welch the Hatter	Hat Factory	Syracuse, N. Y.
471		Steam pipe burst	1		Iron City Sand Co.	River Boat	Pittsburgh, Pa.
472	26	Crown sheet of locomotive failed	3	4	N. Y., N. H. & H. R. R.	Railroad	Kingston, R. I.
473	27	Section of heating boiler cracked			I. Z. Epp	Apt. House	San Francisco, Cal.
474	30	Blow-off pipe of digester failed			Parker-Young Co.	Paper Mill	Lincoln, N. H.

MONTH OF JULY, 1926.

475	1	Section of heating boiler cracked			Eugene C. Pulliam, Guardian	Apt. House	Indianapolis, Ind.
476		Section of heating boiler cracked			Wise, Smith & Co.	Offices & Stores	Hartford, Conn.
477		Ammonia vessel exploded		1		Refrigeration Plt.	Sonoma, Cal.
478	2	Boiler exploded	1	1	Chas. Burton Farm	Threshing Mch.	Temple, Okla.
479	3	Boiler of locomotive exploded	1	2	Western Md. R. R. Co.	Railroad	Galva, Kansas
480		Boiler exploded	2		Holcomb Bros.	Threshing Mch.	Martinsb'g, W. Va.
481		Tube failed			So. Pittsburgh Water Co.	Pumping Sta.	Pittsburgh, Pa.
482		Tube failed			Campbell Soup Co.	Preserving Plt.	Camden, N. J.
483		Crown sheet collapsed			A. Glorioso & J. J. Favalora	Canning Factory	Crystal Spgs., Miss.
484	5	Tube ruptured			City of Purcell	Light & Water Plt.	Purcell, Okla.
485		Boiler exploded			Ohio Oil Co.	Oil Well	Logan Twnsp., Ind.
486		Blow-off pipe failed			No. Fort Worth Ice Co.	Ice Plant	No. Ft. Worth, Tex.
487	6	Boiler exploded*	1		Magic City Development Co.	Oil Well	McHenry, Miss.
488		Tubes failed			Hercules Cement Corp.	Cement Plant	Stockertown, Pa.
489	7	Tube ruptured			Grasselli Chemical Co.	Chemical Plant	Grasselli, N. J.
490	10	Crown sheet of locomotive failed			Holmes Eureka Lumber Co.	Logging	Carlotta, Cal.
491		Two headers fractured			General Eng'r'g & Managem't Co.	Power Plant	Morristown, N. J.

MONTH OF JULY, 1926 (Continued).

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
492	11	Boiler ruptured			Paul A. Sorg Paper Co.	Paper Mill	Middletown, Ohio
493		Cooking tank exploded		1	Geneseo Canning Co.	Canning Factory	Geneseo, N. Y.
494		Tube of superheater ruptured			Texas Power & Light Co.	Power Plant	Trinidad, Texas
495	12	Tube ruptured			Ogden State Bank	Canning Factory	Ogden, Utah
496		Boiler exploded			Keough Canning Co.	Canning Factory	Glassboro, N. J.
497	13	Boiler exploded	1		George Todd Sawmill	Sawmill	Clifty, Ark.
408	14	Section of heating boiler cracked			Theo. Hamm Brewing Co.	Store Bldgs.	St. Paul, Minn.
499		Section of heating boiler cracked			A. B. H. Moore	Apts. & Stores	Niagara Falls, N. Y.
500	15	Boiler ruptured			Eastern Dairies, Inc.	Ice Cream Fcty.	Springfield, Mass.
501		Tubes failed			American Refining Co.	Oil Refinery	Wichita Falls, Tex.
502		Superheater tube ruptured			Texas Power & Light Co.	Power Plant	Trinidad, Texas
503	16	Section of heating boiler cracked			Heatherton Realty Associates	Office Bldg.	New York, N. Y.
504		Tubes ruptured			Central Louisiana Power Co.	Power Plant	Amite, La.
505		Boiler exploded		2	Elihu Reeves Sawmill	Sawmill	Nashville, Tenn.
506		Heating boiler exploded			1107 Lenox Road	Apt. House	Brooklyn, N. Y.
507	17	Boiler exploded		1		Sawmill	Higdon, Mo.
508		Boiler bulged and ruptured			Hummell-Ross Fibre Corp.	Pulp & Paper Mill	Hopewell, Va.
509		Section of heating boiler cracked			Klion Holding Corp.	Apt. House	New York, N. Y.
510	18	Superheater tubes ruptured			Texas Power & Light Co.	Power Plant	Trinidad, Tex.
511	19	Sections of heating boiler cracked			Clark's Spas, Inc.	Lunch Room	Roxbury, Mass.
512		Hot water supply heater exploded			Mongeau Bldg.	Office Bldg.	Lowell, Mass.
513		Air tank exploded		1	Capitol Foundry	Foundry	Hartford, Conn.
514	20	Boiler bulged and ruptured			Natoma-Huntley Dairy Co.	Creamery	Oak Park, Ill.
515		Boiler exploded		1	McKinney Steel Co.	Steel Plant	Rochester, N. Y.
516	21	Tube ruptured			Board of Water Commissioners	Pumping Sta.	Courtland, N. Y.
517		Boiler exploded		3	J. H. Grant	Oil Well	Mildred, Texas
518		Superheater tube ruptured (2nd accident)			Texas Power & Light Co.	Power Plant	Trinidad, Texas
519	22	Six headers cracked			Diamond Alkali Co.	Alkali Plant	Fairport, Ohio
520	23	Tube ruptured			McEwan Bros.	Paper Mill	Whippany, N. J.
521		Two sections heating boiler cracked			A. H. & F. E. Holt	Apt. House	St. Louis, Mo.
522		Boiler of locomotive exploded		2	Pennsylvania Railroad	Railroad	Delanco, N. J.
523	24	Tube ruptured			Alliance Cold Storage & Pack. Co.	Cold Storage Plt.	Alliance, Ohio

524	25	Steam pipe exploded			Hanna Furnace Co.	Blast Furnace	Buffalo, N. Y.
525	26	Main steam pipe failed			Eddy Paper Corp'n.	Paper Mill	Three Rivers, Mich
526		Tube ruptured	2		Union Storage Co.	Cold Storage Plt.	Pittsburgh, Pa.
527	27	Section of heating boiler cracked			Mike & Lena Singer	Store	St. Louis, Mo.
528	28	Hot water heater exploded		2	Clover House	Board House	Maplewood, N. Y.
529		Ammonia tank exploded		2	Somet-Solvay By-Products Co.	Chemical Plant	Wheeling, W. Va.
530	29	Header cracked	1		Eastman Kodak Co.	Kodak Factory	Rochester, N. Y.
531		Autogenously welded generator of absorption refrigerating system exploded		4	Scott-Powell Dairies	Dairy	Philadelphia, Pa.
532		Tubes ruptured			United Engin'r'g & Foundry Co.	Foundry	Canton, Ohio
533	30	Air tank exploded			Knoefel Tire Service	Service Depot	Louisville, Ky.
534	31	Tube ruptured			Bergstrom Paper Co.	Paper Mill	Neenah, Wis.
535		Boiler exploded		2	Oetker Bros.	Threshing Mch.	Billings, Mo.
536		Boiler of locomotive exploded	1	2	Western Maryland R. R.	Railroad	Clear Springs, Md.
537		Heating boiler exploded			L. L. Fontaine	Residence	Vallejo, Cal.

MONTH OF AUGUST, 1926.

538	1	Boiler ruptured			Southern Ohio Elec. Co.	Power Plant	Floodwood, Ohio
539		Section of heating boiler cracked			Robert Findlay Mfg. Co.	Factory	Brooklyn, N. Y.
540	2	Head of rendering tank failed			Federal Packing Co.	Abattoir	Cleveland, Ohio
541		Boiler exploded		1	Trimble Farm	Threshing Mch.	Pattonsburg, Mo.
542	3	Gasket of ammonia condenser coil blew out			Auslander Stores Co.	Refrigerating Plt.	Uniontown, Pa.
543	4	Boiler exploded		1	J. O. Pace Sawmill	Sawmill	Logansport, La.
544		Section of hot water heater cracked			G. & M. Cominos	Hotel	Salinas, Cal.
545		Eight sections heating boiler cracked			Pacific Tel. & Tel. Co.	Tel. Exch. Bldg.	San Francisco, Cal.
546	6	Section of heating boiler cracked			J. Z. Epp	Apt. House	San Francisco, Cal.
547		Three sections heating boiler cracked			Fayetteville Commercial Bank	B'k & Office Bldg.	Fayetteville, N. Y.
548		Boiler exploded	1	1		Oil Well	Covington, Okla.
549		Boiler exploded		1	William Williams Farm	Farm	Wolf S'm't, W. Va.
550		Boiler of locomotive exploded	2	6	New York Central Lines	Railroad	Ashtabula, Ohio
551	7	Ammonia pipe failed			Northwestern Ice & Cold Storage Co.	Cold Storage Plt.	Portland, Oregon
552	8	Glycerine evaporator exploded	1	1	Peet Bros. Mfg. Co.		Kansas City, Kan.
553	9	Headers cracked (2 accidents)			Alexander Smith & Sons C'rp't Co.	Carpet Factory	Yonkers, N. Y.

MONTH OF AUGUST, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
554		Hot water supply heater ruptured			Meyer Kiser Bank Bldg. Co.	Office Bldg.	Indianapolis, Ind.
555		Superheater tube ruptured			Texas Power & Light Co.	Power Plant	Trinidad, Texas
556	10	Hot water pipe exploded	3	2	Firestone Tire & Rubber Co.	Rubber Works	Akron, Ohio
557		Header failed			Brazos Hotel Co.	Hotel	Houston, Texas
558	11	Crown sheet collapsed		1	Lion Oil Refining Co.	Oil Refinery	El Dorado, Ark.
559		Ammonia condenser pipe failed			Williamson Ice & Cold Stor'ge Co.	Ice. Plant	Williamson, W. Va.
560	12	Boiler bulged and ruptured			Mulberry Ice Co.	Ice Plant	Fort Meade, Fla.
561	13	Three sections heating boiler cracked			Daily News Company	Publishers	San Francisco, Cal.
562	14	Tube ruptured			Woodward Iron Company	Blast Furnace	Woodward, Ala.
563		Boiler bulged and ruptured			Post Bros. Tile Co.	Tile Factory	Dexter, Mo.
564		Boilers (2) exploded	7	3	J. H. Self Lumber Co.	Sawmill	Ninety Six, S. C.
565		Boiler of locomotive exploded	1		Pennsylvania Railroad	Railroad	Cleveland, O.
566	15	Three sections heating boiler cracked			Bertha B. Davidson	Public Garage	Forest Park, Ill.
567	16	Furnace collapsed			Model Laundry	Laundry	Des Moines, Iowa
568		Paper machine drying cylinder exploded	1	6	Crown, Columbia & Williamette Paper Company	Pulp & Paper Co.	Oceans Falls, B. C.
569		Steam pipe exploded		4	Landers, Frary & Clark	Factory	New Britain, Conn.
570		Boiler exploded	1	1		Planing Mill	Oxford, Miss.
571		Header cracked			The Dover Mfg. Co.	Factory	Dover, Ohio
572		Two headers cracked			Planters & Merchants Mills Inc.	Cotton Mill	N'w Braunfels, Tex.
573	17	Boiler exploded	2	2	Naval Experimental Station	Naval Station	Annapolis, Md.
574	18	Steam pipe failed			Southwest Ice & Cold Storage Co.	Ice Plant	Dallas, Texas
575		Fitting in main steam pipe failed			Troy Sunshade Co.	Awning Factory	Troy, Ohio
576	19	Blow-off pipe ruptured			San Martin Canning Factory	Canning Factory	San Martin, Cal.
577	20	Boiler ruptured		1	Imperial Oil & Gas Products Co.		El Dorado, Ark.
578	21	Boiler bulged and ruptured			Madison Ice Company	Ice Plant	Madison, Kansas
579	23	Tube failed			Pittsburgh Crucible Steel Co.	Steel Plant	Midland, Pa.
580	25	Section of heating boiler cracked			Standard Talking Machine Co.	Factory	Pittsburgh, Pa.
581	26	Boiler bulged and ruptured			Coal River Collieries Co.	Coal Mine	Prestonburg, Ky.
582	27	Tube ruptured			Bergstram Paper Co.	Paper Mill	Neenah, Wis.
583		Tube failed			Texas Power & Light Co.	Power Plant	Lufkin, Texas
584	28	Two sections heating boiler cracked			Friedman-White Realty Co.	Apt. House	New York, N. Y.
585		Tube ruptured			Merchants Heat & Light Co.	Power Plant	Indianapolis, Ind.

586	29	Boilers exploded			S. S. Kaikyu	Steamship	Johnson Str't, B. C.
587	30	Eight headers ruptured			J. & J. Rogers Co.	Pulp & Paper Mill	Ausable F'ks, N. Y.
588		Four headers cracked			California Packing Corp.	By-Products Plant	San Jose, Cal.
589		Ammonia tank exploded		1	Hotel Noble	Hotel	Jonesboro, Ark.
590		Tube in water screen ruptured			Narragansett Electric Lighting Co.	Power Plant	Providence, R. I.
591		Tube ruptured			The Majestic Co.	Office Bldg.	Detroit, Mich.

MONTH OF SEPTEMBER, 1926.

592	1	Header cracked			Eastman Kodak Co.	Kodak Factory	Rochester, N. Y.
593	2	Tube ruptured			Pickands Mather & Co.	Iron Works	Erie, Pa.
594		Section of heating boiler cracked			Estate of James Sweeney	Real Estate Office	Tonawanda, N. Y.
595		Section of hot water supply heater cracked			Lewis M. Potolski	Apts. & Stores	Holyoke. Mass.
596	3	Tube sheet ruptured			Birmingham Slag Co.		Bessemer, Ala.
597	5	Boiler exploded		2	Mrs. K. Doner	Rendering Plant	Philadelphia, Pa.
598		Section of heating boiler cracked			Pacific Tel. & Tel. Co.	Exchange Bldg.	Oakland, Cal.
599	6	Section of heating boiler cracked			Harry Shipton	Boarding House	Pittsfield, Mass.
600	7	Furnace flue collapsed			Kane Dairy Cooperative Assn.	Dairy	Kane, Pa.
601		Tube ruptured		1	Patillo Lumber Co.	Planing Mill	Atlanta, Ga.
602		Header cracked			Samuel Merritt Hospital	Hospital	Oakland, Cal.
603		Boiler ruptured			T. B. Cook	Cotton Gin	Way, Wis.
604	8	Blow-off pipe ruptured			Winters Canning Co.	Cannery	Suisun, Cal.
605		Inner shell of jacketed vessel failed			C. W. Swingle & Co.	Rnedering Plant	W. Lincoln, Nebr.
606	9	Manifold of hot water heating boiler cracked			Bierer-Shadel Mercantile Co.	Dept. Store	Hiawatha, Kans.
607		Boiler ruptured			Birge-Forbes & Co.	Cotton Gin	Kingston, Okla.
608		Boiler exploded	2	2	H. M. Elam	Sawmill	Selma, Ala.
609		Mud drum of boiler exploded	3	2	Rees & Rees	Cleaners	New York, N. Y.
610		Sections of heating boiler cracked			Saginaw Board of Commerce	Office Bldg.	Saginaw, Mich.
611		Section of heating boiler cracked			Philip Greenberg	Dept. Store	Omaha, Nebr.
612	10	Section of hot water heating boiler cracked			Smith College	College	Northampton, Ms.
613	11	Boiler exploded	1	2	Shields-Geise Lumber Co.	Lumber Mill	Dawson, Ga.
614		Air tank exploded	1		No. 130 Clinton Ave. N	Candy Store	Rochester, N. Y.
615		Section of heating boiler cracked			Mass. Homeopathic Hospital	Hospital	Dorchester, Mass.
616		Section of heating boiler cracked			County of Lawrence	Court House	New Castle, Penn.
617	12	Twelve sections and manifold of heating boiler cracked			Indiana County Commissioners	Poor Farm	Indiana, Penn.

The Hartford Steam Boiler Inspection and Insurance Company

HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1926

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks		$684,103.09
Real Estate		267,631.53
Mortgage and collateral loans		1,523,106.20
Bonds and stocks		12,646,007.33
Premiums in course of collection		1,290,539.98
Interest Accrued		150,884.92
Total Assets		$16,562,273.05

LIABILITIES

Reserve for unearned premiums		$7,318,478.72
Reserve for losses		452,318.90
Reserve for taxes and other contingencies		770,028.22
Capital Stock	$2,500,000.00	
Surplus over all liabilities	5,521,447.21	
Surplus to Policyholders,		**$8,021,447.21**
Total Liabilities		$16,562,273.05

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WM. R. C. CORSON, President and Treasurer.

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The Locomotive

Devoted to Power Plant Protection

Published Quarterly

Vol. XXXVI. HARTFORD, CONN., OCTOBER, 1927. No. 8.

Ammonia Generator Explosion at Philadelphia, Pa.

THERE IS VALUABLE INFORMATION
FOR YOUR ENGINEER IN THIS MAGAZINE
PLEASE LET HIM SEE IT.

Explosion of Generator in Absorption Refrigerating System

AN autogenously welded generator in the absorption refrigerating system at the Stenton Park branch of the Scott-Powell Dairies, Philadelphia, Pennsylvania, exploded July 29, 1926. Four persons were injured, one of them fatally, and the portion of the building that had housed the refrigerating plant was razed. The property loss was estimated at $15,000. A general view of the scene shortly after the accident is shown on the front cover.

Fig. 1.

The tank that exploded was 43 inches in diameter by 10 ft. long, and was 7/16 inch thick. The heads were of the convex, or plus, type, approximately 17/32 inch thick. They were flanged and fitted inside of the shell, the turn of the flange being then welded to the end of the shell. Figure 1 shows a duplicate of the exploded vessel that was part of a standby unit. The exploded vessel was of autogenously welded construction throughout, all longitudinal and girth seams having been made by that process. It had been installed about five years previously. It was equipped with a safety valve. The operating pressure varied from 150 to 225 lbs.

The cause of the accident is not known, but it is believed to have been due to failure of a welded seam at ordinary working pressure. One head blew out, the separation taking place entirely in the weld.

The explosion occurred about 4:50 A. M., approximately half an hour after twenty-five or thirty drivers had loaded their milk wagons and left the plant with the morning delivery. Because of this, the refrigerator was empty, and the plant was not operating at its full capacity. Yet the explosion was extremely violent, as can be observed from the picture. The refrigerating machinery was located in the basement at the left-center of the picture, under the debris at the edge of the partition which is lying flat in the foreground with pipe coils attached. The building was completely destroyed, and the 500 gallon water tank on the roof of the adjacent building was left in a pre-

FIG. 2.

carious position such that it had to be immediately removed to overcome the danger of its falling. Heavy steel beams were blown 200 ft. away, into the park across the street, and telephone and electric wires in the adjoining streets were carried away. The shell of the generator was driven through an 18 inch stone basement wall and into the earth embankment beyond.

Explosion of Ammonia Condenser in Compression Refrigerating System.

The failure of another autogenously welded ammonia vessel occurred July 18, 1927, at the plant of the Seventh District Ice & Manufacturing Co., Ltd., New Orleans, Louisiana. One man was seriously injured, and a property loss of approximately $15,000 was sustained. Fig. 2 shows part of the damage to the building. In addition, four nearby residences were damaged.

The vessel that exploded was a shell type ammonia condenser, part of a 40 ton compression type refrigerating system. It was 38 inches in diameter by 18 ft. long, and was constructed of 1/2 inch plate, in two courses. The heads were connected by a number of 2 inch tubes. An idea of the general construction of the condenser may be obtained from Fig. 3. Cooling water passed through the tubes and ammonia surrounded the tubes. One course of the shell was blown off, the rupture following the longitudinal and girth seams so that the plate opened out flat without any tearing. The rest of the vessel remained practically intact. Fortunately it had been installed out-of-doors, so the property loss was not as great as it undoubtedly would have been had the condenser been located inside of the building.

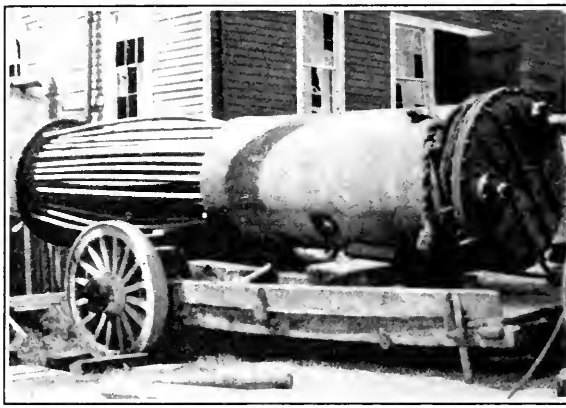


FIG. 3.

The cause of the accident is not definitely known. The vessel is said to have been operating under normal conditions when the explosion occurred, about 4 o'clock in the morning. The engineer, who was seriously injured, was standing nearby. It has been suggested that the circulating-water pump might have stopped or gotten out of order and thus cut off the water supply, allowing an excess pressure to build up in the condenser shell. Another possible cause, in view of reported condition of the welded seams, is that the failure started in one of these seams. The vessel had been in use for 12 years. The operating pressure was 170 pounds.

Neither of these tanks was insured with The Hartford Steam Boiler Inspection and Insurance Company, which has always questioned the advisability of depending on autogenously welded seams in vessels subjected to such high working pressure.

Prevention of Air Tank Explosions.

By Geo. H. Stickney, Sup't. Boiler Department.

AIR tank explosions are due to a great variety of causes, some of which are common to all pressure vessels, while others are peculiar to compressed air systems. The fault may have been in the original design, or a defect that gradually appeared, or the result of improper operation, but whatever the cause, frequent inspections would go a long way toward reducing the number of such accidents. The services of an inspection-insurance company are of inestimable value in this work, but its efforts should be backed up, first, by proper installation, and afterwards by care and observation on the part of the men who are operating the system.

The air tank or receiver is most frequently the seat of the explosion, but attention to this vessel alone will not greatly reduce the hazard. The system as a whole must be considered — tanks, compressors, and piping — and when any part of the system is dismantled for repairs, the opportunity of examining that part should be taken full advantage of. The internal inspection of a tank should be as thorough as possible and should include complete dimensions for computing the maximum safe working pressure. Should the system be in operation and the tank under pressure, it may not be possible to obtain these necessary data, but at least some approximation should be made and checked against the observed working pressure to ascertain the probable factor of safety.

Internal Examination Essential.

If the tank can be entered or the inside seen through openings, the interior of the shell should be carefully examined for evidence of cracks, general corrosion, pitting, and the presence of oil, water, or other deposit. If there are no openings and no pipe fittings of sufficient size that can be dismantled for the purpose of interior examination, hand holes of ample size should be cut into the vessel, the number of holes depending upon the size of the tank. Special attention should be paid to the possibility of finding internal corrosion on the bottom of the vessel, or cracks at the turn of the head flanges. The bottom heads of vertical tanks and the lower portions of heads of horizontal tanks should be given particular attention.

All air tanks should have a blow-off connection fitted to the lowest part of the vessel, and it should be used at least daily in order to prevent the accumulation of oil and water. Vertical tanks should be installed with the " plus " head at the bottom to afford complete drainage. A safety valve, or valves, of proper construction and size and set at the maximum allowable pressure should be installed so as to properly protect the tank or system. A device commonly known as an unloader, which governs the pressure by controlling the air supply, is not by itself considered sufficient protection against overpressure.

Safety valve sizes are based on the allowable pressure and the maximum commercial rating of the compressor in cubic feet per minute of free air at sea level. This capacity is reduced about 3% for every 1,000 feet increase in altitude. The maximum commercial rating is taken as the displacement in cubic feet per minute at the maximum speed of the compressor. In a multiple stage compressor the capacity of the large or low pressure cylinder, handling free air taken from the atmosphere, is alone considered.

The following table showing maximum air compressor ratings in cubic feet per minute for different sizes of safety valves at stated pressures is taken from the Massachusetts Air Tank Regulations and can be used in the absence of local regulations:

MAXIMUM AIR COMPRESSOR RATINGS FOR DIFFERENT SIZES OF SAFETY VALVES.

Diameter of Valve (in.)	Gage Pressure (Pounds)							
	50	100	150	200	250	300	350	400
¼	—	—	—	—	—	—	—	53
½	20	32	42	51	59	67	74	111
¾	37	59	78	96	112	127	141	176
1	58	94	124	152	178	202	224	248
1¼	84	135	180	221	259	293	325	—
1½	114	186	248	302	354	400	444	—
2	189	306	410	501	592	668	741	—
2½	282	457	613	750	880	998	1114	—
3	393	638	856	1050	1230	1398	1557	—

Diameter of Valve (in.)	Gage Pressure (Pounds)							
	500	600	800	1000	1200	1600	2000	2400
¼	61	70	84	97	109	128	147	160
½	129	147	177	205	230	270	304	330
¾	224	232	242	346	386	423	474	518
1	286	324	390	450	500	586	—	—
1¼	374	—	509	—	—	—	—	—
1½	472	—	634	—	—	—	—	—

Close investigation should be made for improper repairs, particularly by the autogenous method of welding. The welding of the seams should be in accordance with the Unfired Pressure Vessel Code of the American

Society of Mechanical Engineers. Brazed seams are quite generally used with apparent freedom from failure. It is believed, however, that brazing of plates over ⅜ inch thick should not be practiced. Brazed seams can be distinguished by the brassy appearance of the surface when scraped.

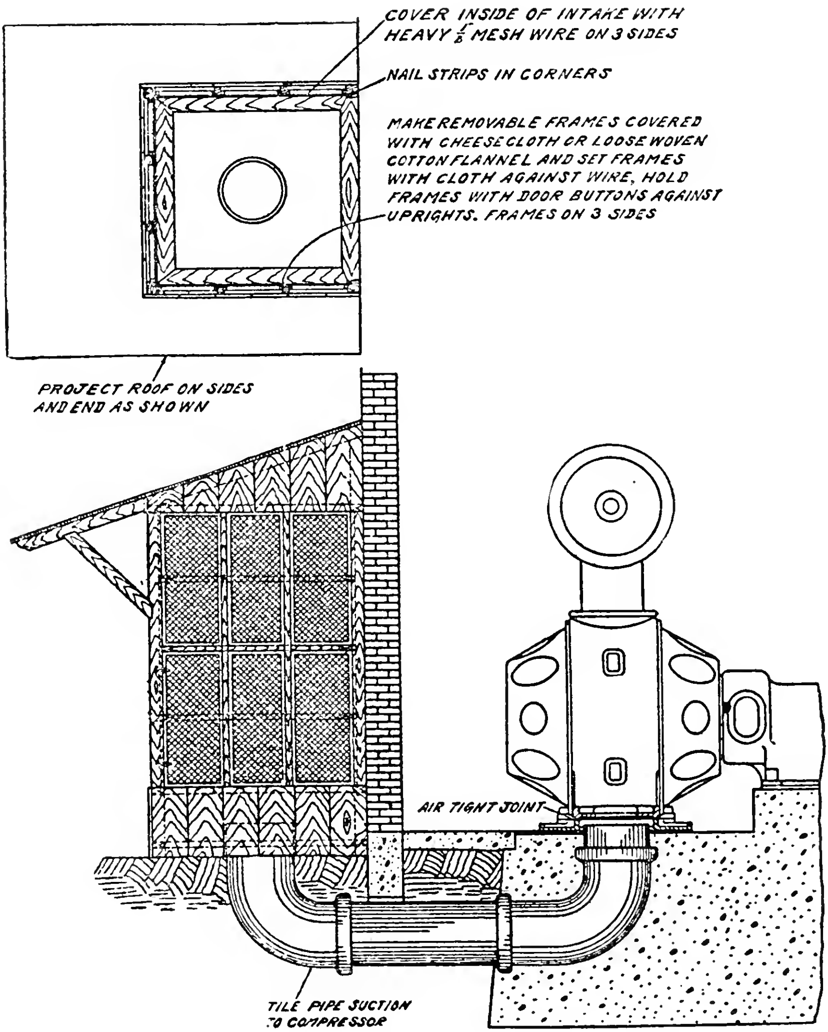
Compressed air tanks should never be buried under ground or installed in inaccessible locations. At least 12 inches of space should be left all around the tank to facilitate inspection.

The use of the proper kind and amount of oil in the compressor cylinder has a very important bearing on the prevention of explosions in air tanks and connecting pipe lines. Mineral oil only should be used, and the proper grade of such oil for service in an air compressor should be specified by some reputable oil company making that particular kind of oil. It should be borne in mind that much less lubrication is required in air compressors than in steam engine cylinders. Too much oil may lead to greater difficulties than an insufficient amount. The subject of Air Compressor Lubrication was considered at some length in the April 1924 issue of The Locomotive.

Control of Air Temperature Important.

Aside from over-pressure in the tank (due to poor design, cracks, corrosion, lack of safety valves or inoperative safety valves), temperature control of the air leaving the compressor is perhaps most important for the prevention of explosions. Many explosions in compressed air systems have been attributed to the high temperature of the air, causing ignition of combustible matter in the pipe lines or receivers. It is essential to have sufficient clean cooling water from an unfailing source circulated through the coolers and jackets of the compressor cylinders so that the temperature of the discharge air is not materially above that of the surrounding atmosphere. With multiple stage compressors, intercoolers between the cylinders and an aftercooler between the high pressure stage and the tanks are usually found necessary, not only to reduce the temperature of the air but also to condense any water vapor and create a dry condition of air for service.

Other causes for high temperature are leaky compressor suction valves and pistons, mud or other deposit filling up the jacket space or adhering to the walls of the cylinders and coolers, hot and dirty inlet air, and high speed of compressors too small for the service required. Still another cause is operating with the jackets only partly filled with water. The pipe lines leading to the water jackets and coolers are usually fitted with stop valves on both the inlet and outlet connections and the flow is often regulated by the inlet valve, but this is poor practice. If the inlet valve is only slightly opened and the discharge valve opened wide, it sometimes happens that the coolers and jackets are only



From *Trade Standards* of the Compressed Air Society

Fig. 1.

partly filled with water due to the water running out faster than it is fed. On the other hand, if the inlet valve is kept wide open and the discharge valve used for regulation, the cooling spaces will be completely filled with water, lower air temperatures will be maintained, and, by keeping the air out of these spaces, corrosion will be reduced. Of course, where there is an open jacket, the jacket is full of water at all times and the regulation must be by means of the inlet valve. A good way to make sure that a constant flow of water is passing through the cooling system is to have the discharge in the open where it is readily and conveniently visible.

The end of the compressor air intake pipe should be located in a place where clean suction air is available. It is advisable to install an air filter or screen over the end of the pipe for protection against the drawing in of dust, smoke, and other material which may be combustible. Air filters should be regularly cleaned and otherwise maintained in good condition. A simple form of air cleaner recommended by the Compressed Air Society is shown in Fig. 1. Quoting from *Trade Standards* of the Society:—

"[It] consists of a wooden frame box made with removable panel frames covered with heavy ½ inch mesh wire to which cheese cloth or loosely woven cotton flannel is tacked. The cheese cloth takes up all the heavy particles of dust and foreign matter, and when the cloth gets completely covered it should be renewed with new cloth. Ample screen area should be provided, at least 1 square foot of surface per 25 cubic feet per minute free air capacity of the compressor. With this amount of surface there will be no appreciable loss of pressure in the air going to the compressor."

Use of Water Tanks for Air Receivers is Dangerous.

The ordinary kitchen variety of hot-water-supply tanks, sometimes called "range boilers," are frequently used as air tanks particularly in garages. As these tanks are intended for water containers only, they are not constructed with a sufficiently high factor of safety for use with compressed air, and should not be so used.

Since it is hoped this article will come to the attention of many users of compressed air, it may not be amiss to call attention to a misuse often made of air under pressure, that is, the initial testing of tanks with air instead of water. Tanks, particularly when they are to hold valuable liquids such as gasoline, are specified to be air tight at a certain pressure. This necessitates testing the tank under air pressure, but the air test should not be made before the tank is hydrostatically tested for strength. Explosions of tanks while under test pressure are not infrequent, especially in boiler shops, and they are usually attended by fatalities because workmen are in close proximity to the vessel looking for, or caulking, leaks. Several such cases have been previously reported in The Locomotive.

It is not uncommon to find kerosene oil used for cleaning compressed air systems. This practice should be discontinued because the volatility and ease of ignition of kerosene predisposes toward a combustion explosion. Full details of a recommended method of cleaning the system by use of a soap solution are given in the article previously mentioned as appearing in the April 1924 issue.

Fusible plugs are recommended, and one should be installed on the receiver and one on the discharge pipe as near the compressor cylinder as possible.

The states of California, Massachusetts, and Minnesota, and the cities of Detroit, Chicago, and Omaha have air tank laws and rules.

State Boiler Laws.

THE extreme complexity of boiler legislation throughout the various states can hardly be appreciated by one who has not made a study of the subject as a whole. Most boiler manufacturers are well posted, particularly with regard to the states in which they find a market for their product, but persons or firms not directly interested in the manufacture or sale of boilers, though interested as users, are not always aware of existing boiler legislation and may sooner or later run afoul of the law. This is particularly true of contractors, who are moving portable equipment from state to state as the need may arise, and of purchasers of second hand boilers. Used boilers that meet the standards of one state do not necessarily meet those of another. For instance, some states do not permit the installation of used boilers from outside territory unless the boilers are built and stamped in accordance with the A. S. M. E. Power Boiler Code, or are built to the particular rules of the state, as in the case of Massachusetts. Great expense may at times be incurred in moving such equipment only to find on its arrival that it cannot be operated, due, perhaps, to some detail of its construction. Incidents of this kind are of more frequent occurrence than one is likely to credit offhand.

This article is offered as a suggestion — one might almost say as a warning — to the firm contemplating the removal of a pressure vessel from one state to another that steps be taken to obtain in advance authoritative approval for operation of the particular vessel in the desired state. Ignorance of the law is no excuse, and action contrary to law always carries with it the stigma of probable intentional evasion.

It is impossible to lay down in a brief and general article of this kind the detailed steps to be taken to receive approval of state or municipal authorities, because the procedure varies in the case of almost every state. In some jurisdictions compliance with a certain code is necessary, a matter that can be checked up by a qualified person. In others it is a matter of the judgment of one man or of a governmental bureau or commission. One way to obtain the necessary information is to address an inquiry to the Chief Boiler Inspector of the state or municipality into which the boiler is to be moved. Such official is usually located in the Municipal Building, in the case of a city, or in the State Capitol, in the case of a state. A trip of inspection by an official inspector may be necessary before receiving the desired approval for operation.

The National Board of Boiler and Pressure Vessel Inspectors is an organization of state and municipal inspectors which has for one of its objects the promotion of interchangeability of such vessels between the political subdivisions of the United States. National Board stamping is acceptable in many states and cities, and often facilitates obtaining approval for operation.

The easiest way to arrange for the transfer of a pressure vessel is to put the matter up to your boiler insurance company. If such company has a well distributed corps of boiler inspectors, the expense of securing definite approval or disapproval will be a minimum, time will be saved, and the details in connection with the transfer will be lifted from the shoulders of the owner.

For convenience, a list of the cities and states having boiler laws at the present time is given below, but this list, of course, is subject to change at any time. All of these, with the exception of the State of Massachusetts, have accepted the American Society of Mechanical Engineers Boiler Construction Code. Massachusetts has adopted its own code.

States That Have Adopted Boiler Laws

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Massachusetts	Oregon	Panama Canal Zone
Michigan	Pennsylvania	Territory of Hawaii
Minnesota		

Cities That Have Adopted Boiler Laws

Chicago, Ill.	Memphis, Tenn.	St. Joseph, Mo.
Detroit, Mich.	Nashville, Tenn.	St. Louis, Mo.
Erie, Pa.	Omaha, Neb.	Scranton, Pa.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.
Los Angeles, Cal.	Philadelphia, Pa.	Tampa, Fla.

Boiler of the Steamship "Beaver".

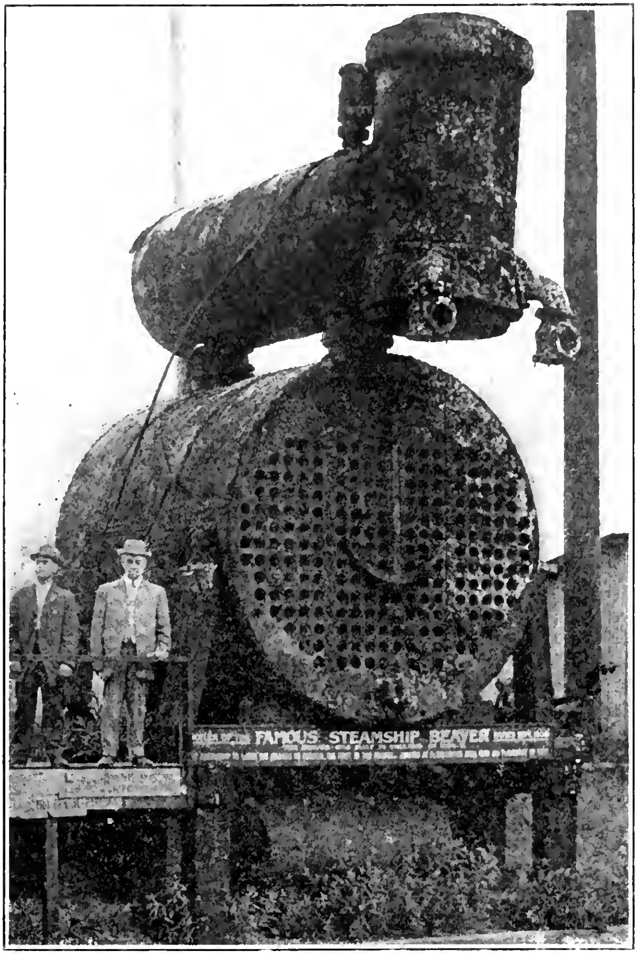
THE accompanying picture shows an ancient marine boiler which will undoubtedly be of interest to many of us, particularly those of maritime inclinations, because of the history of the vessel in which it saw service. As can be observed by the sign displayed in the photograph, the vessel known as the "Beaver" is credited with a trans-Atlantic trip and is further credited with being the first steamship to round Cape Horn and the pioneer in the Pacific Ocean.

The vessel was built in Blackwall, London, England, in 1834. The engines and boilers were installed by Bowlton & Watt, weighed 63 tons, and cost $22,000. As the early log of the vessel speaks of "wooding up", it was undoubtedly a wood burner, externally fired, probably with a Dutch oven such as we encounter today. It is further interesting to note the superheater section, which formed a part of the uptake and is quite prominent in the photograph. The length of the "Beaver" was 101 ft. 4 inches; the breadth was 20 ft. inside of the paddle wheel boxes and 33 ft. over all; the depth was 11 ft. 6 inches. The vessel was registered as of 109 tons, and is said to have carried a crew of 26 men and to have been armed with 5 nine pounder guns.

The "Beaver" sailed from England August 29, 1835, for the Pacific Ocean by way of Cape Horn, arriving at the Island of Juan Fernandez (Robinson Crusoe's Island) on December 17, 1835, and at the mouth of the Columbia River on April 4, 1836. The vessel evidently had a long career on the Pacific for it is reported to have sunk in Burrard Inlet, Vancouver, B. C., on July 26, 1888. The boiler remained in salt water until September, 1906, when it was raised and brought to the Washington State Historical Society at Tacoma, where it is now on exhibition.

The first trans-Atlantic steam vessel was the "Savannah," which crossed the ocean in 1819, requiring 26 days for the trip. The "Savannah," however, is generally discounted as the first "steamship" because the engines were merely for auxiliary power in quiet waters and in docking. Her paddle wheels could be rapidly disassembled and brought on deck when not in use. It is of interest to note in passing that the

"Savannah" was entirely an American vessel, having been financed, built, and engined in the United States, and sailed on this historic voyage from the port of Savannah, Georgia.



Boiler of Steamship "Beaver"

The "S. S. Curacao" of the Royal Netherlands Navy is said to have sailed, or rather steamed, from Holland to the Dutch West Indies in April, 1827, and to have made additional trips in 1828 and 1829.

In 1833 the Canadian steamer "Royal William" left Quebec for England, and by continuing the service became the first trans-Alantic liner. Because of indifferent financial returns, the vessel was later sold and the service discontinued.

In 1838 the "Sirius" made a trip from London to New York in 17 days, and was followed shortly after by the "Great Western," which made the trip from Bristol, England, to New York in 15 days.

Well Water Used to Cool Minneapolis Auditorium.

AT some period in our youth we have all doubtless been amused, and perhaps perplexed, by the story of the man blowing "hot" to warm his hands and blowing "cold" to cool his soup, but man is no more versatile than is Mother Nature, for we now read that well-water is used to heat one building and to cool another. In a previous issue of THE LOCOMOTIVE it was noted that, according to *The Valve World,* the high school building at Pagosa Springs, Colorado, is heated with natural hot water from an artesian well 350 ft. deep. The temperature of the water was not stated, but it was explained that it was not as high as would ordinarily be used in a heating system and therefore approximately double the usual amount of radiation surface would be required.

We now read, in *Ice and Refrigeration,* that the new Minneapolis Municipal Auditorium, with a combined seating capacity of over 18,000 people, is to be cooled in summer with well water. The water is to be pumped from two artesian wells 800 ft. deep, its temperature being 50° F. The refrigerating effect that will be obtained from the cold well-water used in the air supply systems, aggregating 413,000 cu. ft. per minute capacity, will amount to the equivalent of 1,000 tons of ice melting per day, an astounding quantity. Quoting from the article:—

"It is difficult to comprehend the significance of this figure until one stops to think that if ice had to be used to maintain the spray water at 50° F., instead of drawing upon the bounty of Nature, the amount of ice required would be sufficient to supply the normal requirements of a population of 250,000 people, or the combined population of the following Illinois cities: Peoria, Springfield, Joliet, Oak Park and Evanston, in extreme summer weather.

"The volume of water pumped from the wells will be at the rate of 3,000,000 gallons per day; a quantity sufficient for the water supply for a city the size of Belleville, Illinois. It might be remarked in passing that it would take the entire output of ten ice plants of the size needed to meet the requirements of the same city in hottest weather."

This auditorium is of further interest because of several other unusual features, such as the use of ozone to maintain the visibility and freshness of the air by clarifying it of the smoke and odor of burning tobacco, and the arrangements for tempering and humidifying or dehumidifying the air so as to at all times have a comfortable "effective temperature" depending upon outside conditions, such that the contrast of entering or leaving the building will not be unnecessarily distressing.

The Early History of Iron and Steel.

BECAUSE of the rapid strides made in recent years by the iron and steel industry, we are likely to think that the discovery of the methods of working this indispensable metal is of comparatively recent origin. It is now generally conceded, however, that the use of iron may have antedated that of copper and bronze. Many have ascribed the comparative absence of iron implements in the uncovered ruins of ancient civilizations to its great susceptibility to corrosion, but others maintain that some evidence of its presence should remain even though the original implements have disappeared. Many Biblical and ancient historical references indicate that iron was a very valuable substance, highly prized, the spoil of conquering monarchs, and comparable in value to gold, silver, and bronze. It was necessarily very rare at first, and what was available was undoubtedly put to use as tools, particularly for implements of war and other outdoor uses and not hoarded in treasure houses, which probably accounts in part for its absence from tombs and other sources of relics.

The first historical reference to iron or steel is, undoubtedly, that made in the fourth chapter of Genesis to Tubal Cain as the instructor of every artificer in brass and iron. Bearing in mind the recent improvements in the manufacture of iron and steel, it is interesting to consider what small progress was made in the intervening centuries since this member of the sixth generation in descent from Adam plied his trade.

Source of First Iron Unknown.

There is a question as to the source of the earliest iron. By some it is thought to have been of meteoric origin, while others maintain that such iron is not malleable and therefore could not have been successfully forged. At some very early date, however, it was unquestionably extracted from the ores as indicated by the widespread knowledge and use of this metal, and it is interesting to ponder on the accidental way in which the source and methods of extraction must have been discovered. Most likely a fire built on a bed of ore, or perhaps the accidental introduction of a lump of ore in a fire, resulted in a lump of iron. It is said that the natives of the island of Crete learned from a forest fire in the 15th century, B. C., that the ores of their island would make iron.

The earliest workers of iron on an appreciable scale are believed to have been the Assyrians of Western Asia, the Ethiopians of Eastern Africa, and the Hindoos of India. Egyptian relics and paintings in the tombs indicate that this people was familiar with its use, and even indicate that a bellows was used in forging as early as 1500 B. C. Indirect evidence of this knowledge on the part of the Egyptians is given by their works in granite and porphyry, as it is held by authorities that these hard stones could not have been worked without ferrous alloy tools. The Egyptians, however, are believed to have obtained their knowledge and perhaps most of their tools from neighboring peoples, probably through the Phoenicians. It is not clear whether the Phoenicians were artificers to any extent or whether they merely secured their products in trade, but this maritime race is credited with spreading the knowledge of the uses of iron if not of its processes of manufacture, as practically all of the peoples of Asia and Northern Africa are known to have been acquainted with it long before the Christian era. In fact, the origin of the iron bed industry might be credited to Og, King of Bashan, about 1450 B.C., who history records owned such a bed. Just what form the famous bedstead of this monarch took is not clear, but it is safe to assume it was nothing like the imitation walnut of today, nor even the white enameled, barred affair of yesterday.

Greeks and Romans Practiced Steel Treating.

In Homer's time about 900 B. C., steel must have been in wide use among the Greeks and its hardening and tempering well understood, for the poet makes use of a simile that must have been generally understood when he likens the hissing of the stake that Ulysses drove into the eye of Polyphemus to that of the steel which the smith quenches in water, and he incidentally mentions the strengthening effect of this quenching. The Romans likewise were workers in iron, using it to a large extent in their military equipment. They are further credited with a knowledge of the relative values of different baths for hardening steel.

The steels of India, Persia, and Spain have at different periods been famous. The traditional blades of Damascus were made of Indian and Persian steels, while Hannibal's victory over the Romans at Cannae was attributed to superior Spanish swords. The Catalonian forge, used for centuries in many parts of the world for the reduction of iron ores, obtains its name from the province of Catalonia, Spain, where it originated.

Samples of the ferrous metals produced in ancient times are rare, but some are in existence. Explorations in 1837 around the Great

Pyramid of Gizeh revealed a small piece of iron used in one of the inner joints of the structure, which dates back to approximately 4000 B. C. It is said to have been preserved because iron rusts very slowly in the dry climate of Egypt.

Delhi Pillar a Metallurgical Mystery.

In India the science of the metallurgy of iron must have attained a high degree of perfection, probably because the lack of copper caused a certain amount of specialization. At Delhi there still stands an iron pillar that has stood for 1600 years, seemingly rustless. This pillar is approximately 12-½ inches in diameter at the top and 16-½ inches in diameter at the bottom, is 24 ft. high, and weighs nearly 7 tons. The upper section, for a distance of 4 ft. from the top, is elaborately carved and fluted. This memorial to the metallurgical skill of the third century A. D. has caused much speculation as to how it was manufactured without the heavy machine tools and steam hammers of today. Furthermore, its resistance to corrosion is very much of a mystery. Sir Robert Hadfield recently secured a sample of the pillar for analysis and to have microphotographs made, the results of which were reported in the November 26, 1925, issue of the *Iron Trade Review.* The analysis shows the following composition:— Carbon, 0.08; silicon, 0.046; sulphur, 0.006; phosphorus, 0.114; manganese, nil; and nitrogen, 0.030 per cent; total 0.276 per cent; iron 99.700 per cent; total 99.976 per cent.

In the article in the *Review* mention is made of a possible reason advanced for the resistance of the pillar to corrosion — that the natives each year hold a religious ceremony at the pillar and anoint it with a fatty, edible substance known as "butter." This point, however, was still subject to verification. It is interesting to note, in passing, that a portion of the fragment obtained for analysis failed to rust but remained bright when exposed for days to the atmosphere of the laboratory, though when a drop of water was allowed to stand on it overnight a rust spot resulted.

Another similar pillar of about the same age, according to a Hull (England) Board of Trade Bulletin, is in existence at Dhar, Central India; and the Black Pagoda at Kanarak, dating back to the 13th century A. D., contains twenty iron beams, the two largest of which are respectively 23 ft. 6 inches long by 10-½ inches square, and 35 ft. long by 7-½ inches square, weighing respectively 8,000 and 6,000 lbs.

An extremely interesting description by an eye-witness of what an ancient iron extraction plant must have been like is given in an article in *Engineering* (London), volume 79, page 28, entitled "A West

African Smelting-House," by C. V. Bellamy. The article describes, with many illustrations, an iron industry carried on by a primitive people which shows no evidence whatever of outside influence and which must employ methods very similar to those of the ancients.

Hardened Copper.

A Recovered Art.

THERE exists, on the part of those not intimately connected with the working of copper, a belief that the ancients had a method of hardening that metal, with which art we today are not familiar. The fact of the matter is that our present-day metallurgists not only understand how the ancients hardened their copper and bronze, but also know how to produce copper and bronze products that are even harder than those left to us and which represent the evidence of the so called lost art of hardening copper.

Cutting edges developed on swords, daggers, knives and other implements by the ancients were obtained by hammering the metal, or, in other words, cold-working. Those old metal-workers not only hand hammered their copper implements but also used the same means to harden their bronze articles. The heating of many of these products in open fires resulted in the formation of considerable copper oxide, which alloyed with the copper and hardened it. One of the most common mistakes of persons claiming to have rediscovered "the lost art of hardening copper" is to heat it in a forge and in this way saturate it with copper oxide, which combines with the copper to form a much harder and much more brittle product.

There are really two methods of hardening copper that are regularly practised nowadays, just as centuries ago. One consists in alloying the copper with some other metal or several other metals such as zinc, tin, nickel, cadmium, chronium, cobalt, silicon, aluminum, iron, beryllium and arsenic. The second method consists in cold-working the metal or copper alloy. In fact, it is possible to work the metal to such a stage of hardness that a slight amount of additional work will cause it to break. The explanation of all copper hardening may be attributed to one of these methods or a combination of them.

Microphotographs of an ancient copper spearhead indicated that it was extremely hard and that apparently this hardness had been obtained by cold working.

Copper scissors, knives and other cutting tools may be obtained. Unless, however, a special reason exists for their use, they offer no advantages over tools made from steel. Occasionally, however, it becomes necessary to use copper or bronze tools, such as knives. Around a powder plant, for instance, where all sparks must be avoided, bronze knives are almost essential.

The actual hardness of annealed commercial copper as determined by the Brinell machine (an instrument for measuring the hardness of substances) is from 40 to 50. The hardness of cold-worked pure copper probably does not ever exceed 120 Brinell. The hardness of copper that has been alloyed with some other metal or a number of metals but rarely exceeds 250 Brinell, although a hardness just over 300 has been attained as an upper limit. As a basis of comparison for readers unfamiliar with measurements of the hardness of metals, it may be stated that the Brinell hardness of very " soft " iron is around 80 and of steel used in common cutlery, such as in a finished pocket knife, about 420 Brinell.

Not only do many persons spend a short while endeavoring to rediscover an art that never was lost, but some of them devote a whole lifetime to this effort. The tragedy, or rather, the denouement, occurs when they have evolved a hard copper. They next endeavor to find some use for it and then learn that, unless it has some special properties, no market exists. Copper wire, hard drawn, has a tensile strength of about 65,000 pounds per square inch and an elongation in 10 inches of about one per cent, with a conductivity of about 97 per cent. This affords some basis on which to work when endeavoring to develop the hardening of copper. If, for example, it were possible to harden copper so that the tensile strength were materially increased above that just stated, without reducing the conductivity, a worthwhile discovery would have been made.

Some recent methods of hardening copper by alloying have, to a certain extent, come about as near to actually " tempering " copper as would seem possible. In these methods the metal, silicon, plays a most important part because it forms silicides with other metals which in turn form eutectics with the copper. The deoxidizing effect that silicon by itself exerts plays no unimportant part in finally allowing the metal to be worked and by heat treatment to develop a high strength, with a relatively high conductivity. This latter, however, is considerably below that of pure copper and second only, speaking of alloys from the standpoint of both strength and conductivity, to those of copper and cadmium. Alloys of copper with cadmium give, for a stated conductivity, higher strengths than those with silicon. — *Research Narratives No. 128, Engineering Foundation.*

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

BENJ. C. CRUICKSHANKS, Editor.

HARTFORD, OCTOBER, 1927.

SINGLE COPIES *can be obtained free by calling at any of the company's agencies.*
Subscription price 50 cents per year when mailed from this office,
Recent bound volumes one dollar each. Earlier ones two dollars.
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Our Sixtieth Anniversary

ON the opposite page appears a reproduction of the first page of the first issue of THE LOCOMOTIVE, from the date of which it will be noted that the present issue marks its sixtieth anniversary. THE LOCOMOTIVE, we believe, is the oldest house organ that was started as such and has been continuously published without interruption. The first issues contained but four pages, approximately letter size, and appeared monthly. In 1880, however, the page was reduced to its present size, the number of pages increased, and the volume renumbered Volume 1, New Series. Later the magazine became a quarterly, and the issues for each two years constituted a volume.

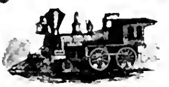
On the editorial page of the first issue the "raison d'etre" is set forth as follows:

> The object of this paper is to bring before the public from time to time, information of a scientific and practical nature that will be both entertaining and useful, and although we shall aim in each number to furnish our readers with at least one good article in some one of the branches of natural science, our chief object will be to discuss practical questions, and more

The Locomotive.

Vol. I. HARTFORD, CT., NOVEMBER, 1867. No. 1.

The Locomotive



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HARTFORD

STEAM BOILER INSPECTION AND INS. CO.

Incorporated by Special Act of the Legislature of Connecticut, to Insure Property against

Loss or Damage,

ARISING FROM EXPLOSIONS OF

Stationary, Marine and Locomotive Boilers.

SEE ADVERTISEMENT ON LAST PAGE.

From the Mechanics' Magazine.

WYLAM, THE CRADLE OF THE LOCOMOTIVE.

There are not many villages on Tyneside that present so uninviting an aspect at first view as Wylam. A stroll up and down its streets, for it can boast streets, and a High Street too, does not mend matters. What the village is to-day it has always been, except perhaps during the short interval when the blast furnace and iron-works were fully employed. Then the place presented a livelier appearance, though at the best of times there have not been, perhaps, a hundred more residents in it than now. It may not be uninteresting to present our readers with a few particulars of Wylam—the cradle of the locomotive—which we extract from a recent article in the *Northern Express*. Wylam is distant from Newcastle about eight miles, and lies close to the north bank of the River Tyne. A wooden bridge, resting on stone pillars, between which the stream rushes somewhat rapidly at most seasons of the year, connects the village with the opposite bank, and with the Wylam station of the Newcastle and Carlisle Railway. This bridge was built in 1834, by Mr. Thompson, who also erected the adjacent blast furnaces. Mr. Blacklock was the engineer. The structure is the property of the Wylam Bridge Company. Across it runs a single line of rails for the convenience of the Wylam Colliery, on either side of which rails is accommodation for foot passengers. Wylam is chiefly notable as possessing the first railroad over which a locomotive steam engine successfully travelled. Jonathan Forster, engineer of Wylam Colliery, re-laid the wagon-way in the interval between 1807 and 1811. From 1811 to 1813 Forster conducted experiments at Wylam under the superintendence of Mr. Blackett and Mr. William Hedley, the then viewer of the colliery, having for their end and aim the substitution of steam for horse power on the wagon way. It was at that period that the entire sufficiency of smooth wheels on smooth rails was demonstrated. Forster placed a wagon, smooth-wheeled, on the way, properly ballasted it, and set men to work the wheels by means of windlasses. The trial proved successful, the adhesion of wheel to rail was quite enough to enable the machine to be propelled without slipping. By 1813, the experiments had succeeded, and a patent for a locomotive was taken out in Hedley's name, dated March 13th, in that year. That steam engine, which ran for fifty years between Wylam and Lemington, and was called indifferently by the country people "Puffing Billy" and "The Dilly," is now laid up as a curiosity in Kensington Museum. But a second was built soon after the first, and this "Dilly" has regularly ran on the Wylam wagon-way till within these couple of years, and now stands in the centre of the village ready to get up steam at a moment's notice.

Wylam Colliery, for which these engines were constructed, is one of the oldest concerns in the North of England, and it was here that George Stephenson's father worked as engineman for seven or eight years. Formerly there were more than a score of pits worked in the immediate vicinity, but only two are now used—the Ann Pit and the Haugh Pit, and these have been in operation as sea-sale collieries since the year 1751. The John Pit, on the south side of the river was sunk in 1836, but soon abandoned, as it was found much cheaper to convey coals underground to the north side of the river than to bring them directly to bank. The seams now workable are the high main, or Towneley, the Tilley, the five-quarter, the six-quarter, the yard, and the Horsley-wood or Brockwell. Fire-clay is also found in abundance. The colliery produces 100,000 tons of coal annually, of a kind much prized in the London market. For heat-producing power they are not excelled, and are greatly in request at potteries, and at the Government rifle works at Enfield. Wylam Colliery is occasionally troubled with feeders from the surface, requiring pumping engines of immense power to keep the workings clear of water. One of the engines in use is supposed to be the first built by Bolton & Watt for the North country. It is of 80-horse power, but latterly it has been supplemented by another of 100-horse power, built by Coulthard & Co., of Gateshead. The two combined free the colliery of 1,200 gallons of water per minute, but are capable of pumping 3,000 gallons of water.

The iron-works, which occupy a prominent position in the centre of the village, were formerly worked by Messrs. Bell, Brothers, and at one time produced 130 tons of iron a week. Several locomotives were built at them in the intervals between 1834-1840. The furnaces have now been blown out for a couple of years, but there is some probability that they will soon be lighted again. It may be inferred from what has been already stated that Wylam is not devoid of associations of a very pleasing and interesting character. Beside its connection with the first successful locomotive, it claims to be the birth-place of George Stephenson, whose parents resided for some years in a cottage still standing close to the Wylam wagon-way, and only a few hundred yards distant from the village. In a basement room of this unpretending dwelling was George Stephenson born, on June 9, 1781. It was then, and is yet, known as High Street House. Here, and wandering about the wooden wagon-way which ran in front of the houses, did George spend several years of his early boyhood, doubtless unconsciously imbibing a liking for all that concerned engines and railways from what he was brought into constant contact with in the locality. The Wylam wagon-way is constructed with a gauge of rails three inches wider than common, and is something like five miles in length, running along the banks of the river from Wylam Colliery to the village of Lemington. Until two years ago, both Mr. Blackett and Mr. Bates used this line for their respective collieries, but an unfortunate law-suit anent way-leaves laid it idle, and so it has continued till now. To the north of this line stands Close House, the handsome mansion of the Bewickes, and on the side of an adjoining hill the Throckley Coal Company are just now sinking for coal.

The first steam voyage across the Atlantic was made by the "Savannah" from New York to Liverpool, in 1818. She ran from here to Liverpool, and thence to St. Petersburg, making the entire trip in twenty-six days.

The Bridgeport *Standard* says that a native of Weston, Conn., named Daniel Treadwell, invented railways in 1816. Mr. Treadwell owned a peat bog, and constructed a tram-way of logs, and a car with flanged iron wheels to bring his peat from the bog to his drying ground. This car was drawn by hand.

The Chicago *Tribune* hints that the commercial supremacy of New York is not so assured but that a new and shorter line of transit to the seaboard might affect it seriously. It calls attention to a proposed route to the James river, below Richmond.

The cost of the nearly completed stone bridge of the Hartford and New Haven Railroad over the Farmington River, at Windsor, Conn., is over $60,000, and work will soon be begun on two more near Berlin.

First Page of First Issue of The Locomotive

particularly, *steam power* and its applications. We propose to keep a careful record of all Steam Boiler Explosions, together with such facts and circumstances attending each, as we are able to obtain, and the various theories of Steam Boiler Explosions, with all the obtainable information bearing upon the subject, will be placed in our columns. The range of scientific investigation is so wide, and the field over which it extends, so large, that there can always be found something to interest

> and instruct. Many valuable suggestions by practical men are entirely lost to the public from the want of some medium by which to communicate them. We hope to make this a paper that will recommend itself to every intelligent person under whose notice it may come, and if we succeed in furnishing *light* to any, our labors will be amply repaid.

Analyzing this pronouncement it is surprising to see how closely it has been followed even down to the present time. The "chief object" of discussing "practical questions, and more particularly, *steam power* and its applications" has certainly been followed in the principal articles. Other articles have set forth "the various theories of Steam Boiler Explosions, with all the obtainable information bearing upon the subject"; and still others, we hope, have been "entertaining and useful." The "careful record of Steam Boiler Explosions" has likewise been continuously compiled, and so far as we can learn, this explosion list is the only compilation of such statistics. Letters from our readers would seem to indicate that we have furnished "light" to some.

The name of the publication was undoubtedly derived from the seal of the Company, which had been adopted a year earlier. A locomotive was selected for the seal probably because it was the most picturesque type of steam boiler and represented the most advanced form of steam engineering. Also, on the first Board of Directors were two railroad presidents, a railroad secretary, and a railroad superintendent, and one of the large stockholders was Mr. M. Baldwin, founder of the Baldwin Locomotive Works, all of which may have had an influence in the selection.

As the official publication of The Hartford Steam Boiler Inspection and Insurance Company, The Locomotive has often been quoted as an authority on the subject of steam boilers, and it is hoped to attain the same standing in its recently enlarged field which now includes engines and electric machinery.

Pacific Coast Division.

TO more expeditiously and efficiently handle its growing business in the extreme western section of the country, the Company will on October 1st of this year group its present two departments at San Francisco and Portland into what will be called the Pacific Coast Division. Messrs. H. R. Mann & Company will continue General Agents of the Company for California, Arizona and Nevada as heretofore and the firm of Bates, Lively and Pearson will be responsible for the production of business in Oregon and, for the present, in Washington and Northern Idaho also. Later, the Company plans to open a branch office at Seattle for direct service to the latter two states. The whole coast territory, however, will be under the supervision of a Company official, who, with the title of Superintendent, will have general charge of its interests and activities; will co-operate with its agents in the development of business, and will have authority to promptly decide the many underwriting, adjustment and inspection problems which hitherto have had to be referred to the distant Home Office. It is felt that thus the Company's service to its assured and to its agency organizations will be materially benefited and improved.

The Company has selected Mr. C. B. Paddock for this important position. Mr. Paddock has been Chief Inspector in the Northwest for the past nineteen years, during which he has proved himself not only a capable administrator but also a competent and intelligent underwriter of all branches of engineering insurance. His appointment as Superintendent of the Pacific Coast Division recognizes his ability to serve the Company in a broader field of usefulness and responsibility. Mr. Paddock's headquarters will be at 114 Sansome Street, San Francisco, but the many friends in his old territory may expect his frequent visits to it.

Other changes in the official personnel are announced at this time. Mr. J. B. Warner, who for forty-two years has been our Chief Inspector at San Francisco, retired from that position on July 1st, 1927. During those years he has made many friends for The Hartford and himself among the power users of his territory. His reputation as an expert in the safeguarding of steam boiler operation was early established and has been constantly reflected in the volume of boiler insurance entrusted to his Company. The affection and respect in which he has been and is held by his associates and subordinates is shown in the presentation by them of a gold watch at a dinner tendered him in July in commemoration of his long service. It is a service that has earned relief from arduous duties and responsibilities and, freed from those of his chief inspectorship, it is hoped that many years of useful association with this Company are still before him.

Mr. Lon J. Reed succeeds Mr. Warner as Chief Inspector, the appointment to date from October 1st, 1927. Mr. Reed joined "The Hartford's" inspection force in 1909. Three years ago he was made Assistant Chief Inspector at San Francisco and in that position has been well prepared for the duties he now assumes.

John Bull, Oldest Of Locomotives Steaming Again,

Leaves Smithsonian Museum After 34 Years to Aid B. & O. Celebration.

AFTER 34 years of unbroken rest John Bull is under steam again. The old locomotive, which began his career in 1831, has been removed from the Smithsonian Institution to take part in the centenary celebration of the Baltimore & Ohio Railroad at Halethorpe, Md., from September 24 to October 8. To get the creak out of his joints and feel the steam in his lungs, he has been taken to the Pennsylvania shops at Altoona.

John Bull is the oldest complete locomotive in America today. He was built in the shops of George Stephenson & Son in England for the Camden & Amboy Railroad, one of the units of the present Pennsylvania system. He did continuous service from 1831 till 1865. In 1885 the Pennsylvania presented him to the Smithsonian Institution for exhibition in the National Museum. Seven years later he ran under his own steam from Washington to Chicago to appear in the World's Columbian Exposition, a so-called "last appearance." But like those of actors, John Bull's last appearance refused to be final. The B. & O. has constructed a five mile circular track at Halethorpe and on that the old locomotive will take his place with the other curiosities, ancient and modern, assembled for the exposition. — *Hartford (Conn.) Courant, August 22, 1927.*

[For further details and picture of the above locomotive, see The Locomotive for January, 1922. — Editor.]

"Verboten" is Right.

IN a recent issue of the *Zeitschrift* of the Steam Boiler Inspection and Insurance Company of Vienna, Austria, appears an account of the serious scalding of a fireman due entirely to his own thoughtlessness. It was in a pulp mill, and the boiler blow-off pipe had become stopped up, possibly by some of the pulp having gotten into the boiler. The blow-off pipe was in a trench, and the fireman was in the trench, with the pipe partly dismantled and the valve removed, poking at the pipe with a wire to try and clear it. He was directly in front of the end of the pipe, with pressure on the boiler and no valve in the line. When he suddenly succeeded in poking through the stoppage, the fireman, of course, was very badly scalded. The item concludes with a statement to the effect that repairing pipes in trenches (while they are under pressure) is "verboten."

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF SEPTEMBER, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
618	13	Section of heating boiler cracked			Garford Motor Truck Co., Inc.	Garage	Chicago, Ill.
619		Blow-off pipe failed			Stout Institute	Institute	Menomonie, Wis.
620	13	Miniature boiler exploded			Tingley Heat, Inc.	Store	Brookline, Mass.
621	14	Boiler exploded		3	Sanford & Brooks	Contractors	New Bern, N. C.
622	15	Eight headers cracked			Lehigh Portland Cement Co.	Cement Mill	Bath, Penn.
623		Crown sheet of locomotive collapsed		1	Goodyear Yellow Pine Co.	Railroad	Picayune, Miss.
624		Section of hot water heating boiler cracked			L. Greenshpon	Apt. House	Hartford, Conn.
625		Section of heating boiler cracked			Princeton Hotel Co.	Hotel	Boston, Mass.
626	16	Three sections heating boiler cracked			Margaretus & Kavenedus	Hotel	Harlan, Ky.
627		Hot water supply heater exploded		4	J. Makowski	Residence	Detroit, Mich.
628	17	Cover of bleaching kier blew off			California Cotton Mills	Cotton Mill	Oakland, Calif.
629	18	Three sections of heating boiler cracked			A. T. & H. E. Dodge	Residence	Grasse Paint Village, Mich.
630		Boiler ruptured			Town of Pulaski	Power Plant	Pulaski, Tenn.
631	19	Boiler exploded	1	1	University High School	School	University, Mo.
632	20	Boiler exploded	2		Williams Yellow Pine Co.	Lumber Mill	Poplarville, Miss.
633		Boiler ruptured			Manasse-Block Tanning Co.	Tannery	Berkeley, Calif.
634		Valve in feed water line failed			Clarksville Light & Power Co.	Power Plant	Clarksville, Ark.
635		Section of heating boiler cracked			The Review Publishing Co.	Publishing Plant	Alliance, Ohio
636		Tube ruptured		1	Georgia Rwy. & Power Co.	Gas House	Atlanta, Ga.
637		Four tubes pulled out of drum			Spicer Mfg. Co.	Factory	So. Plainfield, N. J.
638	21	Boiler exploded		4	D. R. McClendon	Stave Factory	Tompkinsv'le, Ky.
639	22	Three sections of heating boiler cracked			Horn & Hardart Baking Co.	Restaurant	Philadelphia, Pa.
640		Boiler bulged and ruptured			London Canning Co.	Canning Factory	London, Ohio
641	23	Boiler bulged and ruptured			Stanford Creamery Co.	Creamery	Stanford, Ky.
642		Tube ruptured			Texas Power & Light Co.	Power Plant	Trinidad, Texas
643		Header cracked			Buda Company	Factory	Harvey, Illinois

MONTH OF SEPTEMBER, 1926 (Concluded).

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
644	24	Section of heating boiler cracked			The News Company	Publishing House	Hutchinson, Kans.
645	25	Steam outlet nozzle failed			Michigan Alkali Co.	Quarry	Wyandotte, Mich.
646		Section of heating boiler cracked			Rinshed-Mason Company	Paint Factory	Detroit, Mich.
647		Section of heating boiler cracked			Ballard County	Office Bldg.	Wickliffe, Ky.
648	26	Eight sections heating boiler cracked			Greenburg & Weinstein	Apts. & Stores	Omaha, Nebr.
649		Two sections heating boiler cracked			Bishop & Diocese of Colorado	Church	Denver, Colo.
650		Four sections heating boiler cracked			Junction City Municipal Hos.	Hospital	Jnctn. City, Kans.
651		Boiler exploded		1	Cross Refining Co.	Refinery	Smackover, Ark.
652	27	Air tank exploded		2		Garage	Sleepy Eye, Minn
653		Staybolts pulled out			Tennessee Paper Mills	Paper Mill	N. Chattanooga, Tenn.
654		Boiler exploded			Richardson Tire Shop	Tire Shop	Forest City, Iowa
655	28	Tube failed			S. F. Nichols	Hotel	Beatrice, Nebr.
656		Boiler exploded		1	Standard Oil Co.	Pumping Station	Wilmot, Ark.
657		Two sections heating boiler cracked			Dr. J. Ablio	Restaurant	Chicago, Ill.
658	29	Two sections heating boiler cracked			J. H. Lowell, Trustee	School	Newton, Mass.
659		Section of heating boiler cracked			Hutchison Realty Co.	Sales Room	Indianapolis, Ind.
660		Blow-off pipe ruptured			Steves Sash & Door Co.	Sash & Door Fcty.	San Antonio, Tex.
661	30	Heating boiler exploded		2	Five Fifty Six Wellington St.	Residence	London, Ont.
662		Boiler bulged and ruptured			Crescent Cotton Oil Co.	Cotton Gin	Sarah, Miss.
663		Boiler exploded	1		Bear Creek Canning Co.	Canning Factory	Harrison, Ark.

MONTH OF OCTOBER, 1926

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
664	1	Boiler exploded	1	1	H. J. Haile	Logging	Sicily Island, La.
665	2	Tube failed			William Randolph Hearst	Publisher	New York, N. Y.
666	4	Tube pulled out of drum			Buckeye Cotton Oil Co.	Cotton Oil Mill	Jackson, Miss.
667	6	Section of heating boiler cracked			Mrs. Bertha Cramer	Apt. House	Roxbury, Mass.
668		Section of heating boiler cracked			B. Manischewitz Co.	Bakery	Cincinnati, Ohio
669		Tube ruptured			Boott Mills	Cotton Mill	Lowell, Mass.
670		Hot water supply tank exploded			Diamond Alkali Co.	Alkali Plant	Fairport, Ohio

671	7	Boiler exploded	1		Zion Cotton Gin	Cotton Gin	Melbourne, Ark.
672		Boiler ruptured			Turner's Dry Cleaning Works	Dry Cleaners	Orangeburg, S. C
673		Mud drum ruptured			Semet-Solvay Co.	Chemical Plant	Ensley, Ala.
674		Two sections heating boiler cracked			George Morton	Auto Supplies	Omaha, Nebr.
675		Section of heating boiler cracked			S. Liebovitz & Sons	Factory	Ephrata, Pa.
676	8	Section of heating boiler cracked			Board of Education	School	Bridgeport, Conn.
677		Section of heating boiler cracked			Olney Court Corporation	Apt. House	Norfolk, Va.
678	9	Tube ruptured			Barrett Co. of W. Va.	Chemical Plant	Philadelphia, Pa.
679		Blow-off pipe failed			Chicago Starch Co.	Factory	Chicago, Ill.
680		Two sections heating boiler cracked			Y. M. C. A.	Y. M. C. A. Bldg.	N. Adams, Mass.
681		Three sections heating boiler cracked			Citizens Hotel Co.	Hotel	Beckley, W. Va.
682		Two sections heating boiler cracked			White House Baking Co., Inc.	Bakery	Clark, W. Va.
683	10	Section heating boiler cracked			Griffin & Bland Hotel Co.	Hotel	Raleigh, N. C.
684		Header cracked			Pittsburgh Terminal Warehouse and Transfer Co.	Warehouse	Pittsburgh, Pa.
685		Tube ruptured			Chas. H. Tenney & Co.	Power Plant	Orangeburg, N. Y
686		Plush steamer exploded	2	1	LaFrance Textile Mill	Textile Mill	Philadelphia, Pa.
687	11	Sections of heating boiler cracked			William D. Schantz Co.	Furniture Fcty.	Allentown, Pa.
688		Section of heating boiler cracked			Madison Operating Co.	Hotel	New York, N. Y
689		Tube pulled out of water-leg		1	E. W. Bliss Buildings, Inc.	Loft Bldg.	New York, N. Y.
690	12	Manifold of heating boiler cracked			Church of the Ascension	School	New York, N. Y
691		Section of heating boiler cracked			Frank Ruffalo	Apt. House	Kansas City, Mo.
692		Section of heating boiler cracked			Louis F. Haemer	Garage	E. Moline, Ill.
693		Boiler bulged and ruptured			Sullivan Packing Co.	Packing House	Detroit, Mich.
694		Boiler exploded			Coney Island Police Precinct	Police Station	New York, N. Y
665	13	Section of hot water supply boiler cracked			Western Finance & Developm't Co	Apt. House	Denver, Colo.
696		Section of heating boiler cracked			Louis C. Peningroth	Apt. House	St. Louis, Mo.
697		Sections of heating boiler cracked			Harry Zirkin	Stores & Apts.	Springfield, Mass.
698	14	Fitting in main steam pipe ruptured			Utah Idaho Sugar Co.	Sugar Factory	Sugar City, Idaho
699	15	Boiler of pressing machine exploded		2	Rosebud Cleaning & Pressing Co	Cleaners	Dallas, Texas
700		Tube ruptured		1	Duquesne Light Co.	Office Bldg.	Pittsburgh, Pa.
701		Four sections heating boiler cracked			Ursuline Academy of Holy Name	School	Youngstown, O.
702		Section of heating boiler cracked			Nowack, Bush & Lerner	Apt. House	New York, N. Y
703		Section of heating boiler cracked			Johnson City	City Jail	Johns'n Cty., Tenn
704		Section of hot water supply heater cracked			Ban Shecket	Apt. House	New York, N. Y
705	17	Boiler ruptured			Victor Monaghan Co.	Cotton Mill	Greer, S. C.
706		Section of heating boiler cracked			State of Maine	State School	Portland, Me.

MONTH OF OCTOBER, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
707		Section of heating boiler cracked			Mayo Properties Assn.	Laboratories	Rochester, Minn.
708	18	Hot water boiler exploded	1		Powers Theatre Bldg.	Office Bldg.	Gr'd Rapids, Mich.
709		Boiler ruptured			Frisbie & Stansfield Knitting Co.	Knitting Mill	Utica, N. Y.
710		Six headers cracked			James J. Matchett Co.	Miscellaneous	Brooklyn, N. Y.
711		Stop valve ruptured			Nekoosa Edwards Paper Co.	Pulp & Paper Mill	Pt. Edwards, Wis
712		Tube ruptured		1	Plano Cotton Oil Co.	Oil Mill	Plano, Texas
713		Section of heating boiler cracked			Madison Operating Co.	Hotel	New York, N. Y.
714		Two sections heating boiler cracked			Pacific Tel. & Tel. Co.	Tel. Exchange	San Jose, Cal.
715		Two sections heating boiler cracked			Millville Mfg. Co.	Cotton Mill	Philadelphia, Pa.
716		Four sections heating boiler cracked			Johns Mansville, Inc.	Store	Boston, Mass.
717		Vulcanizer exploded			C. C. Weber	Service Station	Taft, Calif.
718	19	Blow-off pipe failed			Emmart Packing Co., Inc.	Packing House	Louisville, Ky.
719		Tube ruptured			Central Illinois Pub. Service Co.	Power Plant	Kincaid, Ill.
720	20	Boiler exploded		2	Boxley, Goodwin & Bray	Contractors	Portsmouth, Pa.
721		Manifold of heating boiler cracked			M. L. Macomber	Apt. House	Des Moines, Iowa
722		Two sections heating boiler cracked			Berkeley Realty Co.	Apt. House	Indianapolis, Ind.
723		Section of heating boiler cracked			Louis M. Sagal	Apt. House	Bridgeport, Conn.
724		Section of heating boiler cracked			S. M. & C. M. Tosgate	Apts. & Stores	Cambridge, Mass.
725		Two sections heating boiler cracked			Stein Furniture & Carpet Co.	Factory	Kansas City, Mo.
726		Sections of heating boiler cracked			S. J. Cordner & Co.	Garage	W. Sprgfld, Mass.
727	21	Section of heating boiler cracked			Francis W. Fabyan, Trustee	Stores & Offices	Boston, Mass.
728		Two sections heating boiler cracked			Jennie G. Goldberg	Office Bldg.	Augusta, Ga.
729	23	Four headers cracked			Susquehanna Collieries Co.	Coal Mine	Shamokin, Penn.
730		Five headers failed			Brazos Hotel Co.	Hotel	Houston, Texas
731		Boiler exploded		2		Oil Well	St. Jo, Texas
732		Boiler ruptured			Eureka Pipe Line Co.	Pumping Station	Braden, W. Va.
733		Valve ruptured			Illinois Maintenance Co.		Chicago, Ill.
734		Two sections heating boiler cracked			Conron Brothers Co.	Restaurant	New York, N. Y
735	24	Two sections heating boiler cracked			Board of Education	School	Pittsburgh, Pa.
736		Section of heating boiler cracked			Louis G. Crabbe	Apt. House	New York, N. Y
737		Section of heating boiler cracked			The Apawamis Club	Club	Rye, N. Y.
738		Four sections heating boiler cracked			Mrs. Mary D. Strickler	Apts. & Stores	Uniontown, Penn

739	25	Two sections heating boiler cracked	Robert Findlay Mfg. Co.	Factory	Brooklyn, N. Y.
740	26	Air tank exploded	Staten Island Shipbuilding Co.	Ship Yard	Pt. Richm'd, N. Y.
741		Section of heating boiler cracked	City Centre Building Corpn.	Office Bldg.	Philadelphia, Pa.
742	27	Two sections heating boiler cracked	Mrs. Matilda Tarrelly	Hotel	Sharon, Pa.
743	28	Five sections of heating boiler cracked	M. Peiser & Louise Sheoman	Restaurant	Independence, Mo.
744		Section of heating boiler cracked	V. N. Carter	Apt. House	Little Rock, Ark
745		Mud drum ruptured	3 Jessop Steel Co.	Steel Plant	Washington, Pa.
746	29	Header cracked	American Beet Sugar Co.	Sugar Mill	Chaska, Minn.
747		Boiler ruptured	Memphis Hardwood Flooring Co	Lumber Mills	N. Memphis, Tenn
748		Boiler ruptured	The Buda Co.	Factory	Harvey, Ill.
749		Section of heating boiler cracked	Board of Public Instruction	School	Jacksonville, Fla
750		Two sections heating boiler cracked	Albert Gordon	Hotel	Chicago, Ill.
751		Two sections heating boiler cracked	Wm. E. Carnahan	Apt. House	Wilkinsburg, Pa

MONTH OF NOVEMBER, 1926.

752	1	Heating boiler exploded	6215 South Drive	Apt. House	Pine Lawn, Mo.
753		Blow-off pipe failed	Union College, Inc.	College	College View, Neb.
754		Tube failed	City Schools of Pineville	School	Pineville, Ky.
755		Two sections heating boiler cracked	A. J. Randall, Inc.	Printing Office	Rockland, Mass.
756		Sections of heating boiler cracked	W. A. Paterson Co.	Office Bldg.	Flint, Mich.
757		Section of heating boiler cracked	City of Springfield	Shop	Springfield, Mass.
758	2	Section of heating boiler cracked	Samuel Roseff & Sons, Inc.	Garage	Mt. Vernon, N. Y.
759		Two sections heating boiler cracked	Geo. O. Bruce	Residence	Poland, Ohio
760		Two sections heating boiler cracked	O. L. & E. A. Gruggel	Apt. House	San Francisco, Cal.
761		Section of heating boiler cracked	Shela Company	Apt. House	Philadelphia, Pa.
762	3	Tubes pulled from tube sheet	Planters Nut & Choc. Co.	Candy Factory	San Francisco, Cal.
763		Crown sheet failed	Edward's Test No. 1	Oil Well	Oxford, Neb.
764	4	Section of hot water supply heater cracked	B. G. & B. Realty Corp'n.	Apts. & Stores	Brooklyn, N. Y.
765		Three sections heating boiler cracked	Sixty-seventh St. Studio Bldg.	Apts. & Studios	New York, N. Y.
766	5	Sections of heating boiler cracked	Bartons Bias Narrow Fabric Corp.	Textile Mill	Bridgeport, Conn.
767		Superheater tube pulled out of header	Hammermill Paper Co.	Paper Mill	Erie, Pa.
768	6	Blow-off pipe ruptured	Craft Gin Co.	Cotton Gin	Leonard, Texas
769		Section of heating boiler cracked	Church of St. Lucy	Church	Jersey City, N. J.
770		Section of heating boiler cracked	Pacific Tel. & Tel. Co.	Office Bldg.	Oakland, Calif.
771	7	Three sections heating boiler cracked	Brownston Realty Corp'n	Apt. House	New York, N. Y.

The Hartford Steam Boiler Inspection and Insurance Company

HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1926

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks		$684,103.09
Real Estate		267,631.53
Mortgage and collateral loans		1,523,106.20
Bonds and Stocks		12,646,007.33
Premiums in course of collection		1,290,539.98
Interest Accrued		150,884.92
Total Assets		$16,562,273.05

LIABILITIES

Reserve for unearned premiums		$7,318,478.72
Reserve for losses		452,318.90
Reserve for taxes and other contingencies		770,028.22
Capital Stock	$2,500,000.00	
Surplus over all liabilities	5,521,447.21	
Surplus to Policyholders,		**$8,021,447.21**
Total Liabilities		$16,562,273.05

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Incorporated 1866 Charter Perpetual

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The Locomotive

OF

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

VOL. XXXVII

PUBLISHED BY
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

HARTFORD, CONN.
1928-1929

INDEX TO VOL. XXXVII.—1928-1929

THE LOCOMOTIVE

REFERENCES MARKED WITH A STAR (*) ARE TO ILLUSTRATED ARTICLES

Vol. XXXVII No. 1 January 1928

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

"Into Such a Peaceful Scene"

RUNNING through the southeast corner of Pennsylvania and into the state of Delaware is a stream of water known as Brandywine Creek — sometimes glorified by being called a river. Before it empties into the Delaware River at Wilmington it traverses historic country — country made famous in the Revolution by the Battle of the Brandywine. Though a comparatively small stream, there may be found along its banks the ruins of old time mills — many of them probably grist mills — where the quiet farmer folk of years gone by would take their grain. Later, there grew up on the banks of this stream numerous small villages supported by textile mills, many of

which still exist, whose workers for three, four, and even five generations had come from the nearby countryside.

Such was the mill of Hodgson Brothers in the little village of Henry Clay, just outside of Wilmington, Delaware. It wasn't a large mill but it had been in existence for 150 years, and it afforded employment to half a hundred women and girls — some of them, undoubtedly, the mainstays in struggling families — secure in the belief that a mill as old as this one had weathered every possible storm.

In those little villages some of the mill workers can go home to their mid-day meal while others carry a lunch and at noon, weather permitting, they may be seen in sociable groups, eating, chatting, and at times entering into friendly banter — laughing and happy.

October 25, 1927, brought a warm sun — a welcome chance to enjoy the outdoors before winter closed in. A score of girls who had brought their lunches could be found during the noon hour on the sunny side of the mill or strolling nearby.

Into such a peaceful scene — a rest in a busy day of toil — there burst a deafening roar. Wreckage of all sorts and sizes came hurtling through the air. Screaming, terrified girls fled across the fields. From that hail of metal and stone they considered themselves lucky to escape with their lives.

The full import of just what had happened dawned on them when they straggled back, timidly, to view the wreckage. What they saw was the spectre of unemployment, for even to an untechnical eye it was evident that the plant would have to close down for an indefinite period.

But more than this, and requiring immediate attention — two men were injured and had to be cared for. Volunteers picked them up and placed them in an ambulance that had hurried down from a Wilmington hospital.

Turning to the ruins, it was apparent that the cause had been centered in what had been the heating plant, housing two horizontal tubular boilers, one of which had exploded. Built originally to carry a pressure of 100 pounds and operated frequently at a pressure of perhaps not more than 20 pounds, these two boilers had been in service for twenty-one years. So long had they served their purpose, perhaps many thought they would never wear out. But hidden defects had developed. Although the Hartford Company had neither inspected nor insured these boilers, one of its inspectors determined, in examining the remains, that a lap seam crack had weakened a construction prone to develop such a defect, and furthermore, exterior corrosion under the covering bricks had wasted away the upper surface of the shell.

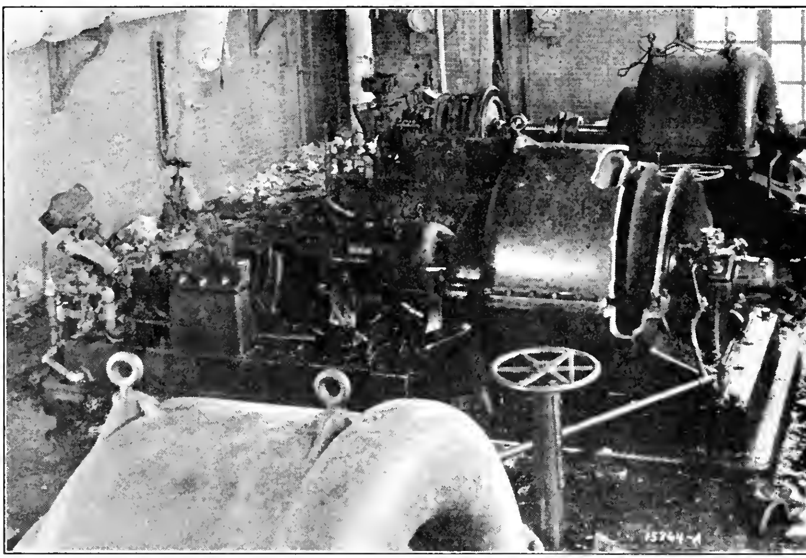
And so an old and trusted servant, through undiscovered bodily ills, failed when least expected — as sometimes seemingly hale and hearty men are struck down, leaving many suddenly dependent to weather the blow as best they can.

Happily for the owners of this mill, they had been foresighted enough to secure protection against just such an occurrence as this; they were insured and were reimbursed for their direct property loss, but for weeks after no laughter from happy groups was heard — even though a warm sun shone on many a later day.

Public Health Endangered by Explosion

NEWSPAPER reports of a turbo-compressor explosion, September 20, 1927, at the sewage disposal plant of Indianapolis, Ind., stressed the claim that health of persons living there and in other cities below it on White River was jeopardized when the break-down paralyzed part of the disposal process and necessitated turning millions of gallons of partially treated sewage into the river.

The compressor unit was used in connection with the sewage aeration system. At about 9:30 on the night of the accident the engineer discovered a leak in the oil pipe and immediately prepared to shift the load to another unit, so as to effect repairs. After warming



up Unit No. 4, he put it on the line and attempted to shut down No. 5, the defective unit, by tripping the emergency governor. Instead of slowing down, the machine seemed actually to gain speed. He then tried to close the throttle valve by hand, but found it jammed. As a last resort he started for the opposite end of the room to get a ladder by means of which he could reach the valve on the branch line from steam header to turbine. The explosion occurred while he was at some distance from the machine. This fact probably saved him from injury.

While examination of the wreckage confirmed the assumption that the machine failed by over-speeding, it did not determine, to the satisfaction of all parties concerned, the actual cause of the runaway. The oiler stated that when the engineer tripped the emergency governor he (the oiler) closed the discharge valve on the air line to relieve the machine of its load. He heard a sound similar to that caused by rushing air and, noting the turbine's increasing speed, left the vicinity as quickly as possible.

The plant's aerating equipment consisted of three similar turbo-compressors. At the time of the accident one of them was dismantled for repairs. Flying metal damaged its delicate internal mechanism so badly it was necessary to send the rotor back to the builders. The accompanying photograph gives some idea of the extent of the wreck. Direct damage, amounting to $21,000, was covered under a policy by the Hartford Company.

Air May Reverse Turbine's Rotation

The fact that the plant had three compressor sets connected in parallel to a common air line and that two of them were sometimes operated at the same time, prompts a discussion of another type of hazard incident to this class of apparatus.

With one turbine running, an attempt to put another on the line has been known to reverse the direction of rotation of the second machine by air pressure backing up into the rotary compressor through the discharge line. When non-return valves are not provided in systems of this kind there is always a possibility of disaster from this cause, providing, of course, the operation of cutting in a second turbine is not done with extreme skill.

It is interesting to consider just what could take place in a case of this sort. Assuming one machine to be supplying pressure to the line and another compressor unit has been brought up to speed and is ready to cut in, the moment the discharge valve of the second machine is opened the pressure in the line drives air back into the rotary compressor, tending to operate it like a turbine — but in a reverse direction. As soon as slowing down occurs, due to the influx of air into its compressor, the governor of the machine will tend to open the steam valve and the steam will act as a powerful brake against the tendency toward backward motion caused by the air. It is possible, however, for the air to overcome the effort of the steam. This would cause the turbine to come down to zero speed and then to operate in the wrong direction.

While approaching zero speed the turbine governor would open wide and would remain so until the machine picked up speed in the wrong direction. But as the speed increased in the wrong direction the governor would commence to shut off steam and from that point on the steam's resistance to the action of the air would diminish rapidly. It is conceivable that disastrous over-speeding would result in case the operator did not act quickly.

In the light of what is known of these systems of turbo-compressors discharging into a common line, it would seem to be good practice to equip each discharge line with a non-return valve.

New Method of Making Crane Rings

SUPERINTENDENTS of foundries and machine shops using cranes for heavy lifting will be interested in a new type of sling-chain ring for which the developers claim distinct advantages over the welded rings of refined bar iron now in general use.

In lifting a heavy part it is customary to pass a sling-chain around it and fasten the ring over the crane hook. These rings have been known to fail, even under apparently safe loads, because of incomplete welding or because metal was crystallized by the heat of welding.

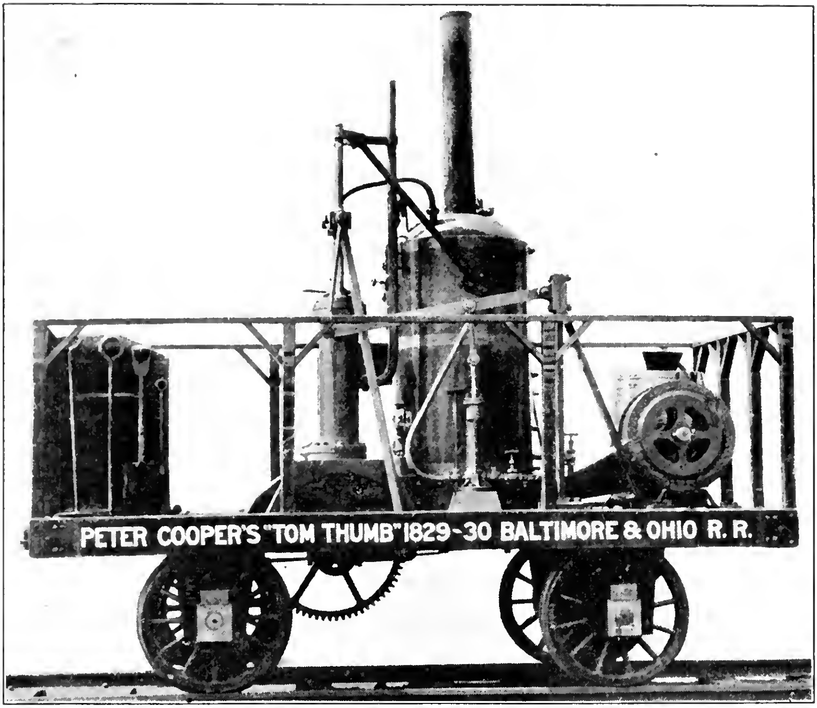
The new type of ring is said to be free from these weaknesses. It is made by winding many turns of wire around a spool to form a blank which, after heating, is formed into a homogeneous mass by means of dies and a powerful press.

Exploding Gas Tank Rocks Pittsburgh

An explosion of a 500,000 cubic foot gas container on November 14, 1927, at the plant of Equitable Gas Company, Pittsburgh, Pa., caused the collapse and burning of two other tanks, one of almost equal size and the other smaller. Newspaper reports placed the death list at twenty with several hundred injured. According to the news report workmen were using blow torches on top of the huge vessel, supposed to have been empty, when it tore loose with a violence that rocked the city and made 5,000 persons homeless. The tank was said to be the largest natural gas container in the world.

Saddling and Breaking the Iron Horse

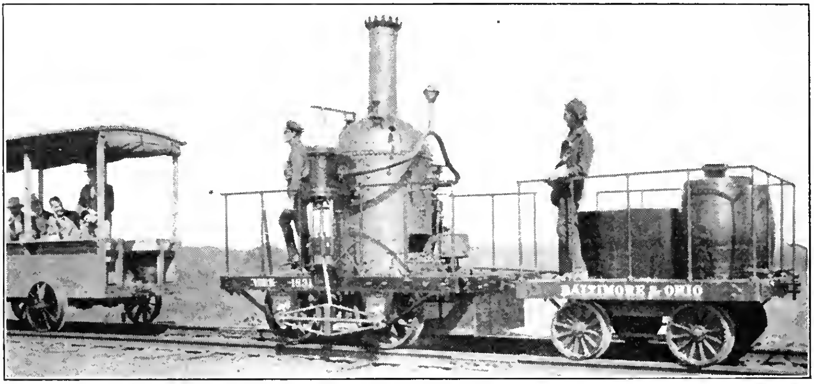
PRESENTED in a manner that provoked public interest to an extent that could not have been approximated by volumes of printed history, " The Fair of the Iron Horse," held in Baltimore, Md., September 24 to October 16, 1927, served to commemorate the first hundred years of service by the Baltimore & Ohio Railroad and at the same time depicted the development of an industry on which



The Baltimore & Ohio's First Engine

our present complex and prosperous civilization is based. Mechanical transportation — the industry by which commodities are moved swiftly across desert, mountain, and stream from producer to consumer — preceded and paved the way for industrial growth, made possible the division into metropolitan and rural areas and, by annihilating the barriers of distance and time, exerted an almost incalculable influence on every phase of modern existence.

The Baltimore & Ohio's Centenary Exhibition did not confine itself merely to presenting original locomotives or accurate reproductions of



The "York," Winner of $4,000 Prize

early models along with their modern grandchildren. In a Hall of Transportation and a Traffic Building were all sorts of devices contributing to railroad service, as well as visual exhibits of almost every industrial enterprise in which the railroad has had a part. Volumes could be devoted to their description and still warrant criticism because of inadequacy. For obvious reasons this article must limit itself to a very few of the most interesting high lights.

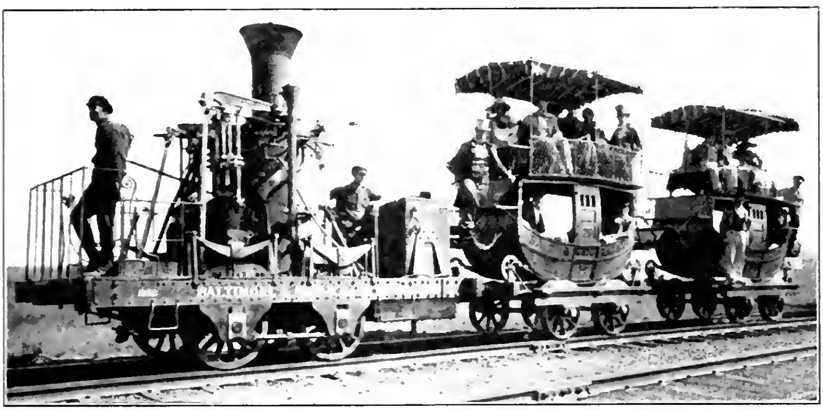
Probably the most entertaining part of the exhibit was the parade of the iron horses around an oval track, the grotesque little engines of early vintage being followed in slow procession by the huge, powerful space annihilators of the present day. Behind all this, however, is the story of how the B & O was formed and the factor that led to the adoption of the steam locomotive for drawing trains.

Recognized in Colonial days as an important sea port, Baltimore prospered and grew until the construction of the Erie Canal threatened to divert Western commerce to rival cities along the Atlantic. The fact that the Allegheny Mountains lay between Baltimore and the territory it sought to tap prevented the city from meeting the challenge by digging a canal of its own. So a group of prominent merchants pooled their resources to build a railroad extending 300 miles westward to the Ohio River. Their idea was to draw cars by horses on level stretches and to overcome steep grades by means of an engine-driven cable drag. A charter was obtained on February 28, 1827; construction started on July 4, 1828.

By 1830 a double line of track stretched to Ellicott's Mills, fourteen miles away, and during the year horse-drawn trains started operation. But Peter Cooper, a New York merchant with large holdings in Baltimore, was not satisfied to accept the limitations imposed by dependence on horses for motive power. He called the directors' attention to the use of steam on English roads and, failing to find them ready to experiment with the new, unproven device, set himself the task of demonstrating its practicability.

Cooper designed and built the Tom Thumb, the first engine built in America for a practical railroad. This little fellow, weighing less than a ton, convinced the directors of the futility of clinging longer to the horse of flesh and blood. They advertised a competitive test to produce the best type of locomotive for their road and five engine builders responded. The York, produced by Phineas Davis of York, Pa., won the judges' approbation and prize of $4,000.00 and was immediately put into service.

Following the York came the Atlantic, the Traveler, the Arabian, the Mercury, and in a few years, the Lafayette, first of the road's

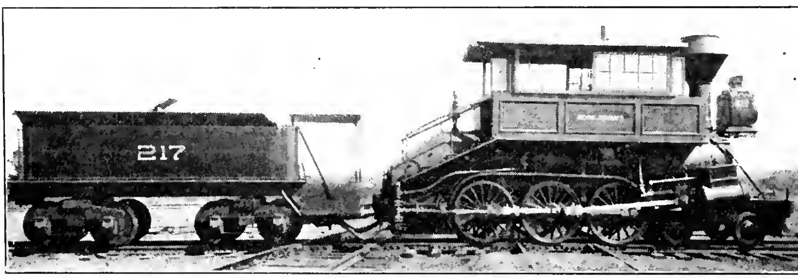


The "Atlantic" and Imlay Coaches

horizontal boiler engines. In the meanwhile trackage had been creeping westward until on November 5, 1842, the line reached Cumberland. Then followed a period of discouragement and delay, but at last the trail of iron reached its objective, the eastern bank of the Ohio River at Wheeling, twenty-five years after the first tie was laid in Baltimore. Thus firmly established, the road has since been a pioneer in the evolution to the present standards of railroad practice, this advance being shown vividly in the parade of engines around the fair ground track.

Led by Tom Thumb, the actors in the drama of the last hundred years of railroading moved slowly past the grand stand. In the van-guard were creations which today must be looked upon as mechanical monstrosities but which, when they were built, represented perhaps an even greater scientific revolution than is embodied today in man's conquest of the air. Following them came engines of the Civil War period; after these came types of locomotives most of us can still remember having seen in actual service. In the rear ambled the huge Mallets, Pacifics, Hudsons, and all their colossal brethren, representing the last word in motive power and economy.

Throughout the exhibit there was evidence of the highest sort of ingenuity applied to the development of devices and methods to solve what were once unfamiliar engineering problems. Steps in the evolution of roadbeds and rails were worthy of more study than most persons had time to give them. Another outstanding example of early engineering skill was shown in a model of the combination railroad and highway bridge across the Potomac at Harper's Ferry. That

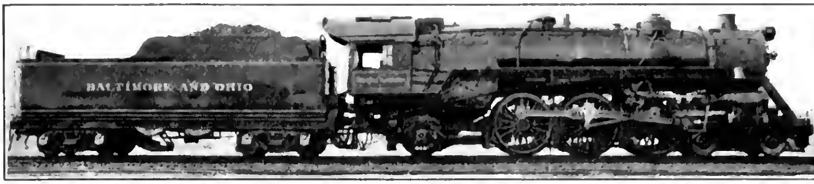


Winan's Famous "Camelback"

bridge had a railroad junction in its center. For years it was considered one of the most difficult bits of railroad location in the world.

The railroad reached a point on the Potomac opposite Harper's Ferry on December 1, 1834. To cross the river it built a bridge on timber arches, but so rapidly did the size and weight of equipment increase that in 1851 the railroad started to reconstruct the bridge in iron. One span was completed about a year later. Probably because lack of previous experience offered no satisfactory answer to the question whether or not the span was strong enough to stand the moving load, the engineers decided to test the bridge for deflection. This test was described in the "History and Description of the Baltimore and Ohio Rail Road," published in 1853.

"Three first class tonnage engines with three tenders were first carefully weighed and then run upon the bridge, at the same time nearly covering its whole length, and weighing in the aggregate 273,550



"President Washington"

pounds, or 136.775 tons net, being over a ton for each foot in length of the bridge. This burden was tried at about eight miles an hour, and the deflections, according to gauges properly set and reliable in their action, were at center post 1 3/8 of an inch, and at the first post from abutment 9/10 of an inch."

Work of rebuilding the entire bridge proceeded slowly and was greatly hindered by the Civil War, in the course of which it was damaged several times. It was eventually completed in 1869 and served until 1893 at which time railroad traffic was diverted to another bridge and the old one assigned to highway use.

While the exhibit served to commemorate the hundredth anniversary of a particular railroad, it must be looked upon as a pageant of the developing of railroading and industry in all parts of the world. The Hartford Steam Boiler Inspection and Insurance Company, whose birth was back in a day when mechanical power was in its infancy, congratulates the Baltimore & Ohio Railroad both because it has passed the century mark and because in observing its birthday centennial it contributed greatly to the knowledge of a feature of history which is of interest to both engineer and layman.

Frozen Water Pipes Cause Accidents

Reports of several recent explosions of domestic hot water tanks serve as a reminder of a common cause of accident to these familiar kitchen appurtenances. In Kensington, Ga., a man and his wife were fortunate in having left the kitchen a few seconds before the galvanized tank gave way. At Memphis, Tenn., a mother and son were badly scalded in a similar accident. In both cases news reports attributed the cause to frozen water pipes that cut off the intake of cold water and thus allowed the heaters to build up tremendous pressure within the tanks.

"Splicing Bone" on a Big Corliss Engine

By Inspector C. Burton

OPERATIONS at a large paper mill came to an abrupt halt at 6 o'clock on the morning of November 2, when the engineer discovered a serious crack in a casting of the large Corliss engine on which the plant depended entirely for light and power. The Hartford's nearest branch office was notified and immediately sent a representative to survey the situation.

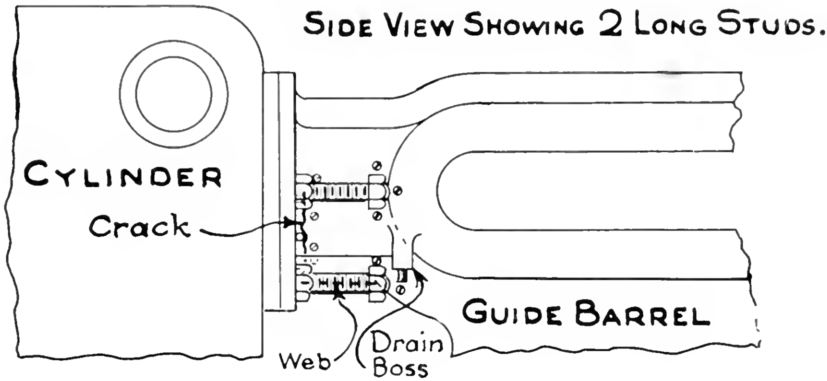
The inspector found the big engine, of 22-inch cylinder and 36-inch stroke, utterly unsafe because of the crack which extended over approximately the lower half of the neck of the flange connecting the guide barrel with the steam cylinder. Due to the extreme need of getting the unit back into operation as quickly as possible it was necessary to select and undertake immediately a practical method of repair.

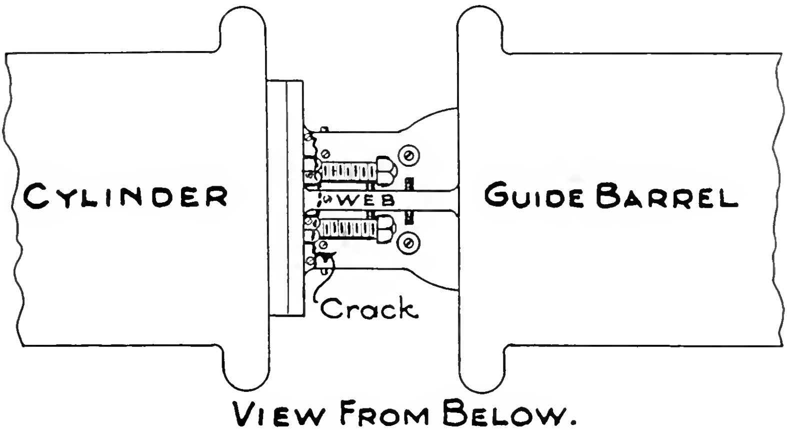
The metal in the vicinity of the crack was cleaned thoroughly. Along both sides of the fissure were placed rows of ½" studs, two inches apart and projecting a quarter of an inch. Electric arc-welding was then applied over the entire length of the crack and on each side sufficiently to cover the studding.

The original fastening of the cylinder to the guide barrel consisted of sixteen 1¼" studs. Nine of these, covering the extent of the crack, were removed and replaced by long studs projecting about ten inches beyond the flange. Nuts were fitted to keep tight the gasket between the two castings.

At the bottom of the guide barrel casting a reinforcing web was incorporated, one inch thick and four inches deep. Two bosses which originally held drains for removing oil and water from inside the guide barrel were tapped and fitted with 1" studs, projecting half an inch. Then the reinforcing web was fitted with two ¾" studs which were allowed to project half an inch on each side. These, together with the studs in drain bosses, formed a triangular pattern around the nuts of the two lower cylinder-studs. (See Sketch)

These two long studs were then welded to their respective projecting studs, and the space between studs and web filled in with welding material. As the next step the seven remaining long studs were screwed into place and around the end of each were placed three ¾" studs, projecting half an inch and located so as to form a triangular pattern. Nuts were screwed onto the long cylinder-studs and welded





to the surrounding studs in the guide barrel. The shape of the finished weld resembled the triangular foot of a boiler brace.

When the engine was started at 8 A. M., November 4, it was found to be as rigid as before the accident, and so far as strength and reliability are concerned it is doubtful whether a better job could have been done even by replacement with a new casting.

Recognition of Insurance Inspectors

Los Angeles (Cal.) City Council has passed a new boiler and elevator ordinance which recognizes licensed safety engineers of casualty companies and empowers them to make inspections with the same legal standing as those made by the city board of mechanical engineers.

Forestalling Potential Boiler Explosions

THE idea uppermost in the mind of a boiler inspector is to pass by no seam, joint, tube, plate, or brace until he is satisfied it contains no defect that might result in an explosion. His concern is as much for the interests of the boiler owner as for those of the insurance company which employs him. In spite of this it happens now and then that a factory manager protests against what may appear to him to be an over-zealous investigation of parts which, to a layman, would seem to be in good condition. A case of this kind was encountered recently by a Hartford inspector.

Sent out to inspect externally two horizontal tubular boilers, this inspector found that a third boiler had been installed and connected to the two boilers already insured. The additional unit was of the same type, having been used in one of the company's other plants. A heavy coating of insulation covered the top of this third boiler and the only external evidence of anything suspicious was a wisp of steam seeping out between the insulation and the dome.

Faulty Welding on Dome Flange

The inspector advised the plant manager to remove some of the covering for a thorough investigation of the leak. At first the manager demurred on the ground the covering had been applied but a short while before. The leak was undoubtedly a minor one, he explained, for when the boiler was relocated repairs had been made to the dome riveting. Another inspector (not a Hartford representative) had pronounced the job O. K.

By employing tact the inspector eventually secured consent for the removal of the lagging. He discovered that welding had been done around the dome flange where it was riveted to the shell. On one side of the dome a weld extended for a distance of sixteen inches; on the other side were four similar welds, ranging in length from four to eight inches.

The inspector concluded that the welding had been done in an effort to repair cracks and he insisted that the dome be removed. Again the manager hesitated and again the inspector carried his point. A fully developed crack was found along the inner edge of the inner row of dome flange rivet holes. This fissure extended through six consecutive holes, from two of which were other cracks extending radially inward. A condition somewhat similar was found on the other side of the dome. Welding was only skin-deep and while it checked most of the leakage it added little to the strength of the defective part.

In his report the inspector said: "There is no question but that cracks would have increased in length until a failure occurred which no doubt would have resulted in a disastrous explosion." Needless to say, the assured were very thankful the dangerous condition was found.

At another plant an equally serious defect was uncovered by a Hartford inspector's perseverance and alertness. Refusing to be satisfied with an internal inspection that disclosed no apparent serious condition, this inspector made it a point to be present when the boiler was next fired up and on this second trip he located a crack that almost certainly would have caused a violent explosion.

The first investigation satisfied the inspector that although there was some slight pitting, beading had broken away from several tube ends, and there was exterior corrosion due to water seeping down through the brick work on top, these things in themselves were not serious defects. However, he suspected that the tube ends were not strong enough for service and, inasmuch as no other boiler or pump was available for a hydrostatic test, he arranged to be present when the boiler was next put under steam pressure.

Crack at Longitudinal Seam

Two weeks later this inspector was on hand when the fire was lighted, and when the gauge showed fifteen pounds pressure he climbed atop the boiler to see whether the manhole cover was tight. A thin feather of steam coming out through the brick work near the horizontal seam attracted his attention. He had part of the brickwork removed and there he found a longitudinal crack running for nine inches parallel with the caulking edge and about 3/8″ from it. He ordered the fire drawn immediately and advised the owner against any effort either to operate or repair the boiler.

While using a sounding hammer on a Stirling type water tube boiler in an ice plant another Hartford inspector located thin metal on the front side of the rear drum. He cleaned off the scale and found that corrosion had thinned the metal to a serious degree. The owners were notified, but at first the inspector could not convince them the condition was dangerous. In fact they vetoed his suggestion that the plate be drilled to determine its remaining thickness.

So the inspector resorted to a hammer test and showed the assured that in places the sheet could be dented. After that he was given all assistance necessary and by means of the drill test it was found that a strip along the water line on the front side of the center drum was corroded from end to end until only ⅛″ of metal remained.

Inasmuch as the plant had another boiler operating under similar conditions the inspector investigated it for the same defect. His suspicion was confirmed.

These boilers were operating at 125 pounds pressure, which, with the shell thickness so reduced, left but a small factor of safety. An explosion would have been the inevitable result had the corrosion not been detected.

Caught in the Separator

Old Bill Logic says: "These fellows who are always belly-achin' about the world owing 'em a living could make themselves useful by figgerin' out a way to collect that and other bad debts."

Inertia Complex, Maybe

"Doctor," said he, "if there's anything the matter with me don't frighten me half to death by giving it a scientific name. Just tell me what it is in plain English."

"Well," said the doctor, "to be frank with you, your trouble is just plain laziness."

"Thank you, doctor," said the patient. "Now give me a scientific name for it, so I can tell my wife."

Persons who suppose magazine editing to be devoid of hazards associated with other occupations should consider the plight of the editor who dropped eleven stories into a wastebasket. — *Selected and revised.*

Keen Work, Boys

Two Negroes were telling about their ability to see and hear. The conversation was something like this:

"Does you see dat house ober dar on de horizon?"

"I sees it."

"Well, can you see dat fly walkin' round on de roof?"

"Can't say as I kin, but I heahs de shingles crack when he steps on 'em."

Glycerine Evaporator Explosions

THERE recently came to our attention information about the explosion of a glycerine evaporator at a plant in Kansas City, Kansas, which resulted in the death of one man and serious injury to another, and which further resulted in a property loss of several thousand dollars.

The vessel that exploded was 72 inches in diameter and 10 feet high, the lower portion of which contained a steam chest and tubes. The vessel was constructed entirely of steel except for the bottom head, which was made of cast iron. Crude glycerine would be charged into the vessel and steam then turned into the steam chest. The glycerine would thus be evaporated and pass off through a 14-inch diameter header to a glycerine condenser. As there were two of these evaporators supplying the same condenser, it became necessary to close a stop valve in the glycerine vapor line whenever a vessel was shut down for cleaning, and this was of frequent occurrence as the residue from the crude glycerine merely settled to the bottom of the vessel from whence it would be taken by manual labor.

The failure was in the lower cast iron head and was due to overpressure. The vessel had just been cleaned and recharged and the steam turned on shortly before the explosion, but the operator neglected to open the stop valve in the glycerine vapor line. There was no safety valve on the vessel and so the pressure rapidly built up, as shown by the chart of a recording thermometer on the evaporator. The pen of this instrument had gone entirely off the scale before the explosion.

A safety valve, of course, is essential on every pressure vessel unless some other means of restricting the internal pressure is provided. It is claimed that safety valves on vessels of this type would be of no avail because they would rapidly become stuck fast due to impurities carried into the valve by the more or less impure vapor. Such being the case it would seem advisable to control the temperature and pressure in the vessel by controlling the temperature of the steam. The strength of the vessel could be readily computed and the maximum allowable pressure determined. The incoming steam could then be controlled so that its temperature would not exceed the boiling point of glycerine at the maximum allowable pressure on the evaporator. The objection will undoubtedly be raised that this would curtail production, but if the heating surface is made ample, this would probably compensate for a lower pressure steam. Safety should never be sacrificed for production.

Taps From the Old Chief's Hammer

SOME of these days St. Peter will get hand-shakers' cramp while welcoming a squad of new arrivals whose passports have been vised by a neglected steam boiler," began the Old Chief. "He'll empanel a Celestial grand jury and dig out some facts that are going to queer the chances of a lot of fellows who otherwise might go to heaven when they die."

The lesser lights at the inspectors' table straightened up from their writing and leaned back in attitudes suggesting a desire to hear the rest of it. The Chief pointed to a sheaf of papers in front of him.

"Take this bunch of first inspection reports, for example. We can't issue a dollar's worth of insurance on these fellows. Most of these applications are from owners of seasonally-operated mills, and as far back as I can remember the steam generator in many of these mills has been the one thing the manager cared less about than any other. You know the kind I'm thinking about. There are plenty of them.

"Usually, when we are called on to insure one of these boilers the inspector visits it during the off-season when the plant is shut down. After you've been in this game as long as I have you boys will find that a seasonally-operated plant in the off-season is something that has to be seen to be appreciated. With few exceptions these old vessels are left in exactly the condition one would expect to find them at the end of the operating season — except now and then the boiler room is piled so full of riff-raff that the inspector has to go outside for a peek at the smoke stack before he knows which end of the boiler room to look into.

"I have a keen recollection of one that was typical of this class. After we had drained the water out we had a sweet job trying to locate the man-hole cover. Apparently the owner had had a hunch his boiler was getting ready to ask for a pension and had tried to keep the old fellow in harness a little longer by the simple expedient of covering the plates and rear head with a good, husky reinforcement of concrete. What we discovered when we dug down to the shell accounts for some of my gray hair."

"Badly cracked, I suppose," ventured the junior member of the group of inspectors.

"Listen, son," said the Chief, "when we got that concrete picked off and saw what was underneath, it started me figuring a problem I haven't solved yet. For the life of me I can't explain why that rust-eaten shell didn't collapse of its own weight. That old steamer was about set to cash in its checks. The chances are it would have taken a couple of innocent boiler room hands along for company.

"Sooner or later St. Peter is going to subpoena the owners of such boilers and his ultimatum will read something like this: 'Look here, boys. You've been getting away with murder long enough. Get that? I called it MURDER. These killed-by-uninspected-boiler cases have got to stop or there won't be the customary harps and wings waiting for you when you apply for entrance.'"

"You think that'll bring 'em to time?" the junior member wanted to know.

"Darned if I know," grunted the Chief, turning again to his work. "Some of those fellows are almost hard-boiled enough to tell St. Peter where to get off at."

A New Branch at Seattle

JANUARY 1, 1928, the Company opened a Seattle Branch Office at 423 Dexter-Horton Building, to operate as part of the newly created Pacific Coast Division under the general supervision of Mr. C. B. Paddock, superintendent.

Mr. E. G. Watson, resident agent, who is in charge of the new branch, was at one time an inspector and later a special agent at Syracuse, N. Y. His wide experience has rendered him especially fitted for the important post to which he has been promoted.

Hereafter the Company's business in the states of Washington and Oregon, and in Bonner, Kootenai, Shoshone, Latah, Clearwater, and Nez Perce counties of Idaho, will be handled by the Seattle Branch. The change does not affect the status of the firm, Bates, Lively and Pearson, which will continue as General Agents in the state of Oregon.

Score Another for the Flivver

Add to the compendium of unusual explosions the following news story from Juliette, Ga: "A large rattlesnake was recently exploded by air pressure from the tire of a Ford car in the swamps of a creek near here. It is reported that while the construction gang of a power company were putting in posts for a line through the swamps the rattlesnake struck the tire of the workmen's car. The air pressure was transmitted through the hollow fangs of the reptile, blew it up and exploded it."

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., January 1, 1928

Single Copies can be obtained free by calling at any of the company's agencies.
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.

Reducing Shut-down Loss

MOST factory owners and managers understand thoroughly the seriousness of a breakdown involving main power units. In many cases failure of an engine necessitates complete stoppage of factory processes and at such times it is to the interest of both the plant and the company underwriting the use and occupancy insurance to get the machine back into safe operating condition as quickly as possible.

The orthodox method of effecting repairs, and the one which must be used in many cases, is to replace the part. But sometimes this entails laborious dismantling and reassembling as well as expensive delay while a new part is being cast, machined, and shipped by the engine builder. Meanwhile, production schedules are knocked galley west and each blow of the repair gang's hammers sounds to the plant manager like the tinkle of a cash register ringing up dwindling profits.

Insurance inspectors have been known, not infrequently, to devise methods of repair that cut several days from the time it would take to secure and fit a new part. They know from experience what can and cannot be done in bringing a broken part back to a safe condition, and factory managers have often had occasion to thank them for suggestions that saved thousand of dollars of shut-down damage. An ingenious repair of this kind was accomplished recently at a plant insured by The Hartford Company. The story is told elsewhere in this issue in an article by Inspector C. Burton. It should be of interest to both plant executives and engine room chiefs.

Announcement

IN September 1927 — to our great regret but with our best wishes — Mr. Benjamin C. Cruickshanks, the editor of this publication, left us to accept an appointment on the faculty of his alma mater, George Washington University. Before doing so, however, he had completed preparation of the October issue, so that number made its appearance on time.

The editorship of this little publication of ours is a somewhat difficult position to fill, requiring as it does a combination of engineering knowledge and literary experience. Those of our own staff who possessed these dual qualifications were too much loaded with regular and important duties to undertake the preparation of the January issue, so that number has had to wait until we found outside our organization one who would meet these requirements. I am very glad now to announce that our quest has been successful and that we have secured such a man in Mr. George H. Prall, who joined our organization in January of this year and with this number takes editorial charge of The Locomotive. Mr. Prall, following his graduation from the mechanical engineering courses of Rutgers College in 1919, was employed in engineering work for several years. Then opportunity offered to try his hand at journalism and led to his becoming editor of a weekly paper at Woodbridge, N. J., a position he resigned to take up his present work with us. With this experience we feel he is especially well equipped for that work.

I trust that the readers of The Locomotive in view of this explanation will excuse the late appearance of this January number, and that they will find in it evidence of our purpose to make even more interesting and valuable this publication which for more than sixty years The Hartford Steam Boiler Inspection and Insurance Company has published for the benefit of its assured and power-users generally.

W. R. C. CORSON,
President.

Resuscitation Method

MECHANICAL appliances for resuscitating victims of suffocation, asphyxiation, or electric shock are useless, of course, when such an accident occurs at a place where a resuscitating device is not available. For that reason safety departments of some industries have undertaken to school employees in a method that requires no apparatus.

When, from any one of the causes mentioned above, respiration has been checked, the victim's chance of recovering depends a great deal on how quickly he is placed under treatment. The obvious advantage of a method involving no apparatus lies in the fact that fellow workmen who have learned the method may commence treatment immediately.

A description of the Schafer Prone Pressure Method, reprinted from Public Service News of Public Service Corporation of New Jersey, appears on the back cover.

Riding the Gauge from 5 Pounds to 1,400

STEAM pressures that only twenty years ago would have been regarded by engineers as dangerously high, now are accepted as not only practical but desirable in power production.

Early attempts by pioneers to apply steam to useful work were handicapped not alone by the mechanical inadequacy of their crude boilers safely to withstand pressures greatly above atmosphere, but also by a skeptical and timid public which, one writer tells us, besought the British Parliament to pass a law limiting pressure to five or six pounds. While boiler accidents still occur, particularly where equipment is allowed to deteriorate for want of inspection, public confidence in the science of engineering has increased in the last hundred years to a point where pressures up to 1,400 pounds in industrial installations cause no great alarm and the traveling public raises no protest in the name of community safety at the announcement of a new locomotive which will use a pressure of 400 pounds.

When engineers determined that by the use of these higher pressures more work could be accomplished by a given weight of engine, boiler designers met their challenge by producing equipment capable of enduring the greater stress and at the same time giving greater fuel economy than was ever before dreamed of. And in the early stages of this evolution the name of one Richard Trevithick, a

Cornish mine foreman, must be given a prominent place, for it was he who in 1802 evolved the Cornish boiler, regarded by some as the ancestor of the present type of boiler construction, and was among the first to apply high pressure steam alternately to both piston faces.

The historic condensing or atmospheric engine had the disadvantage of necessitating a bulky machine for even a small amount of useful work. It used steam propulsion on only one face of its piston and even then the pressure was ridiculously low. After steam had forced the piston the length of the stroke the steam was condensed and atmospheric pressure called on to drive the piston back. Trevithick built an engine in which steam actuated the piston through both strokes, thus discarding a principle limiting piston pressure on one side to 14.7 pounds and giving us in its stead the fundamental idea on which reciprocating engines still are built.

Unfortunately, Trevithick's contribution to civilization brought him no material benefit; he died in poverty. But modern engineers owe him at least a vote of thanks, for he helped prepare a field from which they have reaped a rich harvest of efficiency and economy.

Relation of the Volume of Rust to Iron

IN connection with the corrosion of cast iron boilers, the question as to the relation of the volume of rust to the volume of the iron from which the rust was formed has often arisen. Interest in this question was aroused also because of trouble experienced by an electric power and light company in the breaking of porcelain insulators on their transmission lines. These insulators were supported by iron pins in wooden cross arms. Some of the transmission lines were located adjacent to the sea shore and considerable corrosion of the iron pins occurred on these lines, while the lines further inland were less affected.

It was thought that the breaking of the porcelain insulators might be caused by the pressure exerted as a result of an increase in volume of the rusted pins. Definite information was desired as to the actual increase in volume of rust compared with clean iron.

The chemical reaction taking place in the formation of rust was considered by the writer by comparing the specific gravity of iron with that of iron oxide (the most important constituent of rust). One cubic centimeter of iron weighing 7.4 grams will combine with oxygen to form 10.6 grams of iron oxide. Now one cubic centimeter of iron oxide weighs 5.18 grams or conversely 1 gram of iron oxide has a volume of 1/5.18, or 0.193 cubic centimeters. Then the 10.6 grams of iron oxide made by 1 cubic centimeter of iron will occupy a volume of 10.6 x 0.193 or 2.04 cubic centimeters. Therefore, the ratio of the volume of iron oxide to that of iron is as 2.04 to 1 or approximately rust occupies twice the volume of the iron from which it was formed.

Actually, rust will occupy more than the volume given above, as besides the oxygen, there will be some water of crystallization and hydroxide present. With this increase in volume in mind, it is easy to see how iron rust developing in restricted spaces such as in the water spaces of cast iron boilers or between the pins and insulators mentioned above can cause considerable pressure to develop.

This increase in the volume of iron by rusting may also account for some failures of riveted joints where rust forming between the rivet plates may exert sufficient pressure under certain conditions to burst the rivets apart.

Summary of Boiler Explosions for 1926.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	84	9	16	25
February . . .	88	4	12	16
March	98	9	19	28
April	88	4	13	17
May	63	4	13	17
June	53	9	31	40
July	63	10	27	37
August	54	19	32	51
September . . .	72	11	29	40
October	88	6	14	20
November . . .	129	20	23	43
December . . .	149	7	35	42
Total for 1926 .	1029	112	264	376

BOILER ACCIDENTS

(Including Explosions, Fractures and Ruptures of Pressure Vessels)

MONTH OF NOVEMBER, 1926 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
772	8	Four sections heating boiler cracked			City of Florence	City Hall	Florence, S. C.
773		Section of heating boiler cracked			M. & J. Goodman	Factory	Cleveland, Ohio
774		Fitting on rotary digester failed			Sledman Products Co.	Rubber Plant	So. Braintree, Mass.
775		Tube ruptured			American Refining Co.	Oil Refinery	Wichita Falls, Tex.
776		Tube ruptured			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
777		Tube ruptured			Barrett Co. of W. Va.	Chemical Plant	Philadelphia, Pa.
778	9	Tubes ruptured			Board of Chosen Freeholders	County Bldgs.	Lakeland, N. J.
779		Tube ruptured			Board of City Trusts	Office Bldg.	Philadelphia, Pa.
780		Four sections heating boiler cracked			New York Fibre Co.	Factory	Brooklyn, N. Y.
781		Header cracked			Lang Floral & Nursery Co.	Florist	Dallas, Tex.
782	10	Tube ruptured			Hodenpyl-Hardy & Co.	Power Plant	Jackson, Mich.
783		Section of heating boiler cracked			Abbotts Aldernay Dairies, Inc.	Dairy	Philadelphia, Pa.
784		Section of heating boiler cracked			Massachusetts Cotton Mills	Cotton Mill	Lindale, Ga.
785		Section of heating boiler cracked			City of Waterbury	Fire Dept.	Waterbury, Conn.
786		Section of heating boiler cracked			Elizabeth E. Shannon	Light Mfg.	Omaha, Neb.
787		Four sections heating boiler cracked			National Dept. Stores	Dept. Store	Trenton, N. J.
788	11	Section of heating boiler cracked			Young Israel of Eastern Parkway	Club House	Brooklyn, N. Y.
789		Section of heating boiler cracked			M. L. Sigman	Residence	Monticello, Ark.
790		Section of heating boiler cracked			Anna C. Bement	Offices & Apts.	Terre Haute, Ind.
791		Three sections heating boiler cracked			Buffalo Concrete Stone & Brick Co.	Concrete Block	Buffalo, N. Y.
792		Sections of heating boiler cracked			Lityn Realty Corp.	Hotel & Restaurant	New York, N. Y.
793		Two sections heating boiler cracked			Air Reduction Co., Inc.	Chemical Plant	Birmingham, Ala.
794		Blow-off pipe failed		1	McDonald Gin	Cotton Gin	Blair, Okla.
795	12	Boiler exploded		1	E. J. Mullins, Sr.	Residence	Clarksville, Miss.
796	13	Top head blew out of separator in main steam line			Youngstown Sheet & Tube Co.	Steel Plant	Youngstown, Ohio
797		Main steam pipe ruptured			Jones & Laughlin Steel Corp.	Steel Plant	Pittsburgh, Pa.
798	14	Sections of heating boiler cracked			American Bosch Magneto Co.	Warehouse	Springfield, Mass.

MONTH OF NOVEMBER, 1926 (Continued)

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
799		Three sections of heating boiler cracked			Solomon I. Citron	Apt. House	Boston, Mass.
800		Tube ruptured			Oregon Pulp & Paper Co.	Paper Mill	Salem, Ore.
801	15	Return pipe failed			St. Patrick's School	School	Kankakee, Ill.
802		Hot water heater exploded			Fidelity & Columbia Trust Co.	Apts. & Stores	Louisville, Ky.
803		Blow-off pipe failed			Braley-Ferguson Gin Co.	Cotton Gin	Leonard, Tex.
804		Main steam pipe pulled out of stop valve			Gayoso Lumber Co.	Saw Mill	Memphis, Tenn.
805		Boiler exploded			Gaston Apts.	Apt. House	Louisville, Ky.
806		Two sections heating boiler cracked			Board of Education	School	Pittsburgh, Pa.
807		Six sections heating boiler cracked			Mrs. Mathilda Sobol	Apt. House	New York, N. Y.
808		Section of heating boiler cracked			E. Cohn	Store	Perth Amboy, N. J.
809	16	Flue collapsed			A. & J. E. Champagne	Sugar Mill	Edgard, La.
810		Compressed air system exploded			Rowland Mine	Silver Mine	Helena, Mont.
811		Boiler exploded		2	Martin & Hoffman	Mine	Baxter Sp'gs, Kan.
812		Three sections heating boiler cracked			John J. Dillon	Miscellaneous	New York, N. Y.
813		Two sections heating boiler cracked			Mutual Garage & Auto Co.	Garage	Norwood, Ohio
814		Section of heating boiler cracked			Factory Insurance Assoc., Bldg. Corp.	Office Bldg.	Hartford, Conn.
815	17	Section of heating boiler cracked			Forbes Baking Co.	Bakery	Omaha, Neb.
816	18	Tube pulled out of tube sheet			Lima Locomotive Works, Inc.	Locomotive Works	Lima, Ohio
817		Six sections heating boiler cracked			Pacific Tel & Tel. Co.	Office Bldg.	San Pedro, Calif.
818		Two sections heating boiler cracked			Spencer Hotel Corp.	Hotel	Marion, Ind.
819		Five sections heating boiler cracked			Bacon Motor Co.	Garage	Christopher, Ill.
820		Feed water pipe ruptured			Southern Dyeing Co., Inc.	Dyeing Works	Burlington, N. C.
821		Water grate tube ruptured			Gurley Candy Co., Inc.	Candy Factory	Minneapolis, Minn.
822	19	Section of heating boiler cracked			F. H. Heil	Apt. House	St. Louis, Mo.
823		Section of heating boiler cracked			Albert H. Davis, Inc.	Apt. House	Brooklyn, N. Y.
824		Section of heating boiler cracked			County of Jackson	County Jail	Kansas City, Mo.
825		Section of heating boiler cracked			Episcopal Church of St. Thomas	Church	Taunton, Mass.
826		Three sections heating boiler cracked			Board of Education	School	Lego, W. Va.
827	20	Sections of heating boiler cracked			Wakefield Building Inc.	Office Bldg.	Oakland, Calif.
828		Two sections heating boiler cracked			W. & J. H. Osborne, Trustees	Restaurant	Terre Haute, Ind.
829		Five sections heating boiler cracked			Seventeen E. Forsythe Cor.	Hotel	Jacksonville, Fla.
830		Section of heating boiler cracked			Stone & Goldberg	Store Bldg.	Chicago, Ill

831		Blow-off pipe failed (2nd acc.)			Union College, Inc.	College	College View, Neb.
832		Tube ruptured			The Majestic Co.	Office Bldg.	Detroit, Mich.
833	21	Tube ruptured			Peoples Brewing Co.	Brewery	Trenton, N. J.
834		Four sections heating boiler cracked			Alabama Polytechnic Inst.	Residence	Tuscaloosa, Ala.
835		Six sections heating boiler cracked			Joseph H. Harrison Securities Corp.	Hotel	Denver, Colo.
836		Blow-off pipe failed			H. P. Hood & Sons, Inc.	Creamery	Charlestown, Mass.
837		Superheater tube ruptured			Rainery Wood Coke Co.	Coke Plant	Swedeland, Pa.
838		Boiler on tug boat exploded	9		Gilkey Bros. Towing Co.	Tug Boat	Puget S'd, Wash.
839	22	Eight inch valve on steam line ruptured	1		Texas Gulf Sulphur Co.	Sulphur Plant	Gulf, Texas
840		Section of heating boiler cracked			Mercantile Stores Co., Inc.	Garage & Ware house	Brooklyn, N. Y.
841		Section of heating boiler cracked			Board of Education	School	Bridgeport, Conn.
842		Section of heating boiler cracked			Grace E. Morris	Apt. House	W. Hartford, Ct.
843		Sections of heating boiler cracked			Mayer H. Cohen	Mercantile Bldg.	Greenwich, Conn.
844		Two sections heating boiler cracked			M. B. & E. P. Cummings	Factory	Boston, Mass.
845		Section and return header of heating boiler cracked			Max Mazur	Hotel	San Antonio, Tex.
846	23	Blow-off pipe failed			Rice Bros.	Laundry	Brownsville, Pa.
847		Tube ruptured			Robert Gair Company	Paper Mill	Chicago, Ill.
848		Tubes pulled out of drum			Berea College	College	Berea, Ky.
849		Circulating pipe failed		3	Boston Sand & Gravel Co.	Sand Dealers	Boston, Mass.
850		Eleven sections heating boiler cracked			Alexandrine Sinsheimer	Miscellaneous	New York, N. Y.
851		Three sections heating boiler cracked			J. T. Jamison	Store	SanAntonio, Tex.
852		Air tank exploded	3	1	American Blower Co.	Factory	Detroit, Mich.
853	24	Headers cracked			Bethlehem Steel Corp'n	Steel Plant	Lackawanna, N. Y.
854		Section of hot water heater cracked			St. Louis Amusement Co.	Theatre	St. Louis, Mo.
855		Tube pulled out of header			Kansas City Power & Light Co.	Power Plant	Kansas City, Mo.
856		Two sections heating boiler cracked			American Sea Grass Co.	Upholstery	Brooklyn, N. Y.
857	26	Tube ruptured			Merchants Heat & Light Co.	Power Plant	Indianapolis, Ind.
858		Five sections heating boiler cracked			Walter J. M. Donovan	Store & Dwelling	New York, N. Y.
859		Section of heating boiler cracked			Est. of Bencion Moskow	Apt. House	Boston, Mass.
860		Section of heating boiler cracked			Springfield Boys Club	Public Bldg.	Springfield, Mass.
861		Water column connection pulled out			West Leechburg Steel Co.	Steel Plant	W. Leechburg, Pa.
862	27	Section of heating boiler cracked			Forsyth Apartment Co.	Apt. House	Savannah, Ga.
863		Section of heating boiler cracked			Youngstown Sheet & Tube Co.	Steel Plant	Warren, Ohio.
864		Boiler of locomotive exploded	1	1	Southern Pacific Railway	Railroad	Los Angeles, Cal.
865		Three headers cracked			Standard Laundry Co., Inc.	Laundry	Jersey City, N. J.
866	28	Hot water heating boiler exploded	1		103 Spring Street	Apt. House	Springfield, Mass.

MONTH OF NOVEMBER, 1926 (Continued)

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
867		Boiler exploded		6	Rayfield Matalon	Residence	Brooklyn, N. Y.
868	29	Header cracked			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
869		Section of heating boiler cracked			R. C. Taylor, Trustee	Real Estate Office	Pittsburgh, Pa.
870		Sections of heating boiler cracked			School Trustees	School	Columbus, Ind.
871		Boiler exploded	5		Canadian National Rwys.	Railroad	Doucet, Quebec
872		Boiler exploded	1		Wooten Oil Co.	Oil Pump Station	Tullos, La.
873		Boiler exploded		2	John Willoughby	Saw Mill	Seaford, Del.
874		Two tubes ruptured			Narragansett Elec. Lt. Co.	Power Plant	Providence, R. I.
875	30	Boiler exploded		2	Thos. Donn	Oil Well	Osage, Wyom.
876		Oxygen tank exploded		3	Mountain Clinic Laboratory	Laboratory	Olean, N. Y.
877		Section of heating boiler cracked			Brenshil Realty Corp'n	Miscellaneous	New York, N. Y.
878		Section of heating boiler cracked			J. Lyons & Sons	Mercantile Bldg.	Hartford, Conn.
879		Four sections heating boiler cracked			Sixty-seventh St. Studio Bldg.	Studios & Apts.	New York, N. Y.
880		Five sections heating boiler cracked			Waldorf System, Inc.	Lunch Room	Boston, Mass.

MONTH OF DECEMBER, 1926.

No	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
881	1	Tube failed			Pennsylvania Water Co.	Pumping Station	Nadine, Pa.
882		Matrix table cracked			Western Newspaper Union	Factory	Indianapolis, Ind.
883		Hot water supply heater exploded		1	Mrs. E. B. McMonigle	Boarding House	Philadelphia, Pa.
884		Section of heating boiler cracked			George H. Earle, Jr.	Stores	Philadelphia, Pa.
885		Section of heating boiler cracked			Great Northern Apts. Corp'n	Apt. House	New York, N. Y.
886		Section of heating boiler cracked			West End Realty Const. Co.	Apt. House	St. Louis, Mo.
887		Pipe flange cracked			Plymouth County Hospital	Hospital	So. Hanson, Mass.
888	2	Five sections heating boiler cracked			Bronx Plaza Theatre Corp'n	Theatre	Bronx, N. Y.
889		Three sections heating boiler cracked			Hooper Realty Corp.	Apt. House	New York, N. Y.
890		Section of heating boiler cracked			Savoy Realty Co.	Theatre	Cleveland, Ohio
891		Twelve headers cracked			Wilson Syndicate Trust	Office Bldg.	Dallas, Tex.
892		Hot water heating boiler exploded		3	Two Ninety Six W. 137th St.	Rooming House	New York, N. Y.
893	3	Blow-off pipe failed			The Merchants Creamery Co.	Creamery	Cincinnati, Ohio
894		Section of heating boiler cracked			Reo Motor Car Co.	Factory	Detroit, Mich.
895		Three sections heating boiler cracked			Reformed Protest. Dutch Church	Church	Brooklyn, N. Y.

896		Hot water heating boiler exploded			Whittier Apartments	Apt. House	Bridgeport, Conn.
897	4	Three sections heating boiler cracked			Louise G. Crabbe	Apt. House	New York, N. Y.
898		Section of heating boiler cracked			James H. Baker	Apt. House	Holyoke, Mass.
899	5	Section of heating boiler cracked			Keba Chodrov	Apts. & Lofts	New York, N. Y.
900		Section of heating boiler cracked			Walter E. Mantz	Apt. House	St. Louis, Mo.
901		Fittings on main steam pipe failed			Standard Wheel Co.	Wheel Factory	Terre Haute, Ind.
902		Boiler exploded		1	174 No. Fourth Street	Laundry	Williamsb'g, N. Y.
903		Hot water heating boiler exploded			Weaver Bldg.	Stores	Hartford, Conn.
904	6	Boiler bulged and ruptured			Prouty Lumber & Box Co.	Lumber Mill	Warrenton, Ore.
905		Boiler exploded			National Hall	Tenement	Hoboken, N. J.
906		Two tubes failed			Ajax Rubber Co., Inc.	Rubber Works	Racine, Wisc.
907		Boiler ruptured			Continental Paper & Bag Mills	Pulp & Paper Mills	Oconto Falls, Wisc
908		Sections of heating boiler cracked			L. Gershel's Sons, Inc.	Tobacco Warehse.	E. Hartford, Conn.
909		Sections of heating boiler cracked			The Hotel Matis	Hotel	Meriden, Conn.
910		Section of heating boiler cracked			Wm. J. Woods	Factory	Worcester, Mass.
911		Section of heating boiler cracked			City of Laurel	City Hall	Laurel, Miss.
912		Two sections heating boiler cracked			Bessby Realty Co.	Apt. House	New York, N. Y.
913		Four sections heating boiler cracked			Est. of Chas. N. James	Garage	Cambridge, Mass.
914		Four sections heating boiler cracked			Board of Education	School	S. Glens Falls, N.Y.
915	7	Tube ruptured			Bethlehem Steel Corp'n	Steel Plant	Sparrows P't, Md.
916		Header cracked			Vulcanite Portland Cement	Cement Mill	Vulcanite, N. J.
917		Section of heating boiler cracked			Smith Auto Co.	Auto Salesroom	Omaha, Neb.
918		Sections of heating boiler cracked			Ambassador Realty Co.	Apt. House	Hartford, Conn.
919	8	Sections of heating boiler cracked			John Breitmeyer's Sons	Florist	Detroit, Mich.
920		Section of heating boiler cracked			Carl C. Loh	Miscellaneous	Tarrytown, N. Y.
921		Section of heating boiler cracked			Neilade Holding Corp'n	Restaurant	New York, N. Y.
922		Ten sections heating boiler cracked			Board of Education	School	Canton, Ohio
923		Manifold of heating boiler cracked			Lautenberg Estate, Inc.	Apt. House	New York, N. Y.
924	9	Boiler exploded	1	2	Nazworth & Russell	Pumping Station	Tullos, La.
925		Tube ruptured			Penn Iron & Steel Co.	Steel Plant	Creighton, Pa.
926		Eight sections heating boiler cracked			Loew's, Inc.	Theatre	New York, N. Y.
927	10	Three sections heating boiler cracked			Harry Fleigelman	Warehouse	Philadelphia, Pa.
928		Section of heating boiler cracked			Merit Clothing Co., Inc.	Clothing Factory	Mayfield, Ky.
929		Blow-off pipe failed.			Steves Sash & Door Co.	Plaining Mill	San Antonio, Tex.
930	11	Three sections heating boiler cracked			Mary Nemo	Apt. House	Norfolk, Va.
931		Two sections heating boiler cracked			Louis A. Horowitz	Stores	New Britain, Conn.
932		Sections of heating boiler cracked			Board of Education	School	Niagara F'ls, N. Y.
933		Sections of heating boiler cracked			E. W. Baumann	Apt. House	St. Louis, Mo.
934		Sections of heating boiler cracked			Buena Vista College	College	Storm Lake, Iowa

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street,

HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1927

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks		$622,484.21
Real Estate		283,421.23
Mortgage and collateral loans		1,366,072.48
Bonds and Stocks		15,023,458.34
Premiums in course of collection		1,363,003.55
Interest Accrued		152,728.70
Other Assets		54,678.59
Total Assets		$18,865,847.10

LIABILITIES

Reserve for unearned premiums		$7,710,752.66
Reserve for losses		346,047.69
Reserve for taxes and other contingencies		1,593,077.45
Capital Stock	$2,500,000.00	
Surplus over all liabilities	$6,715,969.30	
Surplus to Policyholders,		**$9,215,969.30**
Total Liabilities		$18,865,847.10

CHARLES S. BLAKE, Chairman Board of Directors

WM. R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

Department	Representatives
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BALTIMORE, Md., . . . 13-14-15 Abell Bldg. . .	LAWFORD & MCKIM, General Agents. JAMES G. REID, Chief Inspector.
BOSTON, Mass., . . . 4 Liberty Sq., Cor. Water St.	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., . . 404-405 City Savings Bank Bldg.	W. G. LINEBURGH & SON, General Agents A. E. BONNET, Chief Inspector.
CHICAGO, Ill., . . . 209 West Jackson B'l'v'd. .	P. M. MURRAY, Manager. J. P. MORRISON, Chief Inspector.
CINCINNATI, Ohio, . . First National Bank Bldg. .	W. E. GLEASON, Manager. W. E. GLENNON, Chief Inspector.
CLEVELAND, Ohio, . . Leader Bldg. . . .	A. PAUL GRAHAM, Manager. L. T. GREGG, Chief Inspector.
DENVER, Colo., . . . 916-918 Gas & Electric Bldg. .	J. H. CHESTNUTT, Manager and Chief Inspector.
HARTFORD, Conn., . . 56 Prospect St. . . .	F. H. KENYON, General Agent. A. E. BONNET, Chief Inspector.
NEW ORLEANS, La., . . Hibernia Bank Bldg. . .	R. T. BURWELL, Mgr. and Chief Inspector. E. UNSWORTH, Ass't Chief Inspector.
NEW YORK, N. Y., . . 80 Maiden Lane . . .	C. C. GARDINER, Vice President. E. MASON PARRY, Chief Inspector.
PHILADELPHIA, Pa., . . 429 Walnut St. . . .	A. S. WICKHAM, Manager. S. B. ADAMS, Chief Inspector.
PITTSBURGH, Pa., . . 1807-8-9-10 Arrott Bldg. .	GEO. S. REYNOLDS, Manager. J. A. SNYDER, Chief Inspector.
ST. LOUIS, Mo., . . . 610-618 Security Bldg. . .	CHAS. D. ASHCROFT, Manager. EUGENE WEBB, Chief Inspector.
TORONTO, Canada, . . Federal Bldg.	H. N. ROBERTS, President The Boiler Inspection and Insurance Company of Canada.

PACIFIC COAST DIVISION

C. B. PADDOCK, Superintendent

114 Sansome St., San Francisco, Cal.

PORTLAND, Ore., ... 306 Yeon Bldg., . . .	BATES, LIVELY & PEARSON, General Agents
SEATTLE, Wash., ... 423 Dexter-Horton Bldg., .	E. G. WATSON, Resident Agent.
SAN FRANCISCO, Cal., . . 114 Sansome St. . . .	H. R. MANN & Co., General Agents L. J. REED, Chief Inspector.

Rules for Resuscitation by Prone Pressure Method

Immediately begin actual resuscitation. Every moment of delay is serious. Proceed as follows:

Lay the patient face down, one arm directly extended, the other bent at elbow and with face to one side resting on the forearm, so that nose and mouth are free for breathing.

Kneel, straddling the patient with knees just below the patient's hip bones, place the palms of your hands on the patient with fingers on the lowest ribs, the little fingers on the lowest ribs, the thumb alongside of your fingers.

While counting one, two, three, four (about one second intervals) and with arms held straight, swing forward slowly so that the weight of your body is gradually, but not violently brought to bear upon the patient. This act should take from three to four seconds.

On the count of four remove your hands quickly from patient's body, so releasing the pressure. Swing backward, sit up straight, count 1, 2, 3, 4.

Replace hands on victim's body as before and counting as before, swing forward and backward so as to establish respiration.

Repeat deliberately twelve to fifteen times a minute the swinging forward and backward—a complete respiration in four or five seconds—until patient breathes, or rigor mortis (stiffening of the body) sets in.

As soon as this artificial respiration has been started, and while it is being continued, an assistant should loosen tight clothing about the patient's neck, chest or waist, open patient's mouth, removing any foreign body that may be in it (tobacco, false teeth, etc.), Place ammonia near the nose, determining safe distance by first trying how near it may be held to your own. Hit patient's shoe heels about twenty times with a stick or something similar and repeat every five minutes until breathing commences.

Continue resuscitation (if necessary, four hours or longer) without interruption, until natural breathing is restored, or until rigor mortis has set in. If natural breathing stops after being restored, use resuscitation again.

Give the patient fresh air, but keep him warm. When patient revives, keep him lying down, on his back. Do not raise his head or body. If doctor has not arrived, give patient one teaspoonful of aromatic spirits of ammonia in a small glass of water, if he can swallow. Do not give any liquid stimulant until the patient is fully conscious.

Carry on resuscitation at closest possible point to the accident. Do not move patient until he is breathing normally without assistance. Do not stop or interrupt resuscitation for an instant.

IN CASE OF DROWNING

Lay the patient face down, head lower than feet if possible, straddle the body, facing patient's head, with your feet opposite patient's hips, lean forward and clasping your hands under patient's belly, straighten up, lifting middle of patient's body several inches from the ground, permitting head to hang down; this will cause the water to run from patient's nose and mouth. Then immediately begin resuscitation, and continue as in other cases.

INHALATION OF GAS OR SMOKE

Resuscitation must be done in atmosphere free from gas, smoke, etc. Open, or if necessary break open, all doors and windows; or drag patient the shortest possible distance into fresh air; then immediately begin resuscitation, and continue as before.

If alone with victim, do not neglect immediate and continued resuscitation in order to call a doctor, or for any other reason. Start at once; the first few minutes are valuable. If other persons are present, send one of them for a doctor.

Vol. XXXVII No. 2 April 1928

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Old Engine Being Dismantled After 70 Years of Service in Printing Plant

RETIRED three years ago after seventy years of active service, an engine which is claimed to be the oldest variable cut-off machine in the country, outside of those using the Corliss type valve movement, is being dismantled at the printing plant of The Case, Lockwood and Brainard Co. at Hartford, Conn. During its long career the old prime mover was charged with only two weeks of breakdown idleness. This is remarkable, in view of the frequency with which engine accidents occur, as shown by The Hartford Company's records.

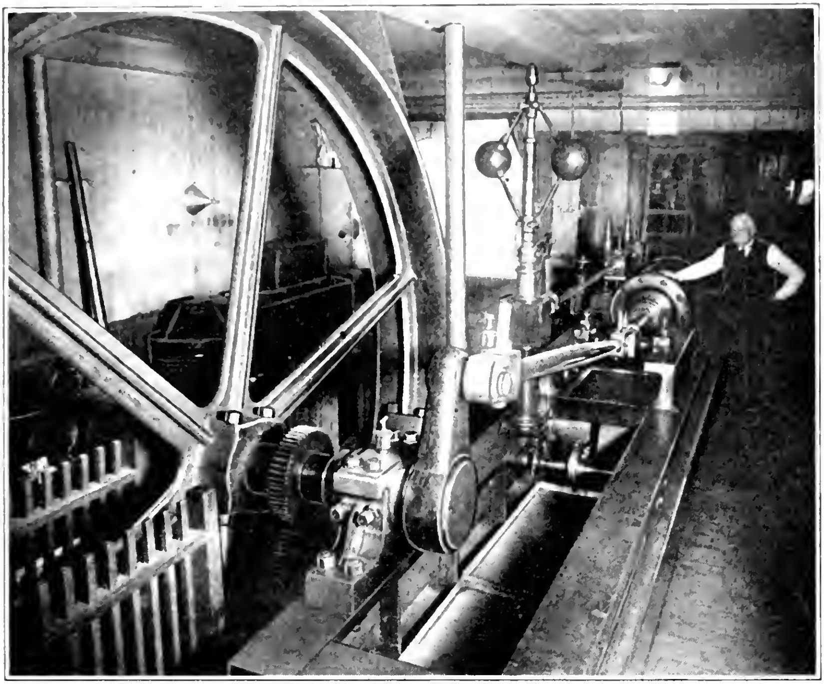
In 1925 the printers decided to build a new plant. It was their intention to supplant the engine and its system of shafts and pulleys with individual electric drive, using current purchased from an electric company. As if the thought of such reward for its long, faithful service was more than it could bear, the old machine developed a crack in its steam chest. Repairs would have entailed considerable expense, so during the last few months in their old plant the printers used a motor to drive the main shafting.

Built in 1855 by Hartford Concern

The engine was designed and built in 1855 at the foundry and machine shop of Woodruff & Beach at Hartford. It had a cylinder diameter of 18 inches, a stroke of 36 inches, and ran at the rate of 55 revolutions a minute. For a boiler pressure of 75 pounds it was rated at 80 horsepower.

The accompanying reproduction of a photograph taken in 1905 shows many of the details of construction. Of especial interest are the poppet valves with quick closing device and variable cut-off. A rotating shaft capable also of lengthwise motion — shown in the photograph as running from the governor post to the valve gear boxes — carried a device to control the time at which cams tripped the steam valves. This shaft was worked back and forth by the flyball governor and so sensitive was the arrangement that the engineer, by a slight pressure of the hand on the above mentioned shaft, could change the speed of the engine.

As stated above, the engine was designed to develop 80 horsepower. The assumption that actually it was turning anywhere near that much into useful work was challenged on several occasions by persons who sought to have the owners discard the engine, belts and shafting and install electric motors. Tests to determine the total power required



They Served Together for 57 Years

to drive the printing machinery seemed to show that 28 horsepower was sufficient. The figure was obtained by indicating the engine while running under load and without load, and assuming the difference to be the power delivered to the machinery. For some reason or other this method did not give accurate results. When the old engine broke down and a 40-horsepower motor undertook to do its work they had to throw some of the equipment off the line to keep from stalling the motor.

In spite of an apparently inefficient arrangement of shafts and belting — made necessary because the engine room stood at an angle to the rest of the plant — the transmission loss seemed moderate. Failure of the 40-horsepower motor to handle what was considered a light load for the engine is significant in view of the fact that at one time the engine ran a machine for making rivets from cold steel, and a large sausage grinder, in addition to the full equipment of the print shop. Up until the time of its retirement, in fact, it supplied a considerable amount of power to other tenants.

Although the owners credit the builders with having turned out a remarkably durable engine, they attribute the machine's extraordinary longevity and freedom from breakdowns to the care given it by the late Charles H. Lynch, who was engineer from 1865 until ill health forced his retirement in 1922. His carefulness is attested by the fact that the original crank pin brasses lasted forty-one years, and were in good condition when replaced. Cross-head slides, in use seventy years, showed very little wear.

Lynch, a Connecticut Yankee, enlisted in Company C, 18th Connecticut Volunteers, at the age of sixteen. After serving for three years in the Civil War he was given an honorable discharge and returned to his home in Norwich. Seeking work, he went to Hartford, where he was hired in a temporary capacity as a helper in The Case, Lockwood & Brainard Co. engine room. He had been there only a few weeks when the regular engineer left the job. The young man was given the position on trial and from that day until his death in 1924 Lynch lived but for his engine. As a member of the firm expressed it, " He loved every revolution of its old fly-wheel."

Engineer Kept Close Eye on Wear

Lynch kept a log book or diary of important events in the engine and boiler rooms. Many of the entries are interesting because of Lynch's pointed sense of humor while others, dealing with devices and practices long since superseded, may be recognized by old-timers as typical of their own experiences in the old days.

It appears that Lynch had a very reasonable theory that a worn part should be replaced before it broke. As a consequence his diary shows that cross-head gibs were renewed at periods of from 6 to 12 years. New gibs were fitted six times during his regime. The cylinder was rebored twice and on both occasions new pistons and rings were fitted. Two sets of governor arms and valve rods were worn out and, in 1897, replacements were secured for exhaust chest, valves and cams.

After fifty years the cylinder casting cracked and was replaced. While the job was being done the owners had the machinists replace valves, valve rods, piston, piston rod, rebabbit pillow block bearings, shrink a new crank arm on the shaft, and smooth up the crank and main shaft bearings. This work cost $1,574.79, according to the diary.

Lynch had no hesitancy in writing frank estimates of things and people. Under date of November 18, 1874, is this entry: " Mr. N——— of N. B. puts in a new patent (feed water) pump to try to beat the K———. The N——— pump is no good." A month later he wrote: " N——— pump taken out. Mr. N——— and his pump a nuisance." On the other hand, when anything pleased him he was quick to say so. Under an entry in 1875 the diary says: "A new improved valve motion put on pump by the K——— Pump Co. No charge. Thanks."

Only the real old-timers can hark back to the days when it was not common practice to lubricate the piston by injecting oil through the steam line. Lynch seemed to regard the idea as something new when in 1877 he wrote: "The H——— Lubricator put on engine. Oils piston through steam line." For years, in fact until steam heat was installed, Lynch preferred to kindle the furnace each morning rather than bank the fire over night. His diary mentions a fire in the pile of kindling wood, ignited by a spark from the furnace. "Have been using hemlock and spruce," wrote Lynch. "No more. It throws too many sparks." Hard coal must have been the fuel in those days for, at a much later date, the diary tells of substituting bituminous for anthracite because a strike at the mines made it impossible to obtain the latter.

Tried Using Commercial Steam

In 1881 the company decided to find out whether steam could be purchased from an outside source more cheaply than it could be produced in its own boilers. The diary records that on June 10, a steam heating company ran a steam main into the building and commenced supplying the engine. In reading what Lynch wrote one gathers the idea that the old timer did not approve of this innovation. "B——— L——— now running the engine, a man who thinks he knows all about steam," he said. Five days later this appeared: "Too much water in city steam, not fit to run engines. Cylinder working loose on bed. Obliged to put in a new set of dowels." For several months Lynch maintained a discreet silence on the subject, but on April 11 of the next year he showed he still retained his poor opinion of 'bought' steam by writing: "Running engine by the city (water) steam. Below speed every day. A leak in steam pipe filled pit and destroyed belt."

How gratified must Lynch have been when, in the following laconic announcement on October 2, he was privileged to record the return to steam generated by his own boilers and under his own supervision. He dismissed the situation thus: "Shut off the city steam. Boiler started up this morning. Engine running O. K. Steam heating company a big failure. A big loss to the C. L. & B. Co. B——— L——— also another big failure."

In 1892 Lynch came upon a period of poor health. He obtained a leave of absence for six weeks and, with Mrs. Lynch, went to Kansas and Colorado. On the eve of departure he wrote: "Andrew D. Scott in charge of engine and boilers." He returned to work after "having the best vacation of my life and in good health." The generous side of the old timer's nature was displayed in the following brief tribute to Scott: "Boilers and engine in good condition. Scott was all right."

In 1895, a twenty-nine year old boiler was condemned by Frank S. Allen, whom many of our readers will recall as chief inspector of The Hartford Steam Boiler Inspection and Insurance Company. It was replaced by a new 100-horsepower boiler made by H. B. Beach & Son, successor to the old Woodruff & Beach Company. The remarkable feature of the installation, as recorded by Lynch, was that the maker's bill was only $1,000 for the boiler and $195.04 for the fittings.

The methodical old fellow, to whom the proper care of equipment amounted to an obsession, must have been perturbed when he arrived at work one morning "to find the blow-off valve partly open and no water in the boiler." He drew the fire and sent for an inspector of The Hartford Company. What a relief it was when "Inspector Cummings found the boiler O. K."

Amusing Entries in Diary

Lynch did not confine his diary comments to affairs of his department. He felt free to express an opinion on the worth or worthlessness of anything used in the plant. When "the old Jumbo press was taken out of Mac's room" perhaps "Mac" himself requested the old man to herald its departure with this blighting epitaph: "Never was any good."

Man or machine, if either was "no good" Lynch minced no words in saying so — in his diary. In speaking of a gang of masons who were pointing up the building he made this comment: "Boss Mason R——— no good. Mr. Brainard soon got sick of that man's way of working."

Cause and effect were chronicled in reverse order in this thumbnail sketch of a man's downfall: "George L———, machinist, finished work for this company. Too much rum." Another rather upside-down arrangement in so far as news value is concerned is evident in the following: "Great toe on my right foot badly jammed. Had to call a doctor. At 10:30 this morning a 16-year old boy named Willie Jahne working over the engine room got caught on the main shaft. Was whirled around the shaft to his death. Knocked the sash and glass all out, making a hole in the ceiling . . . ."

More than likely no one gave much thought to the danger of using boiler pressure steam in office radiators until in the Spring of 1907 a radiator exploded and scattered pieces in all directions. "No one was hurt," said Lynch. A later entry indicates that before steam was turned on in the Fall "three new reducing valves and low pressure steam gauges were installed to control the pressure on the buildings."

The greatest of print-shop tragedies is told of in this brief way: "The railroad time table form all ready for the press, was pied or destroyed by some malicious cuss. No clue." It takes a printer to appreciate the extent of such a catastrophy. Preparation of the form may have entailed a week or two of work by several compositors, make-up men, and proof readers. "Pieing" it meant knocking it apart in such a way that the work had to be done over again from start to finish. No doubt Lynch was deeply impressed by the loud and expressive language that must have reverberated through the composing room when the dastardly work of the "malicious cuss" was discovered.

The last entry in Lynch's diary was made on April 10, 1919, but he served as engineer for several years after that and the engine continued in use for some time after his death. The things to which Lynch devoted his life's work now are giving way to the crow bars and wedges of a wrecking company. The old engine, insured for many years by The Hartford Company, is destined to end its career in some junk man's yard, while the boilers — comparatively youthful — have been sold for use elsewhere. Electrical insurance now covers the equipment by which the printers drive the presses in their new plant.

Inasmuch as we believe a detailed description of the engine's unusual valve mechanism will be of interest to our readers it is made the subject of another article in this issue.

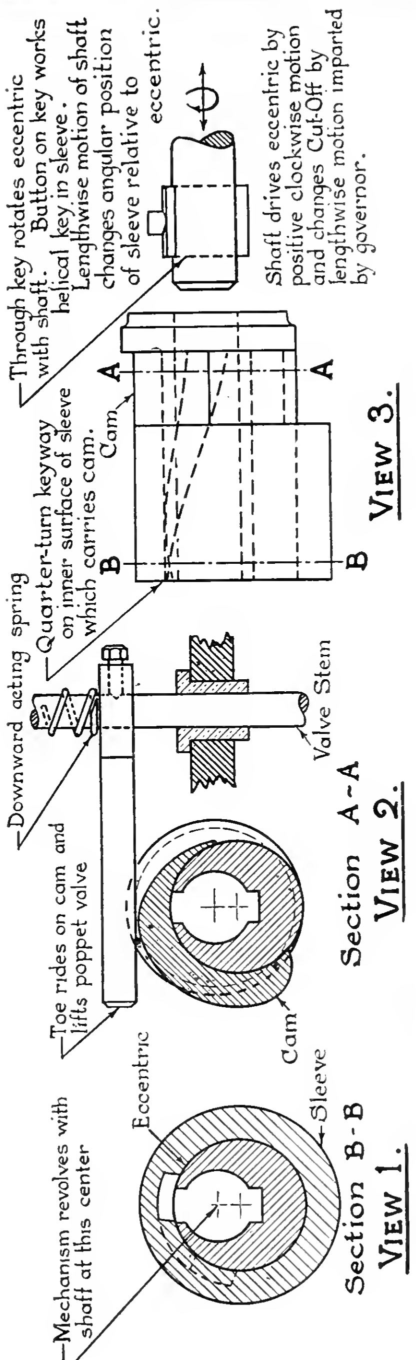
Pride Goeth Before a Fall

The self-confident golfer smiled pityingly at his caddie.

"A driver for this hole? Only 160 yards? Why it's just a mashie and a putt for me!"

Confidently he stepped up to the ball, mashie in hand. "Chug!" The ball dribbled off the tee amid an eruption of clods. There was an instant's silence, and then the caddie murmured:

"Now for a real long putt."



View 4. Sleeve that rides on eccentric and carries cam.

View 5. Eccentric, showing helical key for actuating cam sleeve.

Old Mechanism for Varying Cut-off

IN devising a mechanism to govern the old Woodruff & Beach steam engine (described elsewhere in this issue) by varying the cut-off, instead of by throttling the steam, the designers used a device as effective as it was ingenious. A fly-ball governor was driven positively by gearing. Through a bell crank the upward and downward motion of its collar was transmitted into lengthwise motion of a shaft which ran from the governor post to a valve-gear box over the steam chest at the cylinder. This shaft had also a rotary motion, imparted by gearing. As it rotated it carried a cam on which rode a toe or valve lifter connected to the valve stem. Up and down motion of the toe opened and closed the poppet valve. Lengthwise motion of the shaft was made to vary the time at which cut-off took place. How this was accomplished is shown in the diagrams.

Varied Timing and Valve Lift

Views 4 and 5 are taken from photographs of the parts. The eccentric (5) rode on the governor shaft and was keyed to it by a through-key. Its lengthwise position was fixed but the shaft could slip back and forth through it. View 4 shows the sleeve which fitted over the eccentric and rotated with it — driving force being imparted by a helical key which rode, of course, in a helical keyway on the inner surface of the sleeve. A hole in this key fitted over a button on top of the through-key. Thus both eccentric and sleeve rotated with the shaft, the sleeve carrying the cam (shown in View 2) which raised the poppet valve. A spring returned the latter to its seat when the cam reached the point of cut-off and allowed the toe to descend.

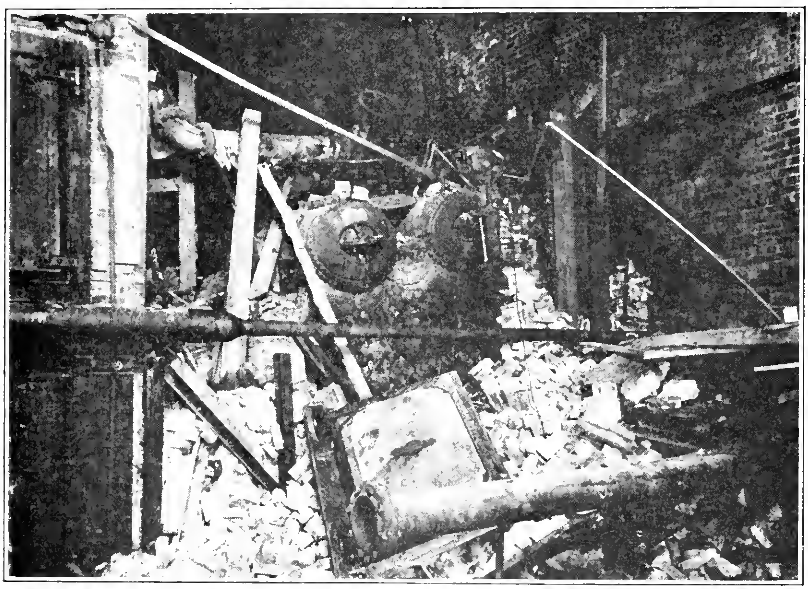
It will be seen that when the shaft from the governor was moved lengthwise by governor action it carried with it both the through-key and the helical key. Inasmuch as neither the eccentric nor the sleeve was capable of endwise motion the result was a change in the angular position of the sleeve on the eccentric. This either advanced or retarded the cut-off, according to the direction of movement of the key in the helical slot. It also decreased or increased the valve lift in that it brought the cam toward either the long or short radius of the eccentric.

Fine performance was obtained by this mechanism, as was shown by indicator cards taken by The Hartford Company in 1920 when it was called upon to replace a fractured main bearing.

Explosion Caused by Tubes Pulling Out

AN explosion that started when eight tubes in the lowest row of a water tube boiler were pulled from the front header, damaged not only the boiler but destroyed its setting, tore loose all pipe connections, parted the breeching, and blew a hole in a brick wall of the boiler room of Consolidated Ice Company, Inc., at Monroe, La., September 6, 1927. Fortunately, no one was near the boiler when it let go.

The explosion was cumulative in effect, in that when the bottom row of tubes pulled loose the energy released by escaping steam and



water raised the boiler from its setting and allowed it to crash downward four feet in such a way as to throw its full weight onto tubes which fell across a brick baffle wall about midway the furnace. Needless to say, this added considerably to the damage.

Both chief engineer and watch engineer had left the boiler room a few seconds before the explosion. They succeeded in closing the stop valve to prevent another boiler on the line from discharging steam through the damaged header.

While the boiler was twenty years old it was apparently in good condition before the accident. Within the past two years it had been completely retubed and neither headers nor drums showed defects when inspected. However, the lowest row of tubes had been the last to be replaced and, when installed, their ends had not been flared. This is believed to have allowed them to blow out under pressure.

Direct property damage, covered by a Hartford policy, amounted to $3,708.60. This included rebuilding the boiler room wall, 23′ high by 30′ long, retubing the boiler, repairing the setting and connections.

The plant uses natural gas as fuel. Inasmuch as there were no actual eye-witnesses to the explosion, the investigators took cognizance of the possibility that instead of being caused by steam pressure the damage might have been the result of a gas explosion within the fire chamber and breeching.

In plants using gas as fuel, care must be taken to guard against combustion chamber detonations by so regulating the relative amounts of fuel and air as to assure complete combustion. In lighting such a furnace great care should be exercised, a piece of burning waste or paper being thrown into the chamber before the gas is turned on. Attempts to light the gas after it has had a chance to accumulate in the chamber may result disastrously. Even when tossing lighted waste into a supposedly empty furnace the fireman should not stand directly in front of the fire door. Leakage may have allowed enough gas to accumulate to form, with air, an explosive mixture.

New Edition of "The Boiler Book"

"THE Boiler Book" was first published by The Hartford Company about six years ago for the purpose of presenting, in convenient form, some of the data most frequently required for the design, manufacture, and installation of boilers and other pressure vessels. The fact that the first edition was so soon exhausted seemed to indicate that the book was playing a useful role and led to the decision to publish a second edition with certain changes and addenda necessary to bring it up to date. This second edition is now ready for distribution at a nominal charge of $1.00 a copy to cover the cost of printing and mailing.

The book confines itself strictly to the field of design, manufacture, and installation and is not intended to serve as a handbook for boiler operators.

Cumulative Fatigue

Lady (to tramp) — "Why don't you work if you are hungry?"
Worn-out Willie — "I tried that ma'am, and it made me hungrier."

Absence of Relief Valve Proves Costly

NOT only was a residence in Fremont, Ohio, deprived of heat at a cold season of the year, but the cellar walls and furnishings of the first floor were damaged by steam and dust when over-pressure blew a piece out of a cast iron hot water boiler, on December 8. The accompanying photograph gives an idea of the destructive force exerted by water when an attempt is made to constrain its natural expansion while it is being heated.

The working of a hot water system depends on having the whole system, including heater, piping, and radiators, completely filled with water. As heat is imparted by the furnace the hot water tends to rise, causing circulation through the radiators and back to the heater. Should the system not be filled completely it is evident that circulation would fail. To avoid this contingency these systems are provided with an expansion tank, located above the level of the highest radiator and connected to the heater by means of a riser or expansion pipe. This acts as a water column to give a static head or pressure to the system. When water stands in the tank the boiler operator knows that the system is completely full, assuming, of course, all air to have been ejected.

Either an altitude gauge or a return pipe from the expansion tank is provided to tell the level of the water. In case a pipe is used it is run down to the boiler room where, by opening a cock, the operator learns whether or not water stands to the required level. It is well, when this tank is located in an unheated part of the house, to provide connections to both supply and return mains so as to insure circulation sufficient to prevent freezing. The riser mentioned above may be considered the connection to the supply line. It should be taken from the main supply line as near the boiler as possible so that air bubbles, liberated when fresh water is fed into the boiler, may rise to the expansion tank instead of going through the system and becoming trapped in the radiators.

Means of Pressure Relief Necessary

Inasmuch as water expands considerably under heat the system must be provided with some means to take care of its increase in volume. Frequently this is accomplished by running an open pipe from the top of the tank to the roof of the house, or back to the basement where it discharges into a drain. In the system mentioned in the first paragraph the relief pipe went to the roof where it was exposed to the cold. Vapor passing up through it gradually froze and formed a plug which closed the pipe completely. Thus constrained, the expanding water broke a casting.

A better method of relieving expansion is to provide a relief valve at a point in the system where circulation is always assured and where there will be no danger of failure because of freezing. A valve constructed on the diaphragm principle will be found more satisfactory than the ordinary springloaded valve, because the former gives more positive action and is not so liable to failure by reason of the valve disc sticking fast to the seat.

Had the owner of the boiler at Fremont followed the Hartford inspector's advice to install a relief valve, no doubt the accident would have been avoided. Damage, amounting to $177.40, was covered by insurance in this company.

Oil Engine Explosion Kills Man

An explosion of the center cylinder of a three-cylinder oil engine near Potosi, Mo., on October 11 of last year, cost the life of the operating engineer. The man was starting the engine by compressed air, and when he admitted a charge of oil to the center cylinder the resulting explosion tore the cylinder from the base plate. As far as is known, the customary precautions had been taken the night before, when shutting down the engine, to free the cylinders of excess oil. Cylinder cocks were open and free before the engine was started. The most probable explanation would seem to be that an overcharge was admitted and the engine fired prematurely before it came up to speed.

An Improved Return Line Hook-up

DEVISING a piping system to return condensate from radiators to low pressure heating boilers is a problem as old as the art of low pressure heating itself. Improperly designed systems have been the direct cause of many a cracked section in cast iron boilers, through failure to maintain a safe water level. This subject was treated at length in the July, 1920 issue of THE LOCOMOTIVE but since then there has been at least one refinement. Inasmuch as few of our readers may be in a position to refer to the old files of the magazine the current article will treat the subject as a whole, rather than confine itself to the improvement made since the previous article was published.

Stated briefly, what happens in these low pressure heating systems is that steam, at a pressure from a few ounces to 10 pounds above atmosphere, flows from the boiler to the radiators where it gives up much of its heat and is condensed into water. This water then flows by gravity back through the return pipe into the boiler and is turned again into steam. The only water lost from the system is the small amount of leakage from valves and fittings but when this is taken into account the water level in the boiler should not change appreciably in several weeks of running. Yet in actual practice it has been found that some steam heating installations contain features that may lead to the water in the boiler falling to a dangerously low level. When this happens the highest parts of the evaporating surface become over-heated. Then, when the level is brought back to normal, relatively cool water comes into contact with the overheated iron. The result is usually a cracked casting.

Figure 1 shows the layout of a two-boiler installation connected to a common steam pipe and receiving return water through a single return pipe. To prevent exchange of water between the boilers of such a system it is necessary to use check valves as shown at "a". With no check valves present the slightest difference in pressure on the water surfaces of boilers No. 1 and No. 2 will drive some of the water from the boiler under higher pressure into the other boiler. This condition carries with it the possibility of dangerously low water in one of the boilers.

To some it may seem almost unbelievable that any pressure difference can exist between two boilers connected to a common steam main. Nevertheless, experience has shown that this condition is possible. The explanation lies in the fact that the balance of temperatures and pressures in these low pressure systems is so delicate that it may be upset by friction of the steam passing through pipes. Should boiler No. 1 be fired harder than No. 2 it will generate more steam. The increased flow of vapor through its steam pipe will create greater pipe friction, thus building up more pressure at the boiler's water surface.

A very slight pressure difference between the two boilers, caused in this way, is sufficient to bring about considerable variation in their respective water levels. Assuming a water temperature of 220 degrees

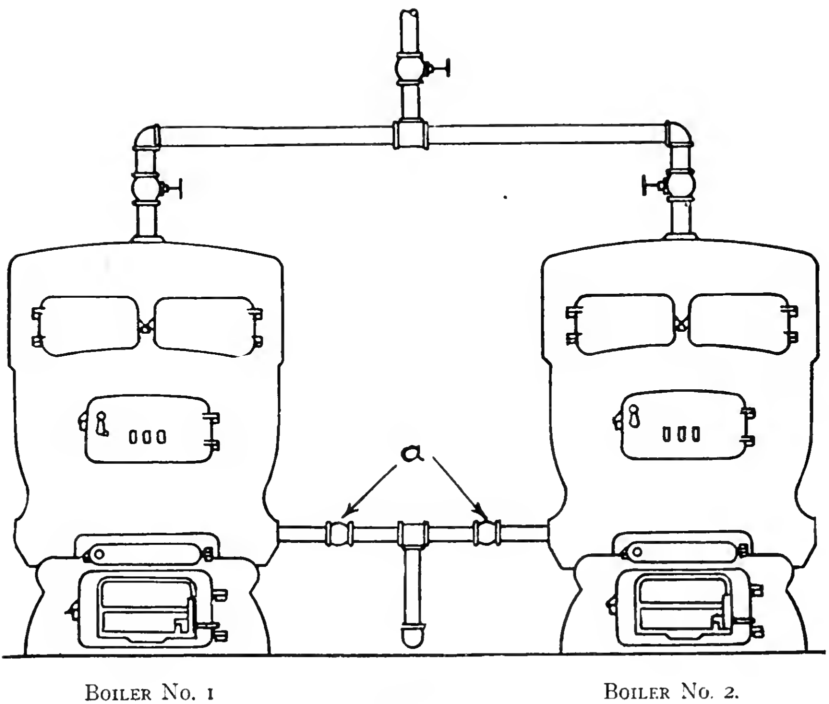


Figure 1

Fahrenheit, a pressure difference of only a quarter pound would cause a variation of approximately 7¼ inches in water level. It can readily be seen that this could uncover the highest part of the evaporating surface of the boiler having the higher pressure, cause overheating, and lead to cracking.

With a pipe arrangement to bring return water in at the lowest part of the boiler — the most common arrangement — a check valve will serve to prevent this exchange of water. It will also prevent water being forced backward from the boiler into the heating system. But inasmuch as safety valves on many heating boilers are not adequate to relieve the great pressure that would be created by the accidental

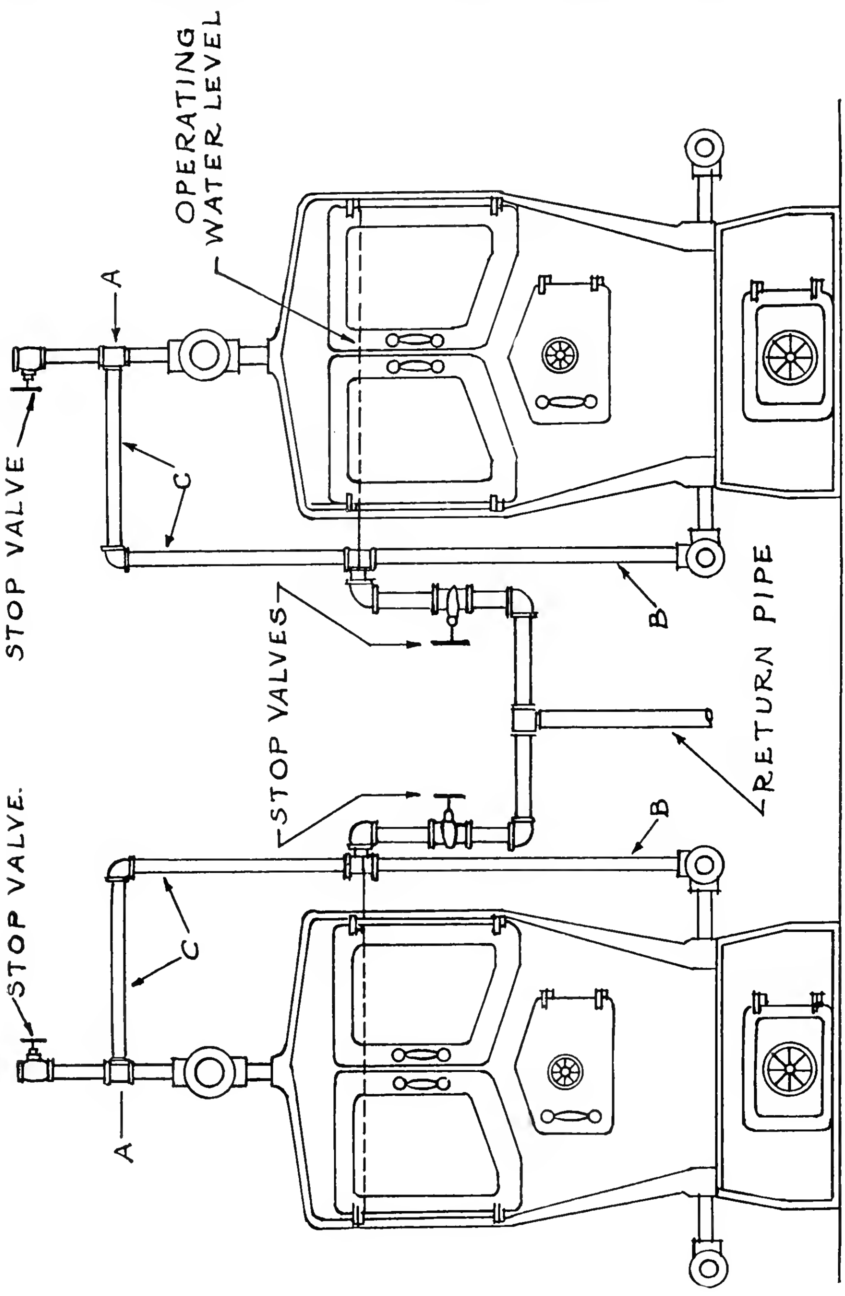

STOP VALVE
A
C
OPERATING
WATER LEVEL
STOP VALVES
B
RETURN PIPE
STOP VALVE.
A
C
STOP VALVES
B

Figure 2

closing of the stop valve, it is easy to conceive of a situation in which this action of the check valve would be a disadvantage, rather than an advantage. It would be clearly desirable, in case of extreme over-pressure, to have no check valve at all, in order that the pressure might be reduced by the steam escaping through the return line to the radiators where it would be condensed.

In practical operation a certain amount of head is necessary to cause a check valve to lift, so that operation of the valve involves a certain amount of unbalance in the system. Both check valves in such a system will remain on their seats until the pressure in the return line becomes somewhat greater than the boiler pressure. Since it is practically impossible to have two check valves act at exactly the same pressure, one will open before the other, and in so doing will further postpone the latter valve's opening. In that way one boiler gets less than its share of the return water, thus bringing about a gradual drop in its water level. Thus it is evident that while check valves prevent exchange of water from one boiler to the other, they may bring about a dangerously low water level in another way.

Having shown the difficulties encountered in this system, we are now prepared to describe another arrangement that avoids these troubles. Figure 2 shows the preferable arrangement which, while avoiding the use of the troublesome check valves, retains the advantage of allowing return water to enter at the lowest part of the boiler instead of at the top, where the introduction of comparatively cold water is not desirable.

Examination of Fig. 2 shows that the return water piping is so arranged as to form a water column to balance the boiler water at the safe water level. But this, in itself, would not prevent steam pressure from backing water out into the system. To counterbalance this boiler pressure, a steam equalizing pipe is provided, as shown at " C ", to produce static balance of the water in the boiler and that in the outside column. Should the reader have difficulty in understanding just how this is effected, the principle may be made clearer by considering the equalizing pipe " C " and riser " B " as just an extra section added to the boiler with free access to both the boiler's steam and water spaces. With this pipe arrangement water cannot be backed out below the safe level. It is important to note that the equalizing pipe must be of ample size and must have as few turns as possible, so as to avoid the effect of steam friction.

In laying out the system it is important that the following table be used in selecting the size of equalizing pipe " C ":

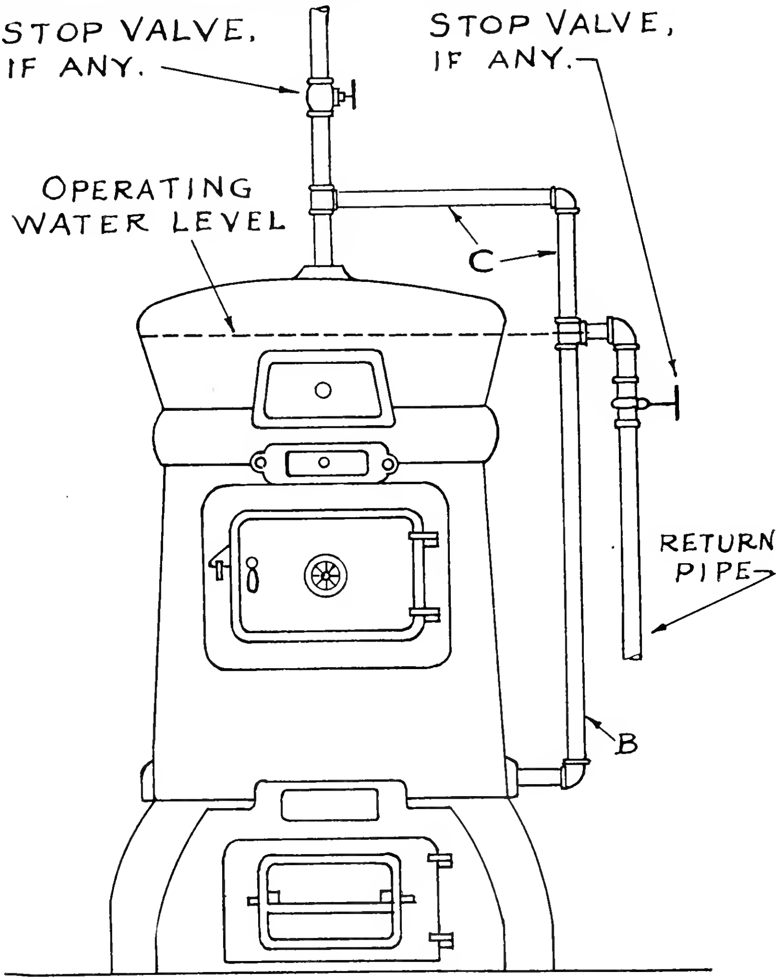


Figure 3.

Grate Area	*Size of Pipe "C"*
4 square feet or less	1-½″
4 square feet to 15 sq. ft.	2-½″
15 square feet or more	4″

The return pipe and pipe "B" should be of the size prescribed by modern practice for return lines.

Fig. 3 shows how this system may be applied to a single-boiler installation.

It will be noted that even though the boiler stop valve should be closed inadvertently — or should the valves on all steam radiators be closed — there would be an outlet to relieve the pressure. The steam would escape through the equalizing pipe and the return pipe where it would produce a rattling sound warning the operator that something was wrong. The proper procedure for him would be to stop evaporation by checking the fire.

The principle of this layout has been well tested in actual practice, so we have no hesitation in commending it to owners of cast iron boilers. While this Company has made no effort to give the system a name, engineers and steamfitters often refer to it as "The Hartford Loop" or "The Hartford Water Level Return Connection".

Improvised Pressure Tanks Dangerous

USING an old metal oil barrel as a pressure tank for an oil-spraying device cost the life of a mechanic at Denver, Colorado, a few weeks ago. The victim's head was crushed when the end of the tank blew out. Though warned by fellow workmen against the danger of subjecting his home-made apparatus to pressure of 150 pounds a square inch, the man refused to delay the job until the safe working pressure of the tank could be determined.

This accident, as well as others of similar nature, should serve as a warning against the tendency to improvise high pressure containers from makeshift equipment not designed for that purpose. The ordinary oil drum, built only strong enough to withstand handling without opening its seams, is nowise suited to contain a fluid under pressure.

Instances come to light now and then of garages and factories rigging up galvanized hot water tanks — intended for domestic use — as compressed air containers. While some of these tanks when new, are able to withstand considerable pressure, many of these installations are second-hand vessels weakened by interior corrosion. Such instances occur because the garage keeper or factory foreman has no idea of the tremendous force exerted on a tank by pressures no greater than fifty or sixty pounds a square inch.

No Bigotry Here

"Dearest, will you marry me?"

"Doug, I must tell you I'm a somnambulist."

"That'll be all right. I'm broad minded about religion."

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., April 1, 1928

Single Copies can be obtained free by calling at any of the company's agencies.
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.

Avoiding Cracking of C. I. Boilers

USERS of steam and hot water heating systems will be interested in reading in this issue articles on " An Improved Return Line Hook-up " and "Absence of Relief Valve Proves Costly ". The article first mentioned above presents a well-tested arrangement by which steam heating plants may be rendered less liable to the most common type of failure, namely the cracking of a section because of low water.

When from any cause the surfaces producing evaporation in a cast iron boiler are not in contact with water, those parts are subject to heat expansion. While this in itself may not cause cracking, there is great danger of breakage when the water level returns to normal and the comparatively cool water causes sudden contraction of the metal. With two boilers discharging into a common steam line and receiving condensate through one return line it has been found that a difference of steam pressure can exist between the two boilers — paradoxical as it may seem — and that this phenomenon can force water from one boiler into the other through the return line. Check valves in the return line will prevent this but their use may produce the same ultimate results by reason of their inability to divide the return water equally between the two boilers.

The piping layout described elsewhere in this issue avoids the use of check valves. It substitutes in their stead a static balance that serves their function with greater certainty and without their disadvantages. Though the system was described in The Locomotive as far back as 1920, since then there has been developed a refinement to reduce water hammer. For that reason it is presented here again for the purpose of giving our readers what we consider a most satisfactory method of avoiding some of the hazards incident to the operation of their boilers.

New Detroit Department

GROWTH of the Company's business in Michigan and Northwestern Ohio has led to the establishment of the Detroit Department with headquarters at 2401-7 First National Bank Building, Detroit, Michigan. This change, intended to expedite the Company's service to its assured in that territory, went into effect April 1.

Mr. L. L. Coates, for many years resident agent at the Detroit branch of the Chicago Department, has been appointed manager. Mr. Coates is especially well-fitted by experience to handle the district now in his charge. He has with him, as chief inspector, Mr. Thomas P. Hetu, who has been Assistant Chief Inspector of the Company's Philadelphia Department. With the exception of a few changes necessitated by readjustment of districts, Mr. Hetu's staff comprises the same trained men who have in the past handled inspections in the district.

Damage by Secondary Combustion

IN February an explosion of oil-permeated soot in the base of a large refinery smokestack shook the city of Tulsa, Oklahoma. Several weeks ago a fireman at a Springfield, Mass., charitable institution, narrowly escaped injury when an explosion blew the heavy iron door from the smoke box of a heating boiler. In both cases the furnaces were using oil as fuel.

When, for any reason, combustible gases are allowed to leave the furnace space unburned, there is a chance of their igniting later, either in the last pass of the furnace in proximity to the upper boiler plates or in the smokebox, breeching, or stack. Bulged plates have resulted from such secondary combustion. Under certain conditions — and where oil is the fuel — ignition of this gas may cause an explosion.

Secondary combustion and explosion have been found to occur where the mixture of fuel and air is not in correct proportion and where the furnace space is not large enough to allow complete burning — as where a boiler is being forced far beyond its rating. In burning oil it is important to guard against unburned gases being allowed to pass beyond the furnace space, both as a safeguard against damage and, of course, as a means of securing the maximum amount of useful heat from the fuel.

Corroded Head Flange Wrecks Boiler

A VERY destructive boiler explosion on October 31 at the plant of Austin Manufacturing Company, Harvey, Ill., is believed to have been caused by corrosion at the knuckle of the blind head in a mud drum. The boiler that exploded is shown at the center of the accompanying illustration. As may be seen, one head was torn out completely. The force of the explosion threw three other boilers from their settings, destroyed the boiler room, and damaged engine room, machine shop, and blacksmith shop. A fireman was injured.

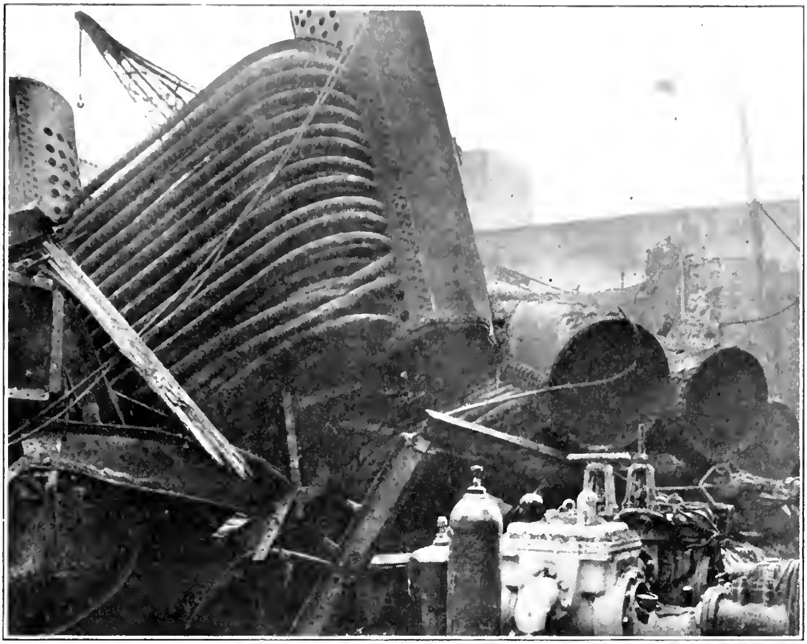
At the time of the accident the plant was obtaining feed water from a lake, but up until shortly before that the feed water was pumped from a deep well. Analysis showed this well water to contain 91 grams of solids to the gallon and to be strongly acid. It was not surprising, therefore, when examination of the wreckage disclosed serious corrosion at the knuckles of the drum heads. At some points only 3/16″ of metal remained.

Lack of Dish Allowed Breathing

Inasmuch as the boiler was of an old type, having heads that lacked the dish required in modern construction, it is probable that these heads were subjected to excessive breathing. In this way the metal would have become fatigued at the section thinned by corrosion.

The boiler was operated at 155 pounds pressure and was rated at 300 h.p. Damage amounting to about $50,000 was covered by insurance although not in The Hartford Company.

Fluctuation of pressure inside a vessel acts on the head as though the latter were a diaphragm, causing it to move in and out — or breathe. As most bumped heads are constructed with a relatively sharp bend where they join the boiler shell, breathing aggravates the stress at that point and subjects the metal to bending fatigue.



It has long been known that metal at the heel of the head flange seems to be especially subject to corrosion, but it was not until recent years that a theory was developed to give a satisfactory explanation of this phenomenon. This theory, in brief, is that in a structure such as a boiler, those parts under the most severe stress fall easy prey to the electrochemical action of the water. Fatigue due to bending increases rapidly as the thickness is reduced by corrosion and, unless the condition be discovered, the outcome will be an explosion.

Power of Advertising

Card in Florida paper: "Thursday I lost a gold watch which I valued very highly. Immediately I inserted an ad in your lost and found column, and waited. Yesterday I went home and found the watch in the pocket of another suit. Thank you very much."

First Burglar — "Come on, Lefty, let's figure up what we made on this haul."

Second Burglar — "I'm too tired. Let's wait and look in the morning papers."

Taps from the Old Chief's Hammer

HAVE you ever noticed the tendency of writers to pick out queer beliefs, inhibitions, and habits of outstanding men and write about them as though they were marks peculiar to genius? As a matter of fact, I doubt whether these so-called geniuses are a whole lot queerer than the rest of us. According to my way of thinking we're all queer in some respects. Our minds may be precise and logical on most subjects but each one of us has a few pet theories on which his brain shows a blind spot. I suppose that's what makes us act like human beings.

Lots of fellows will never light a cigar from the butt of another; neither will they be the third to take a light from one match. They figure it's hard luck, and so it is — for the match manufacturers. But why should we worry about the match manufacturers?

I went up to a cigar counter in Denver a few years ago and the girl clerk told me that folks out there insisted on getting at least part of their change in cartwheels. She said they figured they could help the silver mines by keeping the silver dollars in circulation and wearing them out. I wasn't so keen on taking my change in that form and I said so. "I'm afoot today," I explained, "but I may be riding a horse within a day or two and then you can give me a few." She came back at me with a caustic remark to the effect that out there, where men were men, they didn't have to use horses to carry around a few pieces of silver. So I paid for a can of tobacco with a ten-dollar bill and took my change in the form of seven cartwheels, two bills, and some quarters, dimes and nickels. I didn't want her to think me queer.

Not long ago the cotton growers down South figured that if they could get the society belles to wear cotton stockings it would be a great thing for local industry. But the girls couldn't see it that way and eventually the men had to admit that the whole thing was just another one of those queer ideas.

Strange fancies are not confined to one section nor to one class of people. If a fellow sat down to write out a list of odd habits, customs, and beliefs — including his own — he could fill a book. As far as I'm concerned I don't challenge the right of anyone to believe anything about any subject — except steam boilers. That's one thing about which an amateur has no right theorizing, yet there's a queer theory among users of low pressure heating plants that the boilers never break.

As to their safety, some folks regard their heating plants in a class with vacuum cleaners and waffle irons. Maybe they are safe enough when everything goes right, but the trouble is that dangerously high stresses can be created when things go wrong. For instance, if the water runs low there is good chance of cracking a section. A pressure capable of causing explosion may be brought about by a stopped or frozen pipe, by failure of the safety valve to function, or by accidental closing of a valve that should be open, to say nothing of the various ways an incompetent repair man can gum the works.

Speaking of the last named contingency, a hotel owner in Alabama — who thought his steam heating plant as safe as a vault full of first mortgage bonds — had his idea altered by a couple of blundering steam fitters.

When one of our inspectors visited Garibaldi (that's not the name of the town) last September, he stopped at the Snowden Hotel (that name is likewise fictitious). During the evening he talked with the owner about boiler insurance and learned that Mr. Snowden considered the risk of boiler accident so slight that he wasn't going to waste his money carrying insurance.

In December the same inspector visited the town again and Mr. Snowden met him with a sad story of the cracking of five sections in his boiler — caused by low water. Steam fitters had made repairs by means of wrought iron patches and three cans of "dope", for which job Mr. Snowden had to pay $225. Had he known that was going to happen he would have taken out a policy and saved that much, he said.

During the night the temperature dropped to 35 above. When the inspector turned out in the morning he found Mr. Snowden in the lobby, tearing his hair. At the host's behest he went downstairs for a look at the heating equipment. Water was shooting out of various parts of the system and the "repaired" cracks were leaking like a sieve.

By questioning the fireman the inspector found out what was wrong. When the steam fitters were reconnecting the return pipe they evolved the brilliant idea that it would be a waste of effort to cut a hole in the rubber gasket between flanges. They figured that the hot water would soon make a hole.

Snowden's idea on the infallibility of heating boilers was further revised when he received the subsequent bill for permanent repairs. But the sad feature of the case is that now, while he admits that boilers can break, he has swallowed the old adage that lightning never strikes twice in the same place. That's another queer idea that may cost him money before he's through.

Caught in the Separator

Unleashing a Whirlwind

The professor was trying to demonstrate a simple experiment in the generation of steam.

"What have I in my hand?" he asked.

"A tin can," came the answer.

"Very true. Is the can an animate or an inanimate object?"

"Inanimate."

"Exactly. Now can anyone tell me how, with this can, it is possible to generate a surprising amount of speed and power almost beyond control?"

One student raised his hand.

"Well, Smith?"

"Tie it to a dog's tail." — *Selected.*

He (after long argument) — "I wonder how it would be if you and I ever agreed on something."

She — "I'd be wrong, of course." — *Selected.*

To Do the Chores

The harassed-looking man was being shown over a factory.

"That machine," said the guide, "does the work of thirty men."

The man smiled wanly.

"That's what my wife thinks she married," he said.

This Slaid, Slayed, or Slew Him

A Belgian student was relating his experience in studying the English language. "When I discovered that if I was quick I was fast," he said, "and that if I was tied I was fast, if I spent too freely I was fast, and that not to eat was to fast, I was discouraged. But when I came across the sentence, 'The first one won one one-dollar prize,' I gave up trying to learn English."

The March of Progress

"And are you really content to spend your life walking the country begging?" asked the old lady severely.

"No, lady," answered the tramp. "Many's the time I've wished I had a car."

BOILER ACCIDENTS

(Including Explosions, Fractures and Ruptures of Pressure Vessels)

MONTH OF DECEMBER, 1926 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
935		Section of heating boiler cracked			Wm. C. H. Smith	Garage	New Bedf'd, Mass.
936		Boiler exploded		1	Humble Field	Oil Well	Houston, Tex.
937		Boiler exploded		2	Cornelius Hines	Greenhouse	New Haven, Conn
938		Hot water heating boiler exploded			2741 Garber Street	Apt. House	Berkeley, Calif.
939		Fitting in steam pipe failed			Western Tablet & Stationery Co.	Factory	St. Joseph, Mo.
940	13	Section of heating boiler cracked			Citizens General Hospital	Hospital	New Kens'gt'n, Pa.
941		Section of heating boiler cracked			Garford Motor Truck Co.	Trucking	Atlanta, Ga.
942		Section of heating boiler cracked			Bd. of County Commissioners	Poor Farm	Renssalaer, Ind.
943		Sections of heating boiler cracked			Auto Specialties Co.	Repair Shop	Elkhart, Ind.
944		Blow-off pipe ruptured			Utica Valve and Fixture Co.	Valve Works	Utica, N. Y.
945		Superheater tube failed			Texas Power & Light Co.	Power Plant	Trinidad, Tex.
946		Eleven sections heating boiler cracked			Alexandrine Sinsheimer	Miscellaneous	New York, N. Y.
947		Heating boiler ruptured			Kenwood School	School	Nampa, Idaho
948	14	Boilers (2) ruptured			Stout Institute	Institute	Menomonie, Wis.
949		Three sections heating boiler cracked			First National Bank	Bank Bldg.	Hazard, Ky.
950		Section of heating boiler cracked			Peters-Bradley Mill Co.	Flour Mill	Knoxville, Tenn.
951		Section of heating boiler cracked			Pacific Coast Borax Co.	Borax Works	Ryan, Calif.
952		Section of heating boiler cracked			Snow Brothers	Garage	Oak Park, Ill.
953	15	Section of heating boiler cracked			W. & J. H. Osborne, Trustees	Restaurant	Terre Haute, Ind.
954		Four sections heating boiler cracked			Loew's, Inc.	Theatre	Brooklyn, N. Y.
955		Five sections heating boiler cracked			Lake Amusement Co.	Theatre	Minneapolis, Minn.
956		Two sections heating boiler cracked			Wilson Motor Co.	Garage	Charlotte, N. C.
957		Four sections heating boiler cracked			Albert Steves, Jr.	Residence	San Antonio, Tex.
958		Section of heating boiler cracked			Board of Education	School	Bridgeport, Conn.
959		Nine tubes, pulled out of drum			Spicer Mfg. Corp'n	Factory	S. Plainfield, N. J.
960		Boiler bulged and ruptured			Salisbury & Satterlee Co.	Bed Factory	Minneapolis, Minn.
961		Tank exploded	1	1	Lehigh Structural Steel Co.	Steel Plant	Allentown, Pa.
962		Boiler exploded	1		Northern Pacific Terminal	Station	Portland, Ore.
963	16	Three sections heating boiler cracked			American Sea Grass Co.	Factory	Brooklyn, N. Y.

MONTH OF DECEMBER, 1926 (Continued).

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
964		Fourteen sections heating boiler cracked			Board of Education	School	Lawrenceville, Ill.
965		Seven sections heating boiler cracked			Board of Education	School	Lawrenceville, Ill.
966		Three sections heating boiler cracked			Joseph H. Cohen	Mercantile Bldg.	New York, N. Y.
967		Section of heating boiler cracked			Board of Education	School	Ada, Okla.
968		Section of heating boiler cracked			Mary A. Burnham School	School	N'thampt'n, Mass.
969		Section of heating boiler cracked			Ambassador Realty Co.	Apt. House	Hartford, Conn.
970		Boiler ruptured			Wm. E. Russell Coal Co.	Coal Mine	Firestone, Colo.
971		Blow-off valve failed			Ballman Cabinet Co., Inc.	Furniture Factory	Covington, Ky.
972		Blow-off pipe failed		1	Diamond Refractories Co.	Brick Plant	Cannelton, Ind.
973	17	Manifold and sections of heating boiler cracked			John & James Moscow	Office Bldg.	Columbia, Mo.
974		Section of heating boiler cracked			B. G. Davis & Co.	Cigar Factory	New York, N. Y.
975		Tube ruptured			Cincinnati Rubber Mfg. Co.	Rubber Works	Norwood, Ohio
976		Header cracked			Scovill Mfg. Co.	Factory	Waterbury, Ct.
977		Boiler exploded			Joseph Cowan	Greenhouse	Kansas City, Kan.
978		Boiler of locomotive exploded	1		Chicago & Northwestern Ry.	Railroad	Glenrock, Wyo.
979	18	Three sections heating boiler cracked			Corbin Y. M. C. A.	YMCA Bldg.	Corbin, Ky.
980		Sections of two heating boilers cracked			Board of Public Education	School	Pittsburgh, Pa.
981		Section of heating boiler cracked			Neirak Realty Corp'n	Apt. House	New York, N. Y.
982		Boiler exploded	1	10	Ward Lumber Co.	Lumber Mill	Rocky M't, N. C.
983		Heating boiler exploded	1	2	Y. M. C. A.	YMCA Bldg.	Denison, Tex.
984	19	Tube ruptured			Brooklyn Polytechnic Inst.	College	Brooklyn, N. Y.
985		Boiler of locomotive exploded		2	San Joaquin & Eastern Ry.	Railroad	Fresno, Calif.
986		Section of heating boiler cracked			Children's Aid Society	Institution	Chappaqua, N. Y.
987		Section of heating boiler cracked			Bellevue Community Theatre	Theatre	W. Roxb'ry, Mass.
988	20	Section of heating boiler cracked			Trustees of School District	School	Grand L'dge, Mich.
989		Section of heating boiler cracked			New York Fibre Co.	Factory	New York, N. Y.
990		Tube ruptured		1	St. Joseph's Presentation Academy	Institution	San Franc's'co. Cal.
991	21	Manifold of water grate of heating boiler cracked			Genesee County Savings Bank	Bank	Flint, Mich.
992		Six sections heating boiler cracked			Richard L. Edmonston	Hotel	E. Liverp'l, Ohio.
993		Section of heating boiler cracked			Dr. S. Chester Stahlman	Apt. House	Monongahela, Pa.
994		Sections of heating boiler cracked			Alma Abraham	Apt. House	San Franc'sco, Cal.

995		Acid pressure tank exploded			McClintic-Marshall Co.	Acid Plant	Pottstown, Pa.
996	22	Section of heating boiler cracked			Children's Aid Society	Children's Home	New York, N. Y.
997		Section of heating boiler cracked			Town of Milford	Municipal Bldg.	Milford, Conn.
998	23	Section of heating boiler cracked			H. D. Coghlan	Garage	Chicago, Ill.
999		Boiler ruptured			Stein Bros.	Bakery	Portland, Ore.
1000		Key cap blew out		1	S. S. Atlantic	Steamship	Seattle, Wash.
1001	24	Section of heating boiler cracked			Max Rosenblatt	Mercantile Bldg.	New York, N. Y.
1002		Section of heating boiler cracked			St. Mary's Catholic Church	Church	Shenandoah, Iowa
1003		Two sections heating boiler cracked			Wolf & Crane Co.	Factory	Philadelphia, Pa.
1004		Eight sections heating boiler cracked			A. B. Kirkpatrick	Garage	Topeka, Kan.
1005		Boiler ruptured			Hess & Hopkins Leather Co.	Leather Factory	Rockford, Ill.
1006		Three sections heating boiler cracked			N. Y. Guild for Jewish Blind	Home	Yonkers, N. Y.
1007	25	Section of heating boiler cracked			Bridgeton Realty & Leasing Co.	Offices & Stores	Fitchburg, Mass.
1008		Boiler ruptured			Florence Gas & Fuel Co., Inc.	Gas Plant	Florence, S. C.
1009	26	Sections of hot water heating boiler cracked			Colonial Motor Coach Corp.	Garage	Syracuse, N. Y.
1010		Five sections heating boiler cracked			United Metal Spinning Co.	Metal Works	Brooklyn, N. Y.
1011	27	Two sections and manifold of heating boiler cracked			First Texas Prudential Ins. Co.	Hotel & Stores	Galveston, Tex.
1012		Section of heating boiler cracked			Jacob Stern	Office Bldg.	San Frans'co, Cal.
1013		Section of heating boiler cracked			G. & A. M. Lupardo	Apt. House	Brooklyn, N. Y.
1014		Section of heating boiler cracked			Hom Estic Laundry	Laundry	Brooklyn, N. Y.
1015		Sections of heating boiler cracked			Highland Park Paint & Glass Co.	Store	H'g'l'd P'k, Mich.
1016		Boiler of locomotive exploded		1	Southern Pacific Ry.	Railroad	San Antonio, Tex.
1017	28	Two sections heating boiler cracked			Arkansas State Normal School	School	Conway, Ark.
1018		Tube ruptured			Coale Muffler & Safety Valve Co.	Brass Works	Baltimore, Md.
1019		Boiler exploded	1	1	Franklin County	Court House	Hampton, Iowa.
1020	29	Sections of heating boiler cracked			E. F. Taylor	Business Block	Johns'n C'ty, Tenn.
1021		Boiler ruptured			Board of Education	School	Owensboro, Ky.
1022		Boiler ruptured			Cullen Investment Co.	Hotel	S'lt L'ke C'ty, Utah
1023	30	Two sections heating boiler cracked			Board of Education	High School	Salisbury, Mo.
1024	31	Blow-off pipe failed		4	Blytheville Cotton Oil Co.	Oil Mill	Blytheville, Ark.
1025		Section of heating boiler cracked			Lochmoor Club	Country Club	Crosse P't Shores, Mich.
1026		Tube sheet ruptured			Riverside Coat, Apron & Towel Co.	Laundry	Paterson, N. J.
1027		Boiler exploded		1	Duplex Mfg. Co.	Factory	Superior, Wisc.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street,

HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1927

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$622,484.21
Real Estate	283,421.23
Mortgage and collateral loans	1,366,072.48
Bonds and Stocks	15,023,458.34
Premiums in course of collection	1,363,003.55
Interest Accrued	152,728.70
Other Assets	54,678.59
Total Assets	$18,865,847.10

LIABILITIES

Reserve for unearned premiums		$7,710,752.66
Reserve for losses		346,047.69
Reserve for taxes and other contingencies		1,593,077.45
Capital Stock	$2,500,000.00	
Surplus over all liabilities	$6,715,969.30	
Surplus to Policyholders,		**$9,215,969.30**
Total Liabilities		$18,865,847.10

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Incorporated 1866 Charter Perpetual

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Should an explosion occur, income from production would stop, while the burden of fixed expense would have to be met from the surplus of other years.

At the new rate no owner should neglect to provide for himself a Use and Occupancy policy protecting his income against loss by accidental shut-down from boiler explosion.

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- -

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

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GENTLEMEN :— Please send me more facts concerning Use and Occupancy Insurance and your new rates therefor.

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(Company)

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(Address)

Vol. XXXVII No. 3 July 1928

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Breakage of Cast Iron Steam Rolls

LACK of safeguards against 140 pounds boiler pressure being exerted on parts intended to withstand little more than a third of that amount is thought to have caused a violent explosion of a train of twenty-three cast iron paper-drying rolls at Noble Manufacturing Company's plant, Cedartown, Ga., on March 8. One man was injured so severely that he died within a few hours. Another was badly scalded. Property loss of about $25,000 was not covered by insurance. Figure 1 gives an idea of the extent of the disaster.

When operating, the rolls acted as condensers, the action of drying the paper absorbing enough heat to keep the steam within a pressure range of from 35 to 50 pounds. Whenever the machine was stopped, this radiation was checked and, in as much as there was neither a reducing valve nor a safety valve between the boiler and rolls, there was a tendency for full boiler pressure to build up within the latter. Consequently, operators were instructed to shut off the steam whenever it was necessary to stop the machine.

Rolls Exploded When Machine Was Stopped

At 7 o'clock on the evening of the accident the machine was shut down to permit the repair of a belt. The explosion occurred a few minutes later, and in spite of the testimony of an attendant that he had followed out the order to close the steam valve, evidence seemed to show that the valve was open, thus allowing high pressure to accumulate in the rolls.

The cylinders were 70″ in length, 28″ in outside diameter, and varied in thickness from ½″ to ¾″. Heads, 1″ thick, were fastened on with twenty ⅝″ bolts. So great was the disruptive force that on some of the rolls the entire bolt circle was sheared. Fifteen of the rolls were reduced to fragments and the others were cracked so badly as to be of no further use.

In some respects the accident was similar to an explosion at North Star Strawboard Mills, Quincy, Illinois, on February 29, 1924. That explosion killed two men, injured eight, and caused property damage of $100,000. Testimony of witnesses did not agree as to the pressure being carried at the time of the explosion, but investigators were inclined to believe the pressure to have been much greater than the fifty pounds for which the rolls were approved. It was thought that the shock of water hammer actually caused the rupture. An account of this accident was published in THE LOCOMOTIVE of July, 1924.

When suitable safety devices are provided and maintained in good operating condition, and where intelligent precautions are observed by operators, the danger of accidents to this type of machinery is greatly reduced. But there are several features of construction and operation that should be understood by all persons who have anything to do with apparatus using cast iron rolls subject to internal steam pressure.

In the course of preparing this article the writer sought the views of several manufacturers of chilled calender rolls and found that one,

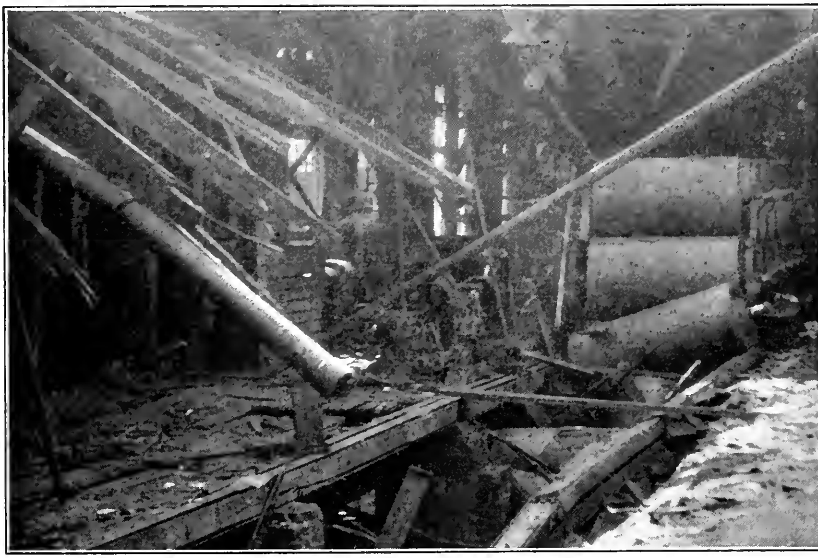


Figure 1

at least, did not consider steam pressure a serious factor in their breakage. But whereas our experience has revealed comparatively few explosions, it can be seen from the accidents mentioned above that over-pressure may cause very violent disasters. To guard against this it is necessary that all such installations have a reducing valve between the boilers and the rolls and a safety valve between the reducing valve and the rolls. The safety valve should be set to blow at a pressure no greater than the steam temperature requirements necessitate, and in no case above the designed safe working pressure of the cylinders. The reducing valve should be set from 5 to 10 pounds less than the safety valve. General use rarely exceeds 50 pounds for paper mill processes.

One type of paper-making machine takes care of the pressure hazard by having a packed steam joint in the roll journal so adjusted by a spring that when the pressure reaches a certain point the joint will leak. Regardless of this safeguard a reducing valve must be used.

One of the problems encountered in the design of rolls or calenders is to remove the water formed by the steam's condensation. Usually this is accomplished by a siphon leading to a steam-tight trap. The latter accumulates water until full. Then the weight of the water causes the trap to tip and discharge its contents into a drain. Steam pressure within the roll forces the water out through the siphon and into the trap. This voiding of water is very important in order to prevent water hammer.

At the end of a day's run there will be some water left in the roll.

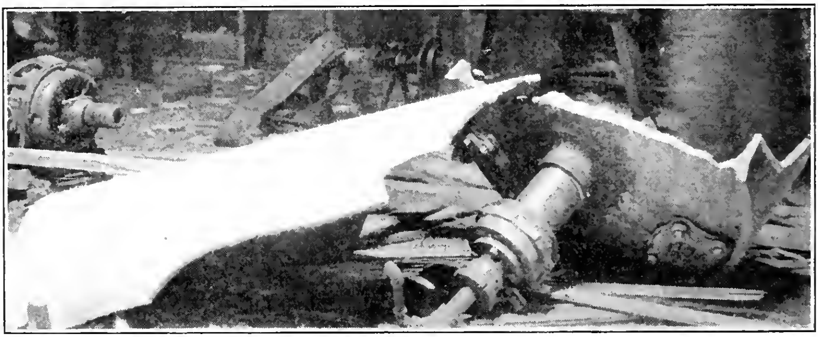


Figure 2

This often leads to cracking of the casting unless the attendant understands the proper method of warming up the machine in the morning. When steam is turned into a cold roll, the water in the lower part acts as a perfect insulator, allowing that part of the roll to remain cool while the upper part is being raised to steam temperature. One manufacturer classes this as among the most frequent causes of the cracking of such rolls. To avoid this, the machine should be turning over slowly before steam is admitted.

In rubber mills in particular some machines are piped up so as to allow a quick reduction of temperature by the admission of cold water. Of course, this sets up serious strains in the roll and is a cause of breakage.

Even while this article is being written, there comes to our desk reports of a steam mangle explosion in a laundry at Kokomo, Indiana, in which four young women were killed and six others were seriously injured. According to newspaper accounts, no cause has been assigned to this catastrophe. But, in view of what we know of cast iron steam rolls, it is significant to note that the explosion occurred at the start of the day's run while the roll was being warmed up by steam at 70 pounds pressure. It is probable that condensate remaining in the roll from the previous day brought on failure in the manner described in preceding paragraphs.

Figure 2 shows the remains of the roll. Note the longitudinal crack along a line that might easily be conceived as the height to which the condensate stood.

It is obvious that while safety devices cannot be counted on absolutely to eliminate all chance of accident, their presence greatly reduces the probability. The men in actual charge of operating such machines should be given to understand the conditions under which danger is greatest as well as approved practices for reducing it to a minimum.

Electric Steam Generators in Use Where Water Power Is Abundant

THE first commercial arrangement for generating steam by passing a current of electricity through water contained in a suitably constructed tank was developed during the early years of the World War by an Italian engineer, Revel. Since then electric steam generators — or electric boilers, as they are often called — have come into more or less general use not only in Europe but in districts of the United States and Canada where cheap electric power is available. But in spite of their advantages over the fuel-fired boiler, as represented by greater flexibility in meeting fluctuating loads, high thermal efficiency, cleanliness, and freedom from smoke and the necessity of having large storage space for fuel, electric boilers apparently are not destined to supplant those of the fuel-fired type except when certain peculiar requirements prevail and when an abundance of water power reduces the cost of electricity far below the average commercial rate.

Pulp plants in Canada and certain parts of the United States are finding electric boilers satisfactory for generating process steam for their kiers and digesters. Other industries, located in territories where there is insufficient water power for their needs during certain seasons of the year but a surplus during others, use both fuel-fired and electric boilers, cutting out their fuel-fired apparatus whenever their water power is sufficient to handle both power and process steam requirements. In some cases power companies use their surplus by installing and maintaining electric boilers at their customers' plants, basing their

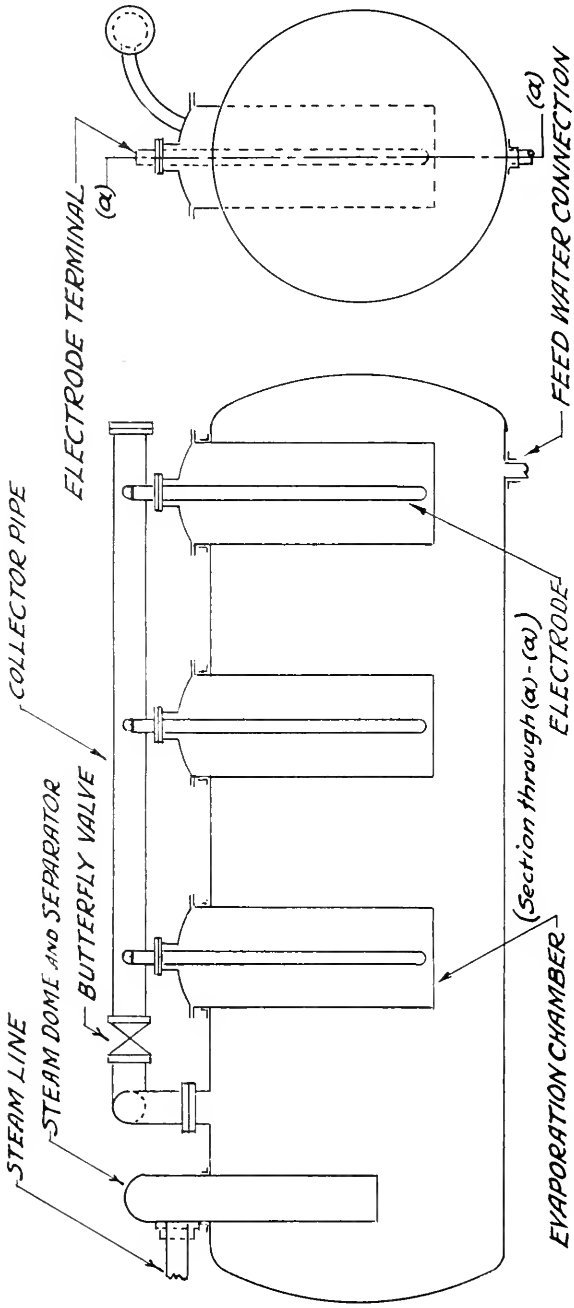

STEAM LINE
STEAM DOME AND SEPARATOR
BUTTERFLY VALVE
COLLECTOR PIPE
ELECTRODE TERMINAL
(α)
(α)
FEED WATER CONNECTION
(Section through (α) - (α))
ELECTRODE
EVAPORATION CHAMBER

Figure 1

charge not on the electrical input, but on the amount of steam metered out of the boiler.

Industrial plants having contracts giving them low rates in consideration of their using a specified minimum amount of current annually, often find it difficult to gauge their power requirement closely enough to avoid an unused surplus. Under such a condition the difference between the amount of current they can use for power and the amount they must pay for whether they use it or not can be utilized with great economy for operating an electric boiler for steam heating or for process steam.

Stores Energy at Night for Use Next Day

Still another use to which these boilers are put is to store up energy at night, when power requirements are zero — or at least at a minimum — and give out this energy in the form of steam for heating or process work next day. During the day current from the plant's hydro-electric generators is needed for mechanical power, but after plant operations have ceased the current may be fed into the electric boiler. By morning, when it is necessary again to turn the current over to plant operation, the boiler has absorbed heat enough to allow steam — at a steadily reducing pressure, of course — to be drawn off throughout the day. In this way, the water that would otherwise go to waste over the dam is made to pay dividends.

In principle, electric steam generators consist of either a horizontal or vertical steel shell in which — for three-phase current — three electrodes enter the top through steam-tight insulators and extend downward far enough to submerge a considerable portion of their surface in the boiler water. In some designs these electrodes are of cast iron; in vertical installations they may be steel plates bent so as to make them concentric with the shell. While details of design vary greatly, all such boilers are alike in that they have no heating coils, but depend on the flow of electric current through the water to create the heat whereby steam is formed.

Either automatic or hand regulation must be provided to take care of fluctuating demands for steam and to compensate for the loss of resistance of the water as its temperature rises.

One type of boiler (shown in Figure 1) has the electrodes extending downward inside of what resemble inverted metal cups — called evaporation chambers. Steam is formed inside these chambers and rises to the top, where it is drawn off into a receiving pipe. This receiving pipe returns the steam to the boiler at another point. By partly closing the butterfly valve shown in the sketch, pressure can be built up within the evaporation chambers. This forces down the water level in the chambers and leaves less of the surface of the electrodes immersed, thus decreasing the flow of electric current and lowering the rate of evaporation. By closing the butterfly valve completely the water level may be forced low enough to uncover the electrodes — a condition that would stop evaporation.

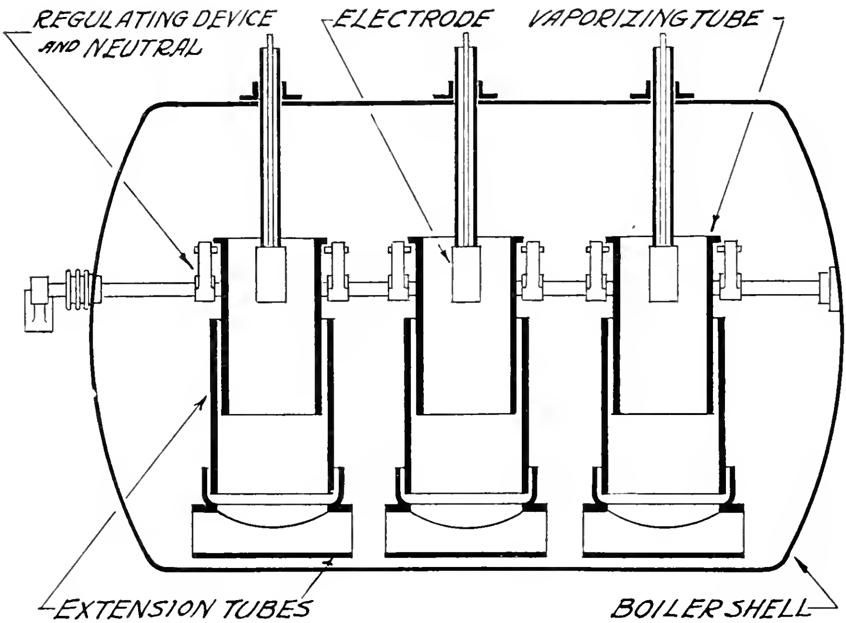


Figure 2

Other types of boilers have no evaporation chambers as distinguished from the boiler proper but, in their stead, have a cylindrical metal tube around each electrode. (See Fig. 2.) These tubes are open at top and bottom and in as much as they are all connected together mechanically by a bar which passes out through the boiler shell, they serve as the neutral. Their function is two-fold, for besides tending to prevent the formation of air bubbles on the electrodes by increasing the circulation of the water immediately surrounding the latter, they are so arranged that they can be raised or lowered to decrease or increase the length of path between conductors and, as a direct result, control the electric input.

Still other boilers are controlled by varying the amount of feed water so as to control directly the height to which the water extends upward around the electrodes.

Automatic control for almost all types may be secured on the basis of constant steam pressure, constant temperature, constant power input, or variable power input to absorb all electrical energy not required elsewhere. The ease with which such control may be provided to meet the individual plant requirements, and the celerity with which these boilers respond to a sudden demand for more steam are two of their most advantageous features.

Overheating of the boiler shell because of low water — so much feared in fuel-fired boilers — is not a hazard in electric installations. As the water level drops, less and less current flows and if, by chance, the level should drop low enough to uncover the electrodes, the current would be shut off altogether. However, electric boilers, like their fuel-fired contemporaries, are subject to cracking, corrosion and pitting. In addition, there has as yet been no conclusive proof that under certain conditions of design and operation they are not liable to an explosion due to the ignition of a mixture of hydrogen and oxygen.

Explosion Led to Experimental Research

In 1924 an electric hot water generator (not a steam generator) exploded violently in a residence at Winnipeg, Manitoba. Among several theories advanced to explain it, one was that it was a hydrogen explosion. As a result, a series of experiments were conducted by Prof. J. W. Shipley of the University of Manitoba, and A. Blackie of the National Testing Laboratories, whereby they demonstrated that alternating current can break water down into hydrogen and oxygen. Previous to that time it was supposed that while direct current could bring about electrolysis, alternating current was incapable of producing that effect. The findings of Messrs. Shipley and Blackie were published in the *Electrical News,* February 15, 1926.

Several radically different explanations were offered for the explosion at Winnipeg. Some believed it to have been caused by overpressure, due to a stoppage of the pipe leading to the expansion tank. Others were inclined toward accepting the hydrogen explosion theory. A point that all were able to agree on was that the ¾ inch pipe to the expansion tank was too small for safe operation. This had, previous to the explosion, caused water hammer and surging when the thermostat controlled valve closed and caused the pressure to back up into the expansion tank.

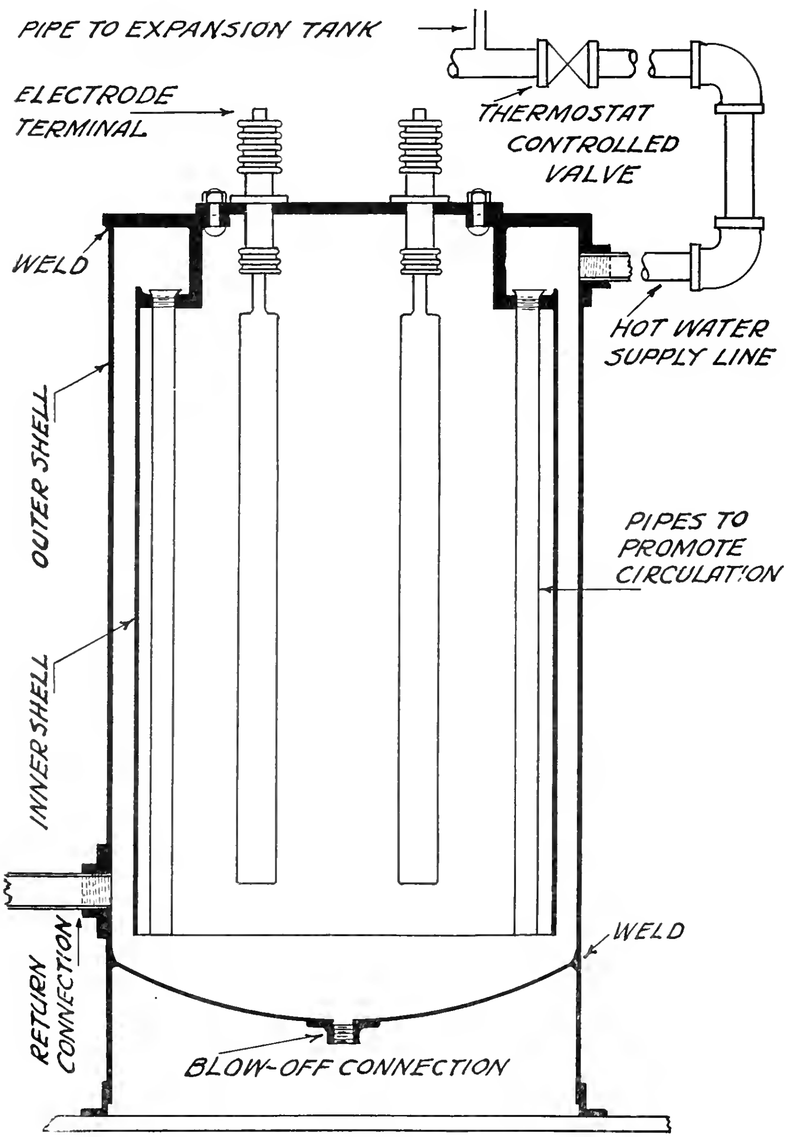


Figure 3

From the diagrammatic sketch in Figure 3 it can be seen that in case an explosive gas were formed it would collect in the upper part of the electrode chamber, from which there was no provision for its escape. It is conceivable that enough steam and gas pressure could be produced to force the water downward in the electrode chamber far enough so that a sudden surge would uncover the electrodes. An arc occurring at the instant contact was broken might detonate the gas mixture. While this theory is mentioned as a possible cause, it is equally reasonable to assume that the accident might have been caused by over-pressure. In any event the force was so violent that it tore the joint where the head was welded to the outer shell and threw head, electrodes, and inner shell up through the roof.

While considering the gas explosion theory, as applied to the case just mentioned, it should be borne in mind that hot water generators and steam generators are enough different in principle as to make it unlikely that the same condition could arise in the case of a steam generator. In the type of hot water generator just described there was a tight trap in which gas could form without chance of escape, while in the steam generator such gas as is formed is continually being carried out with the steam. For that reason there would seem to be very little opportunity for explosive gases to accumulate inside the boiler.

Outside of the case at Winnipeg there have been no other electric boiler explosions in which evidence pointed to hydrogen gas being the cause. This, together with the fact that many electric steam generators are giving entire satisfaction, seems to justify the assumption that the hazard from gas explosion is negligible. Yet too little is now known of these comparatively new devices to certify that assumption as a fact.

Working on a " Live " Steam Line

SOMETIMES, when a wisp of steam shows the presence of a small leak at a pipe joint or union, it is a great temptation for the engineer or pipe fitter to " take a chance " by tightening the joint while pressure is still on the line. Such a piece of carelessness sent two men to the hospital recently as the result of their attempt to put the finishing touches on an overhauling job at a Bridgeport, Connecticut, laundry. An extensive repair job had been completed and steam at a hundred pounds pressure had been turned into the line when the two pipe fitters found a leak which they thought could be fixed easily by means of a Stillson wrench. The union split while they were working on it and both men were badly scalded.

Kier and Auto Clave Explosions

DUE probably to the relative scarcity of kiers, auto-claves, and similar pressure vessels in comparison with the number of steam boilers in use, accidents involving this class of equipment are likewise relatively less numerous. As a consequence it is not at all surprising when The Hartford Company finds factory executives who fail to appreciate the probability of disastrous mishaps to these vessels.

Kiers, auto-claves, and closed feed water heaters differ from steam boilers chiefly in that they are not called upon to endure contact with furnace heat, yet they are subject to almost all the hazards of boiler operation excepting ruptures due to overheating of plates and tubes. In addition, the nature of materials placed in them and the fact that many of them have removable lids or heads for filling and emptying, often cause failures peculiar to their kind of vessel.

On The Hartford's records is an account of a very disastrous accident to an auto-clave in which fine wood chips were treated for the extraction of a tanning fluid. This clave was made of copper, stood vertically, and had a bottom door of iron through which the chips were expelled at the end of the process. A safety valve on the top head was set to blow at 25 pounds — a pressure considered to be well within the capability of the vessel. The explosion occurred when an iron ring to which the door was bolted gave way and allowed the door to swing downward. Reaction of escaping steam hurled the clave through the roof. Three men were injured, one of them fatally.

Wood Chips Had Blocked Safety Valve

There was a pressure reducing valve, set at 65 pounds, between the boiler and the clave, yet the violence of the explosion was such as to lead to the belief that this valve failed to function and allowed full boiler pressure to enter the vessel. The presence of a safety valve on top of the clave had been counted on to prevent excessive pressure, but an examination after the accident disclosed that wood chips had rendered it inoperative. Safety valves on other claves in the plant were then examined for this defect and several of them were found to be blocked. In order to lessen the probability of another similar accident The Hartford's inspector recommended that an additional spring-loaded safety valve be placed in the steam line between reducing valve and clave, a place where chips could not enter it. Property damage amounting to $6,359.87 was covered by a Hartford policy.

At another plant a clave for cooking alum exploded when the bottom head ruptured at the flange. This piece of apparatus had an inner steel pot lined with lead, and an outer shell of boiler plate. Composite coils of lead and benedict metal were submerged in the liquid alum and carried steam at a pressure of 160 pounds. To counteract the pressure tending to rupture the tubes, air pressure of 180 pounds was maintained in the outer shell. Failure was brought about by the corrosive substance slopping out of the pot and collecting in the lower head of the outside shell, where it caused pitting. Four employees were injured; one of them died. Property damage amounted to $23,-361.34.

Investigation of an explosion that blew the upper head from a cotton bleaching kier disclosed that the head lacked sufficient rigidity. Twenty-eight holding-down bolts were intended to hold the cover in place but four of them were not in serviceable condition and the kier was being operated without them. In as much as a new gasket had just been fitted, it is believed that the attendants, finding that the gasket made it less difficult to keep the lid tight, did not tighten the bolts enough to keep the lid from springing out from under them. Damage amounted to $1,326.31.

A closed feed water heater, approved for 160 pounds pressure and operating at about 135, ruptured the top head at the turn of the flange. Excessive pitting was found to be the cause.

Did Not Put Uniform Tension on Bolts

Failure of attendants to put equal tension on twelve ⅞ inch holding-down bolts allowed the head of a kier at a lace mill to blow off with considerable violence. The kier was operating under pressure of 30 pounds and contained a quantity of lace being treated with caustic soda. After the accident four bolts were found to be broken. Others were pushed from their slots. It is believed that the four tightest bolts were carrying the whole load. When they broke, the shock jarred the looser bolts out of place. The accident caused damage to the extent of $4,843.98.

Experience has shown that where corrosive liquids or solids in suspension are used in a kier or auto clave, there is danger of safety valves and pressure gauges being rendered inoperative when they are placed on the top head. This may occur even when an inner baffle is provided to keep the contents from contact with the head. As safety measures it is necessary to have not only a reducing valve to limit the steam pressure to the maximum allowable, but also a safety valve placed between the reducing valve and the kier where it will not be subject to contact with the vessel's contents. Frequent inspections should be made to discover possible weakening of the shell by corrosion or pitting.

In The Locomotive of April, 1924, there appeared an article on Safety Valves applied to pressure vessels other than boilers. It will prove to be a valuable reference for anyone engaged in operating or installing vessels such as are mentioned herein.

Protecting Motors Against Overload

THE importance of adequate overload protection and proper lubrication is well illustrated by the accompanying photograph of a 7½ hp. squirrel cage, 2-phase induction motor with its insulation completely burned out. Lack of oil caused the shaft to seize in its bearings and the rotor, thus brought to a stand-still, caused the stator winding to draw an abnormal amount of current from the line. Before attendants discovered the situation and opened the switch the insulation had been thoroughly roasted. Had there been proper protective devices the motor would have been automatically disconnected from the circuit when slowing down of the rotor caused an excessive amount of current to pass through the stator windings. In all probability thermal cut-outs or time delay fuses would have saved the windings of this motor.

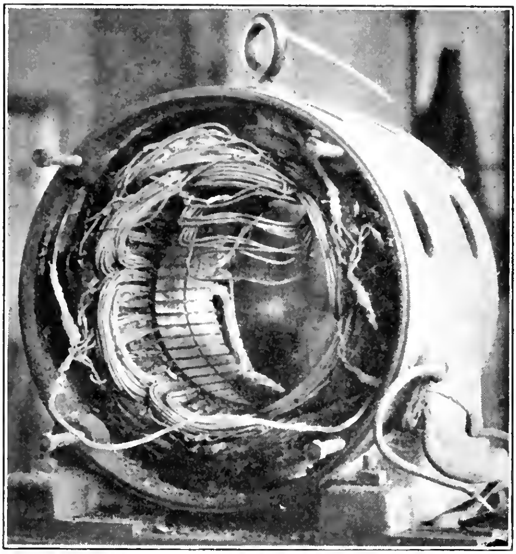
It is generally recognized that the weak link in an electrical machine is its insulation. The temperature to which the insulation is heated in overload operation has a lot to do with its length of life. To exceed normal temperature greatly for any length of time causes rapid deterioration in as much as any great temperature increase, such as is caused by severe overload, will roast the insulation.

In starting small alternating current motors it is common practice to throw them directly across the line. This necessitates using fuses of a capacity large enough to take care of the starting current — which is from three to five times the normal full load current. When this excess current flows through the windings only for the time it takes the motor to get up to speed, it causes no damage. But should the machine be subjected to such a current continuously it is obvious that these fuses could not be regarded as proper protection.

To get around this danger, some installations are provided with double-throw switches with starting and running fuses. However, this arrangement entails the hazard of the operator failing to hold the switch in the starting position long enough to bring the machine up to speed.

In this way one of the running fuses may be blown out, thus causing the machine to operate single-phase and burn out the winding. On the other hand, the operator may be so slow in throwing the switch from the starting to the running position that the motor will drop below speed during the interval the switch is passing through the open position. Under such a condition the excessive starting current would blow the running fuses.

A better way to provide overload protection is by the use of thermal cutouts or time delay fuses. Such devices permit a relatively large current to flow long enough to bring the machine up to speed, but open the circuit if this excessive current continues to flow for a longer period. In general, protective devices for motors should be set approximately 25 per cent. above full-load current. When a 2- or 3-phase motor is protected by thermal cutouts or time delay fuses all such devices for a given machine or circuit should be of the same capacity.



The underlying cause of failure of the motor herein illustrated was, of course, seizing of the shaft due to softening of the babbit by the heat of friction. For electrical machinery it is important to select only the best grade of mineral oil of a density that will allow the oil rings to pick it up and carry it readily. Too much oil should be avoided, for an excess may be drawn into the windings where it will cause deterioration of the insulation, collect dust and dirt, and eventually bring about a short-circuit.

The proper amount of oil may be maintained by keeping the level just below the top of the overflow cups. Oil should never be added while the machine is in operation, for at that time a great deal of oil is being carried by the rings and the apparent level in the cup is a false one. Should the cup be filled while the shaft is revolving, it will overflow when the machine is stopped and the oil drains from the rings.

Broken Blade Wrecks Turbo-Generator

SUDDEN breaking of blades, probably caused by a slug of water coming through with the steam, led to the destruction of a 4,000 kw. turbo-generator at the plant of Indianapolis Power and Light Company at Indianapolis, Indiana, on April 28th of this year. When the clear, ringing hum of the smooth-running turbine suddenly changed to an ominous rumbling, attendants attempted to avert an accident by

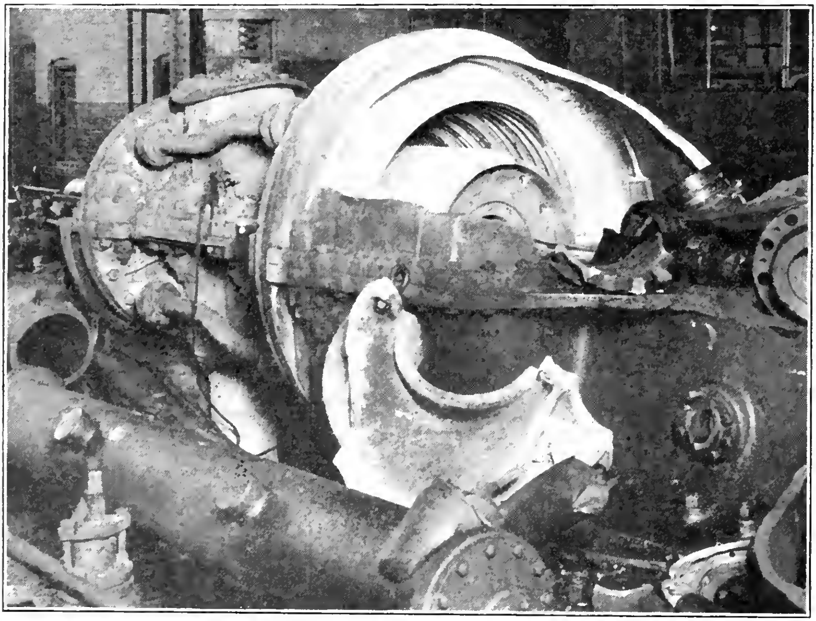


Figure 1

tripping the emergency mechanism and closing the throttle valve. The break-up occurred about twenty seconds later. Fortunately, no one was hurt.

What is thought to have happened is that the broken blades became jammed between the revolving rotor and the stator, thus bringing the machine to a stop so abruptly that the inertia of the heavy, revolving parts broke the rotor in two by breaking off ten bolts in the coupling between the stub-shaft and the steam rotor, bent the stub shaft, and twisted the field shaft into three pieces.

The accompanying photographs were taken shortly after the wreck. Figure 1 is a view of the steam end; Figure 2 shows how the heavy field shaft was bent and twisted off.

At 9:50 on the night of the accident the switchboard operator heard a low, rumbling noise which continued for about three minutes. During that time the meters indicated that the load was about 2,100 kw. This took a sudden drop of 800 kw. and shortly thereafter another drop of 500 kw. The operator saw that the field current and the exciter voltage

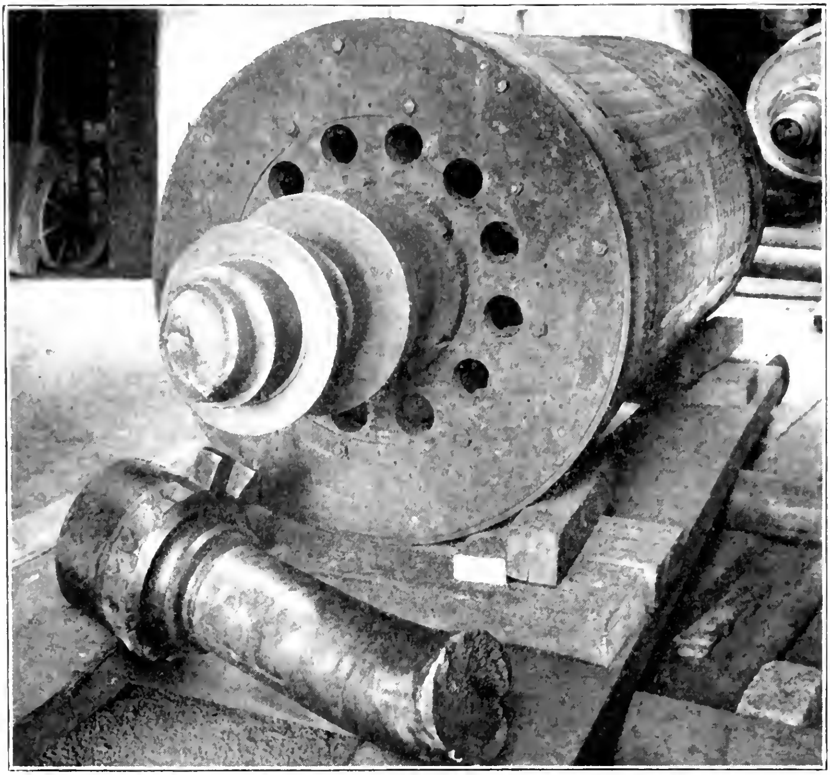


Figure 2

were normal and suspected that the load fluctuation might be due to a ground in the armature. It occurred to him also that the strange sound coming from the turbine might be due to water in the steam. He had signal'ed the boiler room to be on the look-out for this when he saw the operating engineer, whose attention also had been attracted by the unit's strange behavior, signal for him to take the unit off the line by opening the switch. While this was being done the engineer tripped the emergency mechanism and closed the throttle. Immediately thereafter the wreck occurred.

Both steam and electrical ends of the unit were total losses. The only parts left intact were the generator bed plate, the throttle valve, and the operating valve. Pieces hurled from the turbine casing broke fittings on two steam mains. The loss, which amounted to $45,000, was covered by a policy in The Hartford Company and was paid within ten days after the date of the accident.

Revolving Shafting

Revolving shafting is very deceiving. While it looks to be perfectly smooth, still it is capable of catching anything that is loose, such as neckties, shoestrings, hair, ragged sleeves, waste, ropes, etc. Constant caution is necessary while working around revolving machinery, especially shafting.— *National Safety Council.*

Water Hammer Accident Kills Three

Three men were fatally scalded when, on March 2, water hammer ruptured a steam pipe aboard the passenger steamer Senator Cordill near Gallipolis, Ohio. A coroner's jury found that the accident resulted from failure to remove condensation from the cold steam pipe before steam was turned into it. The Senator Cordill was said to be the largest passenger steamer plying the upper Ohio river.

Crushed as Well as Scalded?

Every man to his trade is good advice, but what about newspapermen who, in the course of their writing, are expected to delve understandingly into every field of human activity. Is it any wonder that one paper recently said, in telling of the rupture of a steam pipe, that it "threw 250 pounds of steam onto the engineer"?

And this is scarcely less remarkable than the newspaper report of a flywheel explosion which occurred because the governor failed and the engine ran away. According to the paper the engine "ran off."

Quite a Trick These Days

She: "What would you call a man who hid behind a woman's skirts?"

He: "A magician." — *Powerfax*

Taps From the Old Chief's Hammer

ALTHOUGH his resourcefulness was wrongly applied and might easily have had fatal results, a water tender on a portable steam threshing outfit in the state of Washington displayed something closely akin to ingenuity when he used sand to augment a meagre supply of boiler feed water. The engineer, who was injured in the resulting explosion, recently related the story to one of our inspectors:

"We had been threshing about four weeks when I decided that the boiler needed cleaning. In as much as I had planned to spend Sunday with my family, I persuaded the water tender and another man of the crew to undertake the job. On returning later Sunday evening, I found the boiler filled and apparently ready for a sunrise start.

"Next morning we fired up and everything seemed to be shipshape. Some time later I stepped to the footboard and started the engine. There was a snapping crash and as I leaped from the footboard I saw the rear of the engine bed rise about three inches. At that moment my face and eyes were filled with sand and stubble and, of course, I was in no condition to observe anything more until a doctor had picked the sand out of my face. Fortunately, my eyes were not badly injured.

"We found that the crown sheet had dropped, after tearing away from the tube sheet. Each one of us had some theory to offer as to why it happened. That is to say, each one except the water tender. He listened intently to our discussion and said nothing. When we had exhausted every explanation we could think of,. he asked casually if we thought a little sand in the boiler could have had anything to do with the accident. Encouraged by our interest in his question, he explained that after he and his partner cleaned the boiler they found that they lacked water enough to fill the boiler so that it showed in the gauge glass. Not wanting to haul water that night, they decided on what appeared to them to be a very satisfactory method of coping with the difficulty. They poured sand through the filling plug until the water rose to the proper level in the gauge.

"The filling plug being on the front end, a great pile of sand settled on the crown sheet. When I examined the sheet I found it glazed over with a layer of molten silica. Naturally, it was quite impossible for the sheet to escape burning. Had he made a deliberate attempt to blow up the boiler, the water tender could not have chosen a more certain method."

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., July 1, 1928

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The Locomotive of THE HARTFORD STEAM BOILER INSPECTION & INSURANCE CO.

A FEW weeks ago five New Jersey women employed to put radium paint on luminous watch dials, found that they had contracted a serious bone disease through touching their lips with brushes dipped in the material with which they were working. They had no legal claim for compensation, but a federal court judge, acting as unofficial arbitrator by consent of the parties, aided the women in obtaining a monetary award.

With rapid strides being made by engineers and chemists in maintaining America's prosperity by the constant development of more economical methods of producing almost every commodity from shoelaces to power, the responsibilities involved in making new processes and materials safe for the workmen employed in their use calls for skill and ingenuity of a high order. And while, in spite of the development of safety devices and improvements in methods and design, industrial casualties still occur, there is unmistakable evidence that efforts to keep them at a minimum have not been in vain. Especially is this so in the field of steam and electric power production, where plant owners in general appreciate the danger lurking in neglected equipment and understand the value of periodic check-ups by competent inspectors.

The Boiler Accident List

FOR years one of the regular features of THE LOCOMOTIVE has been a list of explosions, fractures, and ruptures of boilers and other pressure vessels. The Company has continued the publication of this data on the assumption that it has been not only of interest but valuable to some of its clients. So far as is known, the list has been the only one of its kind published in this country.

However, the list has occupied four or five pages of valuable space in each issue. The publishers feel that, perhaps, this space could be used to better advantage in presenting matter of a livelier and more interesting nature. In order to determine how many of the readers are interested in having the list continued, a coupon has been inserted on another page of this issue. The number of such coupons filled out and returned to us will serve as the best evidence as to whether there is any considerable demand on the part of our readers that publication of this list be continued.

Even in the event that the decision should be to discontinue publishing the list herein, the Company still will follow out its practice of compiling this data on boiler accidents and will continue to make it available to such persons or firms as have use for it.

New San Francisco Branch Office

ON June 1 The Hartford Steam Boiler Inspection and Insurance Company started operating, through its own branch office, the San Francisco territory theretofore supervised by H. R. Mann & Company. Mr. C. B. Paddock, formerly chief inspector at Seattle and more recently superintendent of the Pacific Coast Division, has been appointed manager. His territory includes the states of California, Arizona, and Nevada.

Creation of this branch office terminated the long and valued service of Messrs. H. R. Mann & Company and the predecessors of that firm who for over forty years had loyally and successfully represented the Company as general agents. Although it was natural that both that firm and the Company should regret deeply the breaking of this old business relationship, both were able to foresee in the change of administration certain advantages which influenced its adoption.

The change to the branch office plan is in line with the Company's general policy of directing its business elsewhere in the country where experience has shown that the intracacies of machinery insurance with its many modern and varied forms of coverage may be most successfully and economically handled through the direct contact which a branch office brings about between the Company and its patrons and agents. As to Mann & Company, the release from responsibility for the Company's affairs will enable the members of that firm to give their undivided time and attention to their large and continually expanding business in fire, marine, and casualty insurance.

The San Francisco branch office will occupy a part of the quarters of H. R. Mann & Company at 114 Sansome street.

Appointment

E. G. Watson, formerly resident agent at Seattle, has been made manager and chief inspector of the Seattle Department. The appointment carries with it certain added responsibilities for which Mr. Watson is well fitted by reason of his experience and accomplishment while resident agent. The change was made effective on June 1.

Continue the Boiler Accident List

Editor, THE LOCOMOTIVE,
The Hartford Steam Boiler
Inspection and Insurance Co.

P. O. Drawer 2133
Hartford, Conn.

Gentlemen: — I have found the list of boiler accidents of interest and value to me, and am in favor of having the list published in its present form.

Remarks:

(Signed) ....

....
(Official Position)

....
(Company)

....
(Address)

The Company's Youngest Apprentice

"THE sooner you start, the sooner you'll get there," seems to be the slogan of little Junior Favre, whose one ambition is to become a bona fide boiler inspector. Dressed in regulation uniform, he is shown here with his daddy, Inspector C. Favre of St. Louis, who has taught Junior so many details of the trade that plant engineers among his father's friends get a real "kick" out of trying to find a vulnerable point in his armor of information.

Below are a few of the questions for which he is equipped with ready answers. Anyone not engaged in power plant work would be expected to have a bit of difficulty in answering all of them off-hand.

What is a fusible plug for ? "To melt out when the water gets low."

Where would you put a fusible plug in a Heine boiler ? "In the first course not less than 6″ from the bottom of the drum."

In a Stirling boiler ? "In the front side of the center drum." In a B. & W. boiler ? "In the upper drum not less than 6″ from the bottom of the drum and over the first pass of gases." In an H. T. boiler ? "Rear head, 2″ above the tubes." A locomotive boiler ? "Crown sheet." A Scotch boiler ? "What kind of a Scotch boiler ?" A Scotch dry-back. "Rear head, 2″ above the tubes." In a wet-back ? "Top of the combustion chamber." In a cast iron boiler ? "On top of the fire box."

What kind of a valve do you put between the boiler and the safety valve? "You don't put any valve there." Why? "It would make the boiler blow up."

What is a steam gauge for? "To tell how much pressure is in the boiler." What do you put between the steam gauge and the boiler? "A syphon." Why? "To trap some water." Why do you want water there? "To keep the steam out of the gauge."

In addition to these, the youngster will, if asked, tell the general principle on which the steam gauge is constructed and can recite the formula for calculating the strength of a boiler shell.

(Concluded at foot of page 88)

Hot Water Supply Tank, Shooting Through Roof, Grazes Sleeping Man

PROPELLED by a pressure that must have been tremendous, and traveling at a velocity we have no means of estimating, an exploding water supply boiler on March 25 completely ruined the $10,000 home of George Elbert of Reading, Pa., and came within inches of costing the man his life. On its upward journey — that carried it out through the roof — the rocket-like projectile passed directly through the bed on which Elbert was lying. Neighbors and firemen found him unconscious, locked tightly in a roll of mattress and tangled bed-spring.

Although he suffered from shock, his only injury was a deep gash in the palm of one hand. Much more serious was the fact that he had no insurance to cover his loss. He was preparing to make the last payment on the home when the explosion damaged it beyond repair and robbed him of his life's savings.

The shattered timbers and displaced walls of the Elbert home, as well as serious damage to abutting houses and to windows of other places in the neighborhood impressed on those who saw it the destructive possibilities of even so small a vessel as this one. While the accompanying photograph gives some idea of the damage to the living room, lack of space prevents the publishing of other pictures showing the exterior of the house and the cellar, where a hole large enough to accommodate a truck was blown through a thick wall of masonry.

The tank was a foot in diameter, four feet long, and was made of 3/16″ steel. Longitudinal and head seams were welded. It was rated as capable of withstanding 115 pounds pressure and was being used in conjunction with a coil heater in which gas was the fuel.

After lighting the heater on the morning of the accident, Elbert went back to bed. Contrary to his intentions he fell asleep. In as much as there was no relief valve on the tank and a check valve in the supply line did not permit relief in that direction, the stage was set for a violent blow-up as soon as the pressure reached a point where the tank could no longer hold it. With a roar that shook the whole neighborhood, the bottom head blew off and the tank shot through timbers and woodwork. No one knows how high the tank traveled after it

---

While, of course, his chosen work claims a great deal of his attention, the young "inspector" is finding time to develop himself along other lines. He has selected swimming as a hobby and already is rated as quite a diver for his age.

Figure 1

passed beyond the roof. It landed in the back yard twenty feet from where it started.

At Glenolden, Pa., on March 13 an explosion of a somewhat similar arrangement caused about $10,000 damage to the home of Fred Werner. Although in this case the tank did not rise up through the house, the latter was damaged so badly that to undertake repairs was not feasible.

This tank, 14½″ by 32″, was connected to an automatic gas water heater, controlled by a thermostatic valve. It had no relief valve and, as in the case first cited, a check valve prevented the pressure from backing water out into the city mains. Apparently the thermostat failed to close off the gas. The tank ripped open the full length of the welded longitudinal seam.

While to anyone acquainted with pressure vessels it is obvious that a relief valve is a necessity for safety, there are some systems — as the one about to be described — in which at first glance the need of such a valve is not apparent.

At the Y. W. C. A. in York, Pa., a hot water supply boiler was used to heat water for the swimming pool. Feed and discharge connections led directly to the pool, the boiler taking cold water from the bottom of the pool and delivering hot water near the top. Operating thus as an open system, there appeared to be little prospect of danger arising from over-pressure. Yet on April 9th this boiler blew up with

Figure 2

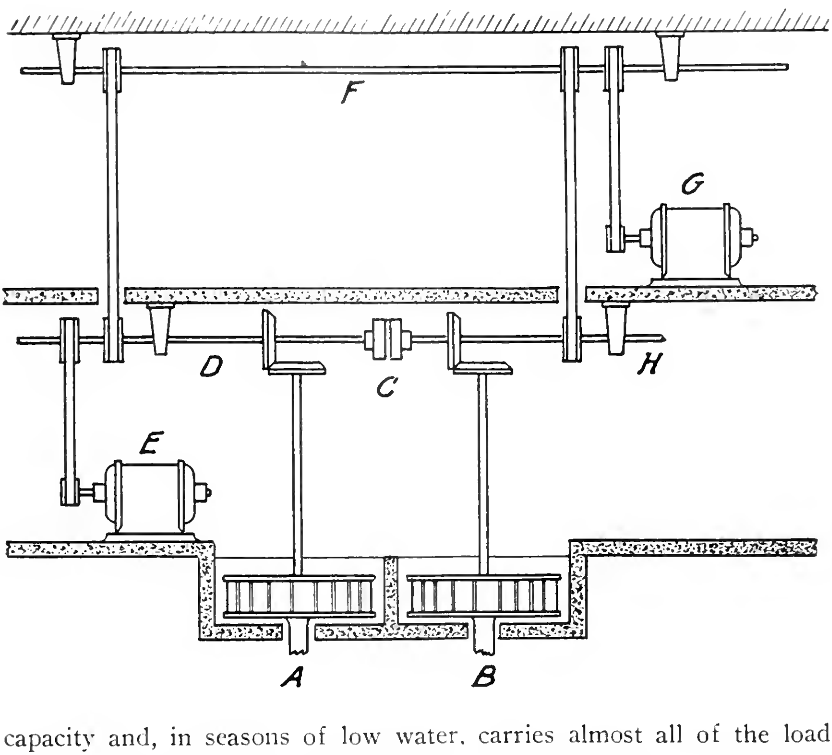
considerable violence, as may be seen from the accompanying illustration.

It appears that in order to drain and clean the pool, attendants closed stop valves in the upper and lower boiler connections. After refilling the pool the boiler was again fired up and the explosion occurred. Apparently the valves had been left closed. As a consequence pressure built up until a point was reached where something had to break.

In each of the cases we have described, a relief valve would have prevented costly damage.

Teaming Up Waterwheel and Diesel*

WHEN power requirements increased to a point where the plant's water power no longer sufficed to meet its peak load, a Southern textile mill found a way of retaining the economies of its power source by "teaming up" its two 75-hp. water wheels with a Diesel engine. The latter supplies the surplus above the water wheels'



capacity and, in seasons of low water, carries almost all of the load. To take care of a fluctuating demand throughout the day the system is so arranged that a synchronous motor "rides" the line until a load peak exceeds the wheels' capacity and causes the shafting to slow down slightly. The motor resists this effort to slow it below its synchronous speed by drawing power from an alternator-Diesel set. In this way the full possibilities of the water power are utilized, the Diesel making up any additional power when and as the demand occurs.

The arrangement of the system is shown diagrammatically in the accompanying sketch. The two water wheels A and B are in separate

* Material from which this article was prepared appeared in *Power*.

housings and operate independently of each other. Ordinarily coupling C is loose. Wheel A drives shaft D which, in turn, drives both the 75 kva alternating current generator E and the main shaft F. Shaft D drives several machines on the first floor, generator E supplying current for lighting and small motors. Wheel B drives shaft H, taking care of additional equipment on the first floor. This shaft is belted to the main shaft F, thus allowing both wheels to help carry the load of the machinery.

When this load is within the capacity of the two water wheels the synchronous motor G merely " rides " the line but when, as mentioned above, a power peak exceeds the wheels' effort the consequent slowing down causes the motor to draw current from a 200 hp. Diesel-engine-driven generator, which is not shown in the sketch. In seasons of low water both E and G may be used as motors to carry the whole load.

Caught in the Separator

Worth Thinking About

The following sign is displayed by the roadside at the entrance to a western town:

4,076 people died last year of gas.
39 inhaled it.
37 put a match to it.
And 4,000 stepped on it.

— *Walworth Kewanee Craftsman.*

Needless Worry

The Employee: " I came in to ask if you could raise my salary."

The Boss: " This isn't payday."

The Employee: " I know that, but I thought I would speak about it today."

The Boss: " Go back to your work and don't worry. I've managed to raise it every week so far, haven't I? " — *Wire and Rope*

Obeying That Impulse

The head of a large business house bought a number of those " Do It Now " signs and hung them up around his offices. When, after the first few days of those signs, the business man counted up the results, he found that the cashier had skipped out with $20,000, the head bookkeeper had eloped with the stenographer, three clerks had asked for a raise in salary, and the office boy had lit out for the West to become a highwayman.

How Could He Tell?

Mannishly dressed lady: "Did you catch any fish, little boy?"

Country boy: "No."

M. D. L.: "No what?"

Boy (puzzled by her rig): "Durned if I know."

Sufficient Provocation

"You are charged," said the judge, "with beating up this government inspector. What have you to say?"

"Nothing," replied the grocer. "I am guilty. I lost my head. All morning I had held my temper while government agents inspected my scales, tasted my butter, smelled my meat, graded my kerosene. In addition, your honor, I had just answered three federal questionnaires. Then this bird came along and wanted to take moving pictures of my cheese and I pasted him in the eye." — *Gas and Electric News.*

Amen! Amen!

An old negro got up one night at a revival meeting and said:

"Brudders and sisters, you knows an' I knows dat I ain't been what I oughter been. I'se robbed hen-roosts, an' stole hawgs, an' told lies, an' got drunk, an' slashed folks with mah razor, an' cussed an' swore; but I thanks heaven dere's one thing I ain't nebber done — I ain't nebber lost mah religion. — *Tit-Bits.*

A Dirty Dig

She (sarcastically): "I guess maybe you prefer the other type of woman who doesn't talk so much."

He: "Which other type?"

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street,
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1927

Capital Stock, . . . $2,500,000.00

ASSETS

Cash in offices and banks	$622,484.21
Real Estate	283,421.23
Mortgage and collateral loans	1,366,072.48
Bonds and Stocks	15,023,458.34
Premiums in course of collection	1,363,003.55
Interest Accrued	152,728.70
Other Assets	54,678.59
Total Assets	$18,865,847.10

LIABILITIES

Reserve for unearned premiums		$7,710,752.66
Reserve for losses		346,047.69
Reserve for taxes and other contingencies		1,593,077.45
Capital Stock	$2,500,000.00	
Surplus over all liabilities	$6,715,969.30	
Surplus to Policyholders,		**$9,215,969.30**
Total Liabilities		$18,865,847.10

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Vol. XXXVII No. 4 October 1928

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Causes *and* Characteristics *of the* Cracking *of* Boiler Plate *by* Caustic Embrittlement

DEFINITELY recognized as one of the most insidious of those agencies which force premature retirement of boilers, caustic embrittlement is by no means always understood even by expert engineers and operators. It is not strange that this is so for, although the discovery of this phenomenon is not new, it is only in recent years that research has developed a knowledge of the conditions which cause it and of means for diminishing its effects.

Most articles on the subject have demanded of the reader an acqaintance with chemical symbols and formulae not possessed by the average engine- or boiler-room attendant. By avoiding as many as possible of the terms and symbols of the chemist, this article will endeavor to present the subject in such a way that the layman will find it easily readable and understandable. To do this we will confine ourselves to the important conclusions brought forth by experience and research and will omit details of the diligent study by Messrs. Samuel W. Parr, professor emeritus of applied chemistry, and Frederick G. Straub, special research assistant in chemical engineering at University of Illinois, and others who have brought the subject to its present status. Acknowledgment is hereby made to them as discoverers of many of the facts used herein. If we succeed in explaining embrittlement to those persons who have neither the time nor the familiarity with chemical language necessary to a study of more technical treatises, our purpose will be served.

At the outset the reader's attention must be called to the fact that the word "embrittlement" is wrongly used in describing the effect of caustic on boiler steel. With steel under high stress a very concentrated solution of hot sodium hydroxide, or caustic soda, will destroy the cement by which the steel crystals are held together, but the result is not what is generally understood as brittleness. In fact, pieces cut from a plate near the region of failure have been found, when tested, to possess tenacity and resilience equal to that of the same steel before it was exposed to caustic action. This harmful agent seems to limit its efforts to forcing the steel apart along a single line of cleavage, leaving the metal on either side of this crack unchanged.

In appearance an embrittlement crack reminds one of the work of some expert engraver who, with infinite care and patience, has chipped away, along a zig-zag line, the cement binding the crystals together but has scrupulously avoided touching the crystals themselves.

The destructive work of caustic embrittlement is plainly evident in this steam drum of a water tube boiler. Removal of the strap after a Hartford inspector had discovered symptoms of embrittlement disclosed a crack extending through 27 rivet holes. Two other boilers in the plant were found similarly affected.

Feed water, which came from an artesian well, had a sodium carbonate to sodium sulphate ratio of 45 to 1. Of course, such water as this is capable of causing embrittlement without the addition of soda ash as a softener.

No doubt the word "embrittlement" is applied because the fracture presents a crystalline surface similar to that of brittle metal, and occurs without the reduction of cross-sectional area so noticeable when ductile metal is pulled apart.

When the existence of such a thing as caustic embrittlement was first suggested, the announcement was regarded with suspicion. Operators and engineers were inclined to dismiss it as just a new name for fire cracking or corrosion. Later the pendulum swung to the other extreme. It became quite the habit to blame caustic embrittlement for many failures to which no better-known cause could be definitely assigned. For a while there was a veritable epidemic of cases listed under that heading. Now, with more complete knowledge of causes and symptoms available, the phenomenon has lost much of its mystery.

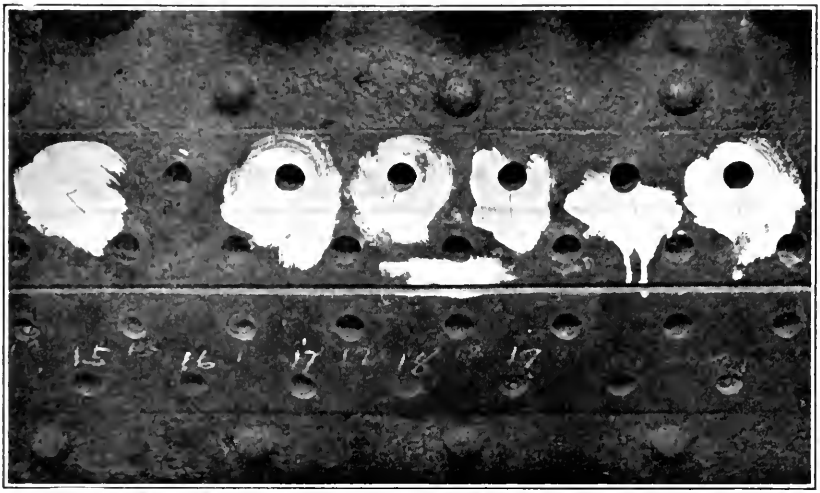
The first step in the evolution of the embrittlement theory was the discovery of a new and very odd sort of crack occurring in boiler plate. Instead of running across or through crystals and breaking them in two — as the crack does when metal is pulled apart — this newly discovered kind limited its field of activity to the cement between crystals. Investigation disclosed that apparently this trouble occurred only in boilers using water with very little sulphate hardness and a great deal of sodium carbonate. In some cases such water occurred naturally; in others, sodium carbonate had been injected as "dope" or created by some form of water treatment that changed existing ingredients into sodium carbonate.

Noting that this feed water condition was always present whenever those odd, crystal-border cracks occurred, the investigators found further that, when heated, sodium carbonate (soda ash) decomposes into sodium hydroxide (caustic soda). They suspected caustic soda was at the root of the trouble and, by laboratory experiments, succeeded in verifying their suspicion. At the same time they found that for embrittlement to take place the metal must be under extraordinarily high stress and caustic soda must be present in excess of 4,000 grains per gallon of water.

On first consideration it is by no means easy to see how metal can be stressed much above a normal working limit in boilers with a factor of safety of five or more. And too, any such concentration of caustic soda as 4,000 grains per gallon is inconceivable in water usable in boilers. Tests of feed water from a source high in this substance have failed to disclose anywhere near that amount. Yet it has been proved these conditions of high stress and concentration can exist, and often do, especially at riveted seams and connections below the water line — the points where caustic embrittlement has always been found.

The combined effects of several conditions may create an excessive stress in metal adjacent to rivet holes even in boilers with normal factor of safety. Riveting and caulking pressures, piercing of the plate for rivet holes, and the impossibility of making each rivet bear just its share of the load and no more, all have a hand in it. As a result, at some point or points in the seam we have a localized stress far above that anticipated by the designer.

That accounts for one of the major conditions necessary to embrittlement. Now it remains to explain how and where the relatively small amount of sodium hydroxide usable in boiler water can reach a high degree of concentration. It is obvious that no such amount as 4,000 grains per gallon of water can be present in a part of the boiler exposed to free circulation. So, again, we direct our study to the submerged seams and joints. Here, in the constricted spaces



Well water in which the sodium carbonate to sodium sulphate ratio was 1.8 to 1 caused the retirement of this boiler and five others in the same battery. It is interesting to note that the cracks in this mud drum extend radially from the rivet holes rather than from one rivet hole to another, which is usually the case.

For boilers operated at 200 pounds pressure, as this one was, the A. S. M. E. Code recommends a carbonate to sulphate ratio of not more than 1 to 2. In this instance the approved ratio was just about reversed.

between plates, are handy little pockets where water can seep in, evaporate, and deposit its caustic content. No doubt this action is accelerated by any slight, and perhaps quite imperceptible, leak through the joint which allows steam vapor to escape to the atmosphere. This is also the point where high stress occurs. It is here that embrittlement always makes its appearance.

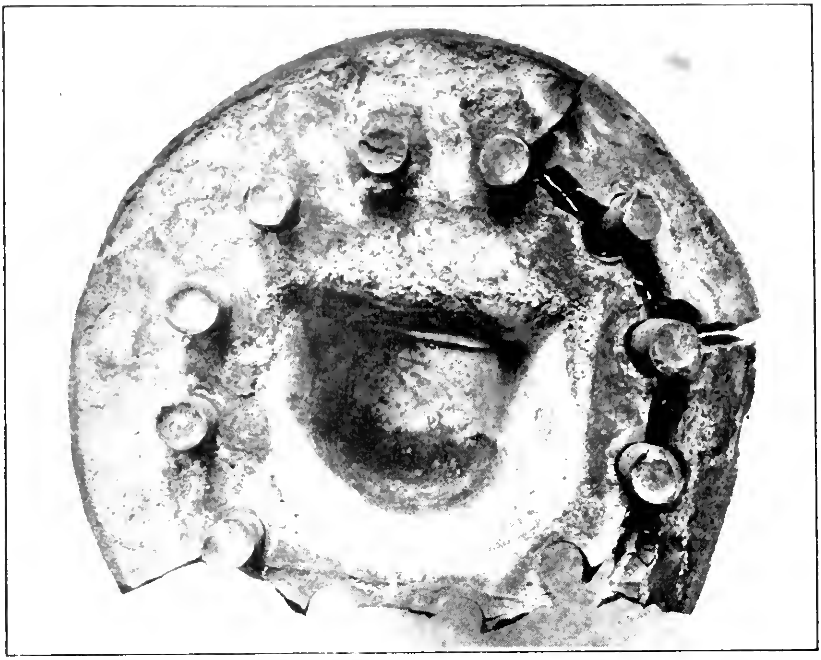
Having introduced the two principal actors — high stress and concentrated sodium hydroxide — we can consider how they behave when brought together.

There is an appreciable electrical voltage or potential between steel and hot sodium hydroxide when the two are in contact. This causes an electro-chemical reaction between iron and water whereby hydrogen is liberated and iron oxide is deposited in a thin layer on the metal. When the metal is under stress the material at crystal boundaries seems to be chemically active to an extraordinary degree, so that the hydrogen penetrates at these points and destroys the oxides forming the material that cements the crystals together. The oxygen and hydrogen combine to form water. Because this water is greater in volume than the oxides from which it was formed, there is set up in the narrow spaces between crystals a pressure which, aided by the break-down of cement, forces crystals apart somewhat as rock is split by water freezing in a crack.

The foregoing paragraphs have described the mechanics of caustic embrittlement without turning aside to discuss either the manner whereby sodium carbonate enters the boiler or the conditions under which it may be present and still not cause embrittlement. We have seen how this material turns to caustic soda; the latter encourages reaction between iron and water to create hydrogen and iron oxide, and the hydrogen breaks down oxides between crystals of the metal. Now we are in a position to appreciate more readily a discussion of impurities in feed water, methods of treatment so far as they are related to embrittlement, and the discovery that even if sodium carbonate be present embrittlement will be prevented by the presence of sodium sulphate or other inhibitants in adequate amount.

In explaining how sodium carbonate finds its way into boilers it is necessary to consider briefly other impurities commonly found in feed waters and means used to keep them from forming hard scale on tubes and plates. Among ingredients occurring most frequently are calcium carbonate, magnesium carbonate, calcium sulphate, and magnesium sulphate. If water containing either one or both of the two salts first named above be heated to about 212° F. they will drop out of solution. As a consequence, an open feed water heater will keep them from entering the boiler. Unfortunately, the sulphates of calcium and magnesium yield to no such simple treatment, because they require a much higher temperature to make them settle out. Unless their chemical makeup be changed by making them react with some other substance they will precipitate as scale in the boiler, the calcium sulphate forming a particularly hard, flint-like deposit. The chemical commonly used to combat this is soda ash (sodium carbonate). Its effect is to break down the calcium sulphate and form sodium sulphate and calcium carbonate.

The danger of this treatment lies in introducing too much soda ash. Of course one of the resulting ingredients is sodium sulphate — a very effective protecting agent which we will discuss later — but, in spite of that, when soda ash is used on feed water naturally low in sulphate hardness there is great danger of adding so much of it that there will not be enough sodium sulphate to afford protection. In a later paragraph we will learn what minimum proportion sodium sulphate must bear to soda ash to prevent embrittlement.



Creek water used in the boiler to which this cast steel blow-off pad was attached was naturally free from sodium carbonate. However, a method of feed-water treatment produced a sodium carbonate to sodium sulphate ratio of about 12 to 1.

According to Messrs. Parr and Straub, another way naturally safe waters may possibly be changed into the embrittling kind is by use of a water treatment which turns calcium and magnesium carbonates into sodium carbonate, and calcium and magnesium sulphates into sodium sulphate. Here again the danger lies in using the treatment on water having a higher carbonate than sulphate content.

There is still another condition under which water of an embrittling nature is found. In some parts of the United States there occurs naturally a water with an appreciable amount of sodium carbonate but little or no sodium sulphate. Such water, even without treatment, is capable of causing embrittlement.

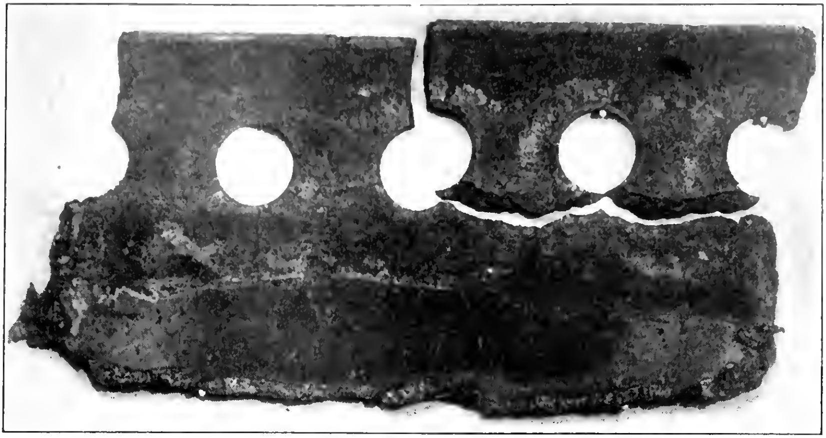
The reader should bear in mind that where embrittlement has occurred it has always been found that the sulphate content, if any, was low in respect to the sodium carbonate. Recognizing the protective tendency of sodium sulphate, the American Society of Mechanical Engineers in its Boiler Construction Code (Section VII, Suggested Rules for the Care of Power Boilers, pp. CA-5) recommends certain limiting proportions of sulphate to carbonate content as a guide for boiler operators. This table specifies that for boilers operating at pressures from zero to 150 pounds the relation of sodium sulphate to sodium carbonate should be at least 1 to 1; for boilers operating at pressures from 150 to 250, 2 to 1; for pressures above 250, 3 to 1. So far as we know, embrittlement has never occurred when these ratios were maintained.

No doubt the foregoing has caused the reader to wonder how the presence of sufficient sodium sulphate prevents the harmful action of the caustic. The inhibiting effect is obtained by the tendency of sodium sulphate to form a thin coating over the plate that reduces the flow of electric current and, consequently, checks electro-chemical activity. Chromate, phosphates, acetates, and tannates have a similar effect.

The actual treatment of feed water to avoid embrittlement involves difficult problems and should be entrusted only to a chemist familiar with that phase of water treatment. The wide proportional limits within which the critical impurities may be present, and their high or low solubility — according to the pressure at which the water is heated — makes it impossible for an article of this scope to prescribe a general cure. The most that can be said is the treatment should either reduce the sodium carbonate content or minimize its effect by use of some inhibiting agent. Solution of any particular problem requires a close study of conditions peculiar to the plant.

It seems well, before leaving the subject, to acknowledge that the general feed water conditions favoring embrittlement effectually are preventives of corrosion and pitting, and vice versa. A small amount of caustic is regarded as a barrier against these last-named boiler ailments, and for that reason is sometimes added to feed water. There arises, as a consequence, the question as to the doubtful benefit of counteracting or removing the caustic to prevent embrittlement if by so doing the boiler is to be made prey to corrosion. However, the deciding element in corrosion and pitting is the amount of dissolved or entrained oxygen in the feed water. If this be driven out before the water enters the boiler the amount of caustic needed to prevent corrosion will not be enough to cause embrittlement. A competent feed water chemist will usually be able to prescribe a treatment that will satisfy both conditions.

For some reason or other an embrittlement crack does not follow what is generally considered the line of maximum stress, although the cracks usually proceed from rivet hole to rivet hole in a jagged,



During a hydrostatic test to determine the seriousness of leakage at the girth seam of a horizontal tubular boiler a trace of salt was found around a rivet on the external surface of the rear head. Removal of several rivets disclosed caustic embrittlement cracks that affected the head seam throughout almost its whole circumference. A section of the cracked plate is shown above.

irregular course. Sometimes two cracks, starting from adjacent rivet holes, will run in a general way parallel to each other, creating between them an island of plate. Very often fine cracks will radiate from rivet holes. Proof that the embrittling effect is not present except in those parts of the boiler where caustic is concentrated and stress is high is furnished by the observation that cracks never extend beyond the lap of the plate.

Usually the first evidence of embrittlement is a leaky joint that cannot be made tight in spite of repeated caulking. Further, white deposits are frequently found at points where leakage occurs and on touching a particle to the tongue the soda ash can be tasted. In other cases a rivet head is found to have dropped off and on hammer-testing other rivet heads it is found they can be easily dislodged. On removal of rivets they, as well as the plate at the edges of holes, are found coated with a black oxide. Whenever a condition of this nature develops, the insurance company should be notified immediately so it can send an inspector to make a thorough investigation to determine just what action is necessary.

Failure from embrittlement cannot be laid to the quality of steel in the boiler, for repeated tests by Messrs. Parr and Straub have shown that one grade of steel is about as susceptible as another. In a measure, workmanship is a factor in that the poorer the setting up of joints and the more uneven the distribution of pressure among rivets the greater will be the opportunity for caustic concentration and high localized stress. But this should not be construed as placing the blame for embrittlement on poor workmanship, for many poorly constructed boilers have never been affected while boilers built according to the best standards have succumbed. Evidently the controlling factor is the presence or absence of sodium carbonate and its relation to the amount of inhibiting agents that may be present with it.

Nevertheless, the importance of careful workmanship is recognized. As a means of preventing concentration of caustic, especially in boilers designed for high pressures, some manufacturers have resorted to inside caulking; that is, seams are all caulked on the inside of the boiler. If caulking of this kind is tight it keeps water from entering the spaces between plates at the joints and consequently prevents the concentration of salts possible with outside caulking.

Too Near for Comfort, Says Inspector

A HARTFORD inspector recently witnessed involuntarily a violent explosion of an uninsured boiler. The blast injured four men, jarred merchandise from the shelves of stores over two miles away, and gave the surrounding countryside a general shaking-up.

The inspector had gone to a plant to inspect boilers insured by The Hartford. Closely adjacent to this plant was the pumping plant of another company. The inspector had just stepped from the office of his company's client when a boiler in the neighboring plant 300 yards away exploded so violently that he was almost knocked down.

"We staggered around like drunken men," he said. "My vision was blurred and I could hear untold numbers of little bells tinkling."

The four men injured were working within 35 feet of the exploding boiler. Two of them, injured less seriously than the others, were protected somewhat by a tool house against which the other boiler of the battery was hurled. The tool house was demolished

The exploded boiler was of the locomotive two-course type with safety valve set to relieve at 150 pounds. It was blown into four parts, the smoke box end, consisting of one course and tube sheet, being torn loose at the girth seam and hurled about 325 feet. During the course of its flight it tore away the side of a large tank.

Parting from the wrapper sheet, the first course was ripped through its entire length parallel to and on the opposite side from the butt strap seam. This sheet crushed the side of another tank 300 feet away.

Overpressure seems to have caused the explosion, though failure to find the safety valve after the accident prevented investigation of the supposition that it had stuck.

Lap Seam Crack Demolishes Boiler

TWO years ago a southern mill applied to The Hartford for insurance on two lap-seam horizontal tubular boilers. After a careful examination of the vessels the Company refused to accept the risk. The plant was violating one of the axiomatic rules for boiler installation by having stop valves between boilers and safety valves. In addition to that, the boilers were carrying pressure very much above an amount warranted by the type of seam.

On June 11th one of these boilers blew up, killed a man, and damaged property to the extent of $10,000. For want of a better explanation a reporter, who covered the story for a local paper, made use of the customary supposition that cold water was admitted to a dry, overheated shell. The inspector that had examined the boiler when the owner applied for insurance searched the tangled wreckage for another, more convincing reason. He found it. Down the longitudinal seam, from girth seam to girth seam, the middle course had parted as clean as a whistle. A well-defined lap-seam crack told the story.

Suggestions *for the* Safety *and* Preservation *of* Stationary Steam Engines

By H. J. Vander Eb, *Supt. Engine Dept.*

Experienced operating engineers of well-managed plants are undoubtedly familiar with many or all of the points brought out in the following article, yet we believe the article will serve not only as a useful reminder to them but also as a reference for all who have engines under their care.

STARTING OF ENGINES

BEFORE an engine is started, either for the first time or after a long period of idleness, it is advisable to bar it over a few turns by hand, if it is at all possible to do so. Never start an engine without first inspecting the governor, valve gear and other moving parts to see that they are in perfect working order and that none of their fastenings are working loose. All parts should be lubricated by hand and the oil cups filled. In case a gravity or force feed lubricating system is used, such apparatus should be in good condition.

In starting an engine *take your time*, warming it up properly with cylinder drains open. Forcing a cold engine may cause serious damage. If the engine exhausts into a condenser, the condenser pump must be started and running properly before any steam is admitted to the engine.

After these precautions have been taken and after all water has been drained from steam pipe, cylinders, and exhaust pipe, the engine may be started and slowly brought up to speed. While the engine is taking its load a close watch should be kept for any unusual behavior, for most engine accidents occur at times of starting or stopping.

GOVERNOR BELT

The governor belt should be kept reasonably taut. In no case should it be so slack that the inner surfaces rub together. Care should be taken to prevent oil from dripping or splashing on the belt, for slipping of an oily belt over the governor pulley is a prolific cause of flywheel explosions. It is frequently found that the eccentric or the main bearing splashes oil on the belt. Sheet metal guards will prevent this. Water, likewise, must be kept away from the governor belt of a running engine. Sprinkler heads for fire protection should not be placed so that water from them can reach the governor belt.

GOVERNOR AND VALVE GEAR

The governor and its driving parts should be kept in perfect operating condition and without excessive clearance in any of the fulcrum pins or bearings. Lost motion in governor or valve-gear parts is dangerous and must not be permitted. These parts should be lubricated at regular intervals.

A belt-driven governor and the valve gear should be so arranged that breakage of the governor belt will shut off steam automatically.

The governor on an engine with a Corliss or other releasing type valve gear should not have a hand-operated stop pin or slotted collar to support the governor when the engine is shut down. These devices are very dangerous since if, through oversight, they are not changed to the safety position after the engine has been started, the safety cams on the valve gear cannot act in case the governor belt breaks. To support the governor while the engine is being started there should be an automatic governor stop that will fall into the safety position as soon as the engine attains normal speed. A governor stop that is linked up with an idler pulley riding on the governor belt is equally acceptable. (See leaflet on approved "Governor Safety Stops" on releasing-gear engines.)

TESTING OF GOVERNOR SAFETY

Belt driven governors should be tested at regular intervals to see that they actually shut off steam when, due to a broken governor belt, they cease revolving. With some Corliss type engines this may be done while the engine is at rest by allowing the governor to drop to its lowest position and moving the wrist plate back and forth by hand a distance equal to its normal stroke. When this is done the steam latches or grab claws should not pick up the steam valve arms. If they do pick up the steam valve arms under these conditions the position of the safety cams must be corrected.

On Corliss type engines having a non-detachable, eccentric reach-rod-connection to the wrist-plate, the safety action of a belt-driven governor should be tested while the engine operates at normal speed under only a friction load and with the throttle valve as nearly closed as possible. When, under these conditions, the governor belt is thrown off the pulley the engine should come to a stop automatically. If it does not do so it is necessary to adjust the valve gear.

During this test a trusted man should have his hand on the wheel of the throttle valve to shut it quickly if the engine does not come to rest.

DASHPOTS

The action of the dashpots on a Corliss type valve gear should at all times be such that they effectively and regularly pull the steam valves closed. If they act sluggishly and irregularly the speed of the engine will fluctuate and there may be a tendency to overspeed. For this reason it is vitally important to keep the dashpots in perfect working order and properly lubricated. Sluggish action of the dashpots sometimes may be due to excessive friction caused by setting up the stuffing box glands of the valve stem too tightly. The packing in these stuffing boxes should be renewed before it becomes too hard.

SHAFT GOVERNORS

Engines with shaft governors should be tested from time to time to see that the governing mechanism is able to shut off steam automatically. This may be done while the engine is at rest by blocking the governor arm in its extreme outer position and admitting steam slowly through the throttle valve. If the governor functions properly there will be no appreciable amount of steam blowing from the open cylinder drains or indicator cocks while the crank stands in a position at which steam would normally enter the cylinder.

POPPET VALVES

Valves of poppet-valve engines should be taken apart and inspected at regular intervals, say at least every three months, to remove from springs and cages any baked-on oil that would interfere with the valves getting fully down to their seats. In that case steam would not be completely shut off by the poppet-valves when the governor was in its extreme position and there would be danger of overspeed at no-load. These valves must be steam tight when down on their seats. Any roughness or cutting of the seats due to wire drawing should be ground smooth with powdered glass and oil. Care must be taken to prevent the powdered glass from getting into the cylinder, for glass will score the cylinder wall.

INDEPENDENT ENGINE STOP

An independent, automatic engine stop, when there is one on an engine, should not merely be left to itself to be relied on in case of emergency. Any automatic device of this kind may stick and fail to perform its function if it is not kept in perfect operating condition. It should be tried out regularly by carefully forcing the speed of the engine up to not exceeding 10% above normal. If the device does not shut off the steam under this test, the necessary adjustment should be made at once.

The independent automatic stop should be tripped by hand to shut down the engine at the end of the day's run. This will help to keep it in operating condition.

If push-buttons or other means of remote control are provided for shutting off steam, they should be tried at regular intervals.

DANGER FROM CONDENSER WATER; VACUUM BREAKER

Engines that exhaust into jet condensers are liable to be wrecked by water backing up from the condenser into the cylinder under certain conditions.

This is most likely to occur at starting or stopping when the water in the condenser may rise to an abnormally high level if, accidentally, the condensate pump should run too slowly or stop entirely. To prevent this there should be either a vacuum breaker that will break the vacuum automatically before the water reaches a dangerous height, or a balanced non-return valve in the exhaust pipe.

Even though some automatic device of this kind is employed, the utmost care should be exercised to keep the condensate and air pump running at the required speed at all times while steam is being admitted to the engine cylinder or while the engine is still in motion due to momentum after the throttle has been closed.

BAROMETRIC CONDENSER

Barometric condensers offer the same kind of danger to an engine as jet condensers do and have been the cause of serious wrecks. It is important that the column of water in a barometric condenser never rise high enough to spill over into the exhaust pipe.

The height of a barometric condenser should preferably be such that the distance from the highest water level in the hotwell to the lower edge of the exhaust pipe where it enters the condenser-head is not less than 38 feet. Though the theoretical height of a column of water drawn up by a perfect vacuum is approximately 34 feet, some excess height is desirable as a factor of safety to compensate for friction of the water going down the tail pipe or for the possibility that a greater quantity of injection water than the condenser can handle may be supplied.

The overflow of the hotwell of a barometric condenser should be located at such a level that the bottom of the condenser tail pipe always is submerged for at least 12 inches. The overflow must also be sufficiently above high water level in the river or canal to avoid the possibility that the water level in the hotwell could rise dangerously.

During the period of extremely cold weather it is advisable to make certain that the tail pipe is drained by breaking the vacuum after the engine is stopped.

To prevent obstruction from ice formation in the throat or in the tail pipe of a barometric condenser when starting up under cold weather conditions it is advisable to heat up the condenser by means of a live steam connection.

A suitable non-return valve in the engine exhaust pipe to a barometric condenser is always desirable, but is an actual necessity for engine safety in some installations.

When, after starting an engine that exhausts into a barometric or jet condenser, there are unusual noises in the exhaust pipe (indicating that the pipe contains considerable water), *do not shut the engine down.* To do so might cause the water to be drawn into the cylinder, and this would surely lead to serious damage. The injection water should be shut off and the exhaust pipe drained before the engine is shut down to investigate the cause of the trouble.

DRAINS

The steam pipe to any engine must have a drain at the throttle valve to relieve it of water. When an engine is to be started, it is very unsafe to attempt to drain the water in the steam pipe through the cylinder.

Cylinder drains, when provided, should be open while an engine is being warmed up and during the first few strokes after starting. They should remain open until cylinder condensation is down to normal.

TRAPS

Traps on drains from steam separators, receivers of compound engines, and exhaust pipes should be inspected regularly to make sure they are in good working order and free from an accumulation of dirt.

Wherever an exhaust pipe forms a loop or pocket below the engine, there should be at the lowest part of such loop or pocket either a drain open to the atmosphere without shut-off or a drain connected with an automatic trap. Discharge pipes from all traps should be open ended and in plain view so that the proper working of the traps can be easily watched.

HOT BEARINGS

If bearings or other adjusted parts show a tendency to heat up abnormally they should be flooded with oil. As a rule, light oil will not be of much avail on a hot bearing. Pure, heavy mineral oil, preferably cylinder oil, may be used for this purpose. An attempt to cool an overheated bearing by throwing water on it by the pailful or with a hose is dangerous. Contraction of the bearing from such sudden cooling will cause it to clamp the shaft or crankpin tightly. The result may be a breakdown.

Under some conditions it may be possible to avoid a shut down when lack of lubrication has caused a bearing to heat up. One method that has given good results is to drip cool water (filtered or distilled) into the bearing along with the oil. When the bearing has been brought to normal temperature, the water should be stopped.

If the bearing continues to heat up despite all efforts to nurse it along, the engine should be stopped and the bearing taken apart, the oil grooves cleaned out and, if necessary, touched up with a groove chisel. If the babbitt has begun to run before the engine can be shut down, the engine should be kept turning over slowly during the time it takes to cool the bearing. Should an engine be stopped suddenly under such conditions, the babbitt would " freeze " to the shaft, making removal of bearing shells very difficult.

POUNDING

Lost motion must be regularly taken out of bearings, crank-boxes and other wearing parts. Pounding of an engine because of excessive lost motion produces severe shock stresses which, in time, may cause failure of the part most affected.

A bad pound in an engine does not necessarily have any connection with lost motion in a bearing. Other sources of pounding are: flywheel loose on the shaft, piston loose on piston rod, slack in the connection of cross-head and piston rod, steam valves and exhaust valves with excessive clearance in their housings, and incorrect valve setting.

In making adjustments of bearings and crank- or crosshead boxes, it should be remembered that this will affect the piston clearance. On the guide there should be line-marks corresponding with a line-mark on the crosshead at both ends of the stroke so that any change in the piston clearance due to adjustments can be easily checked and, if necessary, corrected.

Great care must be taken that the alignment of bearings be not spoiled by adjustments for lost motion. If the bearings once get badly out of alignment because of wear and misadjustment the only means of making a noisy engine run quietly again is to raise the shaft, carefully line up the bearing surfaces and, if necessary, correct the position of the bearings so that the center-line of the shaft is exactly at right angles to the center line of the cylinder.

VIBRATION ON FOUNDATION

Excessive vibration or working of an engine on the foundation should not be allowed, for it may lead to cracking of the frame, particularly near the flange attaching the cylinder to the frame. It may be due to any one or several of the following causes: bent shaft, wheel out of balance, misalignment of bearings or of guide barrel, incorrect valve setting, loose grouting under the frame, broken foundation, foundation too light and with insufficient footing in the soil, or foundation laid on swampy ground. With high speed engines it is particularly important that the foundation have an ample area at the bottom rather than that the necessary weight be obtained by making it deep. Serious vibration in numerous high-speed installations has been traced to insufficient foundation footing.

If a foundation is badly cracked or broken it is by far the best economy to replace it, for the consequent engine vibration is bound to lead to expensive damage. An engine foundation always should be one solid mass and never made in two separate parts. Such separate parts can not be expected to remain in alignment and invariably have caused cracking of the main castings of engines so erected.

CYLINDERS AND PISTONS

The interior of the cylinder and valve housings should be inspected from time to time, at least once or twice a year, to keep track of unusual wear, possible scoring of the cylinder wall, and the condition of the piston follower bolts. When these bolts break they are apt to do great damage. They should not be set up with an undue amount of wrench leverage; much costly engine damage has resulted from the use of a long pipe on the wrench. Doubtless these bolts are sometimes overstrained or even partly broken when put in position.

When a careful inspection reveals the slightest evidence of weakness or looseness in any follower bolts it is best to replace them with new ones. The best material to use is a good grade of iron. Steel follower bolts are not durable and should not be used in a piston.

Broken piston rings as a rule cause serious damage to the cylinder walls by scoring. When a cylinder is found scored it is advisable to remove the piston from the cylinder, as it is then very likely the rings are broken and should be replaced. It is often possible to detect the existence of broken piston rings by a study of the indicator diagram or by investigating an appreciable increase in steam consumption.

CLEANLINESS AND GOOD ORDER

One of the outstanding characteristics of a plant run wastefully is an excessive amount of steam leakage and oil around the engines. It pays handsomely to avoid steam leakage and prevent oil from running over the foundation. Oil has a softening effect on cement and concrete, so that grouting under the engine frame will eventually become loose if oil in considerable quantities flows down on it. This in turn may produce serious overstrain in the main engine castings and cause cracking.

LAYING UP ENGINES

Engines that are subject to seasonal operation should be protected against corrosion during periods of inactivity, particularly if such idle periods are long. Care should be taken to prevent water or vapor from leaking into the cylinder from the throttle or the exhaust pipes. If necessary, blank flanges may be used to advantage on these pipes. The interior of cylinder, valve housings or valve chest should be slushed with cylinder oil. Exposed wearing surfaces, such as the crosshead guides and any other bright parts, should be treated similarly. For the latter purpose special slushing compounds, less expensive than cylinder oil, may be obtained from reputable oil manufacturers.

The governor and valve gear parts should be well oiled and some waterproof material such as oil cloth or tarpaper wrapped around them. It is a good plan to use similar means to prevent the infiltration of dust and grit into the bearings. By taking these precautions a great deal of trouble may be avoided at the time the engine is again put in service and in general the useful life of the engine will be prolonged.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., October 1, 1928

Single Copies can be obtained free by calling at any of the company's agencies.
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Recent bound volumes one dollar each. Earlier ones two dollars.
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The Locomotive of THE HARTFORD STEAM BOILER INSPECTION & INSURANCE CO.

Fusible Plug Undertakes New Role

"EXPLOSIONLESS Era Dawns" might have been, but wasn't the caption of a recent telegraphic news dispatch from San Sebastian, Spain, describing an alleged new device for preventing boiler explosions. The "invention" consists of a plate of special metallic alloy that is supposed to fuse out, turn steam into the firebox, and partly extinguish the fire when pressure reaches a predetermined point. A successful test was conducted aboard a steamship, according to the report, over which appeared this head-line: "Simple Device Halts Boiler Blast Peril."

The fusible plug, of which this seems to be a modified form, has been in use too many years for engineers to entertain any extravagant opinion of its value as a preventive of explosions. It is installed at the lowest safe water level for the purpose of melting out and giving warning in case the water should fall below that point. When used in boilers with very high pressure it has an extremely embarrassing tendency to blow out and cause a shut-down even when water level is normal. Not by the widest stretch of imagination can it be regarded as halting "boiler blast peril" due to corrosion and grooving of the plate or other forms of structural weakness.

Until more specific details of the Spanish invention are available we must withhold final judgment, but from facts at hand the device looks remarkably like the familiar old fusible plug dressed up in new clothes. If so, the explosionless era has not yet dawned.

Walter Austin McGlannan

A LONG, honorable and successful career in the insurance business in Baltimore made Walter A. McGlannan well known far beyond the boundaries of that city. He was born in Baltimore fifty-four years ago, grew up to manhood there and took his part in the business, social and civic life of that community in a way that won its esteem and the warm regard of a wide circle of friends. To them word of his unexpected death on July 9th, after a very brief illness, came as an overwhelming shock and sorrow. Our Hartford Company shares deeply in this sorrow, for Mr. McGlannan's death severed ties of a valued association of many years standing.

Mr. McGlannan was a member of the well-known insurance firm of Lawford & McKim which has continuously represented this Company as its general agents for nearly sixty years in a broad territory centering on Baltimore. Mr. McGlannan and his partner, Mr. Arthur Koppelman, joined this firm as boys and grew up in its organization. Twenty years ago they were admitted by the late J. M. Lawford to partnership with him. Mr. Lawford died in 1913 and since then Mr. McGlannan and Mr. Koppelman together carried on the general insurance business of the firm, retaining its original name and maintaining its traditional relationship with The Hartford.

This long association with Mr. McGlannan gave us occasion to know him well and to observe and appreciate the ability and thorough understanding of insurance principles and practices which he devoted to his business. Our Company benefited by that ability and by the loyal and conscientious attention he gave to the interest of all whom he served. We found him honorable, straight-forward and sincere in all his dealings and a man whose broad, generous sympathies and ready, genial humor made him a delightful companion and friend. Thus, as the years went by, the ties of mutual interest, confidence and regard that bound us to him grew stronger and stronger and our business association became a happy fellowship, grateful memories of which will remain with us always.

Thompson Parish Ware

THOMPSON PARISH WARE, in length of service one of the oldest members of The Hartford organization, died at St. Louis, Mo., on July 21st, 1928, in the 79th year of his age.

Tom Ware, as he was affectionately known by his associates, joined our inspection department at St. Louis in 1889. Prior to that time he had been for several years an operating engineer on river steam-boats, which experience, together with his natural aptitude for mechanical matters, well equipped him for his work with our Company. In it he rapidly acquired proficiency and soon after his employment the Company had such confidence in his judgment and ability that it transferred him to Dallas, Texas, and gave him charge of all inspection work in the territory adjacent to that city. That this confidence was well justified is shown by his thirty-eight years of service there. During them the Company's interests always were his interests too. He was proud of its record and worked earnestly and constantly to establish and increase its reputation for usefulness in his territory. That he succeeded and that now the Company's value to boiler owners is so generally appreciated in Northern Texas, we know is due in great measure to the universal esteem and respect which Mr. Ware won for himself there.

In 1920 Mr. Ware was relieved of his duties as inspector and given the less wearing but no less responsible position of special agent. He continued active in that position until, last winter, the illness to which he finally succumbed forced his retirement from the field.

There are many friends of "Tom" Ware and of ours, we feel sure, who join with us in sorrow at his passing and who will appreciate the loss it means to our Company.

It's the Little Things That Do It

THE mouse that broke up a circus by stampeding the elephants had nothing on a small bird that recently bottled up the immense electrical system in the down-town business district of Toledo, Ohio. A brief newspaper clipping tells the story:

"The death of a swallow carrying material for building its nest halted activities in downtown Toledo yesterday. Burned to death, its beak holding wet straw and string, the bird was found between wires leading from an east side power house to the west side, causing a short circuit. Many public buildings were without light and elevator service and police traffic signals were dead."

Instances of tie-ups from such trifling causes are not infrequent. Every now and then some such occurrence reminds us that, in spite of the carefully made harness by which power is made to serve us, our mechanical horse still has an annoying tendency to get cross-wise the shafts on slight provocation. Insurance will protect plant owners against loss from service interruption when this happens.

Getting Closer to the Elusive Atom

BY distilling metals on a flat surface of rock salt and then dissolving away the salt, physicists recently succeeded in producing a metallic wafer of almost inconceivable thinness. Stacked one on top of another, it would take 2,500,000 of them to make a pile an inch high. In comparison, gold leaf seems bulky.

Scientists say the effective diameter of an atom is about 1/100 the thickness of these films and that each atom requires elbow room many times its diameter to navigate in. If that be so, it is evident these films are only a few atoms thick.

Having whittled matter down to such a thin slice as this, who will say that science may not yet isolate the atom — or even dissect it to clear up the baffling mystery of its behavior?

Advanced to Chief Inspectorship

ANNOUNCEMENT has been made of the appointment of P. E. Terroy as Chief Inspector at the Company's Baltimore office. Prior to this promotion Mr. Terroy served with distinction as Directing Inspector at Atlanta. As a consequence the latter Department should be credited with having added still another name to the list of officials it has furnished the various departments of the Company.

"Some Coal Is Like That"

Donald MacFee, writing in *Power,* tells this one: A former shoe salesman now selling coal was giving his sales talk to a prospect. "There's no ash in this coal; not a bit of sulphur or dirt. I tell you it's a wonderful fuel."

"How many b. t. u.'s are there in it?" inquired the prospect.

"Absolutely none," was the clinching answer.

Taps From the Old Chief's Hammer

"WELL," chuckled the Chief, dropping a letter he had been studying and reaching for his pipe, "my father used to tell about a family in Northampton county, Virginia, that bought a coffin and placed it in the parlor years before they had any idea any of them was getting ready to die. I suppose you boys would consider that just about the last word in preparedness, eh?"

Leaning back while he tamped a charge of rough-cut into his aromatic old briar, the Chief let his glance run down the long table at which sat half a dozen inspectors preparing reports before leaving the office on their various assignments. It wasn't often the old man interrupted the routine at this time of day. His unexpected loquaciousness was a sure signal that something unusual was in the wind.

"I'd say that family ought to rate pretty high on the list," ventured the assistant when it became apparent that the Chief expected some sort of an answer to his question.

The Chief nodded, as if satisfied. "Then tell me," he demanded, "how far up on the scale would you rate a plant owner who, having a good boiler in operation, bought a new one and placed it in storage?"

"What was wrong with the boiler in the plant?" the assistant wanted to know.

"Nothing," the Chief informed him. "It was in first-rate shape, with every expectation of a long life, as a lawyer would say."

Apparently satisfied that he had aroused their curiosity, the Chief launched into his story.

"About two years ago — just before Jones was transferred to Chicago — he went out to the Apex Laundry on a regular inspection trip and discovered a serious bulge in the front course of the plant's boiler. The bulge ran all the way from the head to girth seam and extended well up on both sides. Oil was the cause. Got in through the feed water heater. Naturally, the insurance did not cover a condition of this kind, but just the same I hurried down there as quickly as possible to see what could be done about getting the plant in operation with the least loss of time. Needless to say, the owner, Mr. Littledale, was worried. Any sort of shut-down was bound to lose customers for him and he realized that unless a way were found to repair the boiler the long delay while a new one was ordered and shipped would be a serious matter.

"I went over the bulge inch by inch and found there had been no actual weakening of the metal. Mr. Littledale was tickled when I told him the sheet could be driven back. He called a repair firm and set them to work after I assured him driving back the bulge would not weaken the vessel.

"Things were coming along in good shape until the gang foreman knocked off and quit the job, saying it couldn't be done. Two other companies were called in and they refused flatly to undertake the work. A fourth company was drafted, but after working almost all day the foreman went to Mr. Littledale with the story that the sheets in front and rear courses were too thin to warrant spending money on repairs.

"By this time I was between the devil and the deep sea. It was natural that Mr. Littledale should blame me for letting him waste two valuable days on what he was beginning to think was a job that should never have been undertaken. He couldn't see how four repair companies could be all wrong, so he figured that if in the end he was going to have to buy a new boiler I ought to step aside and let him get it over with.

"The easiest way out for me would have been to withdraw my objections and let him go ahead and spend his money. But I knew I was right about driving back that bulge and it didn't jibe with my conscience to let one of our assured throw away a few thousand dollars and waste valuable time getting a new boiler installed when all the old one needed to put it in first-rate shape was a few hours' work by an intelligent repair gang.

"I stuck to my guns and we battled it out that night. He consented to make just one more attempt at repairs before ordering a new boiler. This last firm of boiler repairers knew the business. It sent over a gang that did a workmanlike job in jig-time. After a thorough examination we O.K.'d their work and the fireman lost no time raising steam.

"Mr. Littledale was mighty grateful and you can imagine I felt pretty good at having saved him the price of a new boiler as well as the expense of a longer shut-down. I was still congratulating myself three days later when I met Mr. Littledale and he told me that in spite of everything he had ordered a new boiler as a spare because he just couldn't make himself believe the bulge wasn't going to reappear. Naturally, I was sorry he had gone ahead and spent his money, but I had the consolation of knowing I had done my best to prevent it.

"As month after month passed with the old boiler showing no signs of distress, Mr. Littledale began to wonder whether it wasn't going to last just about as long in service as the new one would in storage. Of course I don't mean the new boiler was rusting away, but when you have part of your bankroll tied up in mechanical equipment that's doing nothing but occupy warehouse space you're losing money every hour it stays there. Mr. Littledale saw this, so to lay the ghost once and for all time he sent for us about three weeks ago to give his boiler a special inspection. We did, and found it shipshape. That settled the matter with the owner; he sold the spare as soon as he could find a buyer.

"This morning I received a letter from Mr. Littledale. In speaking about installing some safety devices we have recommended he says, among other things, 'We are pleased to follow out the suggestions of The Hartford at all times, as your Company and your Department has our confidence after the complete demonstration of your knowledge of boilers at this plant'."

Laying aside his pipe, the Chief turned to his work. But he could not resist the temptation to point out a moral to his narrative, for a moment later he remarked over his shoulder, "That proves what all you married men ought to know by this time. When you're right you'll always win eventually — providing you hold out long enough."

Hard on the Old Man

Daughter: — "Daddy, will you help me work this algebra problem?"

Conscientious father, looking up from his paper: — "I could, dear, but I don't think it would be right."

Daughter: — "No, I don't suppose it would. But you could try, couldn't you?"

In a down-town show window, above a set of attractive pictures of wild animals, the humane society exhibited this sign: "They skin us to provide women with furs."

The man with a large family of grown daughters paused there long enough to mutter: "You're not the only ones."

Found on an employee's application:

Question: — Give your parents' names.

Answer: — Mama and papa. — *A. G. E. Bulletin.*

Think Chemical Reaction Caused Explosion

SPONTANEOUS combustion of foreign substances in an air tank almost eleven hours after the compressor had been shut down is thought to have caused an explosion that killed the night engineer and did $10,000 property damage at the plant of Simm's Oil Company, Smackover, Ark., on July 28th.

Causes ordinarily attributable to air tank explosions did not fit this unusual case. With the compressor idle so long there was no chance that a piece of incandescent carbon from the valves of the compressor could have ignited oil vapor carried over from the cylinder. Nor could suspicion be directed toward over-pressure for, although the safety valve was damaged so badly it could not be tested, it is almost certain an explosion from over-pressure would have occurred while the compressor was running, instead of several hours after it had been shut down.

Persons who conducted an investigation believe that while the compressor was running an appreciable amount of oil substance, dust, and perhaps some chemical vapor from the air passed into the tank where they set up a slow chemical reaction which eventually caused spontaneous combustion. Another theory is that a charge of static electricity was created by air rushing through the discharge pipe as the engineer opened the valve. This might have caused a spark that ignited the combustible mixture in the tank. In any event, the resultant explosion was so sudden and so violent that the presence of a safety valve meant nothing.

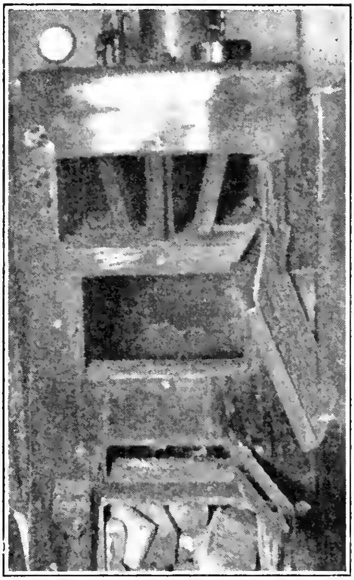
The compressor was shut down at noon. At that time pressure in the tank was below the allowable limit of 270 pounds, at which the safety valve was set to relieve. Eleven hours later the night engineer and the night operator decided to start the compressor. As the engineer opened the valve in the line between the tank and the compressor the tank let go, killing him instantly. The operator escaped, because he was a few steps behind the engineer and had not yet entered the room.

The tank was installed vertically with concave head at the bottom. So great was the force of the explosion the head seam rivets were sheared and the head reversed the direction of its dish. The top head and a fringe of shell were thrown to the roof, but the rest of the shell remained in one piece. Rivets along the horizontal seam sheared off and allowed the shell to flatten out. There was no evidence that metal of either heads or shell had been weakened by corrosion.

This tank was not insured by The Hartford.

Boiler Without Safety Valve Explodes

DEPENDENCE on the presence of an electrically-controlled thermostatic and pressure device to take the place of a safety valve cost the lives of a man and his wife when, on May 14th, it resulted in the explosion of a cast iron heating boiler used to demonstrate an oil burner in the show-room of a store at St. Louis, Mo. The control unit was designed to shut off the oil supply when pressure reached a certain point. After the accident it was discovered that the device had been disconnected to allow electricians to work on relays and switches. Without it, there was nothing to prevent pressure from increasing until it burst the boiler. Besides taking two lives, the accident scalded a woman seriously.



Devices to control heat input of boilers are entirely practical and usually very successful from the standpoint of temperature control and fuel economy. In addition, they may even serve to keep pressure within allowable limits. But, as this case shows, for the sake of safety they should be augmented by the more direct and positive means of pressure relief which a safety valve affords. There is no need to point out how well a safety valve would have served in the case described above.

As may be seen from the accompanying photograph, quite a large piece was blown from the rear section of the firebox. There was no evidence to show that any defect existed before the accident.

Exploding Boiler Kills 26 in Mexico

TWENTY-SIX men, women, and children were killed and over a score were seriously injured by the explosion of a horizontal tubular boiler in a public bath house near Mexico City, June 19th. Employees and patrons of the establishment as well as occupants of nearby houses and passers-by were crushed beneath debris of three buildings which the blast demolished.

An attempt to trace the circumstances leading up to the explosion proved fruitless because the engineer, as well as his wife and son who had brought his lunch and eaten with him, was killed instantly. A bath house attendant told police that, while the engineer was eating, the boiler ran low in water and became overheated. He said the explosion followed an attempt to feed in cold water. This explanation scarcely seems plausible, however, in view of the great amount of

energy that must have been required to wreak the havoc indicated by the photograph.

The plant's two boilers carried 200 pounds pressure. According to newspaper reports, the owner had no insurance and was rendered penniless.

Well, That Settles It

Jones: — "Sorry, old man, that my hen got loose and scratched up your garden."

Smith: — "That's all right; my dog ate your hen."

Jones: — "Fine. I just ran over your dog and killed him." — *St. Paul Farmer.*

Prescription for reducing waist line: Place hands on edge of table — and shove back.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street,
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1927

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$622,484.21
Real Estate	283,421.23
Mortgage and collateral loans	1,366,072.48
Bonds and Stocks	15,023,458.34
Premiums in course of collection	1,363,003.55
Interest accrued	152,728.70
Other Assets	54,678.59
Total Assets	$18,865,847.10

LIABILITIES

Reserve for unearned premiums		$7,710,752.66
Reserve for losses		346,047.69
Reserve for taxes and other contingencies		1,593,077.45
Capital Stock	$2,500,000.00	
Surplus over all liabilities	6,715,969.30	
Surplus to Policyholders,		**$9,215,969.30**
Total Liabilities		$18,865,847.10

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WM. R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

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Vol. XXXVII No. 5 January 1929

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Far Below Surface, Miners Pin Faith *on* Ability *of* Power Plant Men *to* Keep Air Supply Intact

NO doubt about it, winter is winter in Glace Bay, Nova Scotia. When the old giant of the Arctic circle rouses from his summer's siesta and turns loose the wind that howls down across Canada with sub-zero temperature on its coat tails, folk in Glace Bay need no thermometer to tell them what's what. Jutting out into the northern stretches of the Atlantic, that Nova Scotia peninsula can tell you a thing or two about cold weather.

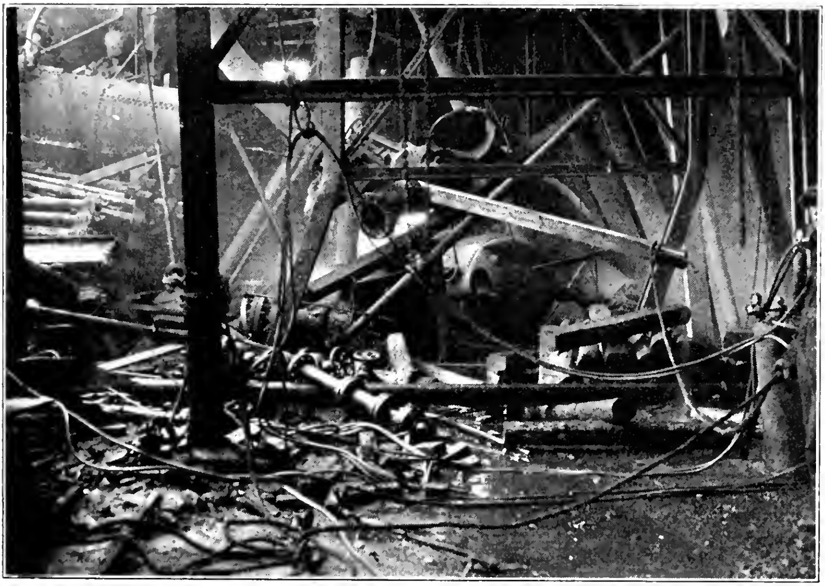
However, one spot in Glace Bay manages to escape winter's cruel talons. Go down, straight down a thousand feet into the earth, then walk three or four miles out under the very floor of the ocean and you'll find miners actually sweating at their task of getting out the 8,000 odd tons of coal that each day come up out of Collieries 1B and 2 of the British Empire Steel Corporation. It's hot down there. So hot that when folks on the surface are clumping along in ulsters and mufflers, beating arms across chests to keep up circulation, the miners are stripped down to just as few clothes as the law allows.

Yes, it's hot down at the bottom of the pits. Neither men nor horses could stand it were it not for huge fans in the power house on the surface — fans that, night and day, send down a continuous supply of fresh air. Let something happen to those fans and the men down there are not long in knowing it. Pinch off that air supply for any length of time and all hands must come up — or fight it out with sweltering heat and mine gas.

Keeping that air going down is the job of men in the power house. And quite a job it is, too, looking after twenty-one boilers, a battery of compressors, fans, turbo-generators and engines — the big fellows that lower men into the pits at the start of a day's work and lift them out again when the next shift comes on to relieve them.

A lot depends on those power plant hands and you can bet they know it. They're on the job every minute of the day, doing all that is humanly possible to guard against break-downs. But care and watchfulness can go only so far toward keeping the thousands of pieces of an enormous power plant clicking in unison. An invisible defect in a spindle or shaft, an insidious fissure hidden away 'neath the lap of a boiler seam, or any one of a hundred other items that might possibly escape the eye of even the keenest inspector may be lying in wait to snarl things up in a hopeless tangle. Yes, lurking there to kill a man or two if any are in the way when it lets go.

At four o'clock on the morning of November 20, 1928, the Glace Bay power plant was running as evenly as a watch. Down the long firing aisle of the boiler room walked Head Fireman Ernest Burchell, glancing up at gauge glasses as he went. No sound was audible save the steady hum of a battery of smoothly steaming boilers and the harsher, grumbling note of automatic stokers at their tireless task of cramming an endless stream of fuel into hungry furnaces. Sweet music to a fireman's ear, for as long as no foreign note intrudes itself into



that symphony he knows that all is well. But no — he can *never* know that for a certainty. There is no premonitory sound to warn of a lap seam about to crack open. No matter how competent and experienced the watcher, he cannot look through the brickwork of a boiler setting and see metal in the throes of a losing battle with a force that is striving to tear it asunder. When metal gives up the fight, the cataclysm descends in the wink of an eye; it enters the boiler room with the suddenness of an aerial bomb.

So Burchell saw no sign that all was not well: little could he guess what was going on inside the lap seam of the middle course of Boiler No. 7.

Old No. 7 was built in 1903, rebuilt in 1923, and was considered a staunch vessel. During her long term of service she had established a reputation as a fine steamer and had given her owners very little trouble. Of course, when they overhauled her four or five years ago they found part of the plate in the middle course a bit pitted, but that was not surprising after twenty years. So they just took out the pitted plate and riveted in a new piece, giving her two longitudinal seams in that course where previously she had had only one. After that, old No. 7 seemed just as sound as the day the erecting gang swung her into place.

Since then something had happened to that old piece of plate. Little by little a crack had developed along the row of rivets joining the old plate with the new. For a time there was plenty of metal left to hold the steam demon in check, but tonight old No. 7 knew that the end was near; slowly but surely she felt her strength giving out under the relentless squeezing of a force that was trying to burst the bonds that held it. If only a boiler could speak, No. 7 surely would have said something to Burchell as he passed by.

Pausing now and then for a word with a fireman, Burchell walked on down the aisle. Shortly, he thought, the men would have lunch. Those seemingly endless hours just before daybreak always go faster when a fellow can break into them long enough for a bite to eat. Guess he'd be having one himself just as soon as ——.

Then it happened. Anyone who has stood close to a battery of naval guns fired in salvo can imagine the blast that rocked the power house, sent walls tumbling down, crushed coal hoppers, and tore open mains to release a flood of scalding steam through which men had to fight their way to reach stop valves.

Out in the compressor room Archie McAdam, an oiler, had just risen from his chair and taken a few steps toward his machine, when the back end of No. 7 came like a projectile through the 12-inch brick wall and smashed the chair to pieces the size of matchsticks. On its journey the heavy missile demolished a Sturtevant blower, cropped off a fifteen-foot section of twenty-inch I-beam to send it rocketing seventy-five feet across the boiler room, and carved down steam pipes as though they were made of paper.

The front end of the boiler drove into the supports of the coal hopper and tipped that heavy structure more than two feet out of line. The middle course, opening up as flat as your hand, landed on top of a companion boiler and sheared off its pipe connections.

In no time at all officials and superintendents, some of them roused from comfortable beds at home by the noise of the explosion, came hurrying down to undertake the job that always is given precedence at a mine accident — the job of getting men to the surface as quickly as possible. A full shift of miners was in No. 2 at the thousand-foot level, and three men were in old Mine No. 9, which lay 400 feet down and was accessible only through the main shaft leading down to No. 2. Getting the men up through this shaft was out of the question, for there was no power to operate the cage and no one dared hazard a guess as to how long it would take to clear away the tangle in the power house sufficiently to produce power.

Putting all available men to the task of making emergency repairs, the superintendent led a party of rescuers down through the shaft leading to Mine 1B from which a drift leads over to No. 2. They soon located the men and brought them out, but still there remained the task of rescuing the three men trapped in No. 9. There was no way of accomplishing that except by getting the cage working, and to do that they had to have power. So all hands fell to work on the wreckage of their power house equipment, racing against time to forestall the fate that sometimes befalls miners who are trapped down in an unventilated mine. The battle was won shortly after noon when, after seven hours of herculean labor, they were able to send down a cage and bring up three miners little the worse for their experience.

Fortunately, there was only one fatality among those working in the power plant when the explosion occurred. Archie Johnstone, a fireman, was blown to the roof of a small building nearby, and died in the hospital. John Frost, another fireman, was badly cut and scalded, but he recovered. McAdam, the oiler whose chair was crushed a moment after he rose from it, was cut on the head by flying debris. His injuries did not prove serious.

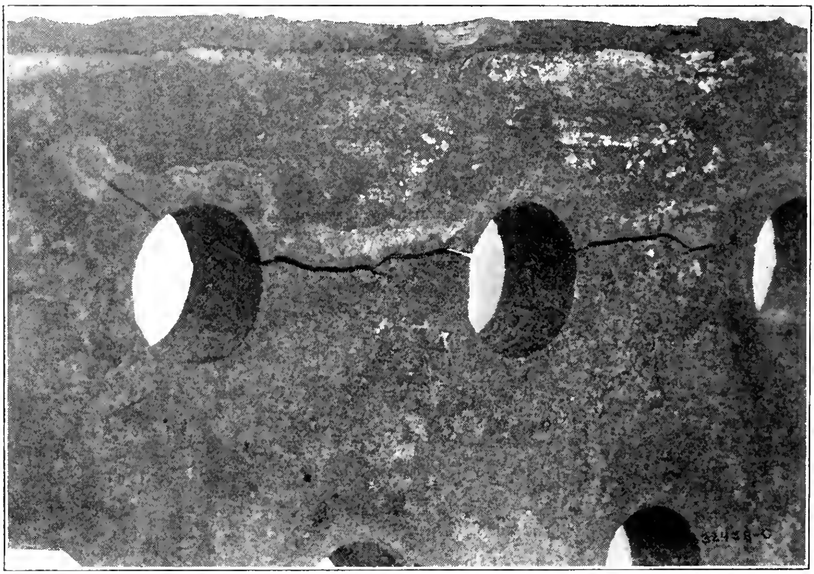
All in all, the casualty list was remarkably short, considering the narrow escapes of some of the men who were closest to No. 7 when she let go. Property damage, amounting to over $31,000, was covered by a policy in The Boiler Inspection and Insurance Company of Canada. The cut on a preceding page shows the damage to stokers and coal hopper.

Wrong Treatment Was Fatal

Acting on the advice of a woman doctor, workmen in Rakova, Czechoslovakia recently buried a man in an attempt to revive him after he had been rendered unconscious by coming in contact with an electrically-charged wire. The doctor claimed that earth had "a peculiar affinity for electricity" and would draw the charge from the victim's body. The cure was worse than the ailment; the patient suffocated.

Discarded Feed Pipe Furnishes Valuable Clue

BANISHED from the boiler room when its job was taken over by a newer and sounder piece of metal, a worn-out section of feed pipe would have carried a vital bit of evidence away to the junk yard had not a Hartford inspector seen it just in time. Four years ago, while examining the boilers of a large Minnesota paper mill, the inspector's interest was aroused by the peculiar appearance of a crack in the threaded end of a pipe which had been tossed onto a scrap heap



behind the boiler house. Suspecting the presence of caustic embrittlement, he immediately questioned the owner on the source and treatment of feed-water and cautioned him to notify The Hartford's Chicago headquarters if leakage developed at the seams or rivets of any boiler in the plant.

From that time on these boilers were kept under the closest scrutiny by The Hartford's inspection force. Within a year a leaky rivet and a headless rivet were discovered, but a thorough examination revealed no further evidence of trouble. However, when an inspector visited the plant in July, 1927, he found that since his last visit a new blow-off flange had been fitted to No. 4 boiler. The old flange had been consigned to the scrap heap from which it was recovered by the inspector and sent to a metallurgist. The latter reported that the intercrystalline cracks from rivet hole to rivet hole had been caused by caustic embrittlement.

The close watch was continued, with inspectors on the alert to detect the first sign that embrittlement was weakening vital parts of the boiler. Eventually, in August of 1928, they came upon leaky rivets behind the bridge wall in the longitudinal seam of Number 4 boiler. Removing a section of the wall, an inspector uncovered several headless rivets. He cut out other rivets in the affected area and found cracks in the shell plate and butt strap. The accompanying illustration shows the serious nature of the crack in the shell plate.

With the owner's consent, the inspector set about removing ten per cent. of all rivets below the water line. Before he had proceeded far he found serious cracks in the rear top drum. It was evident then that the boiler was affected to such an extent that it should be discarded, but before the owner would accept this recommendation he insisted on having the boiler examined by a representative of another insurance company.

A few days later the owner wired The Hartford's Chicago office: "Have had other experts examine boiler. They do not find anything which should make it necessary to reduce pressure." He intimated, too, that if the other insurance company found the boiler an acceptable risk he would have to transfer the insurance.

However, he consented to call in as referee Professor Frederick G. Straub, of the University of Illinois, recognized as an outstanding authority on embrittlement by reason of extensive research in that field. Professor Straub not only diagnosed the case as caustic embrittlement but confirmed the opinion of The Hartford that cracks in the head seams of the mud drum and in longitudinal seams of both mud and feed drums rendered the boiler unsafe. Needless to say, the boiler was replaced.

A great deal of credit is due the inspector who ferreted the first symptom out of the scrap heap. His discovery, made four years before embrittlement actually endangered the safety of the boiler, prompted a close watch on subsequent developments and probably prevented a serious explosion.

Letter to the Chief Inspector

"Dear Sir — You wrote us on the tenth inst., requesting a hydrostatic test on our old boiler. Our engineer says he has read much lately regarding the disastrous effects of water hammer and does not want a water test made on our boiler. Please advise promptly."

Minimum Safe Thickness Drill Test Holes *in* Shells *of* Unfired Pressure Vessels

(By George H. Stickney, *Supt. Boiler Dept.*)

PREVENTION of accidents through detecting weakened structures and observing unsafe operating practices is the underlying purpose of inspections by insurance companies. However, the owner and insurance company both are anxious to maintain equipment in good shape so, naturally, it does not matter by whom or through what agency the discovery of unsafe conditions is made so long as an accident is prevented. It can be said truthfully that eternal vigilance is the price of safety. With this in mind it must be appreciated that inspections, no matter how careful or how frequent, are only periodic.

The purpose of this article is to explain a type of drill test hole which will act as an eternally vigilant watchdog to give warning when the shell metal of pressure vessels (boilers excepted) becomes so thin that it is no longer safe for the pressure carried. This is to be in addition to regular inspections and not in any way to take the place of them. It detects merely the dangerous thinning of shell plate, whereas inspections reveal many and varied unsafe conditions.

Definite knowledge that plate thickness is within safe limits is one of the most important features in explosion prevention, and it is one of the most difficult to determine by the usual inspection methods.

Unfired pressure vessels differ from boilers in that they are used to a great extent to cook or prepare stock of all kinds in process of manufacture. In stationary vessels the stock moves about and circulates under steam pressures and temperatures and, by scouring action, wears away the shell metal. This erosion is in addition to the chemical effect which, in many processes, further reduces plate thickness.

In rotating vessels wear is very positive and has been found, in many cases, to reduce plate thickness uniformly throughout the entire inner surface of the vessel. In vessels fitted with stirring paddles or agitators, bent shafts, misalignment of paddles or other parts, and jamming of stock between paddle blades and shell will frequently cause grooving in addition to the erosion and chemical action already mentioned.

Many localized areas in these vessels need special precautions against dangerous thinning. As an example we can mention a discharge elbow at the bottow of a digester, rendering tank or any other vessel with a fitting or part through which stock is blown when the cooking process is finished. Erosion is concentrated and severe at the turn of the elbow. (See Figure 1) Frequently the metal wears com-

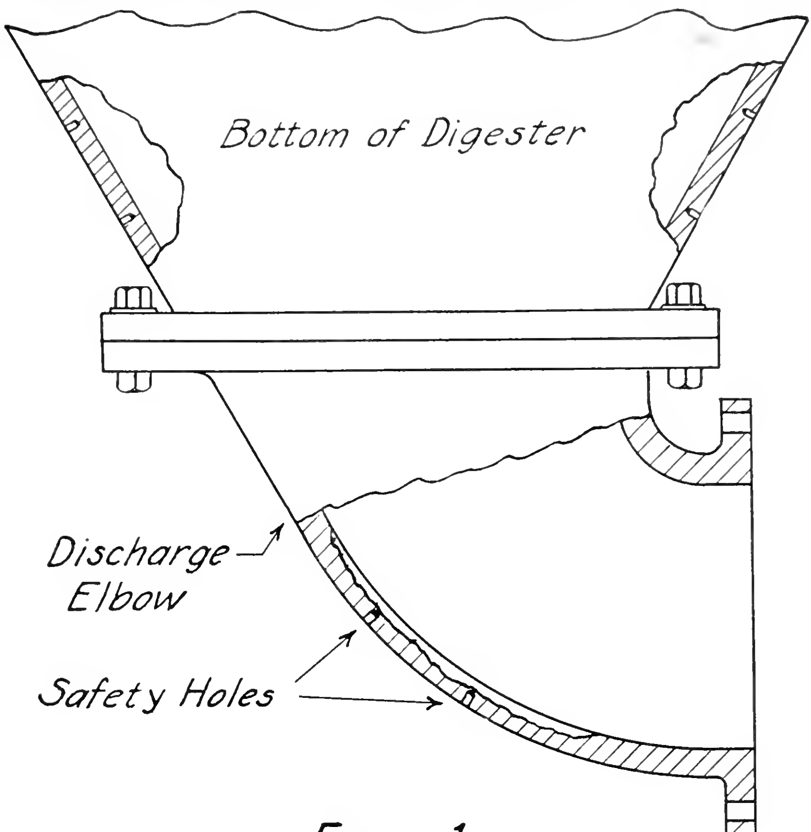


FIGURE 1

pletely through at this point, resulting in loss of material and possible danger to persons.

Drill testing by merely drilling through the metal and then measuring the thickness, sealing or plugging the hole afterward, has been about the only method for accurately determining thickness. This method has many disadvantages and inspectors have generally encountered substantial resistance, for some very good reasons, on the part of owners and users when *through* drill testing has been proposed.

All that we are interested in regarding thickness is to know for a certainty when metal under pressure and subject to wasting has been reduced in thickness to such an extent that the remaining metal is not sufficient to withstand with safety the pressure carried. For this purpose we recommend what may be termed *pre-determined minimum safe thickness test holes*, which are of ¼″ diameter and drilled from the outside (in a single-shell vessel) to a depth equal to the minimum safe shell thickness. (See Figure 2).

The designed maximum safe working pressure of an unfired pressure vessel should be based on a factor of safety of at least five, and it is believed that manufacturers generally meet this standard. The depth of the test holes at the point of the drill should be sufficient to equal a shell thickness that will give a factor of safety of at least three.

Following are the formulae for computing the safe working pressure of single-shell vessels and the minimum safe shell thickness:

$$(1)\quad SWP = \frac{t \times TS \times \%}{R \times FS} \qquad\qquad (2)\quad t = \frac{P \times FS \times R}{TS \times \%}$$

where SWP = safe working pressure; t = plate thickness; % = efficiency of longitudinal joint; FS = factor of safety; TS = tensile strength of shell material; R = radius of shell.

As an example we may consider a shell 72″ in diameter, ¾″ thick, and with a longitudinal joint of 80 per cent. efficiency. The safe working pressure for this vessel would be:

$$SWP = \frac{.75 \times 55{,}000 \times .80}{36 \times 5} = 183 \text{ pounds per square inch.}$$

Using this value in Formula 2, and substituting 3 as the value of FS,

$$t = \frac{183 \times 3 \times 36}{55{,}000 \times .80} = .45 \text{ inch is the minimum safe thickness}$$

and the depth to which test holes should be drilled. (See Figure 4).

The pitch or distance between centers of holes is more or less arbitrary, but in general it should be in proportion to the size of the vessel and in consideration of whether the anticipated wasting is general and uniform over the entire surface, or localized within a restricted area. For very large vessels, say over 72″ in diameter and subject to uniform wasting, a pitch of from 36″ to 48″ is suggested. For vessels between 36″ and 72″ in diameter a pitch of about 24″ to 36″ will generally give adequate protection, while for smaller vessels the pitch can be reduced to about 12″, except where intense wasting away is anticipated within a restricted area. In that event it may be advisable to drill a few holes at carefully selected points over a smaller area.

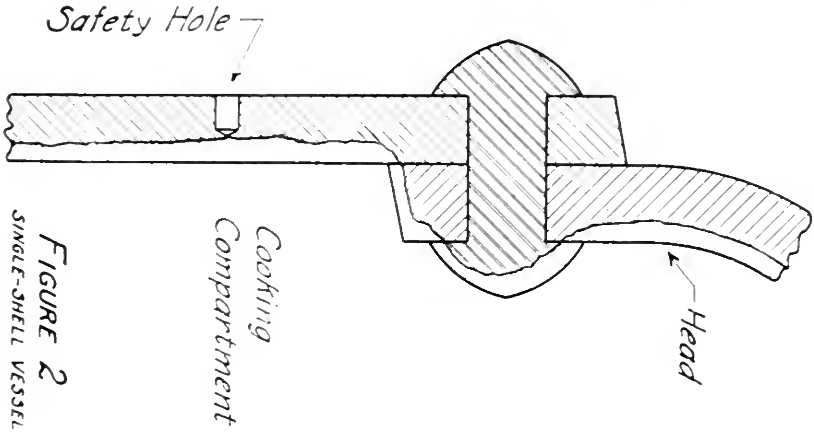


FIGURE 2
SINGLE-SHELL VESSEL

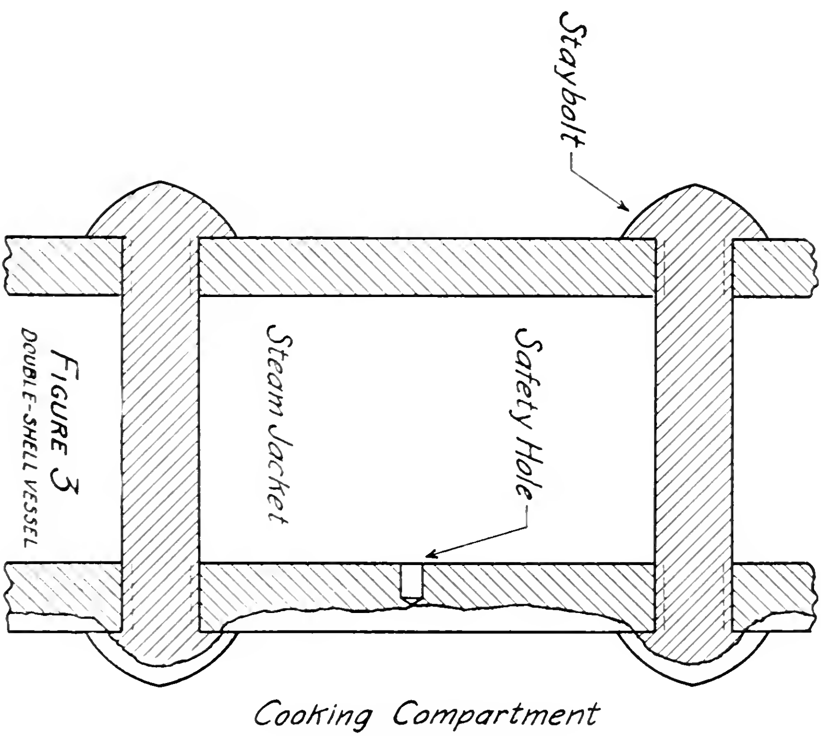


FIGURE 3
DOUBLE-SHELL VESSEL

When metal on the interior or pressure side of the shell wastes away sufficiently to communicate with the bottom of a hole, steam or any other pressure will blow out into the room and give warning by being heard or seen.

In double-shell vessels such as jacketed tanks and hemispherical kettles, the inner shell is the one subjected to reduction of thickness and is therefor the one that must be protected by drill test holes. The holes should, of course, be drilled in the inner shell from the pressure or jacket side. (See Figure 3).

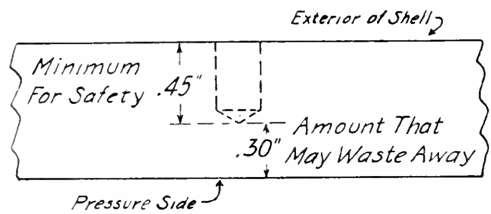


Figure 4

There should be frequent visual inspections of jacketed vessels with pressure in the jacket and the stock-containing chamber empty and open. For very large vessels it will be necessary to use an electric light connected to a long extension cord. Swinging this light around will enable the operator to detect any steam that may be blowing into the vessel.

These test holes in jacketed vessels must, by necessity, be drilled at the time of manufacture. Single-shell vessels can be drilled after installation, but it is better to do the drilling during construction in the shop, particularly for vessels that are to be lagged with insulating material on the outside. When lagging is contemplated small pipes, long enough to reach through the lagging, can be secured to the shell directly over the holes.

Sometimes the question arises as to whether these test holes weaken a structure. We can assure anyone that they do not. In fact, the plate itself can be weakened and still remain stronger than the longitudinal seam, which is scarcely ever 95 per cent. as strong as the solid plate. So unless the holes weaken the plate below the strength of the longitudinal seam, the strength of the structure is not changed. Quarter-inch holes, spaced as close as twelve inches apart and drilled entirely through a plate, will reduce the net strength of the plate only one per cent., as may be seen by the following calculation: $(12 - .125) \div 12 = .99$. From this it is evident that such test holes are too small and too widely spaced to affect the vessel's strength.

Although this method is not new, it has not been generally practiced by manufacturers and certainly has not been used to the extent its merits warrant.

Manufacturers are urged to provide minimum safe thickness test holes as regular practice for all vessels that are used in any service where the metal is subject to wasting away from any cause. If the holes are drilled when the plates are in the flat and on the laying-out table it will take very little time and the cost will be small. Purchasers are urged to include this item in their specifications.

Beware of Dead Air When Entering Boiler

AN inspector of many years' experience recently had a narrow escape from death by suffocation when he was overcome by foul air in the drum of a boiler that had not been in use for three years. Although he took the customary precautions to secure a circulation of fresh air, the inspector made the mistake of entering the drum too soon. He had not gone far when a sensation of dizziness told him he was losing consciousness. Fortunately, he managed to crawl to the man-hole and thrust his head outside before he collapsed. There he lay until the fresh air revived him.

When boilers are idle for a long time the oxygen of the air inside seems to be used up by formation of rust or absorbed by chemical reaction with some foreign substance left inside when the boiler was emptied. The result is stagnant or "dead" air.

A boiler should never be entered until it has been ventilated thoroughly. In a coal-fired unit the condition of the air can be determined by thrusting a candle through the man-hole. If the air is bad, the flame will burn feebly or go out. This test should not be applied where oil or gas is used as fuel, for the process of ventilating the boiler by drawing air through it may carry in explosive vapor, especially if there is a leak in the fuel line. The safe way in all cases is first to make sure the method of ventilation is such that it actually does cause circulation of air through the drum, and then allow ventilation to continue until there is no doubt that the stale air has been replaced by fresh.

Closed tanks and vats of all kinds should likewise be ventilated before they are entered. In some cases they represent a greater danger than does a boiler, for they may contain, in addition to stagnant air, dangerous chemical fumes from materials previously stored there.

Following are several other important precautions that should be observed by anyone who has occasion to enter a boiler:

Make sure the blow-off valve is closed when the boiler under inspection discharges into a blow-off line or tank to which other boilers are connected.

Notify the boiler room attendants that you are about to make an inspection and warn them not to open a valve or do anything else to affect the boiler under inspection. If possible, have an engineer or other responsible man stand within speaking distance.

Beware of stepping into deep soot or ashes in the back connection. Even though they have been wetted down, they may be red hot just below the surface.

Avoid the use of worn-out or partly broken ladders when climbing up onto boilers and their settings. Be careful, also, not to trust your weight on small fittings or pipe connections.

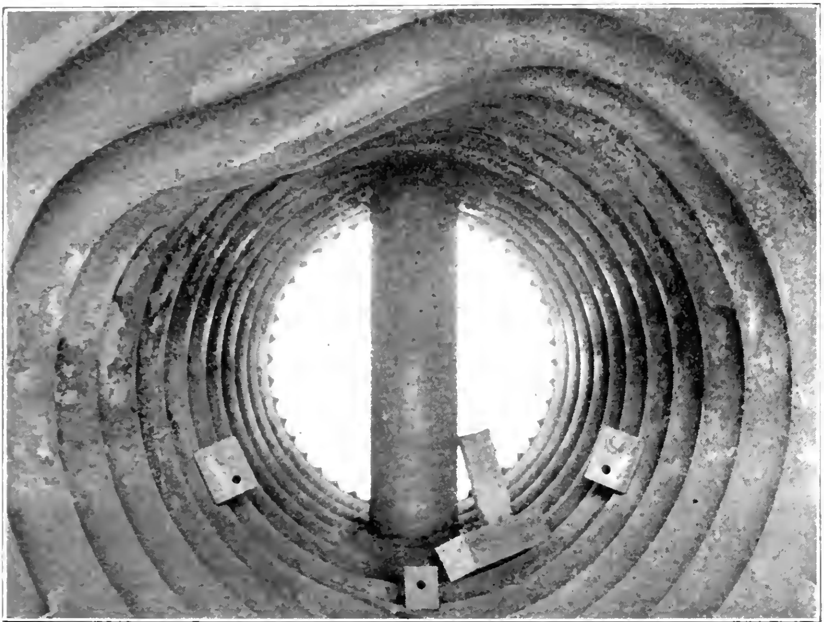
Oil Is Poor Medicine for Boiler Scale

AMONG various "dopes" that have been tried as boiler scale preventives, oil probably holds the record for causing the most damage. As a general rule engineers know the effect of oil inside a boiler and are careful to guard against even the small quantities in condensate from engines and turbines. Yet once in awhile when an inspector encounters a bulged sheet he finds that the operator has given the boiler a dose of oil to combat scale. Where and when such a practice originated no one can say. Even though warnings have been issued repeatedly, it seems that a few operators of small plants still do not know that oil is poison and not medicine when placed inside a boiler.

The accompanying illustration shows a corrugated flue furnace in a boiler that had been "oiled". Some well-meaning but misinformed friend told the operator that a pailful of cylinder oil would end his trouble with scale. As a result the flue overheated and bulged inward.

Cases where oil is deliberately fed into a boiler are not numerous enough to cause great concern. Usually when oil is present it is there quite by accident and by no design of the operator. One such case was discovered recently at a plant using steam coils to heat a tank of oil. When the owner applied for insurance an inspector found crown and firebox sheets bulged so badly they were in danger of collapse. Oil had entered the return line through a leak in the heating coils and had gradually accumulated until it comprised about 15 per cent. of the solution in the boiler. As none of the steam was used in engines, the operator did not think it worth-while to investigate the cause of the boiler priming. It was evident to the inspector that no one at the plant appreciated the danger of the condition.

Metal could not endure contact with the intense furnace heat were it not for the cooling effect of water inside the boiler. This cooling effect is dependent on the free, rapid transfer of heat from metal to water, and when either poor circulation or some mechanical barrier such as scale or oil retards this heat flow the metal may be burned or softened to such an extent that it will collapse.



Oil is a better insulator than scale. Even a thin skin of oil resists the passage of heat so efficiently that wherever it forms the metal is almost certain to be damaged.

Why Not Pulverize It?

"If I cut a beefsteak in two," asked the teacher, "then cut the halves in two, what do I get?"

"Quarters," replied the boy.

"Good. And then again?"

"Eighths."

"Correct. Again?"

"Sixteenths."

"Exactly. And what then?"

"Thirty-seconds."

"And once more?"

"Hamburger," cried the boy in exasperation.

Proper Selection *and* Operation *of* Blow-off Valves Cut Down Maintenance Expense

QUESTIONS concerning boiler blow-off valves are brought to our attention so frequently that a discussion here of the few simple factors involved in the selection, installation, and handling of such equipment should be of interest to many of our readers.

The valve used to start and stop the flow through the blow-off line is subjected to the most severe service and frequently causes more trouble than any other boiler fitting. The instant the valve starts to open, or starts to close, the outrushing water has a wire-drawing effect on both disc and seat. Scale and sediment carried along by the water contribute their share of the damage until, in time, the valve loses tightness and must be replaced or repaired. As tightness is important both for boiler safety and for avoiding the waste of heat involved in the steady loss of even a small stream of hot water, two independent closing devices are usually installed in each blow-off line.

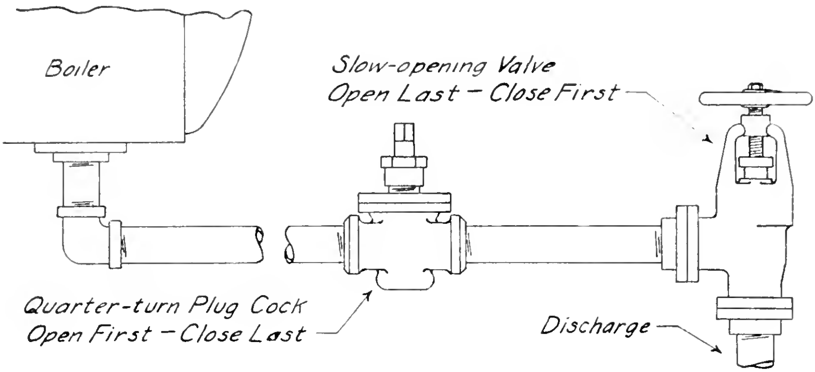
When two valves or a valve and cock are intelligently placed and operated, maintenance of the blow-off line is a comparatively simple matter and it may be taken care of in many cases without putting the boiler out of service. Of the two closing devices, at least one should be of the slow-acting type. A screw-actuated valve best meets this requirement and is in general use. This valve controls the blow-down, while the other — which may be of the plug cock type — is depended on to keep the line tight. In this article the first will be referred to as the "blowing" valve, while the other will be called the "sealing" valve.

Some contend that a quick-acting valve such as the cock type should be used to start and stop the blow-off, because it will suffer less from wire-drawing than a valve with slower action. Nevertheless, a cock or any other quick-acting valve should *not* be used as the "blowing" valve, for sudden starting or stopping of a mass of water involves severe water-hammer shocks that have been known to damage pipes and strip threads from fittings. Such an accident is hard on the equipment and even worse for the attendant. To avoid this danger, the "blowing" valve should be slow-acting. However, the "sealing" device may be either a similar valve, a quarter-turn valve, or a plug cock.

The "sealing" valve is placed between the "blowing" valve and the boiler and should always be opened first and closed last. In this way the "blowing" valve is obliged to stand most of the punishment, while the other valve — which is depended on for tightness — is spared.

Any valve in a blow-off line should be of a type having a free, unobstructed passage. The ordinary globe valve, and others that have pockets in which sediment and scale can collect, are not suitable. An angle valve is usually very satisfactory and is regarded by many as the type best suited to this work.

The plug cock, when one is used, should be of the type that has at the top a stuffing gland or guard which will hold the plug securely in



place. Cocks in which the plug is fastened down by a nut on the small end of the taper are not favored, for the nut, so located that it cannot be readily observed, may work loose and allow the plug to blow out.

Location of the "blowing" valve with respect to the "sealing" valve, and the order in which they should be manipulated are shown in the accompanying sketch. As the angle valve takes most of the wear it will require overhauling more frequently than its mate. Placing the cock between this valve and the boiler makes it possible to repair or replace the "blowing" valve while the boiler is under steam.

Where two or more blow-off outlets lead into a manifold, it is sometimes the practice to have only one valve in each of the individual outlets, the manifold being served by a master valve. In this case the valves on the individual lines are "sealing" valves and the master valve should be opened last and closed first. Some operators make the mistake of opening the master valve and then opening and closing in turn the valves on each individual line. This puts the brunt of the work on the valves which are intended for tightness and sooner or later they will leak. As there is no way of repairing or replacing one of them without shutting down the boiler, it is important that the correct sequence of operation be observed.

Although the arrangement described in the last paragraph cuts down the investment in equipment by having only one instead of two valves in the line between boiler and manifold, it involves several disadvantages that may be avoided if two valves are provided.

Taps From the Old Chief's Hammer

FOR several minutes after the door closed behind the departing visitor the Old Chief stood at the window, gazing thoughtfully out into space. Evidently the conference had left him in a most satisfactory frame of mind, for he was smiling as he crossed the room and seated himself on a corner of his assistant's desk.

"Tom," he said, "if thirty years at this job have taught me anything at all about human nature, from now on that man is going to be a Hartford booster."

"What makes you think so, Chief?" replied Tom, who guessed correctly that the boss had a story he was anxious to tell.

"Well," explained the old man, lighting a pipe that had gone dead between his teeth, "plant managers are a pretty keen lot, take 'em by and large. If you show one a way to cut down expenses a few thousand dollars he isn't likely to forget you.

"Take the case of this Mr. Kennedy. His stockholders are making money and they swear by him, yet up until recently our special agents were unanimous in declaring that when it came to thinking up reasons why he shouldn't spend money for boiler insurance he was a full lap ahead of any other plant manager in this territory. He was sure one tough proposition for a salesman to go up against, and I have an idea he'd still be holding out if he hadn't run into a lot of trouble with boiler leakage for which his own men could find no remedy. Anyway, about three months ago his nine boilers got to leaking so badly that something just had to be done, so he decided to call us in. You can bet I sent Pursell down there *pronto* for a special examination.

"Joe wasn't long finding the cause of the leakage. It was plainly a case of unequal expansion due to the collection of oil on the heating surfaces. Such a quantity was getting into the feed line from some source or other that the separator couldn't handle it. We had them give the boilers a good boiling-out and let them put the plant back into service but, naturally, we weren't going to O. K. the layout until we found and eliminated the source of that oil.

"With Mr. Kennedy's consent we went at his plant with a fine-tooth comb, spending the best part of a week on the feed water heater, purification system, heating equipment and, finally, the engines. There we found the trouble. Those engines were equipped with oil pumps, and the operating engineer — apparently a capable enough fellow in most respects — had an idea the engines wouldn't work properly unless the oil jet was open wide and working full blast. He was putting a whole barrel of oil through the cylinders of seven small engines every day in the week.

"When we suggested that he cut the oil down to about a third of a barrel a day he almost had a fit. We had trouble convincing him that it wouldn't ruin his engines. Finally, however, he agreed to give our plan a trial, with the result that after the feed water heater was thoroughly cleaned out, the oil feed was cut to thirty per cent. of what it formerly had been, and they had no more trouble with the boilers.

"Kennedy dropped in this morning apparently just to get my advice on a new air compressor, but before he had been here ten minutes he changed the subject to plant economy and showed me a slip of paper on which he had calculated how much our inspection visit is going to save him in lubricating oil. According to his figures, cutting the oil consumption seventy per cent. will benefit his firm to the tune of $4,280 a year. Not so bad, Tom, eh?"

"That's great, boss," the assistant agreed, "but haven't both you and Kennedy overlooked the increased fuel economy that is going to result, now that you've arranged to keep the boilers free from oil?"

"Not by a darned sight, we haven't," laughed the Chief. "Kennedy told me his engineer has noticed the effect on the coal pile. At my suggestion he is going to compare the record of coal fired during the past month with the amount used the month before he called us down there. Unless I miss my guess, he's going to save a substantial sum over the $4,280 he obtained by figuring on oil alone."

Over the Chief Inspector's Phone

"This is the purchasing agent of the Crooked Creek Railroad. Our boilermaker wants the Chief to tell him how much material will be required for a petticoat pipe in No. 3 engine."

Chief's New Stenographer — "Well, the Chief is out of town today, but if your wise-cracking boilermaker has an engine that insists on wearing a petticoat you tell him to take it around to an old-fashioned dressmaker."

Tolerably Fast Car

"I have a friend who always crosses bridges before he comes to them."

"You don't mean it!" exclaimed the enthusiastic motorist. "Tell me, what sort of a car does he drive?"

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION
George Hargis Prall, *Editor*

HARTFORD, CONN., January 1, 1929

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Subscription price 50 cents per year when mailed from this office.
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Returning to an Old Smelting Principle

A COMPANY has been formed in Germany to produce 20,000 tons of iron annually by the reduction of ore by contact with carbon monoxide at a temperature below the melting point of the iron. This venture will be watched with particular interest, for it means going back to the principle of a method which has long been abandoned by all save a few wild tribes in the hills of India.

Thousands of years ago prehistoric man learned to produce iron from lumps of ore and charcoal. His apparatus was a cone-shaped clay furnace with a hole at the top for the escape of gases and several holes or tuyeres around the bottom for draft. Men squatted around the furnace and blew air into these tuyeres through hollow reeds or bamboo tubes until the carbon monoxide gas from the burning charcoal reduced each piece of ore to a porous lump of iron. Then the furnace was broken open and the iron lumps compacted by hammering on stone or metal anvils.

The blast furnace took the place of this crude method. But still the blast furnace has its disadvantages, for it involves melting the iron, and molten iron is quick to pick up and absorb impurities as it trickles down through the charge in the furnace. Whether or not the better quality of the iron produced by Germany's new application of the older principle will compensate for its greater cost remains to be seen.

Looking at Coal in a New Light

DEVELOPMENTS that involve radical departures from present methods of utilizing coal were described by chemists and engineers at the second International Conference on Bituminous Coal, held recently in Pittsburgh.

Twenty-five years ago the most efficient power plants needed 6.5 pounds of coal to produce a kilowatt hour of electric energy. Today the giant plants of public utilities are turning out kilowatt hours in hundred-thousand units for less than 2 pounds of coal per Kw.-hr., and at least one plant is equipped and managed so efficiently that slightly less than one pound of coal suffices. But in spite of the remarkable advance in the art of converting coal into power, the mounting cost of this basic commodity, together with a growing realization that there is a limit to the world's deposits of high grade mineral fuel, has led to the belief that it is highly wasteful to use coal in its raw state even in the most efficient furnaces.

A lump of coal now is regarded as a complex mixture of carbon and hydro-carbons, some of which are so valuable that they should not be used directly as fuel, but should be extracted for industrial raw material before coal is turned over to the power plant for its furnaces. From the discussions at the Pittsburgh conference, it is apparent that engineers everywhere are awake to the necessity of utilizing our supply of high-grade fuel to better advantage, and of finding more extensive uses for such fuels as low-grade coal and screenings.

An example of the trend toward more efficient use of this natural resource is the process whereby coal is placed in a retort and heated by low pressure, super-heated steam until it "sweats" out its volatile oils, which are condensed and collected. The carbon left in the retort is an excellent smokeless fuel. Each ton of coal so treated produces about 275 pounds of oil and wax, and 1,300 pounds of smokeless fuel, while the dirt and moisture content — amounting to about 350 pounds — are eliminated.

Turning coal into petroleum is another process of which we may hear more in the future. This involves treatment of raw coal under great heat and high pressure, the resulting liquid and gaseous hydrocarbons being brought into contact with chemically active hydrogen. It is claimed that the product thus formed may be readily "cracked" into gasoline and other petroleum derivatives.

The use of powdered coal directly as furnace fuel has already advanced a long way beyond the experimental stage. This fuel has been used aboard the U. S. Shipping Board freighter "Mercer" so successfully that the Board recently decided to equip five other freighters in the same way. Because this method may provide a way to use efficiently such low grades of fuel as run-of-mine and slack, several steamship companies here and abroad are investigating it, and engineers the world over are watching it with interest.

Still another use for powdered coal is proposed. In Germany they have developed an internal combustion engine which uses this fuel instead of gas or oil, thus reverting to the principle of the original Diesel. A Netherlands scientist, foreseeing that the abrasive action of the ash on cylinder walls might be a stumbling block that would hold back the development of such engines, has evolved what he calls carbonal phine, a powdered carbon which combines the lubricating qualities of finely divided graphite with high fuel value. He intends to mix this with powdered coal. The discoverer claims that on a calory measurement his fuel may be used with five times the economy obtained by burning coal to produce steam. An interesting factor is that low grade coals, peats, and lignites may eventually be used as the sources of carbon.

Such methods for multiplying the value of each pound of fuel should, if successfully placed in practice, extend the world's coal supply several hundred years. But aside from that, the change of fuel from its natural state into a more concentrated form promises other economies. For instance, may not the future witness "liquified" coal pumped from the mines to tidewater through pipe lines hundreds of miles in length, thus reducing the present cost of transportation not merely by eliminating the long haul by rail but also by making it unnecessary to carry the ash and moisture, which would be taken out by the process at the mine?

Naturally, many of the processes discussed at the conference in Pittsburgh still await further study by engineers and chemists before they can be put to use on a commercial basis and at a reasonable cost. But with all things considered, the prospects are extremely bright.

First Fireman — "It's wonderful how smart these scientists are gettin'. Now they got a way of workin' wid Old Nick himself."

Second Fireman — "What makes you say that?"

F. F.— "Well, I was just in the Chief's office and there on his desk was a magazine wid a story about 'Heat Balance at Hell Gate'."

Positive Designation of Portable Boilers and Tanks

(By J. A. Snyder, *Chief Inspector, Pittsburgh, Pa.*)

POSITIVE identification of a particular portable steam boiler or tank is of the utmost importance for the purpose of keeping inspection records and applying for operating certificates. Such contracting equipment is moved continually from place to place and, frequently, when a contractor has several boilers of the same size and type, confusion may arise unless there is some system by which each

RELIABLE CONTRACTING COMPANY

Location of Portable Boilers *January 1, 1929*

Contract *Fineview Theatre* Location *New Castle, Pa.*

NUMBER	EQUIPMENT	LOCATION	IN CHARGE OF
R-21	Concrete Mixer	New Castle, Pa.	J B. Sheur, Box 82, Phone 435
R-19	Steam Shovel	"	"
R-17	Hoist Engine	"	
R-6	Air Compressor	In transportation	New Castle to Braddock

object may be distinguished from others of its kind.

Some boiler users have a splendid plan of designating their portable boilers and tanks by attaching to each vessel a small brass plate bearing the name or initials of the company, together with a number reserved for that particular object. The number is cast or deeply stamped on the plate, which is then fastened securely to the shell of the vessel by small machine screws. In no case should the plate be fastened to a pipe or other attachment, or to the machine on which the vessel is used, for boilers and tanks are sometimes changed from one machine to another.

When thus marked, a boiler should be known only by its number, and should be so designated by the owner, operators, inspectors, and repairmen. This number should be used also for state or municipal operating certificates, when such are required, unless the state or municipality has an established numbering system of its own. To avoid confusing records of an old boiler with those of a new one, it is advisable to discontinue a number when the vessel to which it is assigned is scrapped.

With such a system in use it is easy for the contractor's main office to keep an accurate monthly record of the location or movement of apparatus. This can be done by having the foreman on each job furnish a report on a certain day of each month, showing the equipment on the job and in transportation. The form herein illustrated has been found very satisfactory for such a record. It may be used by the foremen in sending their reports and by the main office in compiling the master record.

By combining reports from various contracts the contractor obtains a complete record which not only tells him the exact whereabouts of his equipment, but enables him to determine more readily the routing of suitable boilers from one contract job to another.

In many cases state highway and factory inspectors are obliged to take note of steam boilers found on their visits, and they are expected to see the state operating certificates. Sometimes this puts a contractor to a great deal of trouble when certificates have just expired or are about to expire and it is necessary to arrange quickly for an inspection. A situation of this kind can be straightened out with the least loss of time if the boiler is plainly marked with a number, for then there is no question of its identity, and it can be more readily inspected and described in the reports and certificates.

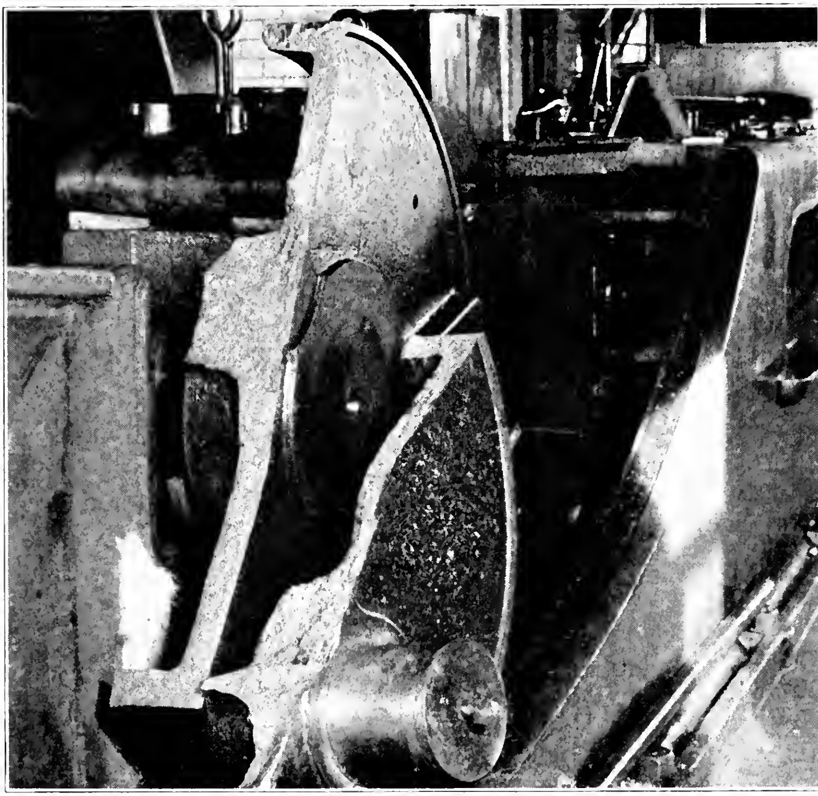
"Blue" Gas Not a New Discovery

COINCIDENT with the trans-Atlantic voyage of the airship "Graf Zeppelin" the newspaper-reading public was led to believe that a new fuel gas had been invented for use in her engines. Blau gas, or "blue" gas as the newspapers called it, was so named for a German chemist Herr Blau who developed a process now used by the concern engaged in its manufacture. However, this gas was known as early as 1815, when Taylor produced it. In 1823 several municipal gas plants in England were manufacturing this type of fuel.

Mineral oil distillates, distillates from lignite tar and shale tar, or even some vegetable oils may be used as the base of blau gas. When mineral oils are used, about ten per cent. of the crude — representing that part lying between the kerosenes and the lubricating oils — is sprayed into a retort heated to about 600 degrees Centigrade, where it volatilizes and then breaks up into gas, tar, coke, and lampblack. The gas, which consists of the light hydro-carbons, is liquefied by a pressure of about 100 atmospheres and is stored in steel cylinders, convenient for handling. Its heat content is in the neighborhood of 26,500 B. t. u. per pound.

Cast Crank Pin Proves Stronger Than Disc

IT will take more than the accompanying photograph of an engine break-down to settle the old argument as to whether casting a semi-steel crank pin and crank disc together makes as strong a job as shrinking a steel pin into the disc. However, it is evident that the cast



pin shown here was sufficiently strong, for it withstood a tremendous shock while the disc itself broke in two.

This break-down occurred recently on a Corliss type engine and was caused by the piston rod breaking off underneath the nut at the head end of the piston. The nut dropped down, jammed between the piston and cylinder head, and broke off the whole end of the cylinder at the center line of the head-end valve chambers. At the same time the guide barrel, cross-head shoe, and crank disc were broken.

The practice of casting the pin in one piece with the disc is opposed by some on the ground that it is difficult to avoid blow-holes and shrinkage strains when making a piece which consists of a bulky part joined to a thinner one, such as a pin on a disc. On the other hand, designers who favor this method point out that a steel pin is prone to work loose and, moreover, unless fitted accurately to the hole in the disc, sometimes breaks off. If the pin fits somewhat tighter at one end of the hole than it does at the other end, it will flex back and forth at each revolution of the engine. Eventually such bending may crack it.

When properly designed and made, either form of construction seems to give satisfactory service. In the case of a cast-on pin there should be a generous fillet at the juncture between pin and disc, for a sharp corner there may serve as the starting point of a crack. Of course, the bearing must be shaped to accommodate this fillet. With the shrunk-in steel pin it is important that the force fit of the pin in the disc be such that when the pin is forced home it will bear solidly at all points.

Boiler Explodes and Kills Boy

RUNNING on ahead of his aunt, with whom he was out for a walk, a three-year-old New Orleans boy was crushed to death on October 29th, 1928, when a steam boiler explosion hurled a heavy wall down across the sidewalk. The wreckage narrowly missed burying the aunt likewise.

The boiler was a Scotch Marine dryback, apparently about twenty years old. It was said to carry a pressure of from 45 to 50 pounds and was used to supply hot water in a laundry. Failure occurred in the flue.

It was fortunate that the blast occurred after employees had left for the day, for the building was demolished. Other buildings in the vicinity were damaged considerably, one catching fire. The laundry owner carried no boiler insurance.

The Crook

"There," exclaimed wifey in righteous indignation. "I told you that overnight guest of yours wasn't to be trusted. One of our towels is missing."

"Was it a good one?" inquired hubby.

"It was the best we had — the one with 'Grand Palace Hotel' on it."

Want Ad. in the Witchita Falls Times — "For Sale — a full-blooded cow, giving milk, three tons of hay, a lot of chickens, and several stoves."

Recent Steamboat Race Recalls Stories *of* Early Days *on* Mississippi *and* Ohio Rivers

A SPECTACULAR sport, which passed from popularity shortly after the Civil War, was revived a few months ago when two snorting stern-wheel steamboats raced up the Ohio river from Cincinnati to New Richmond. This contest witnessed the defeat of the old "Betsy Ann", for many years regarded as the champion among river craft, and called forth newspaper stories of bygone days when Mississippi and Ohio river captains rated a craft according to its ability to outstrip rivals.

Conditions under which the recent race was run were in marked contrast with those of former days. When the two contestants pulled away from the wharf in Cincinnati, officials were on hand to look over the boiler inspection certificates; United States inspectors were aboard to see that steam gauges registered no more than the allowed pressure. Governmental supervision was probably not quite so rigid when the "Robert E. Lee" and the "Natchez" steamed their memorable race from New Orleans to St. Louis.

Between the 30's and the 70's competition among boat captains was keen both for the plaudits of a race-loving public and for what was more substantial, the freight and passenger patronage that went to the fastest boats. As a consequence, inadequate boilers were forced beyond pressures that would be allowable under present-day requirements, and explosions were rather frequent. Instead of discouraging racing, these mishaps seemed to add just another sporting hazard to a venture that was already quite exciting enough.

Enthusiasm was at a high pitch whenever two boats drew abreast and started down the river. Passengers and crew shared equally the excitement of a neck and neck contest and skippers and passengers frequently wagered hundreds of dollars on the outcome. The story is told of one old Kentucky lady, bound south with a shipment of her own lard, who called on the captain to throw the lard into the fire when a rival boat threatened to outdistance the one on which she was a passenger. "I come from Kentucky where they race horses," she cried. "I just won't be beat."

In those days an approved method for getting an extra knot or two, when hard pressed, was to weigh down the safety valve lever. Sometimes, it is told, a negro cabin boy was seated astride the lever to keep the valve from popping. Meanwhile, on the boiler deck, a squad of sweating stokers imbibed generously from a handy keg of whisky while they fed chunks of wood into the seething maws of the furnaces. When pine knots failed to produce enough heat to satisfy the skipper, pure resin and even slabs of fat side meat — when it was handy — were tossed into the fire.

It is little wonder that boilers exploded under such treatment, for usually the factor of safety was too small even for normal conditions of firing. Pressures obtained during a race must have approached dangerously close to the bursting point.

Although the sporting blood of pioneer river men helped to encourage racing, this factor was secondary to the battle among ship owners for the patronage accorded speedy boats. We imagine that in this stiff warfare little time was given to inspecting boilers. The rigid safety standards of today, which insurance companies helped introduce, were unknown in this country before The Hartford Steam Boiler Inspection and Insurance Company was organized in 1866.

Just a year before the Hartford Company was formed a boiler explosion aboard the Mississippi river steamer "Sultana" snuffed out the lives of 1,238 passengers. That disaster was among the worst in the long history of river navigation and has not been forgotten even to this day. Recently this magazine received an interesting letter from Mr. E. Carroll Taber, of Keokuk, Iowa, whose father was captain of a vessel which vied with the "Sultana" for the contract to carry north a detachment of Union soldiers who had just been released from Southern prison camps by the declaration of peace.

As the "Sultana" steamed into Vicksburg to pick up her human cargo, one of her boilers developed a leak along a joint at the front end. Hasty repairs were made by bolting on a soft-patch of quarter-inch iron plate. Then, without waiting even long enough to prepare a passenger list, 1,866 soldiers were herded aboard and the ill-fated journey commenced.

So crowded were the passengers that many did not have room to lie down. Inadequate cooking facilities added to their discomfort. After the disaster these facts led to ugly charges and counter-charges of bribery in connection with the award of the contract to one ship when others were available to carry some of the men.

At three o'clock on the morning of April 27, 1865, when the ship was several miles above Memphis, the repaired boiler let go. Many of the victims were killed outright. Others, terribly scalded, were thrown into the river and drowned.

The boiler was a return-tubular — then a type new to river service. Its dimensions, shell thickness, and type of riveted joint indicate that it could have withstood 90 pounds with a factor of safety of five. However, the chances are that it was carrying more than 90 pounds.

In 1912 a Louisville, Ky., newspaper published a story that a former river engineer, on his deathbed, confessed that he placed a torpedo in a coal bunker just before the ship left Memphis. The truth of such confession — if one was actually made — must be doubted in view of what is known of the boiler's weakness and the probability of rupture under the pressure it was called upon to carry.

The Value of Periodic Inspections

WHAT goes on inside a machine? In a general way, engineers know; but variations from normal behavior often are not evident until the condition has gone beyond easy correction and a shutdown for repair is necessary. And sometimes the condition becomes so serious before it is noticed that an accident or a bad failure is experienced.

This being an unavoidable state of affairs, plans must be laid to minimize its consequences. Periodic, thorough inspection of all power equipment should be as much a part of the plant routine as sleep is a part of a man's activities. Time between inspections should be so regulated as to anticipate the occurrence of serious troubles, and the schedule set for this work should be rigidly adhered to. To open a turbine and go over it at short intervals may mean a lot of work for the operating staff; but it frequently saves the cost of an extensive reblading job and the losses resulting from reduced plant capacity.—*Power*.

Wooden Barrel Explodes, Scalds Man

WASHING out wooden barrels by means of steam has lost popularity in Boone, Iowa. Until recently it was customary for anyone who wanted a barrel "steamed" to take it to the boiler room of Hawkeye Laundry, where an obliging fireman would thrust the nozzle of a steam hose into the bung-hole.

As long as the operator of this ingenious scouring device took care that the nozzle did not fit the bung-hole tightly no trouble was experienced; steam escaped around the nozzle and thus kept down pressure in the barrel. But on one occasion this precaution was overlooked. The nozzle was driven tightly into the hole, where it was clamped even more securely when steam swelled the wood. The resulting explosion scalded one man severely.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1927

Capital Stock, . . $2,500,000.00

ASSETS

Cash in offices and banks	$ 622,484.21
Real Estate	283,421.23
Mortgage and collateral loans	1,366,072.48
Bonds and Stocks	15,023,458.34
Premiums in course of collection	1,363,003.55
Interest accrued	152,728.70
Other Assets	54,678.59
Total Assets	$ 18,865,847.10

LIABILITIES

Reserve for unearned premiums		$ 7,710,752.66
Reserve for losses		346,047.69
Reserve for taxes and other contingencies		1,593,077.45
Capital Stock	$2,500,000.00	
Surplus over all liabilities	6,715,969.30	
Surplus to Policyholders,		**$9,215,969.30**
Total Liabilities		$ 18,865,847.10

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Vol. XXXVII No. 6 April 1929

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Cause *and* Prevention *of* Internal Corrosion *of* Boilers

By WILLIAM D. HALSEY, *Mechanical Eng.*

The general subject of corrosion involves so many ramifications — by reason of the varied conditions under which corrosion may occur — that at least a volume would be required for anywhere near adequate treatment. Recognizing that fact, the author of this article has limited discussion to the variety of corrosion commonly found inside boilers. He has, we believe, succeeded in dealing with this specific phase of the subject in a way which our readers will find interesting.

THE subject of corrosion has, for years, been one of careful study by many investigators. Numerous theories have been advanced as to the cause, and all of them have seemed to fit some particular condition under investigation. However, until the electro-chemical theory was brought forward, there was no theory which adequately explained all cases. The electro-chemical theory was first advanced in 1903 and is now quite generally accepted as the real explanation of corrosion.

Most of us have observed, at one time or another, that a piece of iron in a solution of copper sulphate soon becomes coated with copper. This is because the iron goes into solution — dissolves, as a matter of fact — and in so doing makes room for itself by forcing the copper out of solution.

Iron has exactly this same action with hydrogen in solution. In other words, when free hydrogen exists in water, the iron in contact with such water goes into solution and forces the hydrogen to plate out, just as copper is plated out of the copper sulphate bath. However, as hydrogen accumulates on the iron the rate at which iron dissolves slows up. When the point is reached where the whole surface of the iron is coated with hydrogen the action stops altogether. It is in this connection that the presence of free oxygen or carbon dioxide gas in the water plays an important part in corrosion, for these gases have a notable liking for hydrogen and will combine with it at every opportunity. Thus when there is free oxygen or carbon dioxide in boiler water they quickly strip the protective layer of gaseous hydrogen from the surface of the iron and encourage further interchange of iron and hydrogen. This action will continue until all the free oxygen in the water is used up.

As an understanding of this phenomenon requires that the reader know, at least in a general way, just what is meant by atoms, molecules, and ions, a short explanation at this point may not be amiss.

The various fundamental substances with which we deal in the realm of physics and chemistry are known as elements. Included among them are the metals and the various gases such as oxygen, hydrogen, nitrogen, and many others. The smallest division of one of these elements is called an atom and it is a bit of matter so tiny that it cannot be seen even under the most powerful microscope. In fact, it has been said that if a drop of water were magnified to the size of the earth the atoms would appear to be about the size of oranges.

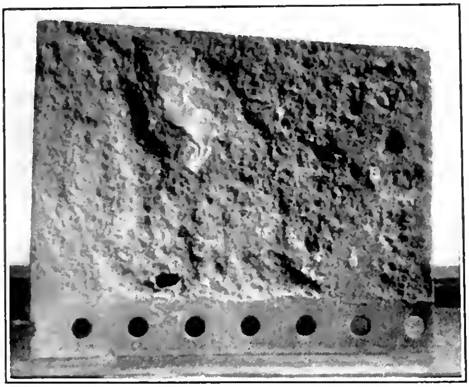


Figure 1.

When two elements combine, such as in the union of hydrogen and oxygen to form water, atoms of the two elements form themselves into what is known as a molecule of the new substance. An ion, the third of this trio of infinitesimal portions, is nothing more than an atom or a group of atoms carrying a charge of electricity. This electricity may be either positive or negative.

Hydrogen ions — electrically charged atoms of hydrogen — may exist in water without being combined with the water. They always carry a positive charge of electricity. When iron goes into solution it does so as ions of iron, which also carry a positive charge. Just why iron is able to force hydrogen out of solution is explained by the fact that some elements seem to be stronger than others in maintaining themselves in solution. Listed in the order of their ability to replace others in solution, some of the more prominent elements are: cadmium, zinc, iron, nickel, lead, tin, hydrogen, copper, silver, gold. Any of these elements will replace, or have a tendency to replace the elements which stand lower on the list, if one of those elements is in solution. It will be noted that iron stands higher in the list than hydrogen.

As the hydrogen ions plate out on the iron they set up what may be looked upon as a back pressure resisting the effort of any more hydrogen to plate out. Since it is necessary for a hydrogen ion to come out of solution in order that an iron ion go in, this action eventually results in no more iron dissolving. Unfortunately, when free oxygen is present in the water this protective coating does not last long, for the oxygen promptly combines with the hydrogen to form water, thus allowing the action to recommence. From this fact it is apparent that although the inherent tendency of iron to go into solution is the cause of corrosion, the presence of free oxygen in the water is a controlling factor.

Carbon dioxide acts in a somewhat different manner but, nevertheless, has the ability to remove the hydrogen, thereby permitting more iron to dissolve.

Figure 2.

The action of iron going into solution and hydrogen coming out may be very well demonstrated by what is known as the ferroxyl test. This consists of a solution of ferrocyanide of potassium and phenolpthalein. Ferrocyanide of potassium in the presence of iron will show a blue color and phenolphthalein in the presence of hydrogen will show a pink color. If a piece of iron, such as a common wire nail, be placed in some gelatin containing the proper proportions of these chemicals or "indicators", as they are called, it will be found that certain parts of the nail will be surrounded by a blue color and other parts by a pink color. Where the blue appears the iron is being dissolved; the hydrogen it replaces is located in the pink area.

The total corrosion which takes place is dependent on the amount of oxygen or carbon dioxide that can reach the total area covered by hydrogen. If the iron actually exposed to the water is large in area we will have general corrosion. Figure 1 is an example. However, if a small area of iron is exposed the total weight of iron which will go into solution will be the same as for a larger area of iron, but the loss will necessarily appear great and will show as a deep pit. This condition, wherein a small area is exposed to the water, may be brought about by mill scale adhering to the metal and thus protecting it against the solution, or by adherent scale from the water through which there is a crack. Under such a crack corrosion may occur in the form of deep pitting. Furthermore, as the iron oxide forms around the mouth of the pit local electrolytic action between the iron itself and the oxide takes place, and this further accelerates the pitting. Other conditions such as segregation of the foreign elements in steel plates or gas inclusion

Excessive internal corrosion in a horizontal tubular boiler at a brick yard in Richmond, Va., caused the explosion shown above. The accident demolished the building and wrecked an engine, causing property damage of almost $10,000.

may also give rise to local corrosion. Where there are dissimilar metals in contact as, for instance, brass fusible plugs or other brass fittings actually in contact with the boiler shell, opportunity is given for electrolytic action between the two metals.

It is also true that where iron is highly stressed and is in direct contact with other iron which is not so highly stressed there is a greater tendency on the part of the iron under the higher stress to go into solution. The experiment of the iron nail in gelatin with the two "indicators", to which reference has already been made, will very frequently show a blue color at the head and point with the pink color along the body of the nail. This is an excellent illustration of the greater tendency of the higher stressed metal (for the forming of the head and point caused high stresses in those parts) to go into solution. Furthermore, this action accounts for the grooving frequently encountered in the turn of the flange of a boiler head or along a long riveted seam. Figure 2 shows a case of this kind.

There are many factors in the corrosion of iron which space will not permit taking up in an article as brief as this one. However, the action described herein covers in a general way the fundamental principle and allows us to turn now to a discussion of the steps which can be taken to prevent corrosion.

Since the presence of oxygen or carbon dioxide in the water is the factor which determines the amount of corrosion, it follows that the best preventive step is the removal of these gases. In the smaller plants an open heater, well vented, is successful in reducing their amount to what is usually considered a harmless quantity. In larger installations deaerators or deactivators are used in an endeavor to further reduce the oxygen content and the water is treated to remove the carbon dioxide. A deaerator is a vessel or system of vessels which drives the air out by the application of heat and vacuum. A deactivator is a vessel in which the water is permitted to act on iron, thus expending its oxygen.

Whenever a persistent case of corrosion is encountered the services of a competent feed water specialist should be obtained before proceeding with the installation of equipment to overcome the trouble. In some cases involved treatment may be necessary; in others the remedy may be quite simple.

Badly Corroded Boiler Kills 6, Injures 4

WHILE the foregoing article was under preparation there came news of a disastrous boiler explosion which very evidently was caused by excessive internal corrosion of the shell. Six persons were killed and five others, including a little girl who was playing in the yard of her home some distance away, were badly injured.

Built about 1890, the horizontal tubular boiler which exploded had been in service at two other locations before it was set up at a sawmill in a Southern state two months ago. Although it was designed for a working pressure of but 90 pounds, it was used at 105 pounds with the safety valve set to blow ten pounds above that. On the day before the explosion leakage developed through the solid plate in the middle of the rear course and it was found that corrosion had eaten entirely through the shell in five different spots.

A local mechanic was employed to check the leakage, which he did by drilling through the plate at the holes and inserting ⅜-inch machine bolts with lead washers inside and nuts outside the boiler shell.

The boiler was fired up next morning, and a moment after the safety valve popped the boiler ruptured from end to end through the bottom of all three courses. At the same time the courses were separated at the girth seams, the solid plate tearing circumferentially parallel to the seams rather than through the rivet holes. A part of the boiler was blown a distance of 225 yards, landing within a few feet of the owner's residence. Another large piece, consisting of most of the front head, was hurled over the mill and a railroad siding, coming to rest 190 yards from the point where it started. Four persons were

killed outright; two others died in the hospital. Property damage alone was approximately $10,000.

The owner carried no boiler insurance, so it is not probable that the boiler was examined by a competent inspector when it was brought to the sawmill and set up. An inspector would surely have noted the dangerous extent to which the shell had deteriorated, for even in the accompanying photograph it can readily be seen that corrosion and pitting had eaten down the metal alarmingly.

MOST RETIRING

Timid Swain, who had been years getting up his courage to take the leap: "Sir, I have been courting your daughter for fifteen years, and—."

Dad: "Well, what do you want?"

Swain: "To marry her."

Dad, sighing with relief: "Phew! I was afraid you were going to ask for a pension or something."

Pat the office boy wanted a raise, so he went to his boss and asked for an increase of $2.00 a week.

"Do you think you are worth it?" he was asked.

"I do," was the reply. "I've been thinking so for the last three weeks but have been too busy to say so."

Detection *of* Very Dangerous Conditions Frequently Accomplished *by* Study *of* Small Symptoms

ALTHOUGH a leak at the lower head seam of the mud drum on Boiler No. 13 persisted even after the seam was twice caulked, plant attendants had no idea what a serious predicament the twelve-year-old vessel was in. It remained for a Hartford Steam Boiler inspector to find that out.

While examining several of the plant's twenty-seven vertical water-tube boilers, the inspector noticed that a mud-drum seam on Boiler No. 13 had been recently caulked. The boiler was not under pressure at the time, but the inspector saw from the white deposit around the seam that leakage had occurred since the caulking was done. Crawling into the drum, he found between three adjacent rivet heads a deposit of soft sediment that reminded him of a mud wasp's nest. From this he reasoned that there was a crack so fine that, as water passed through, small particles of solid matter were filtered out and left behind. The crack was too small to be distinguished by the naked eye, but under a magnifying glass it showed up clearly as a very fine fissure running from rivet hole to rivet hole. Similar cracks were found at two other points along the seam.

Determined to find out the extent to which the plate was affected, the inspector removed the rivets and cut loose the braces joining head and tube plate. No sooner had he unfastened the last brace than the shell plate below the line of rivet holes tore away and tumbled down into the pit, along with the head. Cracks around the entire circumference reduced the plate strength so much that the mere weight of the head broke the remaining metal.

This discovery was made just in time, for there is no doubt that the boiler would have exploded, had it remained in service.

Training and experience frequently enable an inspector to locate defects by means of small symptoms to which others might attach no significance. Now and then the outward indication of a fault is apparently so trivial that the inspector has trouble convincing even the plant engineer that a dangerous condition exists. With the plant running at full capacity and in need of all the steam it can get, the engineer is anxious to put the boiler back on the line as quickly as possible. Even so, most engineers are willing to give the inspector as much time as he needs to investigate a symptom that may mean trouble, but occasionally the engineer attributes the inspector's painstaking work to overzealousness. Such a case came up recently.

While investigating a leak at the longitudinal seam of a Stirling type water-tube boiler the inspector discovered a quantity of some hard substance which had collected near the point of leakage. This prompted him to tap nearby rivet heads with his hammer. Eleven of the heads snapped off under light blows.

The symptoms were those of caustic embrittlement, so the inspector called the chief engineer and secured permission to drill out the shanks of the broken rivets. Then, by cleaning the insides of the holes with muriatic acid, he showed the engineer several fine cracks in both the butt strap and plate.

At first the engineer was inclined to discount the importance of the discovery. He had recently been in Germany, he explained, where he discussed with several German engineers the occurrence of intergranular cracks due to feed water conditions. Their opinion, in which he concurred, was that the theory of caustic embrittlement was "bunk". Such fine cracks, he contended, could be found in any boiler that had been in use for some time, particularly if high riveting pressure was used in construction.

"You're just wasting time worrying over those cracks," was his impatient rejoinder to a request to take out other rivets for a more complete investigation. "Let's rivet up the boiler and get it back into service."

The inspector saw that further argument with the engineer would be futile, so he 'phoned the chief inspector and explained the difficulty to him. After conferring with the engineer and other plant officials, the chief secured their consent to remove the butt strap. Much to the amazement of the engineer, the shell plate was cracked from rivet hole to rivet hole throughout the length of the drum. His chagrin increased when butt straps were taken from the front and rear drums to reveal the same condition there.

Unquestionably the discovery prevented a violent explosion. How extensive the loss of life and property might have been can easily be imagined, for the plant was located in a densely populated section of a large city.

When there is evidence that a hidden defect exists, an inspector cannot allow obstacles, either mechanical or personal, to prevent his carrying out a complete investigation. Sometimes this entails a great deal of extra work and inconvenience, but it is justified by the probability of bringing to light a dangerous condition.

At a small city pumping plant, which was changed over to electric drive, the two horizontal tubular boilers and steam pumps were left in place to serve as stand-by units. After several cases of current interruption the city manager decided to put the boilers in operating condition, so he applied for insurance and an inspector was sent to examine them.

Other than finding the boilers dirty because they had not been cleaned when taken out of service, the inspector saw no signs of trouble until he chipped off the light scale from around the double-riveted lap joint at the longitudinal seam of one of the boilers and noted that the overlapping plate inside stood away from the shell about a sixteenth of an inch. This was due, he judged, to improper forming of the plate when the boiler was built. But just under this edge he discovered an irregular, broken line on the surface of the metal. He probed this with a sharp tool but could not determine in that way whether or not it was a crack.

The next logical procedure was to drill test holes through the supposed crack. A request for drilling equipment revealed that this had been removed to the city machine shop, two miles away, and by 'phone the inspector secured the machine shop superintendent's promise to send the drill over immediately. However, the drill did not arrive, so the inspector called the superintendent again. He learned that the request had been taken up with the city manager who ruled that since the insurance company was well paid for the insurance it should supply all tools necessary for an inspection.

The inspector wasted no time trying to convince the city manager that he was mistaken. Instead, he went into the city and borrowed a breast drill from a garage. With this he ascertained that the plate was cracked to a depth equal to two-thirds its thickness. Of course, the boiler was condemned.

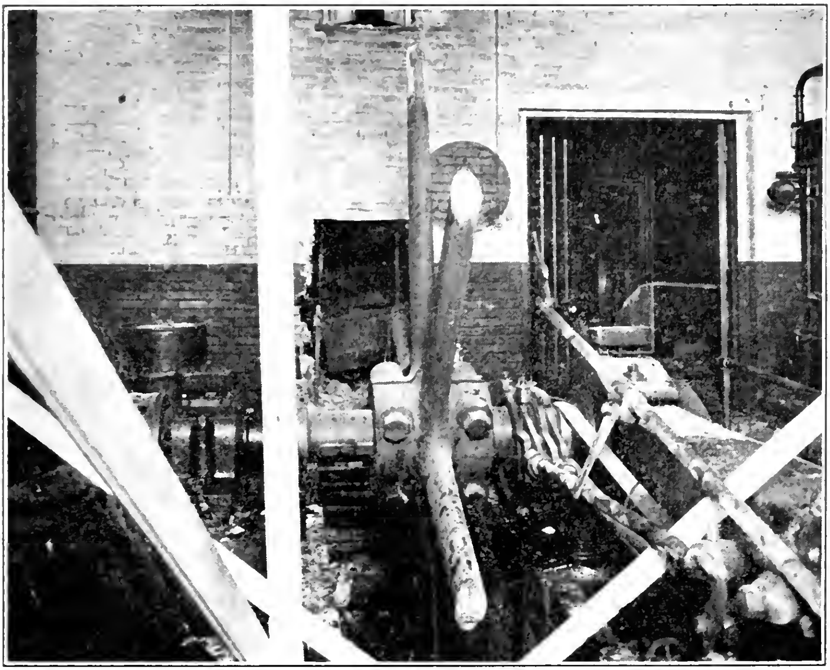
Hydrogen Ion Interests Doctors, Too

If an instrument recently developed by medical research workers proves to be as useful as they predict in furthering the study of cancer, we hope they won't overlook the fact that their device for measuring the hydrogen ion concentration in the blood to the thousandth part of a volt was antedated at least two years by a device for measuring such concentration in boiler water.

Under certain conditions the hydrogen ion is as capable of affecting iron as it is of working changes in organic tissue. As pointed out in another article in this issue, it plays an important part in boiler plate corrosion.

Boys Escape Death in Engine Room as Wheel Bursts

THE fourteen-foot flywheel of a Corliss-driven air compressor at the plant of French and Hecht, Inc., Davenport, Iowa, demolished the machine and caused extensive property damage when it burst, on the evening of February 8th. Three young boys who, after bringing lunch for their father, the fireman, lingered a moment



in the engine room to gaze in awe at the powerful engine, were the only persons in the room when the wheel let go. That they escaped with their lives was almost a miracle.

One piece of the wheel, weighing about 800 pounds, passed through the wall of the engine room, tore out two girders in the main factory building, and went on out through the roof to find a resting place in the coal pile of a neighboring plant 600 feet away. Another piece apparently went almost straight up in the air, for it came down vertically through the roof of the foundry and buried itself three feet deep in the dirt floor. A smaller piece dropped into the pattern vault and crushed a storage rack.

Four other pieces, the largest weighing close to 400 pounds, were hurled about 250 feet through the roof of the Safety Grinding and Machine Company plant, one of the pieces carrying away the top of a kiln.

The engine itself, which was about 30 years old, was damaged so badly that repair was considered impracticable. Not only was the air cylinder cracked, but the valve gear and rocker arms were practically demolished, the shaft was sprung, and the machine was loosened on the foundation.

When the day shift went off duty at 5:15 p. m., the regular operating engineer shut down the engine by means of the automatic stop. Later that evening a shift went on duty for several hours' overtime work, so the chief engineer started the machine again. As the chief's duties as maintenance superintendent frequently took him to other parts of the plant he was accustomed to place the fireman in charge of the machine whenever the plant was operating overtime.

The fireman had eaten supper and had gone out to wheel in more coal when the crash came, tearing down electric light wires and plunging the plant into darkness. The man scrambled a-top the boilers to shut off the stop valves and then rushed into the engine room to find out what had happened to his sons. He found the youngest, a five-year-old, apparently unhurt. A ten-year-old son whose only injury was a scalp wound was trying to carry an older brother to safety. At the hospital it was found that the fourteen-year-old boy had sustained four broken ribs and a compound fracture of the left arm.

From the fact that flange bolts in the rim of the wheel were stretched, there was no doubt that the wheel attained considerable overspeed before it let go. Although the automatic safety stop had been in working order when the machine was last shut down this stop apparently failed. Both the stop and the governing mechanism were so badly twisted and broken that nothing could be learned from examining them.

Property damage was covered by a policy in The Hartford.

Young Oswald was an officious young man, as every one in the firm's employ agreed.

He was always horning in where he was not wanted, and he had a highly exalted opinion of himself.

There were two partners in the firm, and when death claimed one of them the young man approached the surviving partner with whom he was not exactly what you would call a favorite.

"I am sorry, sir, to hear of Mr. John's demise, and I have come to ask you if you would like to have me take his place."

"Yes, I should, very much," was the sad reply, "if you can get the undertaker to arrange it." —*N. Y. Central Lines Magazine.*

Immense New Turbo-Generator Units Dwarf First Central Station Machine Installed 28 Years Ago

THE tendency in central station turbine design to concentrate more and more capacity into a single machine, and to trim down physical bulk to a point where the smallest amount of floor space is required, reached a new high-water mark in the recent installation of a giant 160,000-kilowatt turbo-generator at the Hell Gate Station of the United Light and Power Company, New York. This new turbine — among the largest of several very powerful two-unit machines now in operation — is remarkable not so much on account of its tremendous capacity, but because the designers, handicapped by being obliged to fit the machine into floor space originally laid out for a 30,000-kilowatt unit, managed to produce a machine with a turbine efficiency of 84.5 per cent., the highest yet obtained.

Growth of central station equipment to the point where the output from a single machine is sufficient to light a medium-size city must be regarded as one of the most remarkable mechanical achievements of the last quarter-century, for the transition first from reciprocating engines to small turbines and then to machines of Brobdingnagian proportions came with almost dazzling swiftness. In fact it was just twenty-eight years ago this month that the first turbine ever installed in this country for central station use was put into operation by the Hartford Electric Light Company of Hartford, Conn. (See Figure 1.) That 2000-kilowatt turbo-generator has long since been crowded out by larger members of its own family and is now on display in the museum of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa., but in the heyday of its glory engineers regarded it as little short of a mechanical marvel. Its output was at least twice that of any turbine built previous to that time.

Nowadays there is nothing very impressive about a machine of such relatively small capacity but at a time when central station generators were driven by reciprocating engines, a 2,000-kilowatt unit was something to conjure with; an engine of that rating was anything but a dainty piece of mechanism. The fact that the new turbine at Hartford occupied but 40 per cent. of the floor space taken up by a reciprocating engine of equal capacity and, in bulk, was a mere pygmy alongside one of the ponderous vertical engines then in use, gave engineers something to think about.

Large though the Hartford turbo-generator undoubtedly was for the era which produced it, a glance at Figure 2 cannot fail to show that in spite of a distinct family resemblance, the machine which was considered tremendous no longer ago than 1901 falls far short of matching its grandson in girth and stature. It would take eighty machines of the 2,000-kilowatt variety to do the work of the Hell Gate turbine, and if such a group could be gathered together and crowded side by side and end to end they would occupy a floor space of approximately 80 by 160 feet as against the 38 by 76 foot space which

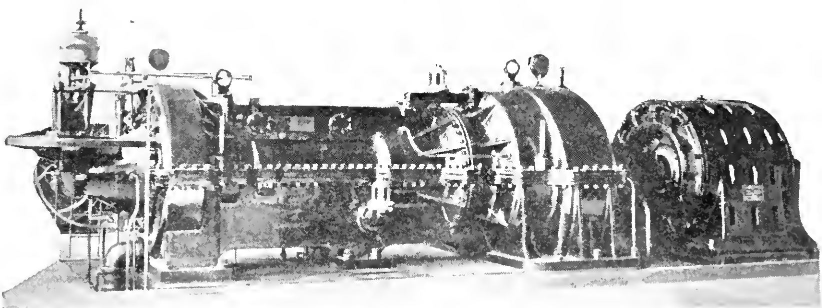


Figure 1.

serves the larger and more compact unit. The difference would, of course, be very much greater if aisles were left between the machines — as would have to be the case if they were spaced far enough apart to allow operation.

Just what an immense proposition the Hell Gate turbo-generator is can be judged from the fact that at full capacity it requires seventy-seven tons of steam per hour; 800 gallons of lubricating oil are pumped through its bearings each minute; and 13,000,000 gallons of cooling water an hour (enough to supply a city of 200,000 population) pass through the condenser. It is a cross-compound machine consisting of a high pressure unit running at 1,800 r. p. m. and developing 72,000 kilowatts, and a low pressure unit turning over at 1,200 r. p. m. and developing 88,000 kilowatts.

Another large two-unit turbo-generator was installed recently at the Brooklyn Edison's Hudson Avenue Station. This, likewise, is a cross-compound machine with high and low pressure units developing 50,000 and 58,000 kilowatts respectively. At Philo, Ohio, near Zanesville, the Ohio Power Company is erecting a triple compounded unit of 5,000 kilowatts greater capacity than the Hell Gate machine. The arrangement is somewhat different, however, for the high pressure and low pressure turbines and generators operate at the same speed, namely

1,800 r. p. m. The high pressure turbine drives one of the three main 53,000-kilowatt generators and each of the two low pressure turbines drives, in addition to a 53,000-kilowatt generator, a 3,000-kilowatt house generator coupled to the same shaft. Each of the three machines has its own coupled exciter and on the low pressure units there is an exciter for each house generator. One of the low pressure units was placed in operation several weeks ago, and since then the high

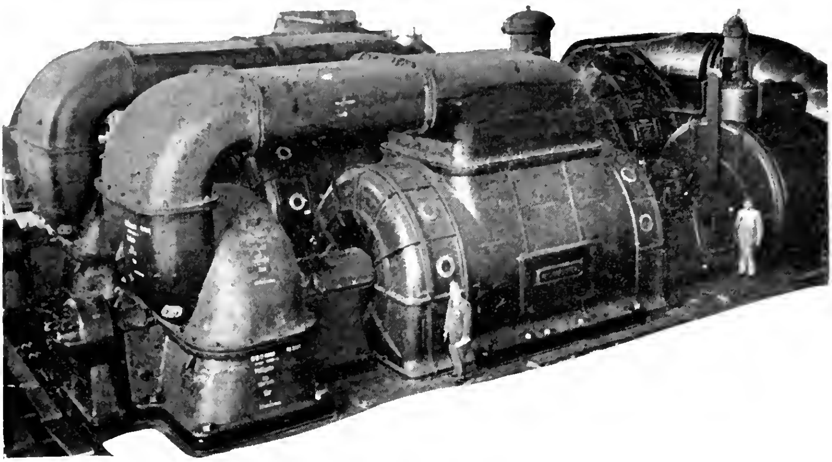


Figure 2.

pressure unit has also been placed on the line. By the time this issue of THE LOCOMOTIVE is distributed it seems likely that the entire machine will be in service and operated as one unit. Insurance on this big machine is carried in The Hartford.

Improvements in the metallurgical and manufacturing fields have been responsible in no small measure for the development of the turbine to its present status. Records at the British Patent Office covering the years from 1800 to 1850 contain many turbine inventions — including some of the principles now used — but apparently the limitations imposed by inadequate manufacturing methods and lack of metals embodying the characteristics necessary to withstand high speed, high temperature, and wear, kept the inventors from putting their ideas into practice.

The turbine is properly regarded as having its birthplace in Europe, yet as early as 1833 steam turbines of the simple "Hero" type were manufactured at Syracuse, N. Y., and used to drive sawmills. However, these early types were exceedingly wasteful of steam and as late as 1896 the turbine as a practical machine was virtually unknown on this side of the Atlantic. As a matter of fact, the first turbine installation of any size was at the Wilmerding, Pa., plant of Westinghouse Air-Brake Company where, in 1899, three 400-kilowatt units were put in operation. Running at full load, these machines required only about 12 pounds of steam per horse power hour. That was by no means a poor showing.

Such was the status of the turbine in the United States when the Hartford Electric Light Company, in 1901, made the historic installation which signallized the dawn of an era in which central stations throughout the country were to discard batteries of huge engines in favor of the newer and more compact type of prime mover.

Twenty-eight years have brought numerous improvements, of course, both in methods of manufacture and in more reliable detail design, yet most of the improvement in economy has been due to increased speeds rather than to any radical changes in principle. One of the factors which enabled manufacturers to bring turbine speeds up to the point where the best economy was obtained was the development of high-speed alternating current generators. Now, in cases of cross-compounding, the designers frequently use a higher speed for the high pressure unit, and a lower speed for the low pressure unit or units, thus reaping the economy that comes from using the speed best adapted to the pressure and volume of steam. Another factor which had an important influence in making possible the general application of the turbine as a prime mover was the development of accurately cut reducing gears. With this arrangement the machine was readily coupled to mill drives, to low speed direct current dynamos, and to the propeller shafts of steamships. On the whole, however, the turbine has found its biggest field of usefulness in central power stations.

Undoubtedly the turbine has not yet reached the limit in size and capacity, for even as we write this a 208,000-kilowatt machine is under construction. The day may come when the turbines which are now thought tremendous will appear small alongside some newer member of the family.

Failure of Hoist Motors

IT may surprise some to learn that motors used to drag cars up inclined tracks at mines or quarries are frequently damaged by overspeeding, yet experience has shown that such accidents are fairly numerous. Therefor, motors in this class of service, unless provided with adequate safety devices of an approved type, represent an unusually hazardous risk.

Although there are several arrangements of hoists in use, the ones most generally found are the two-car system and the one-car system. In the arrangement first named two cars are attached to the same hoist, one rising while the other descends. Sometimes each car has its own track and sometimes a common track is used with a passing switch half-way between the top and the bottom. The counter-balancing effect of the empty car going down reduces the amount of power required to haul the loaded car to the top and at the same time lessens the backward drag of the loaded car in case power interruption takes the pull off the cable. The one-car system has no such counter-balance so, of course, there is a greater tendency for the car to run backward in case of accidental power interruption. Nevertheless, in either case, to secure proper safety from this hazard, it is necessary to have powerful brakes which will set automatically the instant the power line is de-energized. Lack of automatic brokes, or brakes with insufficient holding power frequently result in extensive damage to rotor windings when power failure from any cause allows the car to drop downward and causes the motor to overspeed.

In most cases hoists are equipped with two brakes, one of which is hand-operated and the other automatic. Although designs vary in detail, in principle the automatic brake usually consists of a band which is gripped to a drum by powerful springs or weights. When current is "on," a solenoid holds the band away from the drum, but the moment the current is turned off the springs or weights set the brake instantly. In addition to this safeguard, most installations have limit switches to prevent overtravel of the car either at the top or the bottom of the track, and an overspeed relay which sets the brake if the motor overspeeds in either direction. Devices to guard against other accidental conditions which would endanger the apparatus are also in common use.

Naturally, the speed at which the operator can lower the empty car in a two-car system is limited by the speed at which the motor can haul the loaded car upward, but with the one-car arrangement the operator is sometimes tempted — especially if he is paid on a tonnage basis and his hoist is provided with no automatic brake — to send the "empty" back more rapidly than an intelligent regard for the safety of the motor warrants. This causes many unnecessary failures which could be eliminated if the apparatus were operated properly.

It is customary to drive the car downwards by reversing the motor.

As an induction motor can operate only from three to five per cent. above synchronous speed before it begins to send current back into the line, it serves as a very effective means of checking the speed of the car. If the operator hastens the descent of the car by shutting off the power — which he can ordinarily do when the hoist is equipped with no automatic brake — he is very likely to run into trouble. His judgment of speed may be poor, or the lining of the hand brake may be worn, with the result that the speed of the motor is increased to such an extent that the bands fly off and the windings fan out.

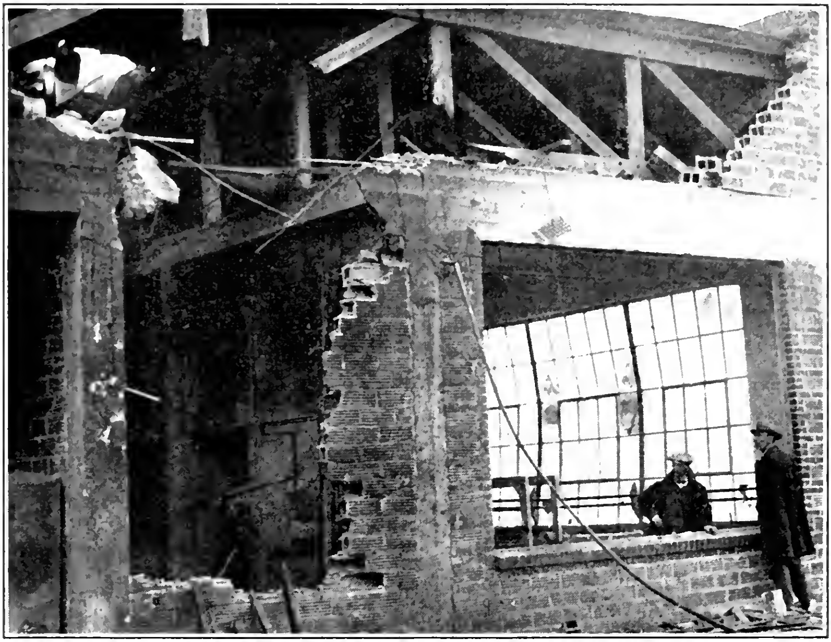
A specific example of another sort of motor abuse came to light recently in a two-car system where the hopper into which the cars discharged their loads sometimes became clogged. While the hopper was being freed it was necessary to hold a loaded car stationary on the incline. The brake on this particular hoist was not powerful enough to keep the car from slipping backward when the power was off, so it occurred to the operator that he could snub the car by giving the motor just enough current to keep the car from moving backward but not enough to move it ahead. After several such occasions the windings were found badly roasted. Not a few mishaps to hoist motors have occurred by reason of just such abuse.

Owner of New Factory Was Victim of Boiler Blast

LESS than two hours after the formal opening of his new plant — which represented the reward of years of work and saving — the owner of the sausage factory pictured here was killed by a steam boiler explosion that injured three employees and caused extensive property damage. In providing his new plant with the most modern equipment the owner spared neither effort nor expense, but unfortunately he failed to obtain boiler insurance. Had he done that, the condition responsible for the explosion might have been found and corrected by the insurance company inspector.

Coming to this country as an immigrant boy twenty-three years ago, the sausage-maker worked for years as a packing plant hand while saving up enough capital to start a small business of his own. Even this, he confided to friends, was but a stepping stone toward a greater goal. His ultimate ambition was to own a plant housed in a new building and equipped throughout with modern appliances. So it was a proud occasion when, in January, he entertained his friends at the new plant the night before the formal opening. Workmen had scarcely been assigned their places next morning when the tragic accident brought the venture to an untimely halt.

The boiler, a comparatively new one of the Scotch type, stood outside and about twenty feet to the rear of the factory building. When it exploded it went like a rocket through the rear wall and up through the roof, dropping back again into the building amidst a gang of workers. Fortunately, none of them was directly beneath it when it landed. The photograph is a view of the damaged building from the rear.



The boiler was used at the old plant only ten weeks before it was set up at the new location. Thus it is almost certain that deterioration could not have caused the failure. Nor was there any evidence to support the opinion that low water might have been the cause. In fact, the flue collapsed from the bottom, instead of over the fire where heat would have done the greatest damage in case of low water. From the distance the shell was thrown it seems apparent that there was plenty of water in it at the time, for a small amount would not have stored so much energy.

It was believed that the safety valve became inoperative, thus allowing a tremendous over-pressure to build up. According to a newspaper account, the valve was adjusted or repaired the night before the explosion.

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., April 1, 1929

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Furnace Explosion Coverage Now Available

A TENDENCY toward more general use of oil, gas, and pulverized coal as fuels has of late brought into prominence the danger of explosions due to the accidental ignition of combustible gas in the furnaces and gas passages of both power and heating boilers. Although such accidents are not ordinarily as destructive as a boiler explosion, so many of them have caused extensive property damage, loss of life, and plant shut-downs that there has been a growing demand on the part of boiler owners for insurance protection against them. To meet this demand The Hartford Company has arranged to write Furnace Explosion Insurance covering all direct damage (except that caused by fire) resulting from an explosion in the furnace, flues or other passages through which the gases pass from the furnace to the stack.

Heretofore such damage, caused not by steam pressure but by a force outside the boiler proper, has not been covered by policies of any of the steam boiler insurance companies. In thus extending its line The Hartford meets a need which has existed for some time and which promises to become even more acute as the use of oil and gas fuels increase.

Without doubt, the danger of combustion space and flue explosions is greatest where gas, oil, or pulverized coal is the fuel, but such explosions may occur with any fuel having a volatile content. As many firemen can testify by experience, improper use of the damper can cause the accumulation of unburned gas in the heating passages where, if enough air be present, the gas may detonate more or less violently Stoppage of an oil burner jet and the subsequent formation of vapor when the jet frees itself and sprays oil onto the hot brickwork of the furnace is another common cause of furnace explosions. Even the less violent of gas explosions usually hurl doors from the furnace and blow soot over the premises; they may even damage the setting or the boiler itself and, in some cases, injure attendants. An accident of this sort may be extremely serious. Recently a furnace explosion at a power plant killed one man, injured several, and caused $25,000 property damage. At an oil mill the same kind of an explosion forced a two-weeks' shut-down and damaged property to the extent of $2,500.

In the past the expense incurred in this way has, of necessity, been borne by the plant owners. The new Hartford Company policy is designed to take the burden from their shoulders.

New Chief Inspector for Cleveland

MR. L. T. Gregg, who for nine years has been Chief Inspector for the Company at its Cleveland Branch Office, has accepted the position of Chief Engineer for The Boiler Inspection and Insurance Company of Canada, an associate of The Hartford organization. He undertook his new duties on March 1.

Mr. Gregg entered the Company's employ in 1911 and while serving as an inspector demonstrated qualities which brought advancement to the position of Assistant Chief Inspector and, later, to that of Chief Inspector. In recognition of a well-deserved reputation as an authority on engineering matters he was made a member of the Ohio Board of Boiler Rules and served that body until his recent transfer to Toronto.

Mr. John F. Hunt has been appointed to succeed Mr. Gregg as Chief Inspector at Cleveland, a post he is well fitted to hold by reason of marked administrative ability and a thorough technical understanding of the work. Mr. Hunt came with the Company in 1921 and was made Directing Inspector six years later. The Company — and the Cleveland Department, in particular — is fortunate in having him available to take over the important duties of his new post. He has already been named to serve in Mr. Gregg's place on the Board of Boiler Rules.

Taps from the Old Chief's Hammer

"YOU say a belting salesman advised them to do it?" spoke up the Old Chief, who had been rummaging through a desk drawer for pipe and tobacco while his assistant explained the reason for a boiler accident down at the Juniper Company plant.

"Yes," assented Tom, "a while ago the front end of No. 2 boiler settled so far they couldn't drain 'er through the blow-off connection. McCreery, the manager, was just getting ready to have a gang of masons straighten things up when in walks Nemesis in the guise of a salesman and shows McCreery how much cheaper and quicker it would be just to move the blow-off connection to the low end. Of course, that wouldn't have been so bad if they'd only bricked in the pipe so as to give it a little protection against the heat, but they never thought of that. The first thing they knew the pipe burned through and emptied the boiler. It was lucky that fireman wasn't scalded to death."

"It sure beats all," the Chief declared, "how some fellows are as hard as nails in swinging a business deal and as soft as a vanilla milk shake when it comes to swallowing 'free advice'. Some of 'em who won't take a silver dollar from a parson without testing it with their teeth will stake real money on the opinion of a stranger who hands out a gratuitous suggestion on how to run their power plant. By the way, did I ever tell you about the planing mill owner and the free advice he got from three oil drummers?"

"I don't recall it," said Tom, who usually found the Chief's reminiscences highly entertaining.

"Well," declared the boss, settling back and lighting his pipe, "he owned and managed a medium-sized mill and as far as business acumen went I guess he had a fair share. But what he didn't know about machinery would have filled a book. The worst of it was he didn't go to the right source for information. Instead, he saved up all his technical problems for the oil drummers, who used to make his plant a regular port of call.

"Everything considered, he got along pretty well with his advisory board until his business expanded so much that he had to put in more machinery and get another engine to run it. The man who installed the engine told him that two boilers weren't going to run both engines, but the owner suspected that this was an attempt to sell him an extra boiler which he didn't need, so he collared the first oil saleman that called and asked him how he could get the extra steam without buying another boiler. I don't know whether the drummer really thought he knew something about boilers or just didn't want the old man to find out how little he did know. Anyway, he didn't mind giving a good customer the benefit of his advice, such as it was, so he recommended knocking out the center wall between the boilers, leaving just enough for support. By the time this was done the drummer had departed. Consequently when the old man saw that the remedy hadn't produced the desired effect all he could do was to fret and fuss around until the next drummer called.

" This second fellow was generous enough not to criticize his competitor's recommendation. Instead, he pointed out that while the change might not have increased capacity it had undoubtedly improved economy. The only sure way he knew to make a boiler give twice as much steam was to put a set of grates at the rear, and fire from both ends at once.

" That sounded reasonable, so the boss had this double-ended arrangement rigged up, only to find, after a few days' trial, that it didn't work. In desperation, he fairly pounced on the third drummer before the poor fellow had a chance even to set down his sample case. This one proved to be the prize of the lot. After a lot of questioning, he made a rough mental estimate of the height of the chimney, the B. t. u. content of the fuel, and size of grate and several other such factors, and then told the owner point-blank that the trouble was merely lack of draft. The best way to fix that, he said, was to cut holes either in the base of the chimney or in the flue.

" To the old boy's credit I've got to admit that he was skeptical. It wasn't until he had been confused by a lot of figures and sketches that he allowed the traveling man to overcome his horse sense.

" Condensed into a few words, the salesman's theory was this: In order for the chimney to accommodate the extra air entering through the 'booster' holes the flue gases would have to travel upward at a faster rate. That, in turn, would create a greater suction through the grates and pull just that much more air up through the firebed. Sort of an endless chain proposition, you see.

" Well, that night the boss had the gang chisel out two holes, about two feet by three, on opposite sides of the flue, hoping that next morning the plant would be running full blast. You can imagine what happened. Until then old Job himself had nothing on those boilers when it came to patience, but that last wallop landed below the belt and knocked them completely out."

" How did you come to hear about it?" queried Tom.

" Oh, I just happened to be going through that territory and heard the story from the engineer of another plant. Naturally, I was curious to see such a strange layout, so I dropped around to call on the old fellow. Of course, I hemmed and hawed a bit before I said anything one way or the other, for I figured that if I was in the old man's shoes I'd have me a piece of pipe right handy for the next man that tried to tell me anything about boilers. He was a good scout, though, and when I told him that no device or arrangement known to man would make that pair of boilers do the work he expected of them he said he'd just about reached that conclusion, too. After I spent the day going over things and showing him how to straighten out the mess his drummer friends had got him into he and I got real friendly."

"How long did it take him to find out that you were a boiler inspector?" put in Tom, who had been wearing a broad grin as the Chief's story progressed.

"Not long, son. When I left there that evening I had an application for insurance on both boilers and flywheels.

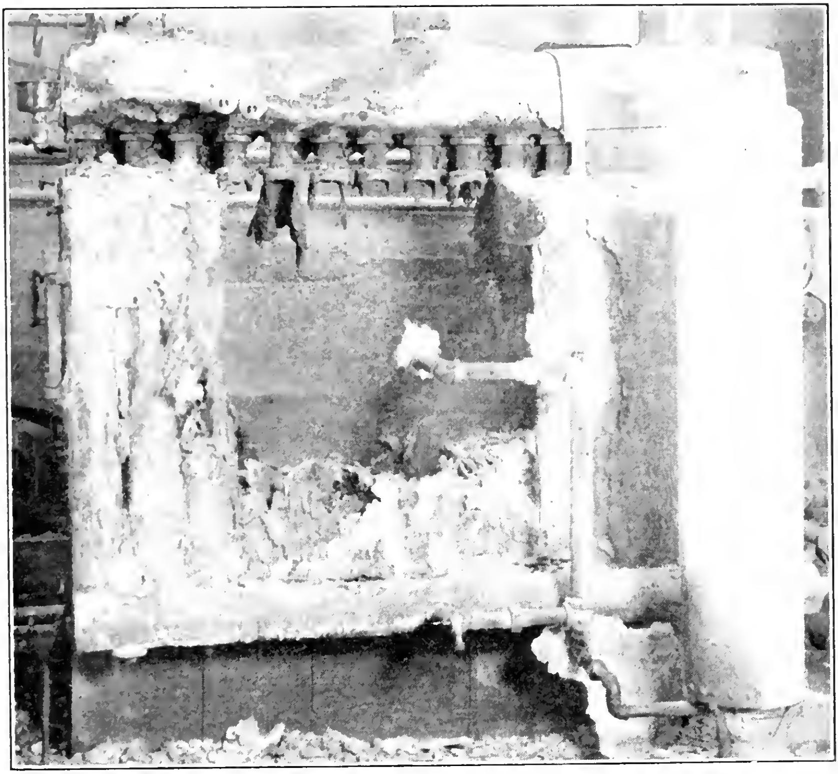
Cast Iron Boiler "Burned Up" by Oil Flame

HAD the cast iron steam heating boiler pictured herein been subjected to the flame of some immense blow-torch it could scarcely have been ruined more completely than it was ruined — accidentally, of course — by the heat from its own oil burner. So thoroughly was this fourteen-section boiler melted down that nothing remained of the six middle sections except a pool of molten iron in the ashpit. A majority of the other sections were partly melted; all were so badly burned and cracked that repair was out of the question.

As the photograph plainly shows, the only traces left of the middle sections were the icicle-like fragments of metal clinging to the steel nipples which connected the sections to the top manifold.

The boiler was used to supply steam for process work and heating at the plant of the American Abrasive Company, Westfield, Mass. The oil burner was of the gun type, manually controlled, and had no automatic regulation except a device which partly closed off the oil supply valve when steam pressure reached twelve pounds, and opened the valve wide again when pressure dropped to a pre-determined minimum. At seven o'clock on the night of February 3rd, which was Sunday, the attendant noted that the burner was working normally and that there was plenty of water showing in the gauge glass. Some time between then and seven o'clock next morning, when the first employee entered the building and heard the alarm bell which had been set ringing by the sprinkler system, the boiler went dry and was ruined.

In common with many other costly accidents, this one was due to a comparatively trivial cause. A plug dropped out of a two-inch opening in one of the radiators connected to the system, thus allowing all the water in the boiler to escape through the aperture in the form



of steam. Had the boiler not been set in a pit lined with cement the chances are it would have set fire to the factory. Heat was so intense that it melted a sprinkler head twenty-five feet away.

From the picture it is apparent that the boiler had to be scrapped. The loss was covered by a Hartford Company policy.

New Cutting Alloys to Speed Manufacturing Processes

NEW cutting alloys capable of removing in a given time greater amounts of metal than is possible with the best cutting tools now available seem to promise decided changes in machine tool design and shop practice. In fact, so keen and tough is one of these alloys, called

" carboloy ", that its sponsors claim it will cut manganese steel and even turn screw threads on rods of such hard materials as glass and porcelain. If such be the case, the importance of this new development can scarcely be overemphasized. Not only will it make possible the machining of materials which now have to be ground, but it will allow manufacturers to set new production records.

No doubt the art of combining two or more metals in such a way as to obtain an alloy with the twin qualities of toughness and hardness was practiced to some extent almost as far back as the time of Tubal Cain, that " instructor of every artificer in brass and iron " who is supposed to have lived in the seventh generation after Adam. It is certain that for many centuries the successors of this pioneer metalsmith knew nothing of the crystalline arrangement of metallic interiors and understood imperfectly, if at all, the process with which they were dealing, yet they produced bronze for weapons and tools by making use of fundamental principles which have held good from that day to this. These new cutting alloys represent the latest step, although doubtless not the last one, in a train of invention and discovery which began at least as far back as the first bronze.

Carboloy consists of tiny crystals of tungsten-carbide, one of the hardest of all chemical compounds, embedded in and between the crystals of metallic cobalt. By itself cobalt is not particularly hard, but it does have the quality of extreme toughness when properly treated. Mixed with tungsten-carbide, it gives a material which has both toughness and a keen cutting edge.

Any metal, viewed under the microscope, appears as a multitude of tiny crystals. When metal bends, these crystals slide and slip over one another and, in some cases, parts of a crystal may even slip on a plane between adjacent members of the crystal structure. Stiff metals — those which will not bend — are metals in which the crystals resist any effort to make them slip. Brittle zinc and cast iron are that way; both will snap in two rather than yield.

Copper is just the opposite; it may be bent double without showing signs of fracture. Yet bronze, rather a hard metal, is nothing more than this soft copper to which tin has been added; steel is made from soft iron by the addition of carbon; duralumin is merely aluminum hardened by copper. In each case the hardening agent takes the form of tiny crystals which lodge in the spaces between larger crystals of the soft metal and prevent slippage just about the same as emery dust would bind a shaft in its bearing, or a layer of ashes prevent the shoe-sole from slipping on ice.

In the tungsten-carbon-cobalt mixture the tiny grains of intensely hard tungsten carbide not only provide resistance to slippage by getting in between the crystals of cobalt, but, too, they give the metal an extremely hard cutting edge just as the copper disc used for cutting stone is made hard by impregnating its edge with diamond dust.

Dependence on Surface Cleaner Was Costly

An accumulation of sediment in the bottom of a horizontal tubular boiler near the blow-off connection caused the rupture shown in the accompanying illustration. The engineer was surprised to learn that sediment was at the root of the trouble, for he was softening the

feed water by means of a lime and soda ash treatment and had installed a surface cleaner or " skimmer " which he supposed would keep the boiler free from sediment without the necessity of periodic internal washing. After operating in this way for three months the boiler ruptured.

The cause was readily apparent to a Hartford Company representative. Not only had sediment collected on the bottom of the shell, but there was a deposit two inches thick on top of the tubes directly in front of the cleaner.

The Hartford representative succeeded in showing the engineer that the primary cause of such an unusual amount of sediment was mishandling of the water softener, from which sludge was carried over into the boiler. This fault was remedied in time to prevent damage to two other boilers in the battery. Needless to say, it was not hard to convince the engineer that in spite of the water softener and the so-called surface cleaner, his boilers needed internal washing from time to time.

German Court Renders Decision on Diesel Explosion

FIVE men were burned to death and nineteen others were severely injured, following a crankcase explosion on board the motorship "Kungsholm," immediately after the vessel had completed her trial trip in the North Sea, on Oct. 14, 1928. The German Marine Court, which subsequently sat on the case, has recently rendered its decision, holding that no one was directly responsible for the accident. The following facts concerning the disaster were established by the court:

The ship is equipped with two double-acting, four-stroke-cycle, six-cylinder Burmeister & Wain Diesel engines. The explosion started in the crankcase of the starboard engine, but did not disable it, as both engines continued to run for six minutes following the explosion. The return trip to Cuxhaven was completed with the port engine.

The investigation showed that a hot bearing developed in an idler bushing of the valve gear chain drive. The bronze bushing locked itself solidly to the shaft, causing the pins which held it in place to shear, so that it rotated with the shaft on the bearing surface. The heat developed by the resulting friction vaporized the lubricating oil. The first explosion occurred only after a flame had propagated itself from within the valve housings into the crankcase in which the vaporized oil and air formed an explosive mixture. All witnesses testified that this explosion was not particularly severe. The result was, however, disastrous, as it blew out two access doors from the crankcase, which allowed the vaporized oil to escape and to ignite into a thin but intense flame.

This flame was diverted by striking a steel bulkhead and instantly propagated itself in an upward winding path through the entire engine room, finally exploding with a severe detonation under the skylight, which was hurled from its fastenings. No damage was done by the explosion in the engine room. The medical examination showed that the unfortunate fatalities and the injuries to the survivors were due entirely to severe burns.

The question arose as to whether the explosion in the engine room had been caused or intensified by the presence of benzine vapor. It was shown the benzine had been used in cleaning the fuel-oil strainers before the trial trip was started, but that no benzine was stored in the engine room.

The examining experts differed in their opinions, some assuming that benzine vapors had caused the second explosion, while others traced the origin of the thin flame to the ignition of lubricating oil vapor which was forced out into the engine room by the first and less severe explosion.

The verdict of the court held no one responsible for the accident, stating that no proof of negligence had been shown, and that there was no definite evidence of the explosion having been caused or intensified by the presence of benzine vapors. — *Power*

Erie City Completes 80,000th Boiler

THE Erie City Iron Works, one of the many large boiler shops in which The Hartford Steam Boiler Inspection and Insurance Company maintains a shop inspector, recently turned out its 80,000th boiler. It was back in 1881 that The Hartford Company first was called on to furnish boiler shop inspection at the Erie City works, and at no time since then has the service been interrupted. This, incidentally, is the longest period of consecutive shop inspection service rendered by this company.

The success of the Erie City organization, of which proof is furnished by the 80,000 boilers sent to serve industries in all parts of the world, prompts us to extend our congratulations on this occasion.

Hartford Inspector Saves Motorist's Life

Fortunately for H. L. Maybach of Detroit, Michigan, Hartford Company inspectors seldom allow such things as sub-zero temperature and snow drifts to keep them from their appointed rounds. According to the *Berkshire County Eagle*, a newspaper published at Pittsfield, Mass., Maybach was motoring over the Mohawk trail on January 29th when his car stuck fast in a snow-bank. While endeavoring to dig it out he succumbed to the cold and lost consciousness. Without doubt he owes his life to the fact that Electrical Inspector H. T. Bailey, who was bucking through the deep snow on his way to make an inspection, found him and carried him to a physician in the nearest town.

NEITHER HAVE MOST OF US

"Gentlemen: I have neither the mind of Shakespeare nor the back of a bull, but I desire employment."—Want Ad. in the Milwaukee Journal.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1928

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 599,693.18
Real Estate		300,423.66
Mortgage and collateral loans		1,296,386.75
Bonds and Stocks		17,475,629.38
Premiums in course of collection		1,288,819.44
Interest accrued		151,132.41
Other Assets		18,205.76
Total Assets		$ 21,130,290.58

LIABILITIES

Reserve for unearned premiums		$ 8,619,119.83
Reserve for losses		377,212.80
Reserve for taxes and other contingencies		1,894,758.35
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,239,199.60	
Surplus to Policyholders,		**$10,239,199.60**
Total Liabilities		$ 21,130,290.58

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 **Charter Perpetual**

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TORONTO, Canada, . . . Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

Protection Against *Furnace* Explosions

To meet a growing demand on the part of boiler owners for insurance protection against explosion due to the accidental ignition of gas in the furnaces or gas passages of boilers, The Hartford Steam Boiler Inspection and Insurance Company now offers its clients

Furnace Explosion Insurance

This new policy covers all direct damage (except fire damage) resulting from an explosion in the furnace of a boiler, or in the tubes, flues, or other passage used to conduct gases from the furnace to the chimney.

Existing HARTFORD COMPANY policies can be endorsed to include Furnace Explosion Insurance, and it can be included in new policies at extremely reasonable rates. THE HARTFORD Use and Occupancy Insurance may be made to apply on this as on its other forms of failure or breakdown coverage.

For Details, Fill in and Mail this Coupon to its Nearest Branch Office

- -

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

GENTLEMEN: Please have the agent supply me with further information regarding Furnace Explosion Insurance. I understand that this will not obligate me in any way.

Name ....

Address ....

....

Vol. XXXVII No. 7 July 1929

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Exploding Air Tank Crushes Shack, Kills 7 Men

SEVEN men were killed and ten were seriously injured at the quarry of Stone Mountain Granite Corporation near Atlanta, Georgia, on February 22, when an air tank head blew out and crashed through the timekeeper's crowded office. Four of the victims were dead when fellow workmen pulled them from beneath the wreckage; three died on the way to a hospital. The photograph shows the remains of the small wooden building which was demolished as completely as though it had

been bombed. The tank was located about 20 feet away and was pointed directly at it.

Air for the pneumatic tools at the various workings in the quarry was supplied by a compressor located in a central power house from which pipes led to perhaps a dozen receiving tanks placed at strategic points throughout the quarry. The tank that let go was one of these storage vessels. It was 66 inches in diameter, 16 feet long, and was made from the shell of a horizontal tubular boiler. The shell was 7/16″ thick and had a double-riveted continuous lap seam. Just how long the vessel was used as a boiler is not known, but fifteen years ago the tube sheets and tubes were taken out and bumped heads substituted. From that time on the tank was in almost daily use under air pressure of about 90 pounds.

Five-sixteenths inch plate was used for the heads, which had an extremely shallow bump and a short radius at the turn of the flange.

These details are apparent in the illustration showing the head that was left intact by the explosion.

On the morning of the accident a short crack appeared at the knuckle of a head flange. Pressure was taken off immediately and the repair gang set to work welding the crack. After a test for tightness pressure was again turned on and the tank lasted throughout the afternoon without showing signs of leakage. The quitting whistle had sounded and workmen were "punching out" on a time clock in the shanty when the tragic accident occurred.

An examination of the head revealed that, with the exception of the place where the welding was applied, the flange showed no evidence of the existence of an old crack. From all appearances the metal gave way simultaneously around the entire circumference of the head. Apparently lack of sufficient thickness and depth in the bumped head allowed bending at the flange as the head " breathed " in and out with the variations in pressure. Eventually this flexing weakened the flange to the point where it gave way.

Furnace Explosion Causes Extensive Damage

AN EXPLOSION of oil vapor that had accidentally accumulated in the heating passages of an oil-burning heating boiler caused extensive damage at the plant of Fashion Hosiery Mill Inc., Boyerstown, Pa., a few weeks ago. The oil vapor detonated so violently that it blew off furnace doors, demolished the masonry foundation of the boiler, and badly damaged the base of the brick chimney. In addition, the heavy furnace room doors were wrenched from their hinges and two steel-framed windows were torn from the casements. Property damage was somewhat over $2,000.

Furnace Explosion insurance, a recent addition to The Hartford line, is designed to protect the boiler owner against losses from accidents of this kind. Such coverage may be included in new boiler policies at very reasonable rates or may be added by an endorsement to existing policies at slight additional cost.

Important Points *in the* Maintenance *and* Safe Operation *of* Cast Iron Steam *and* Hot Water Boilers

The following article, which undertakes to present and discuss as many as possible of the items necessary for the proper operation and maintenance of cast iron boilers, is based largely on a card* of "Rules for the Operation of Cast Iron Steam and Hot Water Boilers" recently prepared by this Company for distribution among those of its assured who use this class of equipment. Where, for conciseness, the card was obliged to omit lengthy discussions of reasons for certain recommendations, the article endeavors to go into these points a little more fully.

CAST iron boilers are damaged by overheating resulting from low water perhaps more frequently than by any other condition, so it is extremely important to keep heating systems free from leaks. The loss of water or steam from any part of a system causes a steady lowering of the water level in the boiler that, unless watched constantly, may cause damage by uncovering parts of the metal in contact with hot furnace gases.

Before a boiler is laid up for the summer the person in charge should go over the system carefully and note all points needing repairs. Before the boiler is put back into service again he should make another check-up to see that these repairs have been made.

Starting Up a Steam System

The first step in getting a steam heating boiler ready for service is to fill it with water until the gauge glass is almost full. Then look inside the furnace and around the outside of the boiler for signs of leakage. If water is escaping, even in small quantities, notify the boiler inspector. Pay especial attention to the return pipes, for although they may not have leaked when the boiler was laid up, corrosion may have eaten through them during the summer.

If everything is satisfactory, open the drain cock or valve at the bottom of the gauge glass, thus permitting water to drain out of the glass. Then close the cock and note whether the water returns promptly to its previous level. If so, the connections between the gauge glass and the water column and between the water column and the boiler are clear; if the water is slow in returning to its former level some or all of these connections are blocked up and in need of cleaning. This should be done before going any further.

The importance of clear connections to the gauge cannot be overemphasized, for unless there is free communication between the gauge

* This card may be obtained on application at any of the Company's Department Offices.

and the boiler the former will certainly not indicate the true water level. When the gauge is functioning properly the next step is to investigate the trycocks. They should be probed clean with a piece of soft wire if water does not flow through them freely.

In steam systems the only safeguard against overpressure is the safety valve, so this should be examined and tested thoroughly. Inoperative safety valves have caused many disastrous explosions which might have been prevented had the operator investigated the condition of the valve at frequent intervals.

The fact that heating boilers may go for months or even years without the pressure rising high enough to "pop" the safety valve gives rise to the possibility that the valve disc may stick fast to the seat. Other parts, likewise, may be affected by corrosion during a long period of inactivity with the result that free functioning of the valve is impossible. Usually the safety valve is provided with a try lever by which a person can find out whether the valve opens freely. Whenever a faulty safety valve is encountered the boiler inspector should be notified at once.

Starting the Hot Water System

In getting ready to start up a hot water system care should be taken to see that all necessary repairs have been made. Then fill the boiler and system with water to the proper level as indicated by the gauge glass on the expansion tank, the overflow pipe from the expansion tank, or the altitude gauge on the boiler. Look over the boiler for leaks and make sure, by opening radiator cocks, that all air is discharged from the system.

In this type of heating system the pipe leading to the expansion tank, the tank itself, and the overflow pipe take over the function of the safety valve on a steam boiler. For that reason they should be investigated carefully. These parts must be free from obstruction if they are to fulfill their purpose of limiting the pressure which can build up within the boiler. Valves are unnecessary in either the riser or overflow pipes and must not be used. On some installations there is a diaphragm relief valve in the pipe leading to the expansion tank to guard against overpressure resulting from the accidental stoppage of either this pipe or the overflow pipe. Although such a valve is an extra precaution its use is not general.

Lastly, after the points mentioned above have been investigated and before either a steam or hot water boiler is ready for firing, the operator should test the damper regulator to make sure it is in order. Chains should be connected to the lever and all parts should work freely.

Starting a Cold Boiler

Be sure the boiler or system is filled with water to the proper level. If there are any valves in the main or return pipes make certain they are open before starting a fire. If, for any reason, it is necessary to close off a part of the system, be sure that at least one line of piping (main and return) is open to permit circulation of steam or hot water.

Build a fire and raise the steam pressure or water temperature gradually. Remember, there is hot furnace gas on one side of the boiler metal and cold water on the other. Forcing a fire before the water has heated up and established circulation will almost certainly crack the metal by setting up stresses due to unequal expansion. Watch the water level carefully in steam boilers and, if necessary, admit more water to keep the gauge glass almost full. After the system is fully operating excess water can be drained off until the gauge glass is half full. Unless there is plenty of water in the boiler at the start the level may drop far enough to uncover parts of the heating surface when a portion of the water is turned into steam and goes out into the system.

Regular Operation

In the morning, or at any other time when there has been a slow fire, do not force the fire, but bring it up slowly so that the boiler will not be overheated before there is good circulation of steam and water through the heating system. Before doing so, however test the water gauge glass, the safety valve, and the damper regulator as directed under "Getting Ready to Start". Naturally, the daily test of the safety valve will have to be dispensed with in cases where the valve is not equipped with a try lever.

A careful watch should be kept at all times to see that the gauge glass is at least half full. If there is difficulty in maintaining the level at that height the boiler inspector should be notified. This is important. Neglect of this point will almost certainly result in cracked sections.

Whenever it is necessary to add water to a cast iron boiler do so very slowly, and at a time when the boiler is not steaming rapidly. Should leakage develop in the furnace or on the outside of the boiler, or anywhere in the return lines, notify the inspector immediately. If the leakage is so serious that it is difficult to maintain the proper water level, proceed as directed under "Low Water", except that the boiler should not be fired until the inspector approves.

Low Water

If at any time the water should go out of sight in the gauge glass, do not add water until the boiler has been allowed to cool. The inexperienced operator, confronted by this condition, frequently violates this rule and cracks the boiler by putting cold water in contact with the overheated metal. The proper procedure is to cover the fire with ashes or coal, shut the ashpit door or damper, and open the firedoor and chimney damper. In this way the fire is deadened and a stream of air is drawn through the fire door to cool the boiler gradually. After the boiler has cooled, water can be admitted slowly until it is up to the proper level. Then if no leakage has developed, steam pressure can be raised again.

The practice of drawing hot water from a heating boiler for washing purposes is a bad one and should not be tolerated. Besides the likelihood of damage by reason of lowering the water level and then putting in cold water to bring it back to normal, the procedure is undesirable on another score. Fresh water carries scale-forming materials into the boiler; if make-up water be added at frequent intervals so much scale may collect that it will interfere seriously with the free transfer of heat through the metal and into the water. Such a condition is not only inefficient but it is conducive to overheating and cracking of the metal.

Soot on the fire side of the heating surfaces also has this insulating effect, and cuts down the efficiency of the boiler. For this reason particular care should be taken to keep the heating surfaces as clean as possible. Likewise, flues and connections should be kept clear of soot, so as not to obstruct the free travel of the gases.

Blowing Down

Muddy water or dirt in the system will cause foaming. When this condition is encountered the fire should be allowed to burn out. After the boiler has cooled it should be drained and refilled with fresh water. If this operation does not stop the foaming it should be repeated, but then if foaming still persists the boiler inspector should be asked for further instructions.

Laying Up a Boiler

The first step in laying up a boiler, after letting the fire burn out and giving the boiler time to cool down gradually, is to clean out the furnace, heating surfaces, and flues as thoroughly as possible. It is impossible to overstress the point that no boiler should ever be allowed to go through the summer with soot and ashes in the furnace and flues, for the sulphur present in the soot from practically all kinds of coal combines readily with moisture to form sulphurous acid, a very corrosive agent.

Opinions differ on the question of whether it is better to drain the boiler or leave it full of water during the off-season. Each method has advantages as well as disadvantages, but this company favors leaving the boiler full, for on the whole the advantages of that method seem to outweigh those of the other.

The chief disadvantage of leaving water in the boiler lies in the fact that it tends to chill and condense moisture from the air on the furnace side of the heating surfaces — a condition that has been known to crack boilers in the off-season by promoting rust growth between sections. However, this may be avoided by taking down the smoke pipe, and in that way preventing or at least cutting down the passage of air through the boiler. One advantage of leaving water in the boiler during the summer is that it prevents the drying out of packing between sections, a thing which may occur when the boiler stands empty for a long period. Another is that it lessens the probability of sections being cracked in case anyone uses the furnace during the summer months as an incinerator for rubbish. Taking down the smoke pipe, of course, discourages this practice.

As to draining a boiler before laying it up, the two outstanding advantages are that it offers a good opportunity to purge the system of sludge and dirt and eliminates the condensation of moisture on the heating surfaces. The disadvantages are those mentioned above, namely that packing may dry out, and sections may be cracked if some thoughtless person undertakes to use the furnace for the disposal of rubbish.

Bursting Cylinder Head Kills Two

Two men were killed instantly and four were severely injured at the plant of Chickasha Cotton Oil Co., Ryan, Oklahoma, on January 23, when the breaking of the piston rod of a large Corliss-type engine allowed the piston to strike the cylinder head with such a terrific impact that the latter was broken to fragments and bolts were driven into a brick wall like pieces of shrapnel. The piston emerged from the cylinder and came to rest about six feet away.

A remarkable feature, according to a report of the accident, was that the two victims were not struck by flying fragments, but were crushed against a wall by the blast of escaping steam. Those who were injured were badly scalded and cut.

The piston rod had been in use about two years.

A CORRECTION

In the last issue mention was made of a flywheel explosion at the Davenport, Iowa, plant of French & Hecht, Inc. The address thus given was incorrect, for although that company has a plant at Davenport, Iowa, the accident occurred at its plant in Springfield, Ohio.

Heating Boiler Explosions Cause Extensive Damage

ALTHOUGH it is generally understood that heating boilers and hot water supply tanks can and sometimes do explode with considerable violence, the average householder who has never actually seen the result of such an explosion is sometimes inclined to

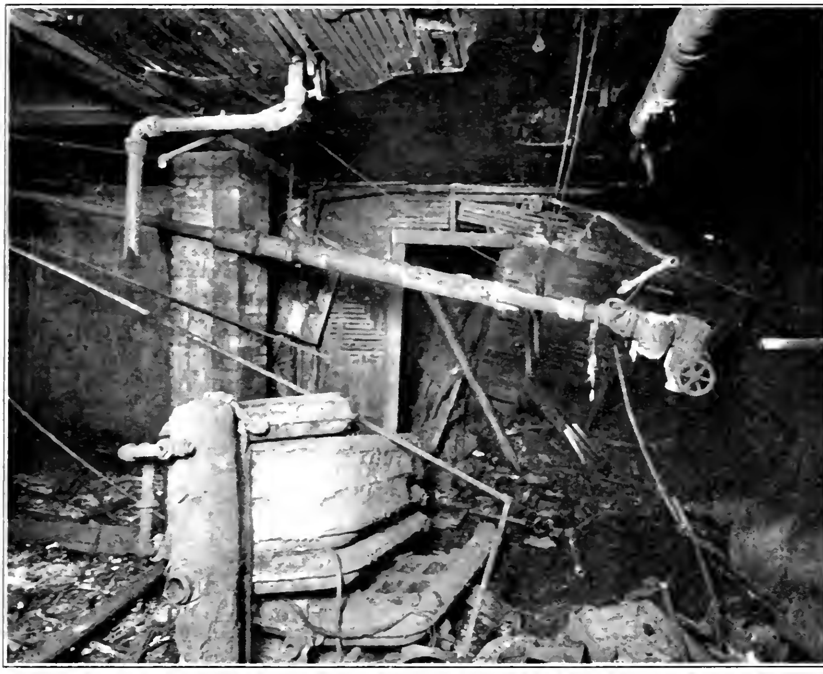


Figure 1

discount claims as to the potential destructiveness of these commonplace vessels. The three cases presented herewith, which were selected as typical of other explosions occurring during the winter, are convincing proof that the low pressures ordinarily involved in house heating equipment by no means render them immune to accidents of a very destructive sort.

Taking advantage of a lull in business shortly after Christmas the proprietor of a small hotel in Cleveland, Ohio, banked the fire in his cast iron steam heating boiler and left town for an overnight visit. During his absence the weather turned cold and some of the water in the lines froze solid. On his return he found the building too frigid for comfort, so he immediately "broke" the bank, opened the drafts, and went out to do some shopping while the building heated up. Evidently the boiler made steam faster than an old-fashioned lever-type safety valve with a ¾″ diameter opening could relieve it, for the boiler exploded, demolished partitions and stairways in the basement, and damaged walls and furniture on the floors above. Figure 1 is a view of the basement shortly after the accident.

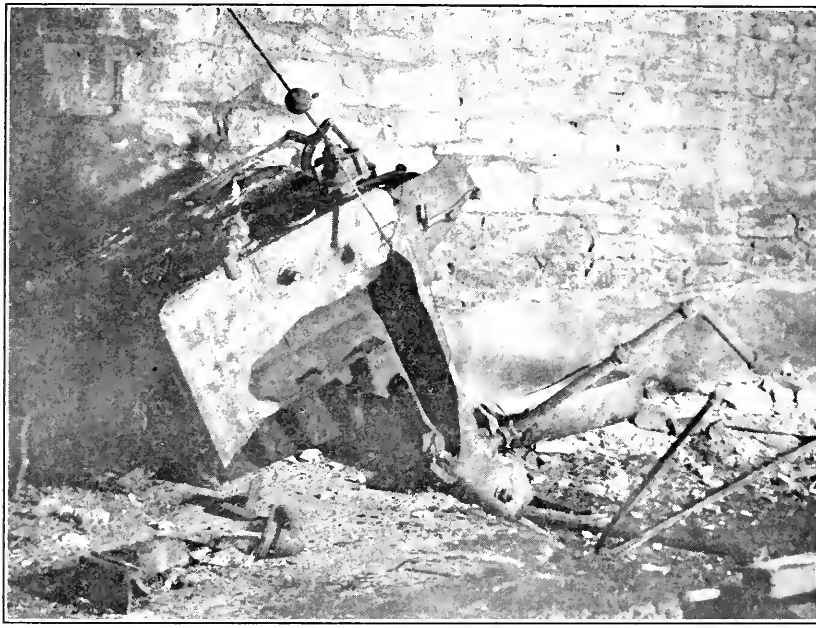


Figure 2

Figure 2 shows the wreckage of a cast iron steam heating boiler which exploded in the basement of a store in St. Louis, Mo. In this case it was fairly evident from the broken gear segment in the steam gauge mechanism that enough pressure had built up to force the gauge hand solidly against the pin at the limit of its travel, but the boiler itself, the safety valve, and the various other attachments were so badly damaged that they offered no clue to the probable cause of this over-pressure. The force of the explosion lifted and cracked a concrete floor overhead, broke the plate glass show windows in the store, and in general created so much havoc that the stock had to be moved to another location. Damage was estimated at $4,000.

At 2 o'clock of a Sunday afternoon in March one of the tenants in an apartment and store block adjoining the Y. M. C. A. in Southbridge, Mass., lighted the gas heater in his bathroom and, through oversight, neglected to turn it off after he had obtained enough hot water for a bath. In the early hours of the morning the storage tank let go and blew away the corner of the building. The blast broke windows and rocked houses for several blocks around. Telephone lines were so badly damaged that service in that neighborhood could not be reestab-

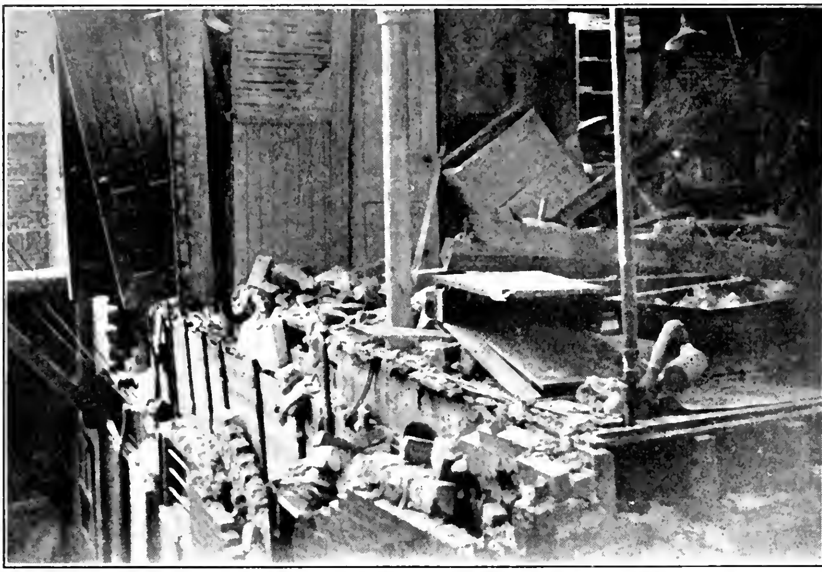


Figure 3

lished until late that evening. Figure 3 shows the wrecked portion of the building.

The 12″ x 48″ tank was of copper, made in two parts soldered together at the girth seam by means of a copper band. Lack of a relief valve, and the fact that the meter prevented pressure from backing out into the mains was advanced as an explanation of the accident.

ONE OF THOSE MYSTERIES

Although we can't quite agree with the Archbold, Ohio, *Buckeye* that a flywheel explosion is something that happens only once in a lifetime, neither can we bring ourselves to censure too severely the reporter who was so thorough and conscientious that he read up on "mechanics" and "natural philosophy" before offering the following comment on a recent flywheel explosion in his town:

"We read of such things in mechanics and natural philosophy. One authority calls it centrifugal expulsion or centrifugal disintegration. Such things happen so rarely that one will probably not encounter the second case in a lifetime."

Thought Corroded Staybolts Were a New Design

(By Inspector T. F. CONNERY, Philadelphia)

NOT long ago I received an order through the mail from one of our assured in a distant town to inspect the boiler of a track locomotive they had just purchased. Owing to previous appointments for that day it was well along in the afternoon before I reached the assured's office and found out that the locomotive was six miles away at a clay mine they had recently taken over after it had been idle for more than a year.

The manager told me that they had an urgent order for a shipment of clay and wanted to put the locomotive in service the next morning. He had had the engineer and a mechanic give the machine an overhauling and, on their assurance that everything was in shape, had arranged with the railroad to place a car on their siding so that loading could commence in the morning. However, he was determined that the boiler be insured before it was put under pressure so it was a case of " off to the mines " for me, even though it was late in the day and the trail, I was sure, would be rather hard on the bus I was driving.

I reached the mine just as the men, including the engineer, were quitting for the day. The manager had been quite right about their being ready to start next morning. As a matter of fact the boiler had been filled to the second gauge and the kindling was all set to touch off. Externally everything seemed ship-shape, including two new safety valves set to blow at 170 pounds, the pressure for which the boiler was built, according to the A. S. M. E. stamp on it.

My request to drain the boiler so as to permit an internal examination dismayed the engineer, for the water tank was some distance down the track and refilling would be quite a job. However, he consented, and when we knocked in the manhole covers the first thing that caught my eye was serious corrosion of the radial stays supporting the firebox crown sheet. These stays were reduced for the most part from 1" diameter at the threaded ends down to 3/8" in the body. When I called this to the engineer's attention he said he had noticed the stays while working on the throttle mechanism and had called the mechanic to have a look at them. In the latter's opinion they were a new kind of staybolt that was screwed from the roof sheet to enter a cap screwed into the crown sheet. Even had the design been such, which of course it was not, this explanation would not have altered the fact that, with their small cross-sectional areas, these stays were not safe for a working pressure of even half the 170 pounds for which the boiler was to be used.

Both the engineer and the mechanic were entirely competent in their respective lines and sincere in their opinions, so I don't know as anyone could blame them for failing to recognize the seriousness of the situation. It was admittedly a little out of their field of experience. However, such instances are by no means uncommon.

The manager, naturally, was distressed when told of the situation that night, but he made the best of things by arranging with a firm of boiler makers to put in new stay bolts as quickly as possible. Although he was anxious to please his customer by making prompt shipment, at the same time he wanted to take no chance of having an explosion and was duly appreciative of the service rendered.

Relating this incident brings to mind another case that occurred not long ago. In passing through a certain town one Saturday evening I met the general mechanic of a textile mill, a man whom I knew very well. In the course of conversation he mentioned that one of their horizontal tubular boilers had developed a leak which they were going to make tight next day, so as to have the boiler ready Monday morning. On finding out the location of the leak I asked him to neither make repairs nor put the boiler in service until I could get out to the mill early in the morning and make an investigation. He agreed, and as a result the mechanics were saved the trouble of making repairs that would have been useless, for we found a lap seam crack 18 inches long — a defect that sent the boiler to the scrap heap.

These occurrences are not related with the thought in mind that any special acumen was displayed by the writer in ferreting out defects. They are simply incidents in the every-day service our Company is rendering. The appearance of similar accounts in recent issues of the magazine prompted me to reduce them to writing.

LIFTED THE DEVIL'S FACE, TOO?

A bill submitted by a church interior painter nearly a hundred years ago, now in the archives of the parish church at Nyed, Sweden, itemizes the services as follows:

"Altered the Ten Commandments and repaired the Sixth.

"Polished Pontius Pilatus, put new furs on his bonnet.

"Put new wings on the Angel Gabriel.

"Expanded heaven, improved the fires of hell, and made the devil's face more awful.

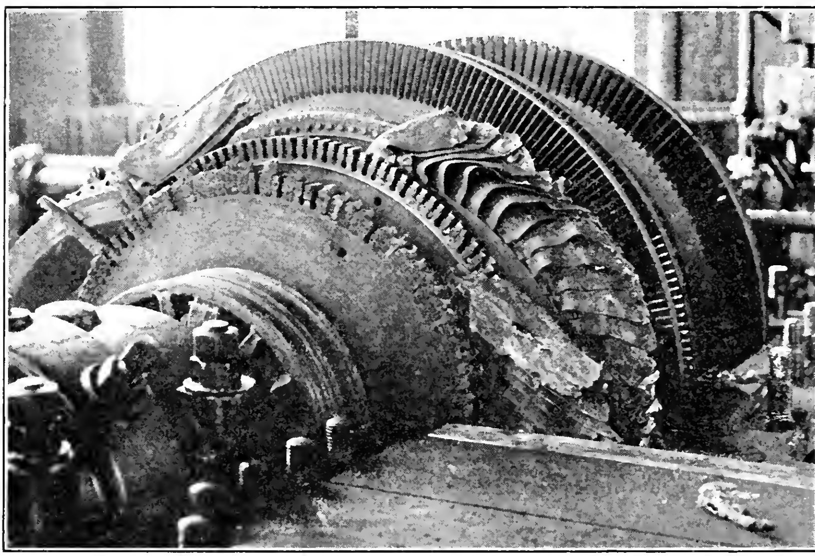
"Cleansed the Red Sea, which was really very dirty."

CRANK-PIN NOT OF CAST IRON

The editor's attention has been called to an error on page 153 of the January issue. The crank-pin shown on that page was referred to as being cast integral with the disc, whereas it was actually made of steel and pressed into the disc. As a consequence, the conclusion as to the strength of cast pins, although proven true in many other instances, is not illustrated by this one.

Low-Pressure Steam Overspeeded Turbine

HAD not a quick-thinking engineer been in the immediate vicinity it is probable that the 1,500 Kw. mixed-pressure turbine pictured here would have been totally wrecked when derangement of the low-pressure control permitted a full flow of low-pressure steam while the machine was running without load. The engineer quickly closed both steam line stop valves and brought the turbine to a halt, but in spite of his promptness the buckets and blading of three discs and their corresponding diaphragms were entirely ripped away. An investigation after the accident revealed that a cast iron lever actuating the low-pressure inlet valve had broken.



The low-pressure stages of this turbine were designed to use exhaust steam at about 8 pounds pressure from a battery of hammers in the forge shop. To augment this, the turbine had also a high-pressure steam inlet and a selective governor arrangement so that high-pressure steam would automatically be admitted in case the supply of low-pressure steam was insufficient to carry the electrical load.

When the accident occurred the engineer heard something snap and noticed the turbine pick up speed. Thinking that perhaps the butterfly valve in the high-pressure line had stuck open, he hastened to close the stop valve in that line. As this did not seem to check the speed he ran to the low-pressure stop valve and spun that closed. He was just in time, for there is little doubt but that the turbine would have run itself to destruction.

As it turned out, the accident was serious enough. Repairs amounted to about $5,000 and, in spite of every means taken to expedite the work, the plant had to purchase outside current for twenty-one days before the machine was again available.

Rooster Controls Street Lights

WRITING in the *Electrical World,* L. H. Hardin, electrical engineer, tells the following story of an ingenious device by which a rooster switches on a town's street lights when he takes to his perch at dusk, and turns the lights off again when, with the rising sun, he strides forth to greet the day.

"In a little North Carolina town there is a superintendent of Public Works whose duties cover, among other things, the operation with his own hands, unaided, of the electric light system, water works system, volunteer fire department, maintenance and repair, meter reading, replacing blown fuse plugs when some good housewife's flat iron acts up, and so forth.

"Needless to say, our unsung hero has no great amount of time to devote to the study of Einstein's theory or the fourth dimension and, in fact, has trouble enough on hand to turn on and off the lights at just the right time to suit all concerned. To the possessor of such talents and ingenuity as one must possess to fill his post successfully this did not present an insuperable problem. In his back yard is a hefty rooster of staid and dependable habits whose belief in the 'early to bed and early to rise' habit is unshakable.

"Here, then, is the problem and the elements of its solution: A special perch was arranged for friend rooster, pivoted at one end and so arranged that his weight would depress the perch a few inches and pull down on a cord to close the street lighting circuit regularly at dusk and to open it when old reliable leaves his perch at break of day.

"To the best of my knowledge there is no device on the market today capable of taking cognizance of the early dusk on a rainy day or the late darkness on a clear day or of the variable hours of dawn with the changing weather as does this old rooster."

FROM GOOD OLD MISSOURI

Father, impressively answering the query of a suitor: "Young fellow, the man who marries my daughter will get a prize."

Suitor, after an embarrassing pause: "May I see it, sir?"

Modern Electric Light Industry Born *in* Edison's Experimental Plant *at* Menlo Park, N. J.

IN SPITE of sporadic attempts by real estate developers to fan the embers of an almost forgotten past into something resembling a vigorous real estate boom, the little New Jersey hamlet in which both the incandescent electric lamp and the trolley car were born is very little larger now than it was fifty odd years ago when Thomas A. Edison established his laboratory there and attracted an amazed world to his doorstep to see what the "Wizard of Menlo Park" was going to do next with a mysterious form of energy known as electricity. In fact, save for a modest stone monument recently erected along the Lincoln Highway by veterans of the Edison organization, there is nothing about the quiet little town to suggest that in its heyday it was known wherever newspapers circulated, and thousands of visitors thronged in to see with their own eyes the remarkable invention by which Edison took electricity from a dynamo in his power house and produced therewith a flameless light in glass bulbs strung on wires around his plant and the railroad station.

Up until a few years ago a crumbling brick foundation and the rusting skeleton of a trolley car could be seen by anyone who cared enough about such things to venture through a weed-grown field to a spot several hundred feet from the highway, but time has erased even those traces of the "Wizard's" lair. Today Menlo Park is no more than just another cross-road to the thousands of motorists who dash through it too rapidly to read either the inscription on the monument or the tire company billboard that gives a brief outline of its history.

Forgotten by the public at large, still Menlo Park means something to the electric light industry. This year public utilities throughout the country are participating in a Golden Jubilee demonstration marking the 50th anniversary of Edison's invention of the incandescent lamp and acknowledging its tremendous influence in making electricity a commodity almost as universally used as food and clothing — an influence which obviously had much to do with dotting the country from coast to coast with big central stations which now meet the demand of an ever-increasing electrical load.

In a sense, then, Edison's plant at Menlo Park, with its small boiler, engine, and dynamo which sent current through the first group of incandescent lamps and drove the experimental trolley cars, was really the forerunner of the huge central stations of today. Through the courtesy of the builders we are privileged to reproduce herein the

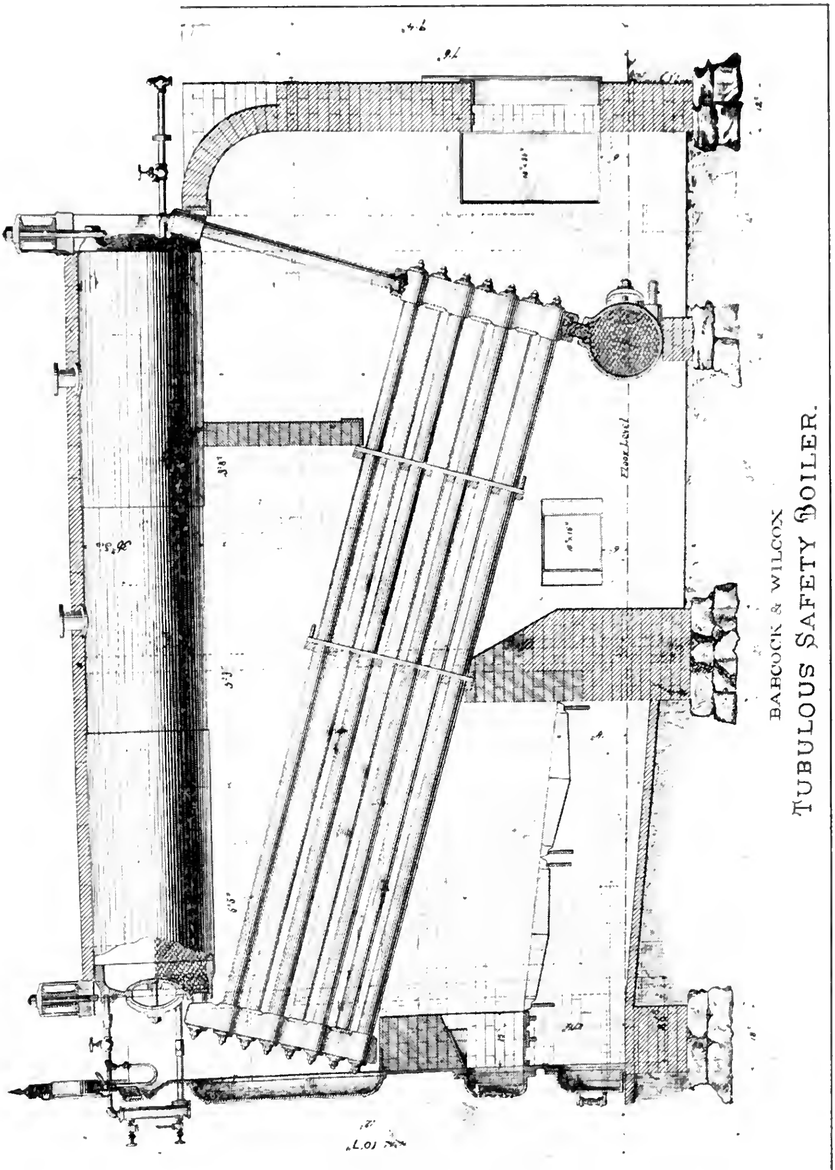


Figure 1

original layout drawing of the boiler which the Babcock & Wilcox Company installed in that plant in 1878. It will be noted that although the "Tubulous Safety" boiler resembles the modern water tube boiler in many respects, there are features about it which have long since been superseded. One of the most striking points of dissimilarity between

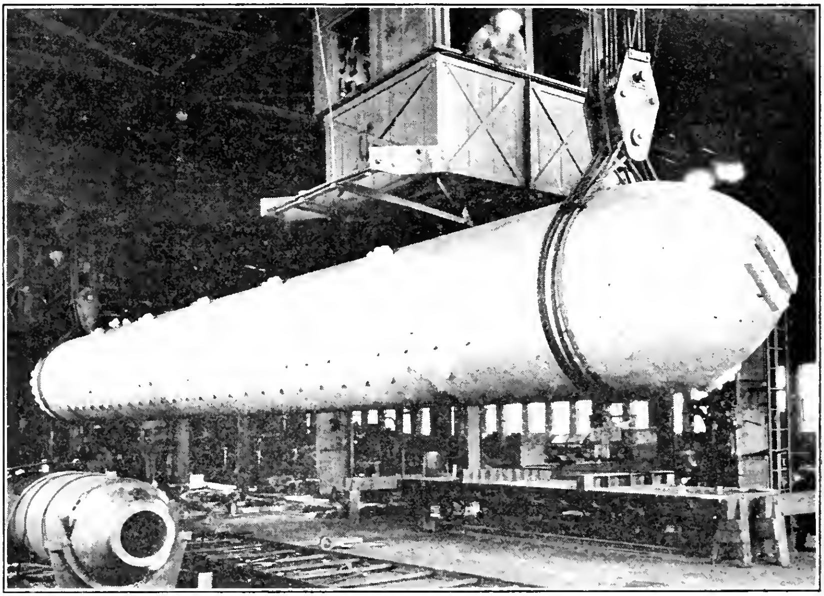


Figure 2

that boiler and those of more modern design is that iron castings were used for the heads of the drum. Another is the method of joining the tube headers to the drum. The present design has connections for the tube headers riveted to the drum some distance from either end, but in the old model the connections were at the ends of the drum through the cast iron heads. However, the old boilers gave a good account of themselves, and thousands of horsepower of that type were built. Unfortunately, there is no record of the final disposal of the Edison boiler, the last account in the record book telling of its removal to Schenectady after several years service at Menlo Park.

All in all, the B. & W. plant sold Edison seven boilers of the same general design, one of which was installed in 1885 at the experimental laboratory in Fort Myers, Fla. Two years ago, when Henry Ford undertook to assemble at his Dearborn museum as many as possible of the old Fort Myers laboratory machines, he was unable to find the boiler, but the B. & W. plant built and presented him an exact duplicate. A bronze plate attached to the boiler explains that the builders were actuated by "deep appreciation of the many benefits that have come to that company as well as to mankind as a result of Mr. Edison's many inventions."

The huge seamless steel drum for the 1,400 pounds per square inch cross-drum boiler now being built by Babcock & Wilcox for the Deepwater, N. J., station of the United Gas & Electric Company (Fig. 2) shows more clearly than words could describe it the vast difference in size between the most up-to-date central station boilers and those of fifty years ago. The big drum is 52 inches in diameter, over 50 feet long, and has walls 4 inches thick. The boiler of which it will be a part is rated at something like one hundred times the capacity of the one Edison used. It is probable that even Edison himself little guessed the size to which power plant equipment would grow when, fifty years back, he started the ball rolling by inventing a device which established a field for the sale of electric current in large quantities.

Even Low Voltages May Cause Fatal Burns

A FEW weeks ago the manager of a plant's safety department raised the question as to whether there is any real danger in electric wires carrying voltages no higher than 110. The answer, based on experience, is "yes".

Recently a power plant employee, working inside a boiler, was burned to death by coming in contact with a bare spot on the 110-volt light extension wire. Caught in a cramped position, he was unable to release himself. At another plant a direct-current lighting wire carrying only 98 volts caused the death of a workman who accidentally touched it while he was standing on a wet floor. There are enough such accidents each year in mills and homes throughout the country to prove, beyond question, that when the body is well shorted between two wires or between a wire and another good conductor such as a damp floor or a grounded piece of metal, a person may be seriously if not fatally burned, providing he is unable to free himself quickly.

A safe rule to follow is to assume that any voltage may be dangerous and to make sure, when working around conductors, that there is no chance of shorting the current through the body. This precaution is especially appropriate in the case of alternating-current, for the failure of insulation in a transformer sometimes raises the secondary line voltage well above normal.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., July 1, 1929

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Hower Succeeds Gleason at Cincinnati

THE many friends of Mr. William E. Gleason among the clients and agents in the Cincinnati territory will share our regret at his decision to relinquish the managership of the Cincinnati Department on July 1. Mr. Gleason's retirement brings to an end a service of forty-one years which commenced in 1888 with his appointment as special agent. For the past twenty years he has been manager of his department, and the success with which he has discharged the duties of that important post is clearly reflected in the friendly relations which The Hartford has enjoyed with those it serves in that territory.

Mr. Frank L. Hower, who has been selected as Mr. Gleason's successor, has been Assistant Manager of the Philadelphia Department for several years. In that time and in a long previous term in other responsible capacities, he has acquired an experience and demonstrated qualities which well fit him for the post to which he is now advanced. In turning the important duties of managership over to Mr. Hower, the Company is confident that he will perform them in such a manner as to maintain the high standard of service prevailing in that territory and deserve continuance of the cordial feeling the Company enjoys on the part of its clients and agents.

Erect Tablet to Dean of Operating Engineers

IN THE old Dutch Reformed churchyard at Belleville, N. J., a tablet now marks the once obscure grave of Josiah Hornblower, the man who erected the first steam engine in America and was, for several years, the only steam operating engineer this side of the Atlantic. Even among members of the craft the name of Hornblower was never widely known. Omitted from many of the encyclopedias and from histories of the steam engine, he might have remained in perpetual obscurity had not the American Branch of the Newcomen Society accorded him the distinction he so well deserved. Under the auspices of this society a distinguished group was present at the unveiling ceremonies on April 24.

Hornblower, an Englishman, was engaged with his father and brother in the business of erecting engines when, in 1753, he was commissioned to sail to America and set up an engine for pumping a copper mine on the shores of Newark Bay. Impressed by his thorough knowledge of the strange machine, the owners prevailed on him to remain with them as operating engineer. Thus Hornblower became the dean of a craft which, numbering in its membership the thousands of operating engineers in large and small plants throughout the country, has played an important part in creating and maintaining the American standard of living made possible by the advent of mechanical power.

The engine which Hornblower erected and ran was of the Newcomen design, a type then widely used in England to pump mines. It continued in operation for years and stood as a curiosity many years after it had pumped its last stroke. But, like many other historic relics, it was allowed to find its way into the junk heap before anyone awoke to a realization that it rightly deserved preservation in some museum.

To Mark Centennial of " Stourbridge Lion "

THE Chamber of Commerce of Honesdale, Pa., is planning a celebration to commemorate the centennial, on August 8th, of the first successful operation of a steam-driven locomotive on the Western hemisphere. The locomotive was the " Stourbridge Lion " which was built in England and shipped to this country in February, 1829, as the property of the Delaware and Hudson Canal Company. A year before that the company had built a railroad from its coal mine to the terminal of its canal at Honesdale and, impressed by the performance of the new type of motive power then making its appearance on English roads, Assistant Chief Engineer Horatio Allen went abroad to purchase one of the new machines.

It was Allen's intention to secure an engine of not more than a ton and a quarter on a wheel, but when the "Lion" arrived and was assembled at the West Point Foundry in New York it was found to weigh nearly sixty per cent. more than the specifications called for. Lack of experience on the part of the builders probably accounted for their failure to estimate the weight of their design within closer limits, and this fact virtually forced abandonment of the "Lion" after its single trial trip. The track and the trestles, of which there were several, proved inadequate to support the heavy engine and so, although it demonstrated the practicability of the steam-driven locomotive, it was never put into service.

For several years the "Lion" was kept in storage while the owners sought a buyer. Eventually the boiler was removed and set up in a foundry at Carbondale, Pa., where it served for about twenty years.

Plans to Make Ocean Run Compressed Air Engine

INVENTORS have for years tried to coerce the ocean into giving up the energy of its waves toward the production of useful work. Indeed, machines have been built for that purpose and have been destroyed by the very element they sought to control. But now a Polish inventor, undaunted by the difficulties which wrecked the hopes of others, claims that he has partly solved the problem by means of a device which, mounted on a ship, utilizes the up and down movement of the waves for storing up energy in the form of compressed air. The latter, in turn, is to be used to drive an engine and create electric energy which, no doubt, he intends to put into a storage battery.

Erecting the apparatus on shipboard instead of on fixed foundations ashore will minimize the danger of its being destroyed by the first storm that comes along but, sad to say, this is not the only difficulty. If it were, the inventor would be fortunate. For one thing, he may find it quite a problem to maintain air pressure for his engine while the ocean, one of the most fickle of all nature's elements, indulges in one of its occasional spells of prolonged quiescence. And, too, he will have to demonstrate that the energy output warrants the cost of building and maintaining units of commercial size. This last hurdle is likely to prove as hard to surmount as those of a purely mechanical nature.

The difference between a pedestrian and a jaywalker is this: When you're walking among them they're pedestrians; when you're driving they're jaywalkers.
—*Detroit Motor News.*

Taps from the Old Chief's Hammer

ALONE in the office an hour before the usual opening time, Assistant Chief Inspector Tom Preble was working through a bunch of inspection reports when the Old Chief sauntered in and flung himself wearily into a chair.

"Just look at that, Tom," he demanded, holding up a felt hat so grimy that it might have seen service in a boiler room. "And these clothes, too," he added, gloomily regarding the bedraggled remains of a light summer suit.

Tom's astonished gaze roved from the disreputable head covering to the wrinkled and grease-marked trousers that had been just about the last word in sartorial splendor when the Chief left the office the evening before.

"Where have you been?" he gasped.

"Son," grinned the old fellow, amused at Tom's amazement. "I've been up all night tracking down a ghost at the Imperial Hotel." Then, sensing that this enigmatic statement conveyed no information to his puzzled understudy, the Chief told his story.

"Along about eleven o'clock last night Andy Ferguson, the hotel engineer, 'phoned me to come down and take a look at that elevator pump we insure for them. I wasn't keen on being steered away from bed at that time of night but Andy insisted that the steam pump was about ready to break down and tie up their elevator, so I told him I'd run right down and see what, if anything, could be done about it. When I arrived I found out that the trouble really wasn't in the pump at all, but that's a part of the story I'll explain later.

"It seems that a knock had developed in the hydraulic elevator system — a knock so annoying to the guests that they were complaining to the manager. Ferguson stayed up all one night trying to diagnose the trouble and the only explanation he could think of was that something had gone wrong inside the pump.

"The hydraulic layout down there consists of a large open tank in the attic which supplies water to the elevator ram-chamber through a ten-inch pipe. To lower the elevator, water is discharged from the ram-chamber into a sump tank in the basement. From there it is picked up by a duplex steam pump controlled automatically by a float in the sump tank, and pumped up through another ten-inch pipe into the open tank in the attic. To support this ten-inch pipe they have run it down to the basement floor and anchored it in the cement. Three feet above the floor they have a sweep tee from which a connection goes to the pump. The vertical run of pipe below the tee is blanked off so as not to leave a dead-end pocket at the foot of the pipe.

"While we were standing there talking, the pump started. It hadn't made more than two or three strokes when we heard a metallic knocking that appeared to be in that vertical return pipe leading up to the tank in the attic. Tap, tap, tap went the noise, and the mysterious part about it was that it didn't stop when the pump stopped. For several seconds after the pump shut down the same regular tap, tapping continued. On the next trip of the elevator the performance was repeated. The knock wasn't a water-hammer; both of us were satisfied of that, yet we couldn't for the life of us say just what it did sound like.

"I guess we must have fiddled around there for an hour, listening and arguing, until all at once my mind flashed back over a space of at least fifty years to a time when, as a youngster, I tossed a tin disc into a pond and was impressed by the fact that instead of sinking straight down like a plummet, it descended gradually, moving from side to side. Right away it occurred to me that there might be just such a disc in the vertical run of pipe — a disc that zig-zagged up from one side of the pipe to the other as the pump forced water upward, and zig-zagged downward again when the pump stopped.

"Ferguson, too, thought there might be something in my theory, although he couldn't figure out how such a thing could have gotten into the pipe, since as far as he knew none of the plates from the plate valves or discs from the pump valves were missing. Well, anyway, to test out our assumption we held open the steam valve the next time the pump started, allowing the pump to make perhaps a dozen strokes more than it made ordinarily. Sure enough, whatever was in the pipe seemed to go right on up and disappear into the tank at the top.

"Right then was the time for us to call quits, but neither one of us had enough sense to do that. Nothing would satisfy us but to wait until the elevator stopped for the night and then drain some of the water out of the attic tank and fish out whatever it was that had caused all the trouble. Getting that valve disc out was what messed me up like this. If I hadn't been so all-fired insistent on proving my theory correct I'd have avoided that and got a good night's sleep in the bargain."

"You didn't finish up until just before you came in here a few minutes ago?" queried Tom.

"Well, not exactly," confessed the Chief, standing up and adjusting his hat at a jaunty angle. "We finished up along about four o'clock, but by the time we'd had a snack from the chef's pantry and smoked a cigar it didn't look like there was much use going home."

Tom smiled as the old fellow went out the door, bound homeward to change his clothes and explain the all-night absence. "I'll bet a nickle," he chuckled, "the old man got more satisfaction out of nailing down that 'ghost' than out of a full night's sleep."

Weight Cut, Diesel Now Enters the Airplane Field

THE handicap that has kept the Diesel engine from competing with its gasoline cousin in the aircraft industry is gradually being whittled down. At least one concern, the Packard Motor Car Company, has actually flown a plane powered by a Diesel weighing but slightly more than three pounds per horsepower, and several others are experimenting with oil-engines light enough for use in heavier-than-air flying machines.

Weight has been the chief factor barring this fast-growing field to the Diesel. If that disadvantage can be overcome there is a good possibility that the Diesel, favored by such features as low fuel cost. simplicity of fuel admission and ignition systems, a minimum of working parts to get out of order, and reasonable freedom from the fire hazard, may force the gasoline engine to relinquish its tight monopoly in the field of small, mobile power units.

The indications are that in order to cut down the pounds-per-horsepower weight it will be necessary to increase speed from the 200 or 300 r. p. m. of the stationary power-plant Diesel to around 1,500 or even 2,000 r. p. m. and, at the same time, to go in for higher compression ratios. Whereas the ordinary Diesel has a maximum cylinder pressure of about 500 pounds per square inch during combustion of the charge — which is about the same as in the gasoline engine — the new Packard Diesel is said to operate at a maximum unit pressure of something like 1,200 pounds. Naturally, a structure adequate to withstand alternating stresses of such magnitude must be stronger than that required in the gasoline engine. To provide strength and at the same time keep down weight it seems obvious that where steel, iron, or alloy castings do very nicely for certain parts of the gasoline engine, corresponding parts of the airplane Diesel will have to be machined from the strongest steel obtainable, and dimensions shaved down to the minimum sufficient for safety. The added manufacturing expense thus involved will be one of the points in which the Diesel will be at a disadvantage in competition with the gasoline motor, but other features may more than make up for it. In reciting the advantages of the Diesel for aircraft *The Scientific American* recently had this to say:

"The gain in simplicity by the use of the Diesel is shown by the following facts: — In the typical gasoline engine (of 9 cylinders) there are two separate magnetos, 18 ignition wires, 18 spark plugs, and an ignition switch. There is an aggregate of perhaps 1,000 individual parts making up the ignition system. In the Diesel, with its automatic ignition, no additional parts of any kind are required. Continuous ignition is assured just as long as the engine is operating. Furthermore, the ignition system of each Diesel cylinder is entirely independent of the ignition system in any other cylinder.

"Now compare the fuel supply systems. The conventional nine-cylinder gasoline engine is dependent on perhaps a single carburetor — at best on a triple-barrel carburetor. Even with the triple carburetor, there are only three independent carburetion systems, the failure of any one of which will result in the loss of one-third of the operating cylinders. In the Diesel, each cylinder receives fuel from an independent pump, thus making it impossible for a clogged fuel line to impair the performance of more than one cylinder.

"Comparing fire hazards, we find that the fire point of gasoline is below zero, Fahrenheit; for heavy fuel used in the Diesel it is 175 degrees, Fahrenheit......

"Heavy fuel oil is much cheaper than gasoline. With aviation gasoline at 19.8 cents a gallon, the cost is 1.7 cents per brake horsepower hour. With the Diesel engine, the corresponding cost is 0.36 cents per brake horsepower hour, or about one fifth as much.

"Another interesting point in the Diesel is the fact that it will operate successfully in any position. All engines using carburetors are dependent upon gravity as far as correct functioning of the carburetor is concerned. With the Diesel, worry as to the position in a steep climb or in stunting is entirely eliminated."

However, in our enthusiasm at the prospect of a more general use of low-fuel-cost Diesels it will not do to overlook the important features in which the gasoline engine is still superior. In the matter of flexibility the Diesel is at a great disadvantage. Moreover, starting a Diesel when it is cold is by no means as simple a matter as starting a gasoline engine. Due to high compression considerable torque is required to "kick" the motor over. Packard engineers have not divulged the method by which they have solved this problem, but persons who witnessed a recent demonstration at Langley Field are of the opinion that the starting impulse was supplied by the explosion of a powder cartridge in one of the cylinders.

But all in all the prospects for the Diesel's wider use seem bright.

So much progress has been made in the last few years that the engine whose usefulness once seemed limited to power plants and ship propulsion now looms as a serious future competitor to the gasoline engine in both the airplane and automotive fields.

Open Heater Explodes When Vent Clogs

THE possibility of an explosion resulting from the accidental stopping-up of the pipe through which a vessel designed for heating water at atmospheric pressure is vented to the open air was demonstrated recently when such an accident caused extensive property damage at the plant of Hinde & Dauch Paper Company, Muncie, Indiana.

The vessel was a vertical tank or tub eight feet in diameter and seven feet high, made of half-inch shell plate with a double-riveted lap seam. Flat heads were riveted to 3″ x 3″ x ½″ angle-irons which were bent around and riveted to the shell at top and bottom. Eighteen similar angle-irons, placed back to back in pairs, were riveted across the heads for reinforcement.

The tank was arranged to utilize exhaust steam from an engine to heat water for the pulp beaters. However, at times the exhaust did not heat the water sufficiently, so there was another connection which furnished live steam at 40 pounds pressure. A 3½″ vent pipe in the top head provided free access to the atmosphere and, to all appearances, made it impossible for pressure to build up within the tank. For that reason the plant carried no insurance on this particular object, although all other pressure tanks were insured.

In some way the vent pipe became clogged, pressure inside the tank increasing until, without warning, the angle-iron holding the lower head gave way and allowed the tank to shoot up through the roof. Fortunately, there were no casualties, but damage to the building, equipment, and stock ran into thousands of dollars.

So badly were the tank and vent pipe twisted and torn that a search to find the direct cause of the stoppage was futile. It is supposed that a board or some other foreign object found its way into the tank and eventually lodged against the mouth of the vent. Another possibility is that vapor may have frozen and formed a plug of ice in the upper end of the pipe. Whatever the cause, the case serves to bring home forcibly the necessity of taking every precaution to prevent the accidental blocking off of a vent when steam under pressure is admitted to a tank intended to serve as an open heater.

Caught in the Separator

KNOWLEDGE STRIDES ON RELENTLESSLY

"South Amboy Rotarians Hear About Electricity." — Headline in the Perth Amboy (N. J.) *Evening News.*

So far, so good, but are they to be kept in the dark about the World War and wireless telegraphy?

A flying rumor never has any trouble in making a landing. — *Arkansas Gazette.*

HERE'S HOW CHINESE TEACH SAFETY

Chinese jay-walkers are being educated by professional story tellers, employed by the government, who deliver talks on the Shanghai streets. Here is one of their tales —

"Now, the swift motor car and the clanging street car are just like tigers, and if you do not take care to watch the policeman at the corner and obey his signals you will not live to grow up and acquire many sons, but will be killed, and your sons, too, so that your ancestral tablets will be unattended. The road is like a tiger's mouth — from its center keep away."

OR WEAR NOTHING BUT

"Dad, what is an advertisement?"

"An advertisement is a picture of a pretty girl, eating, wearing, holding, or driving something that somebody wants to sell."

HE ADMITS IT

"Any luck?" asked a curious individual looking over the rail of the bridge.

"Any luck?" asked the fisherman below. "Why, I caught 40 bass out of here yesterday."

"Say, do you know who I am?" asked the man on the bridge.

The fisherman replied that he did not.

"Well, I am the fish and game warden."

The fisherman, after a moment's thought, said: "Say, do you know who I am?"

"No," replied the officer.

"Well, I'm the biggest liar in the country."

THE LAST WORD IN DINNER ORATORY

Mr. Welch had been dining out six nights in succession. On the seventh night he turned up at home for the evening meal. When he was seated, Mrs. Welch then rose and addressed the other occupants of the table:

"Children, we have with us tonight a guest of whom you have all heard, even if you do not know him personally. He is a man who has a reputation for good cheer in every club in the city, and this evening we are to have the honor and pleasure of being numbered among the admirers of his entertaining qualities. It is with the greatest pleasure that I present to you — your father!"

DARKY GREETINGS

During the war the officers frequently had difficulty in getting the proper salutes from the negro recruits. One bright morning a negro private met the colonel of his regiment and greeted him with "Howdy, boss."

There followed a long tirade from the officer on the correct way to salute. The other listened in silence, scratching his head in perplexity. Finally he interrupted long enough to say: "Land's sakes, boss if Ah'd thought you was goin' to feel so bad about it, Ah wouldn't have spoke to you a-tall."

SUMMARY OF INSPECTOR'S WORK FOR 1927

Number of visits of inspection made (boilers and engines)	279,805
Total number of boilers examined	528,361
Number of boilers inspected internally	188,589
Number of boilers tested by hydrostatic pressure	12,894
Number of boilers found to be uninsurable	1,061
Number of shop boilers inspected	22,417
Number of premises where pipe lines were inspected	27,445
Total number of engines and wheels examined	57,175
Number of uninsurable engines and wheels	128

Summary of Defects Discovered

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale and adhering scale	78,972	4,256
Cases of grooving and internal and external corrosion	45,435	2,530
Cases of defective bracing	792	221
Cases of defective staybolting	3,934	769
Settings defective	8,981	960
Fractured plates and heads	3,162	552
Burned plates	3,169	439
Laminated plates	191	33
Cases of defective riveting	1,427	234
Cases of leakage around tubes and defective tubes and flues	28,099	6,705
Cases of leakage at seams	6,091	500
Water gauges defective	3,875	702
Blow-offs defective	5,117	1,441
Cases of low water	474	297
Safety valves overloaded or defective	3,231	843
Pressure gauges defective or missing	7,004	679
Miscellaneous defects in boilers	9,115	907
Flywheels found overspeeded	64	7
Cases of cracks found in engine parts and wheels	564	211
Defective governors	298	151
Miscellaneous defects in engines and wheels	34	0

Grand Total of the Inspectors' Work on Boilers from the Time the Company Began Business to January 1, 1928

Visits of inspection made	6,648,030
Whole number of inspections (both internal and ext.)	13,111,402
Complete internal inspections	5,072,148
Boilers tested by hydrostatic pressure	458,518
Total number of boilers condemned	36,794
Total number of defects discovered	7,038,903
Total number of dangerous defects discovered	789,380

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1928

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 599,693.18
Real Estate		300,423.66
Mortgage and collateral loans		1,296,386.75
Bonds and Stocks		17,475,629.38
Premiums in course of collection		1,288,819.44
Interest accrued		151,132.41
Other Assets		18,205.76
Total Assets		$ 21,130,290.58

LIABILITIES

Reserve for unearned premiums		$ 8,619,119.83
Reserve for losses		377,212.80
Reserve for taxes and other contingencies		1,894,758.35
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,239,199.60	
Surplus to Policyholders		**$10,239,199.06**
Total		$ 21,130,290.58

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

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BALTIMORE, Md., ... 5 South St.	LAWFORD & MCKIM INC., General Agents. P. E. TERROY, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., . . . 404-405 City Savings Bank Bldg.	W. G. LINEBURGH & SON, General Agents. A. E. BONNETT, Chief Inspector.
CHICAGO, Ill., ... 209 West Jackson Boulevard .	P. M. MURRAY, Manager. J. P. MORRISON, Chief Inspector.
CINCINNATI, Ohio. . . . First National Bank Bldg. .	F. L. HOWER, Manager. W. E. GLENNON, Chief Inspector.
CLEVELAND, Ohio, . . . Leader Bldg.	A. PAUL GRAHAM, Manager. J. F. HUN., Chief Inspector.
DENVER, Colo., ... 916-918 Gas & Electric Bldg.	J. H. CHESNUTT, Manager and Chief Inspector.
DETROIT, Mich., ... 2401-7 First Nat'l Bank Bldg.	L. L. COATES, Manager. THOMAS P. HETU, Chief Inspector.
HARTFORD, Conn., . . . 56 Prospect St.	F. H. KENYON, General Agent. A. E. BONNET, Chief Inspector.
NEW ORLEANS, La., . . . 1128 Hibernia Bank Bldg. .	R. T. BURWELL, Mgr. and Chief Inspector. E. UNSWORTH, Ass't Chief Inspector.
NEW YORK, N. Y., . . . 80 Maiden Lane	C. C. GARDINER, Vice-President. E. MASON PARRY, Chief Inspector.
PHILADELPHIA, Pa., . . . 429 Walnut St.	A. S. WICKHAM, Manager. S. B. ADAMS, Chief Inspector.
PITTSBURGH, Pa., . . . 1807-8-9-10 Arrott Bldg. .	GEORGE S. REYNOLDS, Manager. J. A. SNYDER, Chief Inspector.
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SEATTLE, Wash., ... 423 Dexter-Horton Bldg. .	E. G. WATSON, Manager and Chief Inspector.
TORONTO, Canada, . . . Federal Bldg.	H. N. ROBERTS, President The Boiler Inspection and Insurance Company of Canada.

" I draw no conclusions but such as are naturally deduced from known and visible facts, and such will always have a being while the facts which produced them remain unaltered."

— *Thomas Paine*

Vol. XXXVII No. 8 October 1929

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Experts Differ *on* Theory That Caustic Embrittlement Caused Violent Explosion *at* Crossett, Ark.

WEAKENED by an agency which one expert claimed was caustic embrittlement and another claimed was not, a comparatively new water tube boiler exploded with tremendous violence at the Crossett Lumber Company, Crossett, Arkansas, on May 30th, killing one man and injuring four others. The explosion demolished half the boiler house, wrecked a companion boiler completely, and badly damaged a third. Property damage was estimated at $150,000.

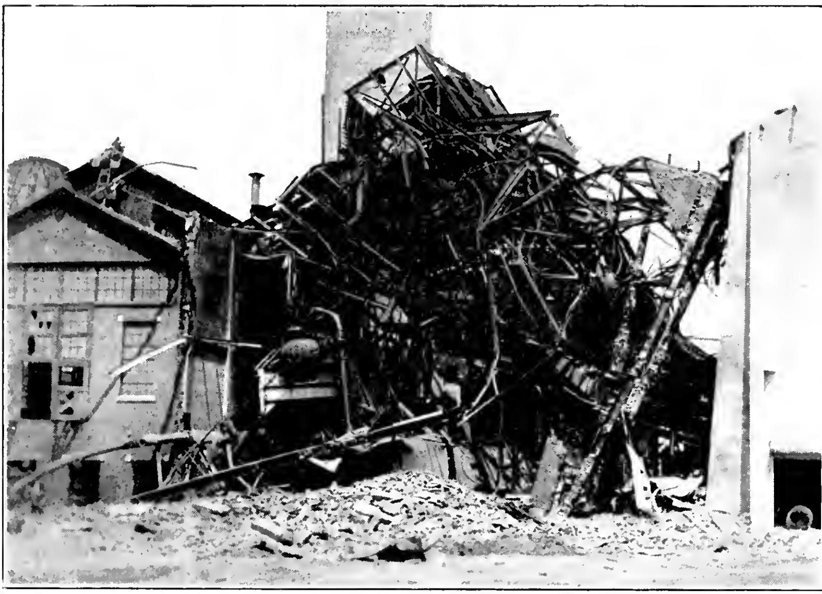
The power plant was erected in 1922, and it not only served the saw mills, planing mills and other properties of the company but, in addition, supplied light and steam heat for the entire town. It consisted of six water tube boilers of the bent tube, two-drum type operating at a pressure of 225 lbs., and four turbo-generator condensing units of an aggregate capacity of 5,250 kw. This plant took the place of 24 fire tube boilers and several reciprocating engines that had been located at strategic points throughout the mill. As engines and boilers had been in use for many years and were in need of extensive overhauling, the owners decided to electrify the mill and supply current from an up-to-date central power house.

For two years after the new plant was put into use, it used raw pond water for condensing and for boiler makeup. However, this water contained considerable scale forming material and, when the pond level was low during dry seasons, it picked up an appreciable amount of mud and vegetable matter, as well. Consequently, in 1925, the owners installed a deconcentrator system accompanied by lime and soda treatment, thereby eliminating the trouble resulting from feeding dirty steam to the turbine, and reducing scale formation in the boilers.

The sudden and disastrous explosion of Boiler No. 6 came without any previous indication that a dangerous defect had developed. The initial failure was along the longitudinal seam of the lower drum, which opened up from end to end; both heads of the drum blew out, and the upper drum and tubes rocketed into the air, descending amid the debris. Boiler No. 5, was hurled from its setting and crushed beyond hope of salvage, while Boiler No. 4 was damaged so badly that it was permanently retired. The fireman met death instantly, and the four plant laborers who were injured probably owe their lives to the fact that they were not exposed to the direct force of the blast.

Two independent investigations were made to determine the cause of the explosion. Mr. F. G. Straub, a faculty member at the Engineering Experiment Station of the University of Illinois, and recognized, by reason of his extensive research, as an authority on caustic embrittlement, found conclusive evidence of caustic action. On the other hand, physical and chemical tests conducted by the Detroit Testing Laboratory convinced experts of that organization that the sample of plate submitted to them had not been embrittled by caustic.

Mr. Straub found that the sample of plate which he examined showed numerous embrittlement cracks, and that the boiler water was



of the same type that had been found in embrittled boilers. In his opinion, the Crosset boiler was weakened by embrittlement cracks which undoubtedly caused the explosion.

In discussing the nature of the water supply and the effect produced by treating the water with soda ash, Mr. Straub said that the water was of the surface variety and naturally low in sulphate. The addition of soda ash caused a total alkalinity of about 50 grains per gallon, which, because of the very meagre sulphate content, produced a sodium sulphate-to-total alkalinity ratio of about one to three. According to recommendations of the A. S. M. E. boiler code, the sulphate-to-carbonate ratio should have been at least two to one. In other words, he was of the opinion that the water as used at the Crosset plant needed a great deal more sulphate in order to render harmless the soda ash which was injected during the softening treatment.

An interesting point in connection with this embrittlement failure — if embrittlement was at the root of the explosion — is that the boiler was caulked both inside and out. Sessions Engineering Company, the consulting engineers that installed the plant, were of the opinion that the outside caulking may have actually contributed to the continued concentration of alkali in the seam by preventing the tell-tale outside stain which sometimes gives warning of what is taking place.

There was no thought on the part of any of the investigators to place the blame on either the design, material, or workmanship of the boiler, nor was there any evidence that the boilers had not been operated carefully. In fact, the same make of boiler was selected to replace the ones which were destroyed. It was decided that drums on the three undamaged boilers should be replaced before these boilers were put back into service.

Several Fatalities Involved *in* Recent Heating Boiler Explosions *in* Apartments *and* Homes

ONE person was crushed to death and several others had extremely narrow escapes when, on June 26th, the explosion of a welded steel heating boiler demolished one wing of the Cevera Apartments, an 80-family house in Detroit, Mich. The extraordinary violence with which the boiler went up is shown by Figure 1. A three-story brick wall was blown to pieces, floors were torn loose from their fastenings, and heavy pieces of furniture were left hanging precariously on supports that were in immediate danger of collapse. Damage to the refrigeration system released a flood of sulphur dioxide gas that hampered efforts by firemen to subdue a small blaze started by the explosion.

The mother of a nine-months-old baby was buried under a pile of debris and was killed instantly. By some strange twist of fate, however, neither the child nor its father was injured, although they were with the mother in an apartment directly over the boiler room. The man was blown clear of the falling wall and landed safely in the courtyard below; the baby, asleep in its crib, dropped to the basement where a steel girder fell across it in such a way that it was not even scratched. Fortunately, the explosion occurred at a time when few other tenants were at home, for it is evident from the photograph that the accident could very easily have claimed a larger toll in deaths and injuries had all the apartments been occupied.

A conservative estimate placed the property damage at $25,000. The owner was not carrying boiler insurance.

Those who examined the wreckage of the boiler believe that over-pressure caused the accident. The evidence pointed to the sudden release of a tremendous amount of energy, for the wrapper sheet unwound completely by bursting the welded seams and pulling away from the staybolts. There were no signs that the metal had been previously weakened by over-heating, and the fusible plug was found to be unaffected. It seems probable that the fault lay in the safety valve, although the valve was so badly damaged in the accident that this supposition could not be verified.

Figure 1

During cold weather the boiler was called on to heat the building, but at all other times it was used merely to supply hot water for the tenants. When operating in this way, the heating system stop valve and return line valve were closed and the boiler water circulated through a coil heater where it gave up its heat to the water of the supply system. Thus it is evident that the only safeguard against over-pressure was the safety valve, for during hours when the demand for hot water was least the fire would put heat into the boiler water faster than the heating coils could extract it.

Although an accident in a store and flat building at Gary, Indiana, on March 26th, was by no means as violent and destructive as the one described above, it snuffed out two lives and caused property damage of about $1,000. In this case lack of a relief valve and improper manipulation of valves in the system caused the explosion of a cast iron hot water supply boiler, killing an eight-year-old boy outright and inflicting fatal injuries on his grandfather, the janitor.

On the morning of the accident the janitor instructed the fireman to shut off the hot water supply so as to give him an opportunity to repair a leaky faucet. The fireman followed instructions to the letter, closing off, among others, the valves between the boiler and the hot

Figure 2

water supply tank. As the boiler had not been provided with a relief valve, it took but very few minutes for the rapidly accumulated pressure to exceed the strength of the cast iron. A severe explosion was the result.

Figure 2 is a picture of the boiler after the accident. Evidently the corrugated internal furnace of the little boiler was somewhat stronger than the outer shell, for although the latter was shattered into fragments, the furnace escaped with but slight damage.

An apartment house in Seattle, Washington, was damaged to the extent of about $10,000 by the explosion of an oil-fired cast iron hot water supply boiler, on June 12th. This blast was so violent that it raised the first floor of the building more than an inch, wrecking equipment in the basement and damaging foundation walls severely.

A two-inch relief valve on a hot water supply tank directly connected to the boiler was depended on to prevent over-pressure but,

Figure 3

as has happened in many other instances, the valve disc had stuck to the seat and the valve was unable to open. Moreover, a check-valve in the supply line prevented such relief as would have been obtained had the pressure been able to back water out into the city mains.

The practice at the apartment was to shut off the oil-burner late each evening after the demand for hot water had ceased. The janitor overlooked this duty on the evening before the accident and as a result tenants were hurled violently from their beds at 3:20 in the morning. Fortunately, there were no serious injuries.

A chauffeur and his wife, whose living quarters were over the garage of a private residence in Chicago, escaped death or serious injury by the narrowest of margins when, on April 1, a welded steel heating boiler exploded and literally demolished the building beneath them. The cause of this explosion was not definitely determined although, as the extensive damage shown in Figure 3 on page 231 would indicate, a very high pressure must have been present when the boiler let go.

Wheel Bursts During Test Run of Stand-by Unit

STRUCK on the head by a piece of flying metal, an engine-room attendant at the Elite Laundry, Washington, D. C., was killed instantly on June 1, when the flywheel of a small, high-speed engine burst and imperilled over 100 laundry workers by filling the place with scalding steam from a severed 4″ main.

The engine was one of a battery of three and, along with another small machine, was ordinarily used merely as a stand-by unit while the third and largest engine carried the load. In fact, so infrequently were the two small engines used that the laundry had excluded them from the policy when renewing insurance on its power plant equipment. As a consequence, the accident found the plant without insurance protection even though a policy was in force on the large engine and on two water-tube boilers. The attendant had been adjusting the crank bearing and evidently started the engine, without load, merely to find out whether or not the adjustment was satisfactory. He had opened the throttle wide and was standing beside the cylinder when the wheel let go, killing him.

Just what caused the accident will probably never be known, for no one was with the victim in the engine room, and the shaft governor was demolished so completely that it could not be tested to determine whether or not it was working freely. There is a possibility, of course, that an old crack or flaw may have existed in the wheel, or that the attendant, in working on the bearing, may have accidentally placed a tool where it interfered with the action of the governor. A more or less puzzling feature was the breaking of the eccentric rod flush with the lock nut where it screwed into the eccentric strap, for although the rod showed signs of severe stress there was no mark on it to indicate that it had been struck by a piece of the wheel.

Failures Show Up Weakness of Unapproved Designs

TWO air tank explosions — both the fruits of unapproved design, and one the direct result of a foreman's failure to observe the long-established safety rule against caulking a vessel under pressure — recently cost a life and caused property damage in excess of $25,000 at plants in Seattle and Philadelphia.

While applying an air-pressure test to a 500-gallon tank intended for water storage, the foreman at the Seattle plant undertook to caulk a leaky head seam. The head blew out with a tremendous concussion, killing the foreman instantly, severely injuring a workman, and hurling from the track a 10-ton traveling crane, which stood twenty feet away.

The tank was of welded construction with bumped heads that had no skirts or flanges. Edges of the disc-like heads were welded directly

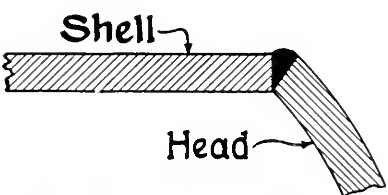


Figure 1.

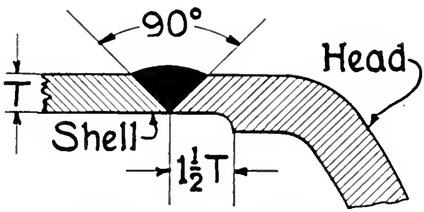


Figure 2.

to the ends of the shell plate. (See Fig. 1.) It is believed that the testing was being done under a pressure of 100 pounds per square inch, for the safety valve was set at that pressure.

Of course, the foreman's mistake in hammering the seam while the vessel was under pressure was the direct cause of the explosion, but the design itself was not satisfactory, from a safety standpoint, even for a tank intended merely for the storage of water. The heads should have been flanged and welded in accordance with the provisions of Section U-71 of the A. S. M. E. "Rules for the Construction of Unfired Pressure Vessels." (See Fig. 2.)

The explosion at the Philadelphia plant involved an air tank protected by a safety valve on the tank itself as well as by an unloading device in the line between the tank and the compressor. These appliances were set to operate when pressure reached 125 pounds and it it not thought probable that both could have been inoperative at the same time, for although the safety valve was destroyed in the accident and thus could not be tested, the unloading device was found in good condition.

The tank was 6 feet in length and had a diameter of 30 inches. Shell thickness was 3/16″ and both the "minus" lower head and the "plus" upper head were made of 3/8″ plate. Autogenous welding had been used throughout, Figure 3 showing the manner in which

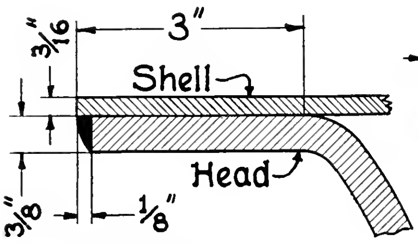


Figure 3.

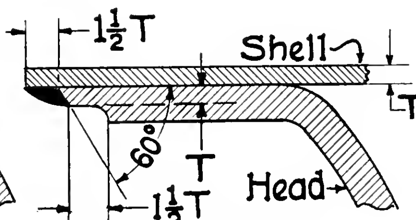


Figure 4.

the lower head was fastened. Failure occurred by shearing of the 1/8″ section at the point where the welding joined the shell, the explosion hurling the shell and top head up through the roof and driving the lower head through the floor and into a room below. An examination disclosed no signs of distress in any part of the vessel other than the sheared seam, which very evidently lacked the strength that would have been obtained had the makers used the design shown in Figure 4, the method recommended by the A. S. M. E. Code for welding minus heads of unfired pressure vessels. There was no marking on the vessel to identify the maker.

Although no one was killed or injured by this accident, property damage was extensive, for the flying parts severed water pipes in a room containing $25,000 worth of paper stock.

Steam Stages *a* Comeback *to* Regain Its Status *as the* Most Economical Source *of* Mechanical Power

ACCORDING to Mr. R. M. Boykin, president of the Northwestern Electric Light & Power Association, the rapid strides being made toward cutting down the cost of producing electricity in steam-driven plants, and the difficulties and expense involved in securing franchises and developing hydro-electric sites are factors which promise to postpone indefinitely the fullest possible utilization of the country's resources in the form of "white coal." Writing in the *Scientific American* on "Steam Stages a Comeback", Mr. Boykin declares that with new economies being effected by better design, the cost of steam-generated power will soon be less than that generated by hydro. "Today", he avers, "the two plants are practically equal and only the highest technical skill can determine which of the two would be more economical for any given condition."

"In theory at least," his article continues in part, "all our power sites should be harnessed before our more perishable resources — such as wood, coal, or fuel oil — are used. But practically the problem is not so simple, and that is a factor that the conservationist has overlooked. It begins to appear as though his eternal vigilance of this treasure chest of nature has been unnecessary, for the inventive genius of the engineer has brought the steam plant back into the picture as a formidable competitor of the hydro-electric plant in the production of electricity, and the guardians of 'white coal' may find themselves holding an empty sack.

"With unprecedented wealth of water power at our very door, the power companies of the Pacific slope are definitely turning to steam as a source of electric light and power. Our company, The Puget Sound Power and Light Company, is just beginning the construction of a $5,000,000 steam plant on Lake Washington, which will eventually generate as much electricity as is now produced by its hydro-electric stations. In Southern California, the Edison Company, alone, has put in service over 400,000 horsepower of steam plants since 1924.

"Hydro-electric developments are never a matter of easy exploitation. Aside from the barriers of legal restrictions and regulations which are difficult enough to hurdle, many are the added problems to solve. The excessive values that some individuals have placed on undeveloped water power sites, the difficulty of power companies to purchase such public land, demands for imaginary damages to land used for power purposes, and many similar obstacles must be taken into consideration on every proposed hydro plant. Aside from these difficulties, long periods of time must elapse in order to make proper studies of stream flow and, because of the seasonal and annual variations, it is extremely necessary to take slow records over several years. The value of a hydro-electric plant depends largely on the amount of water available and this must be predetermined carefully before a proper analysis can be made. Then, too, geological and topographical conditions must be carefully studied; and when a definite conclusion is reached, the power demands may not be suited to the plant proposed.

"There are likewise other difficulties confronting the engineer who must plan the construction of a hydro plant. The construction period is usually two or three times as long as that for the steam plant. Where a 100,000 horsepower steam plant can be designed and put in operation in less than a year, a similar hydro plant might take from two to three years, depending upon its complexity. If long rock tunnels, high dams, difficult foundations and inaccessible country are involved — which is usually the case — the problems take months to solve. This ties up capital for a long time without return. Furthermore, the original investment in a hydro plant is several times that of a steam plant of equal capacity. If the hydro cost per horsepower is more than a predetermined amount, the interest on the indebtedness may well be more than the cost of operating a steam plant, including such charges as fuel and labor.

"Then consider the stupendous cost of long transmission of high-voltage current from the mountain recesses to centers of population, wider right-of-way, and costly transformation and distribution of the hydro-electric output. Furthermore, the initial construction of a hydro plant, such as the dam, water tunnels, and so on, representing by far the greatest investment, must be completed at once regardless of whether or not the entire power available is needed. Unlike a steam plant, this part of the hydro plant cannot be built in units, as needed, and therefore the investment is often far out of proportion to the available market for the electricity produced.

"The steam plant is a mere child's toy by comparison. In the first place it involves no cumbersome regulations. Any location with rail or water transportation, near the center of population, and close to a water supply for condenser purposes, will serve; and usually such a site is easy to find. A plant whose storage reservoir is a coal pile does not have to fear a lack of rainfall during the summer months. The steam plant is usually located at a point close to the load center, and this greatly simplifies transmission line problems. Because of the short distance that power must be transmitted, low voltage can be used, and this fact again simplifies switching and transformation.

"But the real crux in the comeback of steam in the generation of electric energy is the vast improvement in equipment of the steam plant. Although there have been few marked changes in the hydro-electric plant during the last twenty years, the modern steam plant of today is as different from that of a few years ago as day is from night. A station operated by the Edison Electric Illuminating Company of Boston produces energy for less than a pound of coal per kilowatt hour. Another station in the same city, built by the same firm ten years earlier, proudly boasted a record of 1.75 lbs. of coal per kilowatt hour. The newest geological survey reports that the national average since 1919 has been reduced from 3.20 lbs. per kilowatt hour to 1.83 lbs. per kilowatt hour — a remarkable showing in just a few years.

"At the time the hydro-electric plant reached its present high state of efficiency, the steam engine was still of the cumbersome reciprocating type, with huge cylinders and pistons. The machines were ponderous and slow moving, and occupied an extensive floor area. Boilers were small in size and stoked by hand, of low pressure, and with practically no super-heat. Electric generators were belted to the engine, and the result of all this was that efficiency was low and power cost high.

"Consequently the super-power of age of today was mothered by hydro-electric plant rather than by steam. But the tide is turning to steam power. There came a time when an engineering genius discovered that a jet of steam could be used just as well to play on a wheel blade as could the giant water nozzles of the hydraulic mining days of California and the steam turbine became a reality. By substituting rotating for reciprocating elements, it became possible to use higher steam pressures, greater speeds, and therefore smaller units to produce more power. From that time on, the development of the steam turbine has been rapid until it has now reached a point where the water turbine must look to its laurels."

Caustic Embrittlement, Accelerated *by* Wrong Feed Water Treatment, Ruins 4 Water Tube Boilers

CAUSTIC embrittlement recently cost a large mid-western concern $85,000 when, in less than a year and a half after four new water tube boilers of the longitudinal-drum type had been installed, they were found so badly affected by embrittlement cracks that replacement was necessary. The extreme rapidity with which deterioration progressed is explained by the fact that not only was the raw feed water of an embrittling nature, but the water softening system was such that it aggravated the condition, sending into the boiler a water that had a sulphate-to-carbonate ratio of about one to three.

The boilers and the water softening system were installed and put to use in December, 1926. In about a year an inspector discovered leakage at the rear tube end of Boiler No. 4 and, on close examination, found that some of the tubes had developed cracks near the point where they entered the tube sheet. In a short time the leakage became so troublesome that the boiler had to be taken out of service. Then it was found that the highly concentrated water, leaking out at the water-tube ends, had deposited a hard-baked, cement-like substance that literally matted the tubes together for a distance of four feet from the tube sheet, as shown in Figure 1.

At first it was thought that the cracks in the tubes might have been caused by too heavy rolling or by improper annealing, but five

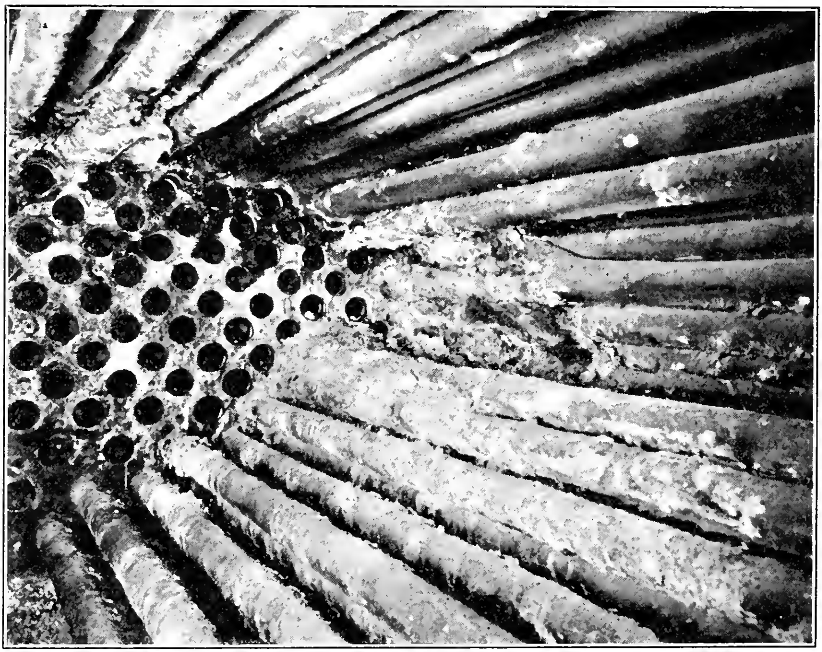


Figure 1

different laboratories, after independent analyses, agreed that the metal was up to the A. S. M. E. standard and had not been injured either in manufacture or when the tube ends were belled over. However, a microscopic investigation of the cracks themselves gave a clue to the true cause, for the fissures followed the borders of the grain — a condition typical of caustic embrittlement. Figure 2 shows the nature of the failure in the tube ends.

Boiler No. 2 was next taken off the line and examined. A slight leakage was noted at four or five points along the longitudinal seam of the drum and several rivet heads were missing. Removal of the butt straps disclosed rivet-hole to rivet-hole cracks in both the straps and the plate. Similar conditions were found in two other boilers.

Satisfied that they were dealing with embrittlement, the investigators turned their attention to the feed water and found that even before passing through the softening apparatus the raw water contained more carbonate than sulphate. Such a condition would, in itself, be entirely capable of causing embrittlement, for in order to

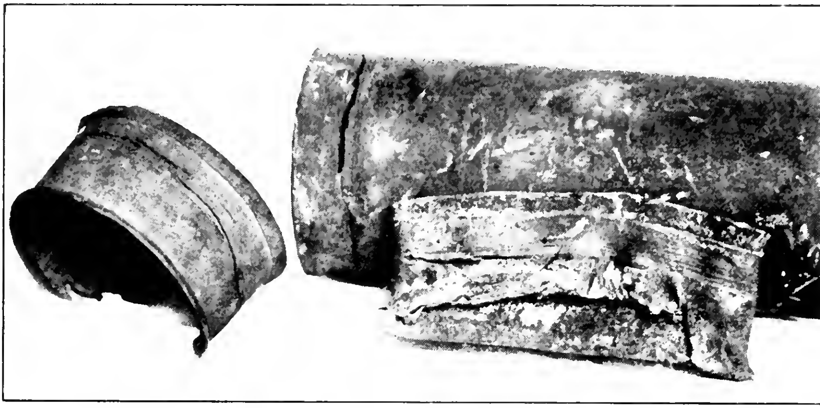


Figure 2

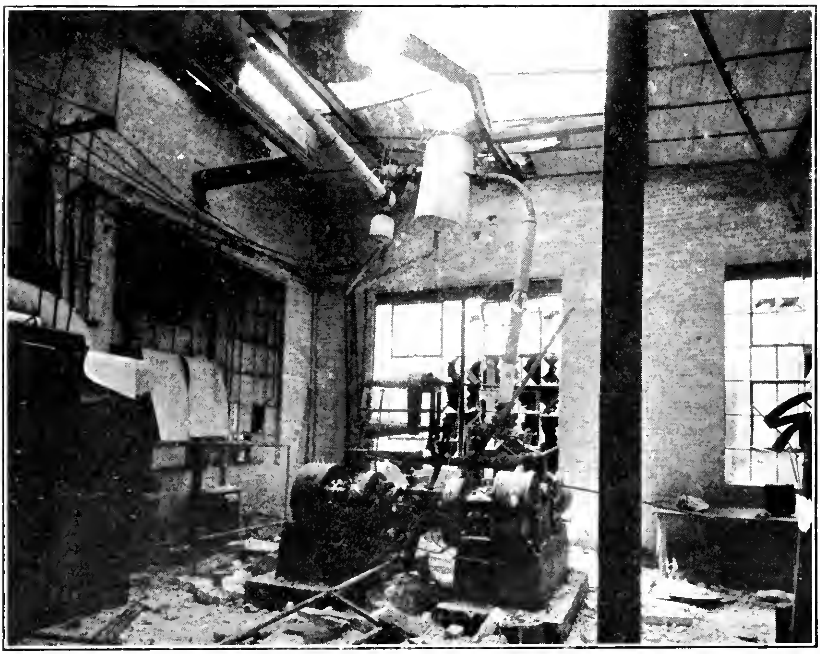
inhibit caustic action on the steel the sulphate content should exceed that of carbonate. However, the slight over-balance in favor of the carbonate might not have caused such rapid deterioration had it not been that the particular system of feed water softening in use at this plant increased the unfavorable ratio, actually making the "softened" water more dangerous than the raw.

The plant had no choice but to scrap the boilers for, weakened as they were, their continued use would have been dangerous. Pending the erection of new boilers, the water softening system was replaced by one that would correct the unfavorable carbonate-to-sulphate ratio.

Broken Belt Deranged Safety Devices

An unusual combination of circumstances was involved in an engine accident which, on June 28th, caused property damage in excess of $2,500 at the plant of The Charles Boldt Paper Mill Co., New Iberia, La., where a duplex, variable-speed engine ran away, burst the flywheel, and tore gaping holes in the roof and walls of the building. Fortunately, the plant carried insurance in "The Hartford".

Although no one was present in the engine room when the accident occurred, the superintendent had passed through just a few moments before without noticing anything unusual in the engine's behavior. As a matter of fact there is no reason for supposing that a dangerous condition existed either in the engine itself or in the safety devices, for the machine had been inspected recently. At that time both the governor and the automatic stop were in perfect working order.



The first indication of trouble was the sudden stopping of the paper-making machine. A few seconds afterward there was a tremendous crash in the engine room as the flywheel went to pieces. From this fact as well as from the appearance of the parts after the accident it seems evident that the main driving belt either broke or ran off the pulley, and that as it did so it whipped around and struck the governor and emergency stop, rendering both of these devices useless. Thus freed of its load and with the throttle wide open, the engine needed but very few seconds to speed up sufficiently to burst the flywheel.

Investigators found that a centrifugally-operated device on the engine shaft had swung out, as it was supposed to do under overspeed conditions, and released the catch which should have allowed the emergency stop to shut down the engine. However, something — evidently the belt — had already damaged the stop so that it jammed in the open position. The accompanying illustration shows the wreckage of the engine.

Before the engine was put back into service the owners erected a heavy, plank barricade to protect the safety devices against damage in case the belt should either break or run off the wheel again.

Taps from the Old Chief's Hammer

"PSHAW," broke in the Old Chief with an indulgent chuckle, tilting his chair back against the wall and reaching for a cigar, "Anybody who didn't know you boys would think from the way you talk that spending a night or two away from your own downy couches was enough to break down your health."

The old fellow had walked into the inspectors' room just as Inspector Jamieson was relating, in language not devoid of color, a painful experience with a small-town hotel bed that, from his description, must have been paved with macadam. And, as usual, the Old Chief wasn't going to pass up such a made-to-order opportunity for reiterating his oft-stated opinion that boiler inspecting had eased up considerably since the days when he himself was on the road.

"I'm right surprised at you, Jim, taking notice of a little thing like that," declared the veteran, pausing in the operation of lighting his cigar to cast a reproachful glance in Jamieson's direction. "If you're going to let such a trivial matter as a hard bed fease you it's a good thing you weren't with me in the old days when the St. Louis Department presented me an eighteen-day route that had to be covered two or three times a year down in the wilds of Tennessee where I loaded the buggy with corn for my two hired mules and struck out over roads that were nothing better than logging trails and dry brookbeds. Talk about food and lodging! Why, say, man, I had to eat when, where, and if I could find anything, and it was a red star night for yours truly when I was privileged to sleep on a cot instead of on a straw shake-down on the floor of a mountain cabin. Compared to the places I've had to put up in, your hotel — hard bed and all — was downright luxurious. Yes sirree, you young fellows who never had a taste of real rough and ready traveling don't appreciate how much easier the job of inspecting has become since good roads and automobiles divided distances by ten.

"In spite of it all," mused the old fellow after a pause, "I used to get quite a kick out of the trip. Of course I had to put up with a lot of hard traveling and uncertain accommodations but there was something kind of restful in being out there with 'unspoiled nature' as the poets call it. Then, too, I'd run across a real amusing experience now and then.

"When they first assigned me the route the boys back at the office took pains to warn me what to do and what not to do, for those hills were full of old-fashioned mountaineer moonshiners and it was real bad form for anyone to travel through there unless he was prepared to furnish — on quick notice, sometimes — a good, plausible reason for his presence. In fact, after a day or two I changed my mind about telling them I was a boiler inspector for the Hartford Steam Boiler Inspection and Insurance Company. Instead, I just said I was hired by Seth Harkins to look over his boilers. They all knew Seth and his mills, whereas they never could quite see the logic of a concern in far-off Connecticut sending a man all the way down to Tennessee.

"Well, anyway, I hired a young colored boy to go along on the first two or three trips, and with his help I managed to get by without unusual difficulties. Our method was to follow a creek from the point where it joined the river up to its headwaters, then cross over the hills and follow the next creek down to its mouth. The sawmills were located either on or near the creeks, so in that way we could take them all in.

"Traveling was pretty rough — due to the lack of roads and the poor condition of the ones we did find — and the best we could average was two or three miles an hour even with our mules and buggy. Consequently in order to make the circuit in the time allowed us, we had to start early and keep riding pretty late in the evening, trusting to luck that nightfall would find us near some cabin where we could get something to eat and a place to stretch out. All in all, I suppose we put up at twenty or thirty different cabins on our first few trips, and I always suspected that the men folks at half of those places each had his own whisky still somewhere out in the woods. But, if they did, the stills were so cleverly hidden that I never saw one, although sometimes I had a right uneasy feeling that I might stumble on one by accident and be mistaken for a revenue agent. Fortunately, I never did.

"One night, though, the boy and I landed at a cabin where we'd never stayed before and I saw some things that made me wonder whether we hadn't better hitch up and leave before the situation became embarrassing. The owner of the place was a tall, raw-boned fellow who said he worked at the mill where I planned to inspect a boiler next day. We had a real pleasant evening, he and I, sitting out in front of the cabin and smoking our pipes, but every now and then I couldn't help feeling that he was wondering just how much truth there was in my claim of being a boiler inspector.

"While we were sitting there, listening to the sounds that always come from the woods at night and watching a round, full moon float up from behind the tips of the tall pines, someone came to the edge of the clearing and called 'Ho, Bob'. Without a word, our host got up and walked off in the direction from whence the sound had come. When he came back he went around behind the cabin and got a jug — which he carried out to the visitor. A little later the performance was repeated — our host returning after each excursion and picking up the conversation where we had left off. Naturally, I suspected what was going on but I was discreet enough to avoid steering the talk in that direction. Well, not a word was said one way or the other until our friend departed to deliver the fourth jug, and his wife turned to me and explained, in a confidential sort of way, that her man had just returned from Nashville and had brought with him a small supply of liquor. 'Some of the neighbors like to have a little on hand in case of sickness', was the tactful way she put it.

"To make a long story short, those folks treated us the nicest they knew how, giving me a cot up under the eaves — which I shared with a bearded stranger who came in sometime later in the night — and sending us off in the morning with a good breakfast of corn bread and eggs under our belts. In fact, they were so hospitable that I made a mental note to stay with them again on the next trip through that part of the mountains. But, as things turned out, that was the last I ever saw of them.

"On the next swing around the circuit I found their cabin deserted, and inquiry as to what had become of the man and his wife brought all sorts of evasive replies until one old mountaineer vouchsafed the information that the man had 'gone over to Atlanta to stay for a spell'. I didn't press the inquiry any further for I had a feeling that the subject could be dropped right gracefully at that point."

"Are you interested in Einstein's theory about space?"
"If it's anything to do with parking space, let's hear it."

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George Hargis Prall, *Editor*

HARTFORD, CONN., October, 1929

Single Copies can be obtained free by calling at any of the company's agencies.
Subscription price 50 cents per year when mailed from this office.
Recent bound volumes one dollar each. Earlier ones two dollars.

Power Interruption Insurance

"WHEN the sudden breakdown of electric power yesterday stilled the hum of countless motors in industrial and domestic machines throughout the city, hushed the voice of radio, silenced pipe organs and 'froze' scenes in motion picture houses, and left lifeless the unnumbered small electrical devices which modern men consider essential to living, it revealed in a startlingly drastic manner the extent to which the city of today has come to depend on electricity," declared the *Springfield (Mass.) Republican* in its issue of August 16th.

The tie-up to which the article referred resulted from an accident at the public utility plant serving the Springfield district. For 43 minutes factories, stores, theatres, auto laundries — in short, all sorts of activity dependent on purchased current — were entirely paralyzed. It was several hours before complete service could be re-established.

So widespread were the effects of the break-down that scarcely a person in the city was not affected in some measure. Machinery in factories came to a standstill, radios were silent, moving picture theatres had to dismiss patrons, dentists were obliged to give respite to patients on whose teeth they were grinding, street traffic jammed up as signal lights failed to function, auto laundries found themselves unable to deliver cars for which the owners were waiting, large store and office buildings became unbearably " stuffy " for lack of ventilation, electric refrigerators in homes, butcher shops and delicatessens went on strike, and even barber shops found their " production " hampered by failure of their clippers and massage machines to function.

From the standpoint of the public at large the outstanding feature of the situation was in the inconvenience it caused. However, industry viewed the breakdown of electric service from another angle, for industry lost many thousands of dollars while workmen stood idly by their lifeless machinery. One large plant alone reported a loss of 3,500 production hours.

The incident, together with a similar case that arose in New Britain, Conn., ten days later, illustrates the need for " Power Interruption " insurance by all sorts of commercial undertakings depending for continuous production on an outside current supply. Even the best managed and most reliable of public utility plants are susceptible to accidental breakdown and, too, the lines which transmit current to the consumer are prone to fail for, as the *Electrical World* aptly points out, " continuous, uninterruptible transmission service is still in the future."

J. P. Morrison Named for New Post

Mr. J. P. Morrison, for the past ten years Chief Inspector of the Company's Chicago Department, was called to a broader field of usefulness when, on August 1, he was made Superintendent of Inspections with headquarters at the Home Office. In creating the new post and selecting Mr. Morrison to fill it, the Company feels that it has enhanced the worth of its boiler and machinery insurance, for Mr. Morrison's wide experience in inspection work, together with a resultant extensive knowledge of matters pertaining to power equipment, is now available to The Hartford's patrons in all parts of the country.

Entering the Company's employ at its St. Louis Office in 1901, Mr. Morrison worked as an inspector until, in 1913, he was promoted to the chief inspectorship of his department. In 1919 another advancement took him to Chicago where he assumed charge of the larger inspection force in that territory.

C. W. Zimmer Made Chief Inspector

Mr. C. W. Zimmer has been promoted to fill the responsible post at Chicago left vacant by Mr. Morrison and, as Chief Inspector, will be in a position to utilize fully a wealth of experience and intimate knowledge of problems peculiar to the district, obtained during nineteen years as an inspector and ten years as Assistant Chief Inspector of the department of which he is now Chief. The Company was fortunate in having immediately available a man so well qualified to continue the high standard which the Chicago Department has attained.

J. F. Butler and W. P. Wallace Advanced

Two recent changes, both of which represented well-merited promotions, were the appointments of Mr. J. F. Butler and Mr. W. P. Wallace as Assistant Managers at Chicago and Pittsburgh, respectively.

Mr. Butler, since coming with the Company in 1899, had been a Special Agent in the Chicago Department. For some time, however, he had been serving as assistant to Manager Murray, in addition to his duties as Special Agent.

Mr. Wallace entered the Company's employ in 1895 and, while a Special Agent in the Boston Department, disclosed the qualities which fit him for the administrative post to which he has been advanced.

Railroad Speed Records Made Years Ago Survive In Spite *of* Better Engines *and* Roadbeds

THE continuous quest for greater and greater speed, both for sport's sake and as a means of shortening the time it takes to transport passengers and freight from one point to another, seems to be one of the most influential of all factors involved in the present-day trend in airplane, automobile, and boat design. No sooner had the "*Bremen*" set up a new steamship record for the trans-Atlantic crossing than rival lines announced their intentions of building even faster vessels; the ink had scarcely dried on the phenomenal automobile record established by the late Ray Keech at Daytona Beach when Major Seagrave came forward with a machine capable of surpassing it; and when this year's winner of the Schneider Cup hoisted the record for seaplanes to 355 miles an hour, plane designers in three countries then and there turned their inventive genius to the task of developing winged power plants of even greater speeds. But, in contrast with these rival transportation agencies and their record-breaking exploits, the railroad seems definitely to have outgrown the urge to be continually writing new speed records into the books. As a matter of fact it had its fill of establishing records several years ago, and since that time speed has been forced into a compromise with such equally important factors as comfort, safety, economy, and regularity of schedule.

The 20-hour schedule now maintained between New York and Chicago is entirely satisfactory both to the railroads and to the passengers, and while it represents a very respectable rate of traveling it is by no means the best speed possible. As far back as 1902 the run was made in exactly the same time, and for several years thereafter the schedule was held down to eighteen hours. Competition between two major trunk lines for the passenger traffic was responsible, of course, and the result was that for a time the traveler could make the trip in 17 hours, 50 minutes on one of the roads. But so great was the wear and tear on rolling stock and roadbed, the extra cost of maintaining such a difficult schedule, and the likelihood of accidents, that in 1912 the rival lines were glad to reach a compromise and return to the 20-hour running time. Thus, while passenger service is constantly being improved by the addition of more comfortable and luxurious trains and better roadbeds, features which in general have allowed the cutting down of time between distant points, the fact remains that old record books contain evidence of rail "scorching" somewhat more sensational than the speeds attempted in present-day operation.

Indeed, railroad speed is by no means a modern development, for as far back as 80 years ago a train on the Great Northern Railroad in England is said to have run the 53.25 miles from London to Didscot at the rate of 68 miles an hour. Such a ride must have been anything but a treat to nervous passengers, for even with better equipment, heavier rails, and more stable roadbeds, such modern trains as the Twentieth Century and the Broadway Limited content themselves with an average terminal to terminal speed of somewhere around 45 miles an hour.

At no time, at least not during the last thirty years or so, has the maximum speed of the steam locomotive been the factor limiting train schedules. The less refined engines of several years back seemed to possess all the speed the boldest of engineers dared call on; certainly they could run somewhat faster than was warranted by the ability of rails and roadbeds to stand up under the pounding. As long ago as 1901 a train on the Plant System covered the five miles between Fleming and Jacksonville in two and a half minutes, an average of 120 miles an hour. Further back than that the Empire State Express of the New York Central did a single test mile at the rate of 112.5 miles an hour. In 1904 a Philadelphia & Reading train ran 4.8 miles at 115.2 miles an hour. Moreover the Burlington train of 1902 was by no means "poking along" when it maintained an average speed of 93.7 miles an hour over a stretch of 14.8 miles.

Of course, these extraordinary records were made under extraordinary conditions; they were not listed on the timetables and in no sense did they represent the average schedules for fixed runs. Nevertheless, they furnish proof that as far as railroads are concerned there was plenty of speed on tap even thirty or thirty-five years ago, whereas automobiles, airplanes, and boats are today running a great deal faster than they did even five years ago.

In June 1905, a special train on the Lake Shore and Michigan Central Railroad covered the stretch of 525 miles between Buffalo and Chicago at an average speed of 70 miles an hour. That same year a New York Central train averaged 64.2 miles an hour between New York and Buffalo. A real fast run, of course, but not so remarkable when we find in the records that ten years before that a train of the same railroad rolled the 148 miles between Albany and Syracuse at 68 miles an hour.

Such speeds, or speeds even approaching some of the old records are now so unusual that when in 1927 a special train averaged 51 miles an hour on a run from New York to Atlantic City, the newspapers recorded the feat in headlines.

What seems to be the record coast to coast run was made in 1924 by a relay of specials which rushed Mrs. A. H. Smith from Los Angeles to New York. One train reached Chicago in 49 hours, 17 minutes, and another made the run from that city to New York in 19 hours, 54 minutes, thus fixing 69 hours, 11 minutes as the fastest time yet recorded for a continuous run from one coast to the other. But, if we go back to 1905 and take into account the record of 44 hours, 54 minutes made by the " Scotty the Miner Special " from Los Angeles to Chicago, and then add to this the 16 hours, 55 minutes in which a special chartered by Mrs. Cyrus H. McCormick made the New York-Chicago run in 1926, we find that the composite time shatters the accepted record by 7 hours and 22 minutes.

Of course, there is no doubt that old speed records would be extinguished in short order if the railroads should make up their minds to do so. The fact is that railroads feel no temptation to try such feats, for sound management must take into account not only comfort, safety and regularity of service in the face of capacity traffic, but also the expense of maintaining roadbed and equipment, an item which mounts considerably as train speeds increase. In spite of several recent improvements in running time instigated by competition with newer modes of travel, many of the entries in the old record books seem reasonably certain of surviving for some time to come.

Removing Explosion Hazard From Electrical Equipment

IN PLANTS where dust, explosives, or inflammable materials are present, says *Power*, there is great danger of explosions caused by sparks from electrical apparatus. For that reason, the magazine points out, it is advisable for such plants to install specially constructed and inclosed motors.

"When an attempt is made to inclose ordinary electric motors," continues the article, "there is danger of their overheating if nearly loaded. Sometimes they can be successfully inclosed by using a blower to bring in cool, fresh air and such an arrangement will keep the motor fairly clean. But as a safe measure in rooms where there is danger from igniting inflammable material it is better not take the chance of inclosing the ordinary motor to prevent sparks escaping. When motors are to be used where explosive vapors or materials are near, the squirrel-cage type is preferred.

"Storage batteries offer another explosive hazard. They should be placed in a room by themselves, and no one except a qualified person should be allowed to enter that room. When batteries are placed in such rooms care must be exercised to provide for proper ventilation, so that acid fumes and inflammable gases will be removed. Under no conditions allow open flames to be brought in or near a battery room, for when a battery is being charged considerable gas is given off which is inflammable and may cause a serious explosion if ignited."

Fatal Accident Stresses Need for Caution

Either a momentary lapse of caution or unfamiliarity with the extreme hazard he was taking cost a man his life recently when, having entered a switch room at a pumping plant in South Hingham, Mass., to examine apparatus, he touched a metal-sheathed pencil to an exposed lug on the 2,300-volt side of a current transformer. The plant engineer offered to pull the switch before the man entered the room but the latter said it would not be necessary.

A few minutes later the engineer heard the sound of something falling in the switchroom and found the man on the floor. The victim soon lapsed into unconsciousness and efforts to resuscitate him were unavailing. The fused end of the man's pencil gave the clue to what had happened.

Steam Auto in 1832 Had Remarkable Boiler

"A MOVING power by which carriages can be propelled on the common roads of the country with speed and safety and without smoke," had just made its appearance in England when the editor of The American Railroad Journal sent to press the issue of November 17, 1832, an article from which was recently sent us by Mr. G. E. Windau, of Huron, Ohio. The old paper informed its readers that the epoch-making device enbodied a "patent" boiler that could withstand 294 pounds of pressure per square inch; was operated regularly at two-thirds that ultimate rating; and "exhibited upward of 19,000,000 pounds of pressure without the slightest danger."

We do not know how this tremendous though meaningless figure was derived, although we suspect it was the product of the total square inches of surface multiplied by the working pressure in pounds per square inch. Whatever it was, we imagine that few of the readers were able to share the editor's confidence in an arrangement that involved any such pressure, for in those days steam boilers were regarded with unfeigned skepticism.

"This coach," said the article, "is the invention of Messrs. Ogle and Summers, of Southhampton, who after a most serious expenditure of time and money have at length accomplished the desideratum of a moving power by which carriages can be propelled on the common roads with speed, and safety and without smoke. The first attempt was from Southhampton to Oxford, and then from Oxford to Birmingham. During its progress there was considerable difficulty in regulating the speed down hills, the machine having in one instance hurried down a declivity at a most enormous rate, probably 50 miles an hour. Captain Ogle, by his nerve and management, steered it notwithstanding, with perfect ease."

Such "ease" on the part of the brave chauffeur must have been inspiring to the twenty-two passengers (or inmates, as the article called them) while the ponderous machine hurtled down hill at a speed which even today is not looked on with favor. Evidently even Captain Ogle had no desire to put his "nerve and management" to another such test, for he equipped his machine with brakes before he made the next trip.

Possibly some of our readers will be able to explain how a boiler that was operated at a factor of safety of only 1.5 survived the jars and jolts incident to a trip over the rough roads of that day. Likewise someone with an inclination toward higher mathematics may figure out what the editor meant in saying that a boiler with 398 square feet of heating surface under a pressure of 200 pounds "exhibited upward of 19,000,000 pounds pressure."

Removal of Safety Devices Results in 2 Deaths

UNIQUE means taken to conceal the presence of an old vertical tubular boiler which they were using in conjunction with an illicit whisky distillery were partly to blame for the deaths of two men in a small town near Baltimore, Md., on July 11, when the boiler exploded after it had been in operation only three hours.

The boiler and still were set up in a clump of pines not far from the edge of town, and in order to eliminate such noises as would have been caused by the normal operation of the safety valve and by the possible bursting of a gauge glass, the owners removed the safety valve and gauge glass, and even plugged up all but the lower gauge-cock opening with old automobile spark plugs. Having thus stripped the boiler of its most essential fittings, they evidently thought that the pressure gauge and the single gauge cock would enable the fireman to keep pressure within safe limits.

An examination of the wreckage showed that rivets of the mud ring seam were so badly corroded that half of them were without heads. Staybolts holding the head were also eaten away to an extent that deprived the head of almost all support. Failure occurred at this mud ring seam, the boiler rocketing up into the air and coming to rest in a field a hundred yards away.

The junk dealer who sold the boiler maintained that he had warned the purchasers of its condition and had told them that he was holding the boiler only as scrap. However, either he or the purchasers had installed a set of second-hand tubes which, although beaded properly at the top head, were not beaded at all at the bottom head. Needless to say, the boiler was not insured.

What "Matter" Is Thought To Be

According to the scientists' latest conception of matter (the theory that even such solid-appearing things as wood, iron, and stone are nothing more than groups of positive and negative charges of electricity with unfilled spaces between them) if we could eliminate all the unfilled space in a man's body and collect his protons and electrons (positive and negative electric charges) into one mass, the man would be reduced to a speck so small that he could not be seen by the naked eye.

Caught in the Separator

SPEAKING OF APOLOGIES

The young lawyer, of counsel for the defendant, finally lost all vestige of patience as the judge, on point after point, over-ruled his objections. Springing to his feet, he started to harangue the court. "Your Honor, I am surprised," he commenced, indignantly.

The judge, a severe old fellow, glowered angrily and thundered a demand for silence — following this up with a promise that the offending barrister would be brought up on charges of contempt.

But the young man's associate, a suave old lawyer with years of experience, sought to smooth things over. "Your Honor," he said, by way of apology, "I trust you will pardon the momentary lapse on the part of my associate. As you can appreciate, he is new to the ways of the court and cannot be expected to exercise the restraint which will come as greater experience makes him more sensible of the Court's dignity. I venture to say that when he has practised before Your Honor as long as I have, he will not be surprised at any ruling Your Honor may make."

JUST A PARTING SHOT

A lawyer stopped at the boiler room door and called for Timothy O'Toole. One of the firemen inquired in a heavy voice, "Who's wantin' me?"

"Mr. O'Toole," said the lawyer, "it is my duty to inform you that your aunt has died in Dublin, leaving you an estate of sixty thousand dollars."

There was a silence below and then a lively commotion.

"Are you coming, Mr. O'Toole?" the lawyer called down.

"In wan minute," was the bellowed answer. "I've just stopped to lick the chief."

Golfer: These links are terrible, caddy.

Caddy: This ain't the links, sir. You got off them a long time ago.

YOU DON'T SAY!

"With all due deference, my boy, I really think our English custom at the telephone is better than saying 'Hello' as you do."

"What do you say in England?"

"We say, 'Are you there?' Then, of course, if you are not there, there is no use going on with the conversation."

"Did you manage to give the cop the slip?"

"No, he gave me one."

A motorist, meeting a negro trudging along the dusty road, generously offered him a lift.

"No, thank you, sah," said the old man. "Ah reckon mah old laigs will take me 'long fast enough."

"Aren't afraid are you, uncle? Have you ever been in an automobile?"

"Nevah but once, sah, and den ah didn't let all mah weight down."

A colored employe of an express company approached his superior with the query:

"Boss, what we gwine do 'bout dat billy goat? He's done et up where he gwine."

"The preacher in our church last Sunday told us how Lot's wife looked back and turned into a pillar of salt. I couldn't help thinking whenever my wife looks back she turns into a telegraph pole or a lamp-post or something."

— *Detroit Motor News.*

SUMMARY OF INSPECTORS' WORK FOR 1928

Number of visits of inspection made (boilers and engines)	277,763
Total number of boilers examined	536,763
Number of boilers inspected internally	191,348
Number of boilers tested by hydrostatic pressure	13,917
Number of boilers found to be uninsurable	946
Number of shop boilers inspected	23,184
Number of premises where pipe lines were inspected	32,736
Total number of engines and wheels examined	59,481
Number of uninsurable engines and wheels	227

Summary of Defects Discovered

Nature of Defect	Whole Number	Danger-ous
Cases of sediment or loose scale and adhering scale	78,207	3,926
Cases of grooving and internal and external corrosion	45,642	2,302
Cases of defective bracing	804	180
Cases of defective staybolting	3,247	497
Settings defective	8,672	802
Fractured plates and heads	2,504	488
Burned plates	2,841	385
Laminated plates	179	28
Cases of defective riveting	1,621	475
Cases of leakage around tubes and defective tubes and flues	26,215	6,477
Cases of leakage at seams	5,604	416
Water gauges defective	3,528	624
Blow-offs defective	4,520	1,195
Cases of low water	571	208
Safety valves overloaded or defective	2,884	715
Pressure gauges defective or missing	6,947	652
Miscellaneous defects in boilers	9,741	765
Flywheels found overspeeded	65	11
Cases of cracks found in engine parts and wheels	578	106
Defective governors	333	164
Miscellaneous defects in engines and wheels	69	2

Grand Total of the Inspectors' Work on Boilers from the Time the Company Began Business to January 1, 1929

Visits of inspection made	6,913,086
Whole number of inspections (both internal and ext.)	13,648,165
Complete internal inspections	5,263,496
Boilers tested by hydrostatic pressure	472,435
Total number of boilers condemned	37,740
Total number of defects discovered	7,242,630
Total number of dangerous defects discovered	809,517

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1928

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 599,693.18
Real Estate		300,423.66
Mortgage and collateral loans		1,296,386.75
Bonds and Stocks		17,475,629.38
Premiums in course of collection		1,288,819.44
Interest accrued		151,132.41
Other Assets		18,205.76
Total Assets		$ 21,130,290.58

LIABILITIES

Reserve for unearned premiums		$ 8,619,119.83
Reserve for losses		377,212.80
Reserve for taxes and other contingencies		1,894,758.35
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,239,199.60	
Surplus to Policyholders		**$10,239,199.06**
Total		$ 21,130,290.58

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. Charter Perpetual

Department	Representatives
ATLANTA, Ga. . . . . 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., . . . 5 South St.	Lawford & McKim Inc., General Agents. P. E. Terroy, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector
BRIDGEPORT, Conn., . . 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnett, Chief Inspector.
CHICAGO, Ill., ... 209 West Jackson Boulevard .	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio. . . First National Bank Bldg. .	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, . . Leader Bldg.	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER, Colo., ... 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
DETROIT, Mich., ... 2401-7 First Nat'l Bank Bldg.	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., . . 56 Prospect St. . . .	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., . . 1128 Hibernia Bank Bldg. .	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., . . 80 Maiden Lane . . .	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., . . 429 Walnut St. . . .	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., . . 1807-8-9-10 Arrott Bldg. .	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., ... 319 North Fourth St. . .	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., . . 114 Sansome St. . . .	C. B. Paddock, Manager. L. J. Reed, Chief Inspector.
SEATTLE, Wash., ... 423 Dexter-Horton Bldg. .	E. G. Watson, Manager and Chief Inspector.
TORONTO, Canada, . . Federal Bldg. . . .	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

Business Interruption

A boiler explosion, a turbine break-down — in fact, almost any serious accident to a plant's power-producing equipment — very often causes a loss far greater than the amount it takes to effect repairs. An accident of this sort may halt entirely or, at least, seriously curtail plant output for days, weeks, and even months, during which such FIXED EXPENSES as Salaries, Taxes, Interest, Service, Lease-holds, Contracts, and Depreciation must be met with CASH that can come only from the firm's reserves.

"Hartford Steam Boiler's" USE & OCCUPANCY policy furnishes certain protection against that sort of loss. May we, without obligation on your part, send details of this form of insurance and the manner in which it stands ready to reimburse you for loss of production due to an accident to the "heart" of your plant?

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

P. O. Drawer 2133
Hartford, Conn.

GENTLEMEN: — Please send me the details of Use & Occupancy Insurance.

Signed ....

....
(Official Position)

....
(Company)

....
(Address)