The Locomotive

OF

THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

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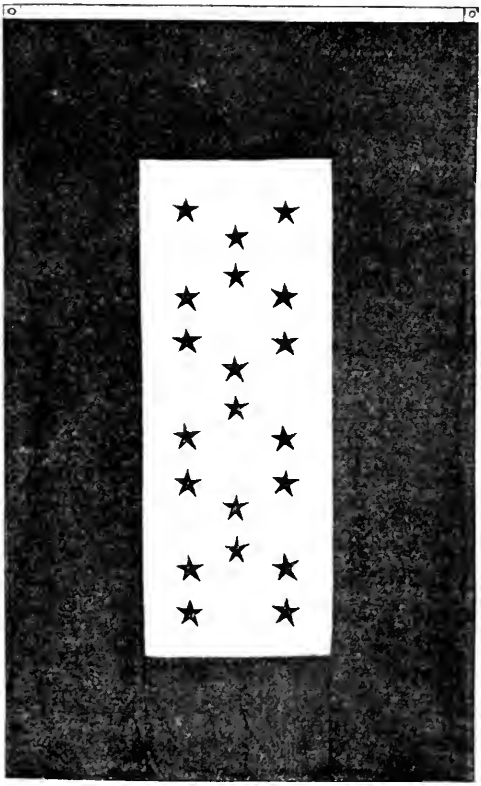


THE HARTFORD'S SERVICE FLAG.

Economy Hints.

We printed in the last issue of The Locomotive an article which explained in detail the process of burning fuel. It is of no service to study combustion if we cannot apply the knowledge to the actual improvement of the performance of our boiler furnaces.

At the present time, owing to the congestion of our railroads and the need of diverting all available material to war needs, it is absurd to advise remodeling existing equipment in most cases. The problem of the moment is the production of the most power with existing equipment, from the least amount possible of whatever sort of fuel may be had, without much regard for whether that kind or grade of fuel fits our furnace conditions or not.

This situation is not quite so hopeless as it seems. The underlying principles of combustion govern what will happen when we attempt to burn any grade of fuel in a furnace, and a knowledge of them should help us to discover why we have trouble, and how to limit that trouble to a minimum.. We will assume that any changes and modifications in a plant that are in the nature of repairs and maintenance, and which mean the putting of what we have in the best possible condition rather than trying to replace it with something else are justified.

The first thing to consider, since it applies to all kinds of fuel and every sort of furnace, is air leakage. Every pound of air which leaks into a boiler setting, in excess of that deliberately admitted to burn the coal and the gaseous combustible, is a loss in two ways. Some of the heat of the coal has to be used up in heating this air and so cannot go to the boiler to heat water. Besides this, if air leakage takes place, the amount of gases passing through the boiler for each pound of coal burned is greater, than it ought to be by just the amount of air which leaks in. This in itself is not so bad, but there is only a certain amount of heat in a pound of coal. If that heat is given up to a larger amount of gas instead of to a smaller one, the larger amount of gas will not be so hot (will not attain so high a temperature) as would the smaller one, and so gases of lower temperature than necessary pass through the boiler. This will be true, notwithstanding the fact that the total amount of heat delivered to the boiler per hour or per day, might be exactly the same with the larger amount as in the case of the smaller. An extreme case may serve to show just what this means. Suppose a boiler to have steam up to the working pressure, and everything hot, ready to deliver steam.

Imagine a very large excess of air to be passed through the furnace of this boiler, at the time when it is called upon to begin taking its share of the load. Suppose indeed that the excess is so great that the heat in the coal is only able to just heat this volume of gases to the temperature corresponding to that at which steam will form at the pressure at which the boiler is working. In such a case since the gases are no hotter than the steam and water in the boiler, no heat will flow from the gases to the water, and the result will be that the boiler has no power, or putting the same idea into other words, the efficiency of that boiler under those particular circumstances is 0. Now, if the quantity of coal burned per hour on the grate is kept constant, and the amount of air supplied is decreased a little, the gases will be hotter, because there is less of them to carry the heat, hence a little steam will be formed in the boiler, and the efficiency will begin to rise. If the process of cutting down on the air supply is carried to the point where the fuel is supplied with just the amount necessary, and no more, for complete combustion to take place, there will be no excess air, the efficiency of the boiler, at least insofar as it depends on the temperature of the gases of combustion, will be as high as it can get, and we will have an economical furnace. Whether the boiler would be economical or not, would depend then on boiler and not furnace conditions. Summing this important matter up in a word excess air is bad because it not only carries up chimney bodily a part of the heat developed by the combustion of the fuel, but it is doubly bad because it so dilutes the other and necessary gases that their temperature is less than it would be, and so lowers the boiler efficiency, by decreasing the temperature difference between the water and the gases upon which that efficiency depends, and as we have shown, in an extreme case, it might render useless for steam making, all the heat developed by the burning of the fuel.

It is hard to realize the vital importance of stopping air leaks because we do not see the loss. We burn enough coal to make the steam required, and if the boiler is not overloaded seriously, there is no direct appeal to any of our senses to tell us that we need not have burned as much as we did. We have to use indirect methods to prove it in any particular case, whereas if a steam pipe leaks, or a blow-off valve becomes scored so that it is constantly wasting hot water, we realize directly that something is wrong and are much more apt to attend to the matter promptly. Air leaks however are just as bad as steam leaks and it is unfortunate that they do not herald their presence by a scalding, hissing blast of something hot and uncomfortable, to remind us of their existence.

The remedy for air leakage, is to test all parts of the boiler setting with a candle flame, locating the leaks. Some leaks will be at cracks in the brickwork, some will be found around cleanout doors. Leakage is usually present at points where blow-off pipes pass through the setting walls, at the joint between the back connection arch and the boiler head in the case of horizontal return tubular boilers, and at the points where inspection and clean out doors are fitted to the settings of water tube boilers. This is not even an approximately complete list, but it indicates where to start hunting. The hunt should not be considered over till every square inch of the setting wall, clear up to the damper in the breaching has been carefully tested. All the places at which leaks have been located, should be marked with a piece of chalk, so that none of them will be missed when the repairs are made.

The stopping of leaks is best done with some material which makes a tight joint, resists heat, and is at the same time elastic enough to keep the crack filled under varying expansion and contraction. A stiff mortar of plastic asbestos such as is used for covering pipe fittings and boiler tops is as good as anything for pointing brickwork or for filling the smaller cracks. For large wide cracks, openings around pipes or for calking in between door frames and brickwork, asbestos rope is good. It should be lightly calked into place and covered with the plaster. If a strand of rope is too thick to properly work into a crevice, then unravel it, removing a yarn. The chances are that the smaller strand will just fit some other location. As a substitute for the asbestos plaster, broken or defective magnesia pipe covering, or broken magnesia blocks may be separated from any cloth which may be attached to them, and broken up, when they can be easily worked up into a mortar with a little water. Asbestos rope will also be found the best material to use in filling the opening between the back connection arch and boiler head, in the settings of horizontal return tubular boilers.

After stopping all the crevices marked through which air entered the setting, it is best to go over the setting again with the candle flame to see if the job is actually as good as it seems. This candle test should then be repeated every few weeks on suspicion, for no setting will long remain air tight, and the fight against air leakage must be constantly kept up to be effective.

After the air leakage matter has been settled, the next thing to tackle is the possibility of gases passing to the stack without sweeping over the heating surface. In horizontal tubular boilers of the flush front type, without an extended dry sheet, there is always a chance for gases to leak through the joint between the arch over the fire doors and the boiler. This is especially the case where a turned arch only is used, and no smoke box is bolted to the shell. Here is a place to use asbestos rope, thoroughly calked into the crevices. Attention should also be given to the arch itself, so that it shall not be allowed to get out of repair. Every bit of heat which cuts 'cross lots from the furnace to the chimney at this point is of course a dead loss. In the settings of water tube boilers, many sorts of baffles are in use to guide the hot gases over the heating surface, so that they may travel far enough in contact with the boiler to give up their heat. These baffle walls often deteriorate rapidly. Their maintenance in as nearly perfect condition as possible is essential to economy, as every opening in a baffle permits a short circuit of heat to the stack. Baffle walls are not very accessible, are hard to inspect and harder to repair, but they must be maintained in a high state of efficiency, nevertheless.

The whole setting of a boiler should be kept clean. Soot should be removed regularly and frequently from the combustion chamber, from pockets in the baffling, from flues and uptakes, and from the chimney base. It must also be kept off the boiler surfaces. In this connection, remember that no system of blowing will of itself turn the whole trick. This is not meant to discourage the use of soot blowers, for they are most useful tools, but at intervals their work should be supplemented by thorough sweeping and scraping to get the soot which attaches itself too firmly to be blown off. Economizers also should be kept clean and free from soot. Furthermore, if economizers are used, it is just as necessary that the flues be kept air tight from the boiler to the economizer, and that the setting of the economizer itself be kept tight, as for the boiler setting, and for the same reason.

The setting being tight and clean, we can turn our attention to the fire. Every sort of fuel presents its own problems, and in many cases the necessity of burning an available fuel in furnaces designed for a very different sort proves a real hardship. It may often serve to limit the output, for the furnace which would carry the load easily with the fuel for which it was designed may be wholly inadequate with a different sort. Probably the greatest difficulties will come when those accustomed to the burning of bituminous coal are forced to use the smaller sizes of anthracite (and vice versa), and when those who have been using the eastern low volatile bituminous coals, are given the coals of the Pittsburg or Illinois districts.

Anthracite in small sizes is a very different sort of fuel from soft coal. It must be fired in small charges, sprinkled evenly all over the fire, and a thin, hot, level fire must be carried. From two to four inches thick for the fire itself, is about right. The total layer of material on the grates of course will get thicker as the time for cleaning is approached. If shaking grates are available, the labor of cleaning fires can be reduced to a minimum by frequently cutting off the bottom layer of ashes, unless the coal clinkers badly, which unfortunately is often the case. In slicing an anthracite fire, the bar should be passed under the fire itself, in the layer of ashes. It can be moved about in the furnace, pushing the fine ash through the grates, but it should be kept flat on the grates, avoiding any tendency to pry up the fire, for such a movement will bring the clinker into the hot fire layer, where it will at once melt, run back to the grate, and by cementing together the ash already there, make a worse clinker than that which existed before the bar was used. The less the bar and indeed the other fire tools are used in an anthracite burning furnace, except when cleaning fires, the better. A good fireman scarcely ever touches them. (Incidentally this advice regarding the slice bar, usually applies to the burning of bituminous coal as well.) Sprinkle the coal thinly on the brightest spots. Do not cover an anthracite fire enough to shut off the hot fuel bed from sight, just sprinkle it over lightly and evenly, and repeat at short intervals, say from three to five minutes. The thinner the fire, so that it is level and has no holes or dead spots, the less trouble is likely to arise from clinker. A "dead" or black spot usually means that a clinker has formed under it which cuts off the air. Break it up with a cutting or slicing motion of the slice bar, run in flat on the grate, but do not raise it into the fire unless no other method will work. In that case, push it clear up on top of the fire and hook it out at once with the rake or hoe, so that it cannot melt and run back on the grate.

The most effective clinker preventers with hard coal are: a clean ash pit, which allows a free flow of air to all parts of the grate, a thin, even fire, water in the ash pit, and in extreme cases in addition to all the other suggestions, steam admitted under the grates is sometimes of great assistance.

The very small sizes of anthracite are difficult to burn with natural draft. Either forced or induced draft will work well, and because of the beneficial effect of steam under the grates on the formation of clinker, the various forms of steam jet forced draft blowers are often very satisfactory.

When bituminous coal must be burned in furnaces designed for anthracite, difficulty is usually experienced because the distance from the grates to the heating surface is too little, and because the combustion space is too cramped. Both these conditions favor incomplete combustion and the production of heavy smoke. The combustible gases formed when fresh coal is fired do not have room in which to become thoroughly mixed with air and burned, and hence pass to the stack in an unburned or partly burned condition. The result of this is both the loss up the stack of a quantity of perfectly good fuel which ought to have been burned in the furnace and the production of an excessive amount of black smoke. If the combustion space is limited, the only way in which bituminous coal can be handled with any semblance of economy is to distill off the gases in as steady a stream as possible, and thus have the amount distilled off per minute less than if larger amounts are distilled off at high rates followed by intervals in which comparatively little is formed. This can only be accomplished if small amounts of coal are fired often. The fire must be kept level. To do this the coal should be placed in small charges on the thin spots only. A good fireman seldom needs a rake or hoe to keep a level fire. The thick spots are not burning well. To put coal on them makes them burn still slower. The thin spots are thin, because there the coal burns rapidly, therefore those are the places where coal is needed. Holes in a fire are disastrous alike to steam production and economy. They mean that the fireman is either too careless or not sufficiently skillful to place the coal on the bright (and therefore thin) spots, or that his attention has never been called to the need for a level fire. A few small shovelfuls, repeated at short intervals should be the recognized method of firing. The thinner the fire (from four to ten inches will be found about the best range of thickness), the less trouble from clinker. A thick heavy fire wastes coal, will not make steam rapidly, causes clinker and hence adds to the labor at the time of fire cleaning more than it saves by the less frequent firings. When firing soft coal, do not fire the whole furnace at once. Place coal on the front part at one door at one firing, then on, say, the back portion at the other door at the next, to be followed in turn by the back part at the first door, and the front part at the second after which the cycle may be repeated. Any other method, which will divide the grate into a checker board, firing alternate squares in rotation will do as well, the object is to have the fresh coal from which gases are being distilled off, adjacent to bright parts of the fire, so that the gases must either pass over or along side of the bright patches, which will greatly assist in the ignition of the gaseous fuel, and tend to decrease the losses of unburned gas up the stack. If the whole grate is covered at once, then for a few minutes directly after firing, gases are being given off from the whole surface of the fire. On the other hand, none of the coal on the surface is burning, and hence there is no bright portion to ignite them. As nearly the whole of the combustible gases will be given off before the coal itself becomes bright, there is about as great a loss of good fuel up the stack as can possibly be produced.

Air must be admitted over the fire for a short time after each firing to mix with the distilled gases so that they may burn. If no special devices are available good results can be had by leaving the fire door open a crack for a short time after each firing. In addition, the louvres or slides in the fire doors should be open all the time. If it is possible to check up the effect of the air admission by gas analyses it should be done. In this way, by finding the amount of opening of the fire doors, and the time of opening, which reduces the amount of carbon monoxide, CO, in the gases to zero, at the same time showing a minimum amount of oxygen, the condition for the greatest possible combustion efficiency will be found. Of course it may be found that no amount of effort in the admission of air after firing by means of the fire doors will cause the carbon monoxide to disappear. This may and probably will be due to the fact that the setting does not permit the streams of gas and air to mix properly, so that although there may be enough air admitted, it cannot come in contact with all the gas to be burned. In such a case some of the special types of furnaces, with devices such as combining arches and wing walls of brickwork may be the only means by which complete combustion can be obtained.

The slice bar should not be used if it can be avoided. When it is absolutely necessary to slice or bar up a fire, do not raise the clinker into the hot top layer of the fire, nor permit burning coal to get under the clinker. Either of these conditions will cause the clinker to melt and run down on the grates, making a larger clinker and perhaps cementing it so solidly to the grate that it cannot be removed till fires are cleaned. A thin fire, over a clean ash pit kept with a layer of water in it will prove in most cases the best preventive of clinker, and at the same time will prolong the life of the grates. Aggravated cases, as in the case of hard coal, may sometimes yield to steam jet treatment, under the grates.

The ash pit doors should be left open. The proper place to control the fire is at the damper, and if damper regulators are in use, they should be adjusted so as to regulate the fire properly and then left to do it as far as possible. The fireman should not be expected to climb on top of the boilers, or over hot flues every time the damper needs adjustment, but some convenient system of chains and levers should be installed so that he can have his damper control right at the furnace front, along with the gages and feed valves. With the exception of the use of the fire doors as already mentioned to admit air over the fire directly after firing, they should be kept closed whenever possible. If the fireman can study his work so that he can cut a few seconds off the time that the doors are open for each firing or cleaning interval, he will cut down immensely on the amount of excess air through the furnace. We have shown above what the effect of air excess is on combustion and boiler efficiency, but it should not be lost sight of that there is another and perhaps equally serious side to the matter. Every time that the fire door is opened up, a blast of cold air strikes back directly onto the boiler surface. With whatever kind of boiler is in use, there will be a chilling effect that will tend to lessen the amount of steam produced, but in many if not most boilers serious mechanical stresses may be set up due to the sudden contraction of a part of the boiler structure. In the return tubular boiler, the girth seams and tube ends are the first to suffer, vertical fire tube boilers and locomotive type boilers also suffer from tube end trouble and may also gradually acquire stay bolt difficulties from the same cause, while all types of boilers will be affected, each in its own peculiar way. This matter as well as economy points toward frequent firings of small quantities of coal, for in this way the time during which the doors remain open at any particular firing is much less than in the case where a large amount of coal is fired at longer intervals.

Clean boilers, free from scale and oil, a steady non-fluctuating water level, and a steady steam pressure all are necessary to economy, and it is one of the measures of a good fireman, that he can maintain a steady water line and a uniform steam pressure, without sacrifice of good furnace or combustion conditions, with a varying load.

Last of all, it is perhaps not out of place to mention the gains which can be made by picking up and saving every drop of hot water which is sufficiently free from oil to be safe in the boiler, and returning them with the feed. Many devices are to be had which will safely remove the oil from exhaust steam, so that the steam may be used for most purposes where industrial conditions call for steam heating or cooking. No live steam should be so used where exhaust steam can be made to serve, and no exhaust steam should be permitted to escape from an atmospheric exhaust pipe, so long as it can possibly be used for heating feed water or for other purposes. Steam traps may waste a tremendous amount of steam if out of adjustment. Uncovered or poorly covered steam pipes need attention, and indeed a campaign of good power plant housekeeping should be entered into wherever coal is burned and steam used.

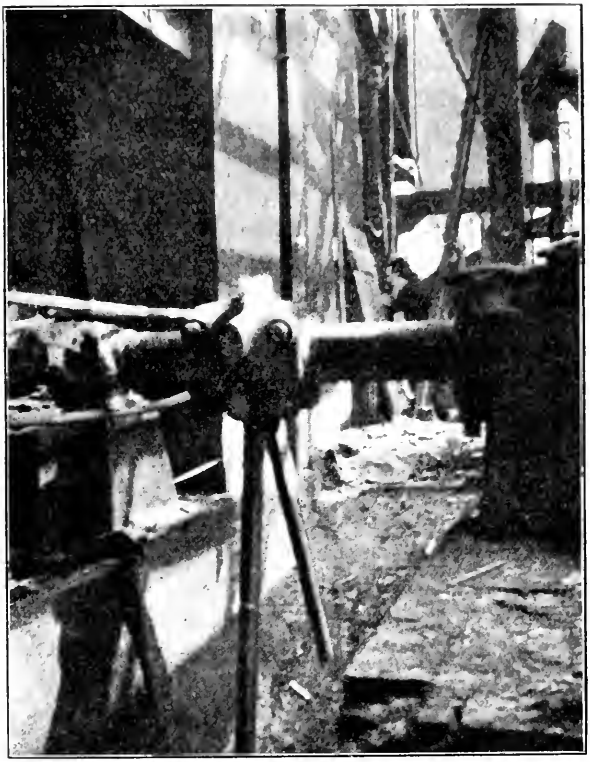
The Barn Door.

By Chief Inspector J. P. Morrison.

Whether it were an act of wisdom to "lock the barn door" after the horse had been stolen would depend upon the value of the harness; so what is often referred to as a proverbially ridiculous proceeding may, after all, be based on sound judgment, although if the barn-door lock is to be a real safeguard it should be purchased simultaneously with the horse.

At first glance it may be difficult to find any relation between the foregoing observations and the fly wheel explosion, the results of which are shown by the accompanying photographs, but a brief recital of the history of the accident will not only establish a connection, but should impress upon the owner of each engine that he has a barn door to lock.

In the ordinary course of our business transactions an application for insurance was received on the 12-foot engine wheel operated as part of a Corliss type engine in a middle-west manufacturing establishment. An examination of the wheel, valves and



THE FLYWHEEL, AFTER THE EXPLOSION.

governing mechanism was made, which discovered the fact that the governor stop of the engine was not of the automatic type, and that the safety cams were not adjusted to prevent the cylinder from obtaining steam when the governor was at its lowest point; on account of which the operation of the wheel was considered unsafe.

Considerable has been written on the subject, but it may not be amiss to describe fully the conditions which were considered sufficient to temporarily prevent the insurance of the wheel.

The speed at which the wheel of a Corliss type engine rotates is regulated by the amount of steam at boiler pressure admitted at each stroke, and when sufficient steam has entered the cylinder the valve closes. Should the load increase, a greater volume of steam is admitted and in case the load decreases the volume is decreased. The changes in admission are to a slight extent continuous during the time the engine is in operation even under a normal load and, whether the change is great or small, it is controlled by the governor, which travels at a higher plane as the speed increases and at a lower plane as the speed decreases; the former causing the valves to close earlier thus decreasing the volume of steam admitted, while the latter causes the valve to remain open longer increasing the volume of initial pressure steam.

The closing of the valve is regulated by what are commonly known as "knock-off cams," which, when properly adjusted would prevent the wheel from attaining a dangerous speed, so long as the engine was under normal load, and the governor in operating condition. However, should the governor belt break or slip, so the governor would cease revolving, the governor would descend to its lowest position and admit the greatest possible volume of steam, resulting, of course, in an increase in the speed of the wheel until disruption occurs.

In order to guard against an accident of that kind, the valves are equipped with safety cams, which, when properly adjusted, prevent the valve hooks from engaging the valve blocks, so the valves remain closed.

It will be seen that when the engine is stopped at any time and the governor ceases to revolve the governor will drop to its lowest position, bringing the safety cams into place, so the engine cannot be started. This is overcome by blocking the governor when idle, into a position above that at which the safety cams act. The appliance used for this purpose is called the "Governor Stop" and may be one of many different forms.

Some of the governor stops are so arranged that the attendant must put the governor stop into shut-down position before the throttle is closed and then remove it when the engine attains normal speed after again being started; while other types of governor stops are overbalanced, or otherwise arranged to drop into running position automatically when the governor lifts upon starting.

It should now be perfectly clear that, should the knock-off cams be out of adjustment so that the governor could not control the admission of steam, the amount of the load only would prevent the engine from running away. A broken main belt would, of course, release the load, and the wheel could hardly be prevented from attaining a disrupting speed.

Again, should the safety cams be missing or be set too low, and the governor belt break or slip allowing the governor to descend to its lowest position, the engine would obtain the maximum amount of steam and a dangerous speed would result.

Or, should the governor stop be of the non-automatic type and through ignorance, carelessness, or design, not be removed from shut-down position when the engine starts, and the governor belt should break or slip, the governor would cease revolving, descend on to the stop and allow the cylinders to obtain steam full-stroke. as a result of which the engine would speed up correspondingly and attain a disrupting speed if the main drive belt should break or the load be thrown off at the time.

On the other hand, were the knock-off cams and safety cams properly located and the governor stop of the automatic variety the probability of overspeeding is greatly reduced, if not entirely eliminated.

To return to the conditions discovered by our Inspector it will be remembered the safety cams were not in proper position and the governor stop did not operate automatically; so in case the governor stop was allowed to remain in shut-down position and the governor ceased to revolve for any reason, the cylinders would receive the maximum amount of steam and the governor would not act even if it descended to its lowest position as the safety cams were not properly adjusted.

However, upon receiving our report and recommendations the owner of the engine immediately made proper changes and improvements, so upon the re-examination the wheel was considered a desirable risk and a policy of insurance was written but only to be returned with the statement that the owner of the wheel did not then desire to insure it, feeling, no doubt, that as our recommendations had been complied with, the possibility of an accident had been eliminated and by carrying his own risk the premium would be saved; which, however, was not conclusive as later developments fully illustrated.

The Inspector who made the examination of the wheel and engine visited the plant, a short time after the policy covering the wheel was returned, to examine the boilers and remembering his recent reports on the wheel made a re-examination of it also, when he discovered the knock-off cams had been allowed to get out of proper adjustment so the governor could control the engine only when the full load was on. To this he called attention of the engineer in charge and reported it to the Company. As we had no interest in the wheel, our policy of insurance having been returned, we do not know what changes, if any, were made but within a few days after our Inspector's visit, the main drive belt broke, released the engine of its load and allowed the wheel to explode violently.

Two men were seriously, although not fatally injured, and the property damage was approximately $3,000, to say nothing of the Use and Occupancy loss due to the plant being out of service for a couple of weeks while a new wheel was being fitted and the engine overhauled. One piece of the wheel weighing about five hundred pounds, was thrown through the ceiling of the engine room, through the outside wall of the building and then passed through the brick wall of a powder house about one hundred yards away.

It is impossible to state the exact speed attained by the wheel before the explosion occurred but the increase was so sudden that the governor balls were moved to a higher plane with sufficient force to bend the rods supporting them.

The wheel which is now in operation at the plant, is insured and great care is exercised in keeping the various parts of the engine, upon which the safety of the wheel depends, in first-class condition, although had the first lock been allowed to remain on the barn door, we are firmly convinced the first horse would not have been stolen.

The Designation of Bumped Heads.

There has been unfortunately, considerable discrepancy in the terms applied to the heads of cyclindrical shells for boilers and tanks when they are formed to a spherical shape. The trouble comes because there are two possible ways of riveting the heads to the shells. One way, which is always associated in the writer's mind with the expression "bumped head," is illustrated in figure 1. The other way, always a "dished head" in the writer's own mind, is shown by figure 2.

If we always added a picture to our own words, no trouble would follow and every one would know which method of attachment we had in mind. The trouble comes, however, when we try to calculate how strong a head is, if attached by either of the methods shown. We soon discover that the manner shown in figure 1 yields a stronger vessel, for the same thickness of metal in the head and shell, and for the same design of riveted joint, than that in figure 2.

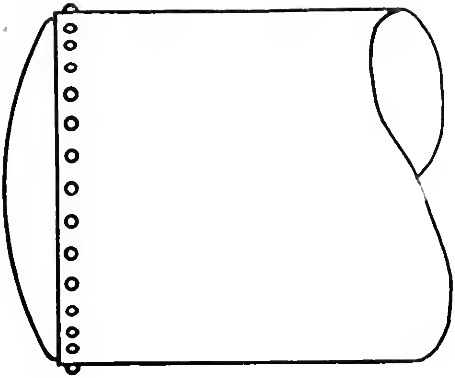


FIG. 1.

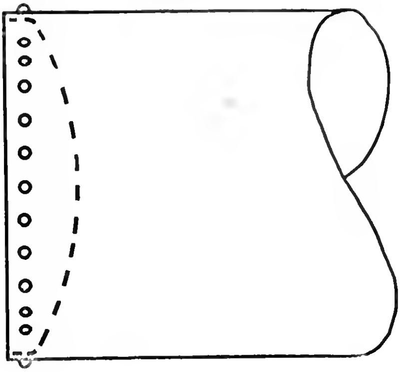


FIG. 2.

In formulating rules for calculating the strength which a spherical head may be assumed to possess, various bodies of men have attempted to make the particular case to which their rules applied so clear that no one would mistake their meaning. It is not the writer's intent to criticize the terms which have appeared in these various sets of rules. In most of them (though not all), the language used has been such as to express what was in mind if it is very carefully followed. The trouble is however, that the words "bumped" and "dished" have been used by some in the sense of figures 1 and 2. By others "bumped" has been applied to all sorts of spherical heads, and by still others "dished" has been used with equal universality. Then to make matters clear they have fallen back on the words concave and convex. Immediately there comes the need to say whether they consider themselves on the outside looking in, or on the inside looking out, for any spherical head is either convex or concave, depending on which side is in view at the time it is described. This has given rise, in one case at least, to the perfectly truthful expression, a "concave head convex to pressure" and vice versa. These terms are really quite self explanatory, but unfortunately are just involved enough to cause the confusion they are intended to avoid. Concrete cases, coming to the attention of the writer, show that intelligent men, with an ordinary understanding of the English language, have mistaken, and are mistaking them.

The writer, at the expense of possible criticism, or even ridicule proposes a new set of terms for thoughtful consideration by our readers. He conceives of the head of figure 1, as having its contents added to the volume of the shell, making a larger vessel than would result from the use of a flat head. He therefore proposes that we call it a "plus" (+) head. The head of figure 2 has its volume subtracted from that which the vessel would have with a flat head, and therefore, it is proposed to call it a "minus" (—) head.

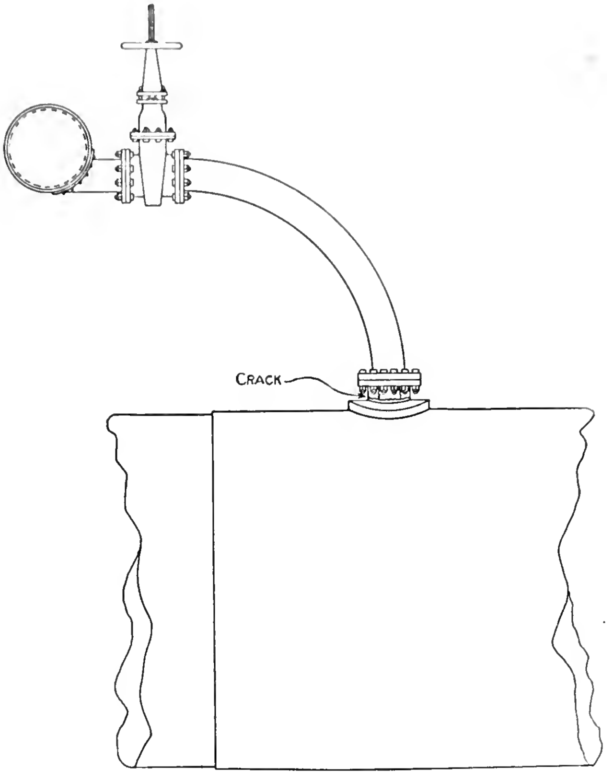
Criticisms, suggestions, or approval of these terms would be warmly welcomed, and we earnestly hope we have started something.

Why Is a Boiler Inspector?

The accompanying sketch shows a condition recently unearthed by one of our inspectors in the regular course of his work which in itself is interesting as an example of what may be done in preventing a serious accident. The circumstances under which the discovery was made add a double interest.

The inspector had been sent on a trip which included calling at a certain plant to inspect some locomotives. After he started on his trip the manager of the plant telephoned the office from which the inspector worked that the locomotives could not be prepared for inspection, and asked two or three weeks time in which to get them ready. As the information came in too late to catch the inspector he proceeded to the plant in ignorance of the fact that these boilers would not be available, and while there looked over the idle stationary boilers, finding the condition sketched. The cast iron nozzle or flange by which the connection was made from the boiler to the pipe which lead to the steam drum was cracked circumferentially, and the crack had extended nearly around the nozzle. This condition it need scarcely be said was so dangerous that had the boilers been put under steam again without removing the cracked nozzle, an accident would have been almost inevitable. The steam pipe would have suffered, even if the shock did not prove sufficient to cause an explosion of the boiler. Indeed, the sudden parting of the flange might well have caused a violent boiler explosion.

The owner of the plant was grateful enough that his telephone call had been too late to intercept the inspector, and he took good care that the locomotives were prepared to receive their share of the inspector's skilled attention at an early date.



THE CRACKED NOZZLE WHICH THE INSPECTOR FOUND.

With the Colors.

On the front cover we print a reproduction of The Hartford Steam Boiler Inspection and Insurance Company's service flag, the outward and visible sign of the pride which the Company takes in its boys in the service.

John C. Ross, who left the Home Office inspection force to enter the naval service as Machinist with the calling out of the Connecticut Naval Militia, has been commissioned an Ensign, and transferred to the Reserve force (U. S. Navy). He is at present attached to the U. S. S. Virginia, and may be addressed in care of the postmaster, New York City.

A. Gordon Merry, who left the office force at the Home office to attend the Officers Training Camp at Plattsburg, has been commissioned First Lieutenant of Infantry, and is at present stationed at Camp Devens, Ayer, Mass.

Graham R. Hart, and Henry E. Gerrish, who enlisted from the drafting room force of the Home Office, have been heard from as safely in France.

Elmer B. Haines, who attended the Coast Artillery School for Non-Commissioned Officers at Fortress Monroe, Va., has been appointed Master Gunner, and attached to the Artillery Board, at Washington, D. C.

Walter A. Marley, a clerk in the New York Office of the Hartford, has been called into the service, and when last heard from was stationed at Camp Dix, Wrightstown, N. J.

The Food Situation.

The railroads cannot carry coal to you and also handle military supplies in the quickest way. Help by burning less coal.

Coal supplies power for electric light and steam heat. Turn off both when you don't need them.

If you can get wood, use it instead of coal.

THE UNITED STATES FOOD ADMINISTRATION asks you to get behind our soldiers, sailors and associates by sending them now the most food possible in the least shipping space. Every man, woman and child in America can help by eating less wheat, beef, pork, fats and sugar, more of other plentiful foods which cannot be shipped, and by avoiding waste.

EAT PLENTY, WISELY, WITHOUT WASTE, AND HELP WIN THE WAR.

Reprint from material furnished by the UNITED STATES FOOD ADMINISTRATION.

Coal Saving Poster of the Connecticut Fuel Administrator.

In an effort to emphasize the importance of the fireman himself, the man who actually shovels the coal, in furthering the ends of the conservation of fuel, the Connecticut Fuel Administrator has distributed to all boiler rooms in his territory a copy of the poster reproduced on the opposite page. It is printed in color, and shows Uncle Sam reaching out to the fireman and extending his message direct to the man with the shovel. " Save your coal to fire the Kaiser, Here's How," with a few simple rules for good firing.

We thought that the poster was good enough to pass along to the fire rooms outside Connecticut, and so included it in this issue of The Locomotive.

SAVE YOUR COAL to FIRE THE KAISER

HERE'S HOW!

1. Keep boiler tubes clean from soot and scale both inside and outside.
2. Stop air leaks in boiler settings, flue doors, and cleaning holes.
3. Repair leaky steam pipes and valves.
4. Keep side and bridge walls free from ashes and clinkers.
5. Keep ash pit cleaned out.
6. Keep your fire thin as your draft allows.
7. Fire at short intervals and in small quantities.
8. Keep your fire bed level by spreading coal over thin spots.
9. Do not stir your fire unless necessary. To do so will cause clinkers.
10. Do not fire lumps larger than your fist.
11. Regulate draft with dampers not with ash pit doors.
12. Work your fire by your automatic damper, not your steam gauge.

THOMAS W. RUSSELL,
Connecticut Fuel Administrator

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. PERRY, EDITOR.

HARTFORD, JANUARY, 1918.

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 of matter from this paper is permitted if credited to
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

This issue of The Locomotive marks the beginning of a new volume. We have taken advantage of the opportunity to change the size of the type with which the body of the magazine is set. Some of our best friends believe that The Locomotive has lost some of its possible usefulness by retaining so conservatively the type face in which it has appeared since 1880, reasoning that the type page, when unrelieved by illustrations, was somewhat trying to read. We think the criticism a just one and as we earnestly desire that the material, to the preparation of which we give our best thought, shall be presented to our readers in a form at once as attractive and useful as possible, we have listened to the suggestion and have decided to make the change. We hope that by so doing we have produced a more readable paper, and would appreciate the views of our readers in the matter. Explosion lists will continue to appear in the same type as at present lest this feature, valuable as it is, should encroach too freely on space needed for other things.

The Locomotive is trying to supply information which will help the engineers and firemen in their efforts to conserve coal. Going as it does to such a large list of steam users, these articles should prove of wide spread interest and service. It is needless to say that this service cannot be fully realized unless the request printed on the mailing envelope, that the paper be read and handed to the engineer, is complied with. We therefore call attention to the desirability of getting The Locomotive, when it has been read, into the hands of the man who burns the coal, and we, on our part, will endeavor to give him something of practical value in every issue. In the October number, we printed an article on the general principles of combustion, together with articles containing useful suggestions regarding the care and operation of heating boilers, while this issue contains an article intended to help the man who is trying to make steam economically with existing equipment, and whatever fuel is available. We think these articles to be timely, and trust that they may help some of our readers to solve the serious problems with which they are at present confronted.

Personal.

Mr. Geo. H. Ward, until recently Manager of the Pittsburg office of The Hartford Boiler Inspection and Insurance Co. has resigned. Mr. Ward has been succeeded by Mr. M. M. Atherton. Mr. Atherton has been associated with the Company for over ten years and latterly as Special Agent at Indianapolis, where he has made a large circle of business and personal friends. We consider it fortunate that Mr. Atherton is available for this office, as we are confident that he will carefully look after the interests of our clients and agents, and in so doing give assurance of continued patronage and friendly relationship.

Mr. J. A. Snyder, who has long been attached to the inspection department at the Pittsburg office, has been advanced to the rank of Assistant Chief Inspector.

Fly Wheel Explosions.
1915.

(21.) — A fly wheel exploded October 5, at the saw mill of the Schneider and Brown Lumber Co., Marquette, Mich. One man was injured and considerable damage done to other wheels, shafting and belts.

(22.) — A fly wheel exploded October 25, at the plant of the Central Foundry Co., Newark, N. J. The plant engineer was killed and considerable property damage done.

(23.) — On October 27, a 4-foot pulley exploded at the plant owned by the estate of Henry W. and William D. Whitaker, Philadelphia, Pa. The damage was slight.

(24.) — The fly wheel of a threshing machine burst October 28, on the farm of Fred Schrader, near Gackle, N. D. Mr. Schrader was seriously and perhaps fatally injured as a result of the explosion.

(25.) — The fly wheel of a motor truck belonging to Deuth Brothers, hardware dealers, at Forreston, Ill., exploded October 28, while the truck was standing in front of their store receiving a load of goods. The exploding wheel did some little damage to surrounding property, and slightly injured the driver who was seated on the truck at the time.

(26.) — The fly wheel on an ensilage cutter exploded November 6, on the farm of Jerome Billings, Corning, N. Y. One man who was feeding the cutter was injured.

(27.) — The fly wheel of a gas engine exploded November 7, on an oil lease on the James Brown farm, Bolivar, N. Y. Two men, who had been repairing the engine were instantly killed.

(28.) — The balance wheel of a hand-driven sheller exploded November 23, on the ranch of Carlos Sedillo, Sweetwater, N. M. The fifteen-year-old daughter of the owner of the machine was fatally injured, having been struck in the temple by a flying fragment.

(29.) — The fly wheel of an automobile exploded November 26, at Canisteo, N. Y. The car was driven by the owner, Mr. C. G. Andrews at the time of the accident, who fortunately escaped injury, but a friend who was riding with him was seriously injured.

(30.) — A fly wheel exploded December 3, at the Omaha, Neb., plant of Swift and Company. The flying fragments of the exploded wheel struck and broke an ammonia pipe, resulting in the death by suffocation of two machinists who were working at the plant.

Fly Wheel Explosions.

1916.

(1.) — A fly wheel exploded January 7, at the Peck Foundry, Le Mars, Ia. One man was badly injured.

(2.) — During the testing of newly installed machinery at the Christianson Cary planing mill, Cumberland City, Tenn., on January 22, a wheel burst, seriously injuring one man.

(3.) — The fly wheel of a gasoline engine used to drive a fodder cutter exploded January 22, on a farm near Pottstown, Pa. One man was seriously, and probably fatally injured.

(4.) — A fly wheel exploded January 22, at the plant of the Sayles Bleacheries, Saylesville, R. I. One man was instantly killed and two others were injured by the explosion.

(5.) — The fly wheel of a gasoline engine used for wood sawing exploded January 25, near Chippewa Falls, Wis. One man was fatally injured.

(6.) — A fly wheel exploded February 5, at the Schuylkill Haven Rolling Mills, Schuylkill Haven, Pa. No one was injured, but the plant was shut down pending repairs.

(7.) — On February 15, a fly wheel failed at the plant of the Unity Paper Mills Company, Potsdam, N. Y. The damage was confined to the wheel.

(8.) — An idler pulley in a rope drive failed February 15, at the plant of the Leaksville Cotton Mills, Spray, N. C.

(9.) — A fly wheel exploded March 15, at the Simonds saw mill, near Portland, Me. One man was instantly killed, being carried by a flying fragment of the wheel through the side of the mill, and a distance of some twenty-five feet beyond the wall.

(10.) — A fly wheel exploded April 1, at the Houghton Brewery, Roxbury, Mass. One man was seriously injured.

(11.) — A fly wheel exploded April 1, at the Ada electric light plant, Ada, Okla. No one was injured, but damage to an extent estimated at $8,000 was done to the plant.

(12.) — A fly wheel exploded at the plant of the Easton Finishing Co., Philadelphia, Pa., on April 8. The damage was estimated at more than $5,000.

(13.) — A fly wheel failed April 18, at the plant of McEwan Bros., Malapardis, N. J. The damage was confined to the wheel.

(14.) — On May 19, a fly wheel ruptured at the plant of the Lock-Moore Co., Ltd., West Lake, La.

(15.) — A fly wheel exploded May 31, at the power house of the Montgomery Electric Co., Montgomery, Pa. The damage to the plant was considerable, and the towns of Montgomery and Muncy were left without electric current as a result of the accident.

(16.) — The fly wheel of a motor truck, belonging to the Canton Home Furnishing Co., exploded June 1, at Canton, O. The truck was being towed at the time, and the driver tried to start the motor. Fragments of the exploded wheel seriously injured the driver.

(17.) — A pulley exploded June 12, at the plant of McEwan Bros., Whippany, N. J.

(18.) — A fly wheel exploded June 20, at the plant of the South Atlantic Lumber Co., Greensboro, N. C.

(19.) — A fly wheel exploded July 17, at the plant of the Leona Mills Co., Leona, Ore. A millwright at the plant was in the act of closing the engine throttle when the accident occurred, and was fatally injured.

(20.) — A fly wheel exploded July 18, at the Goodrich reclaiming plant, Kenmore, O. One man was killed and another injured.

(21.) — A fly wheel exploded August 1, at the plant of the Kirby Lumber Co., Silsbee, Tex. One man was killed and heavy damage done to the mill property.

(22.) — A fly wheel exploded August 7, at the plant of the W. Dewees Wood Co., McKeesport, Pa. No one was injured, but property damage was estimated at $20,000.

(23.) — The fly wheel of a crude oil engine exploded August 7, at the plant of the Henke Artesian Ice and Refrigerating Co., Houston, Tex. An engineer who had been engaged in erecting the machine which was newly installed, was injured.

(24.) — A fly wheel exploded August 8, at the plant of the Northland Pine Co., Minneapolis, Minn. Two persons were injured, and extensive damage done both by the explosion, and by a fire that followed it.

(25.) — Two pulleys burst August 22, at the plant of the Jersey Shore Electric Co., Williamsport, Pa. The property damage was considerable.

(26.) — A 20-foot fly wheel exploded August 23, at the plant of the St. Louis Portland Cement Co., St. Louis, Mo. One man was killed, five others were injured, and the damage to property was estimated at $150,000.

(27.) — A fly wheel exploded August 31, at the plant of the Carey Ice and Salt Co., Hutchinson, Kan.

(28.) — A fly wheel exploded September 4, on an engine owned by the Associated Oil Company, operating on the Kern River field near Bakersfield, Cal. One man was killed.

(29.) — A pulley exploded September 10, at the plant of the Interlake Pulp and Paper Co., Appleton, Wis. One man was killed and considerable property was destroyed.

(30.) — On September 22, a fly wheel exploded at the plant of the Mansfield Railway Light and Power Co., Mansfield, O. One man was killed and large damage resulted to property.

(31.) — A large fly wheel exploded October 12, at the Andrews Rolling Mills, Newport, O. One man was injured and the property damage was estimated at $25,000.

(32.) — A fly wheel exploded October 17, at the Keystone Paper Mill, Lansdowne, Pa. One man was killed.

(33.) — A fly wheel exploded October 26, at the saw mill of A. W. Ross at Browning, Miss. Two men were injured, one fatally.

(34.) — A fly wheel exploded November 6, at the plant of the Queen City Forging Co., Cincinnati, O. Damage estimated at $2,500.

(35.) — A fly wheel exploded November 9, in a silk mill at Haverstraw, N. Y. Two men were injured.

(36.) — A fly wheel exploded November 22, at the grain elevator of George W. Lamb, near Lancaster, O. Mr. Lamb was killed.

(37.) — A fly wheel exploded December 1, at the plant of the Adams Clay Products Co., Martinsville, Ind.

(38.) — The fly wheel of a sawing outfit owned by Prosper Nainteau exploded December 13, at Manville, R. I. Flying fragments passed through a tenement house, but without injuring anyone.

(39.) — A fly wheel on a wood sawing outfit exploded December 16 at Fairbanks, Alaska. One man was killed.

(40.) — A fly wheel exploded December 22, in the rolling mill of the Harrow Spring Co., Kalamazoo, Mich. One man was killed and six others seriously injured.

(41.) — A pulley exploded December 21, at the plant of the West Virginia Pulp and Paper Co., Tyrone, Pa.

(42.) — The fly wheel of a feed cutter exploded December 30, at Marshfield, Wis. One man was killed.

Fly Wheel Explosions.

1917.

(1.) — A fly wheel exploded January 29, at the saw mill of the Fidalgo Lumber and Box Co., Anacortes, Wash. The accident shut down the plant.

(2.) — A fly wheel exploded January 29, at the plant of the Antietam Power and Electric Lighting Co., Breathedsville, Md.

(3.) — The fly wheel of a gasoline engine used for grinding corn exploded January 30, on the farm of Robert Miller, Chickasha, Okla. Mr. Miller was killed.

(4.) — A fly wheel exploded March 9, at the plant of the Fox Paper Co., Lockland, O. One man was seriously injured. The property damage was estimated at $5,000.

(5.) — An accident occurred to a fly wheel at the plant of the J. G. Cherry Co., Tama, Ia., on March 18.

(6.) — A fly wheel exploded March 23, at the Abington Cotton Mills, Huntsville, Ala. The damage was estimated at $15,000.

(7.) — A 66-inch generator drive pulley failed April 14, at the plant of H. F. and S. E. Jackman, Minneapolis, Kan.

(8.) — On April 29, a pulley failed at the plant of the Pynetree Paper Co., Gordon, Ga.

(9.) — An accident occurred to a fly wheel May 10, at the plant of the Essex Rubber Co., Trenton, N. J.

(10.) — A crank shaft broke May 13, at the plant of the Colorado Ice and Cold Storage Co., Denver, Col. The damage to the machine was large.

(11.) — On May 17, an accident occurred to a shaft governor wheel at the Manchester Cotton Mills, Manchester, Ga.

(12.) — A fly wheel exploded April 19, at the plant of the Lawless Paper Co., East Rochester, N. Y.

(13.) — A steam turbine exploded May 20, at the power plant of the Republic Iron and Steel Co., Youngstown, O. Four men were killed and eleven others injured. The property damage was extensive.

(14.) — A fly wheel exploded July 18, at the plant of the Logan Iron and Steel Co., Lewistown, Pa. One man was injured.

(15.) — About May 20, a turbine exploded at the plant of the King Paper Co., Kalamazoo, Mich.

(16.) — A pulley failed July 28, at the plant of the Weis Paper Mill Co., Quincy, Ill.

(17.) — A fly wheel exploded July 31, at the lighting plant at Bentonville, Ark.

(18.) — On August 22, an accident occurred to a fly wheel at the plant of the Densten Hair Co., Philadelphia, Pa.

(19.) — A fly wheel exploded August 23 at the Shabona power house, Shabona, Ill. One man was killed.

(20.) — A fly wheel exploded September 7, in a power house adjoining the Millinocket Opera House, Millinocket, Me. One man was killed and one other injured.

(21.) — A fly wheel exploded September 15, at the stone cutting plant of Carr and Ball, Harrison, N. J. The damage was set at $5,000.

(22.) — A fly wheel exploded September 15, at the plant of the Fort Smith Spelter Co., South Fort Smith, Ark.

(23.) — An automobile fly wheel exploded October 6, at Rochester, N. Y. The wheel was a part of a racing car, and when it exploded a mechanician who was tuning up the car was killed.

(24.) — A fly wheel exploded October 17, at the power house of the Northern States Power Co., Fargo, N. D. One man was killed.

(25.) — The rotor of a turbine blower exploded October 23, at the Camden, N. J., plant of the Public Service Corp. of New Jersey. Two men were seriously injured.

Boiler Explosions.
August, 1917.

(274.) — On August 1, a boiler exploded at the Leckrone, Pa., plant of the H. C. Frick Coke Co. Three men were killed, four persons injured, and five other boilers together with the boiler and engine house wrecked.

(275.) — On August 2, a boiler ruptured at the plant of the Standard Ice and Fuel Co., Pittsburg, Kan.

(276.) — A boiler ruptured August 2 at the plant of the Terrell Cotton Oil Co., Terrell, Tex.

(277.) — A boiler ruptured August 3, at the plant of the Creamery Package Mfg. Co., De Kalb, Ill. The boiler was ruined.

(278.) — A boiler exploded August 3, at the plant of the Ash Lumber Co., Mobile, Ala. Two men were killed, five injured, and the plant badly wrecked.

(279.) — The boiler of a peanut roaster exploded August 6, at St. Clair, Pa. John Mazloon, the owner of the roaster was badly scalded.

(280.) — A blow-off failed August 8, at the plant of the Southern Cement Co., Birmingham, Ala. One man was injured.

(281.) — On August 10, a blow-off failed at the plant of the Kimbell Milling Co., Wolfe City, Tex. One man was injured.

(282.) — A tube ruptured and eight headers failed in a water tube boiler on August 10, at the Jersey City, N. J., plant of Armour and Co.

(283.) — On August 11, a tube ruptured in a water tube boiler at the Sharonville, O., station of the C. C. C. and St. L. Ry. Co.

(284.) — A tube ruptured August 15, in a water tube boiler at the plant of the Superior Steel Co., Carnegie, Pa.

(285.) — Children built a fire under an old boiler which they had found in a field, and which they had filled with water, at Lithonia, Ga., on August 13. There was a small hole from which steam escaped. This hole the children filled by driving in a nail, shortly after which the boiler exploded, fatally injuring four-year-old Wesley Smith.

(286.) — On August 16, a tube ruptured in a water tube boiler at the Southern Indiana Power Co. plant of the Middle West Utilities Co., Williams, Ind. One man was injured.

(287.) — On August 17, a header failed in a water tube boiler at the plant of J. H. Garrison and Son, Garrison, Tex.

(288.) — A blow-off failed August 17, at the plant of the Seymour Mill, Elevator and Light Co., Seymour, Tex.

(289.) — A boiler ruptured August 17, at the piano factory of the Hobart M. Cable Co., La Porte, Ind.

(290.) — A boiler exploded August 17, at the saw mill of G. B. Richmond, near Macon, Ga. One man was killed.

(291.) — On August 18, a superheater connection failed on a boiler at the Central Power Co. plant of the American Gas and Electric Co., Canton, O.

(292.) — On August 21, a flange on the steam connection to a boiler failed at the plant of the Dawson Cotton Oil Co., Dawson, Ga.

(293.) — A boiler exploded August 21, at the William Ford farm, Fond Du Lac, Wis. One man was seriously scalded.

(294.) — The boiler of a threshing machine outfit exploded August 24, on the farm of Chris. Roth, near Mansfield, Ill. One man was killed and two others injured.

(295.) — The boiler of a threshing outfit exploded August 24 on the Huston farm, near Early, Ia. Two men were injured.

(296.) — Two men were injured by a boiler accident August 25, on a converted navy patrol boat at Norfolk, Va.

(297.) — Ten headers failed August 26, in a water tube boiler at the National Home for Disabled Volunteer Soldiers, Hot Springs, S. D.

(298.) — A tube ruptured in a water tube boiler August 27 at the plant of the Federal Light and Traction Co., Walsenburg, Colo. One man was injured.

(299.) — A boiler exploded August 28, in a laundry at Battle Creek, Mich.

(300.) — A tube ruptured August 29, in a water tube boiler at the Penn. Coal and Iron Co. plant of M. A. Hanna and Co., Dover, O.

(301.) — Two tubes pulled from the drum of a water tube boiler at the Maas mine of the Cleveland Cliffs Iron Co., Negaunee, Mich.

(302.) — On August 29, a circulating tube failed in a water tube boiler at the Best Laundry, Indianapolis, Ind.

(303.) — A slight accident occurred to a water tube boiler at the plant of the T. A. Snider Preserve Co., Madison, Wis.

(304.) — A boiler ruptured August 29, on a prospecting outfit at Carthage, Mo. One man was badly scalded.

(305.) — An elevator pressure pipe failed at the plant of the West Boylston Mfg. Co., Easthampton, Mass., on August 30.

(306.) — On August 31, a blow-off pipe failed at the plant of the United States Industrial Alcohol Co., New Orleans, La.

(307.) — A tube pulled from the tube sheet on August 31, in a water tube boiler at the plant of the Chicago Cold Storage Warehouse Co., Chicago, Ill.

September, 1917.

(308.) — The boiler of a threshing machine outfit exploded September 1, at the farm of Simon Staley, Marysville, O. Three persons were injured, one of them perhaps fatally.

(309.) — A boiler ruptured September 2, at the plant of the Peoples Ice and Cold Storage Co., Claremore, Okla.

(310.) — The boiler of a threshing outfit exploded September 3, on the Winbigler farm, near Galion, O. One man was killed and two others badly injured.

(311.) — A section cracked September 4, in a cast iron sectional heating boiler on the premises of E. P. Earle, Newark, N. J.

(312.) — A boiler exploded September 6, at the Escondido coal mines over the Mexican border, some ten miles from Eagle Pass, Texas. Seven men were said to have been killed and seven others injured.

(313.) — On September 7, four tubes ruptured in a water tube boiler at the building of the Continental Trust Co., Baltimore, Md. One man was injured.

(314.) — A boiler exploded September 8, at the saw mill of T. A. Stanley, Arlington, Ky. Mr. Stanley and his two sons were eating lunch at the time of the explosion, and were all three hurled some forty feet and severely injured, one of them perhaps fatally.

(315.) — A tube ruptured September 10, in a water tube boiler at the plant of the Carthage Board and Paper Co., Carthage, Ind.

(316.) — A boiler exploded September 12, in a building at Pelham Bay Park, N. Y. The damage to the building was estimated at $1,500, no one being injured.

(317.) — A boiler exploded September 13, at the cap works of the Du Pont Powder Co., Pompton Lakes, N. J.

(318.) — On September 13, a tube ruptured in a water tube boiler at the plant of the Fitzgerald Cotton Mills, Fitzgerald, Ga.

(319.) — The boiler of a Great Northern locomotive exploded about September 14, at Butte, Mont. Both the engineer and fireman were killed.

(320.) — A boiler exploded September 18, at Neighbor's quarries, Vernoy, N. J. Two men were injured.

(321.) — The boiler of a threshing outfit exploded September 18, at Fred Reinke's farm, near Ashton, Ia. Four men were severely injured.

(322.) — A tube ruptured September 19, in a water tube boiler at the plant of the Weis Paper Mill Co., Quincy, Ill.

(323.) — On September 20, a section cracked in a cast iron sectional boiler at the building of the Children's Aid Society, New York City.

(324.) — A section cracked September 22, in a cast iron sectional heating boiler at the apartment house of George B. Elkins, San Francisco, Cal.

(325.) — On September 23, 11 headers and 2 tubes ruptured in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(326.) — A boiler ruptured September 25, at the plant of the Home Ice Factory, San Antonio, Tex.

(327.) — A tube ruptured September 25, at the glue works of Armour and Co., Chicago, Ill.

(328.) — On September 26, a tube ruptured in a water tube boiler at the plant of the Coshocton Straw Paper Co., Coshocton, O.

(329.) — On September 26, a blow-off failed at the plant of the Milwaukee Reliance Boiler Works, Milwaukee, Wis.

(330.) — On September 27, two headers failed in a water tube boiler at the plant of the Diamond Alkali Co., Fairport, O.

(331.) — The boiler of a dredging machine exploded September 27, at the sand dredging plant of the Virgil C. Jones Sand and Gravel Co., Indianapolis, Ind. Two men were injured.

(332.) — A boiler ruptured September 28, at the plant of the H. Weston Lumber Co., Logtown, Miss.

(333.) — A tube ruptured September 28, in a water tube boiler at the plant of the Morrow Milling Co., Milwaukee, Wis.

(334.) — On September 28, a return pipe failed on a cast iron sectional heating boiler at the building of Frederick E. Moore, Williamstown, Mass.

(335.) — A boiler exploded September 28, at Koopman and Epler's cotton gin, Muldoon, Texas. Two men were injured and the plant was wrecked.

(336.) — On September 29, 4 headers ruptured in a water tube boiler at the Benedict and Burnham branch of The American Brass Co., Waterbury, Ct.

(337.) — A header cracked September 30, in a water tube boiler at the plant of the Pollock Becker Co., Ashtabula Harbor, O.

October, 1917.

(338.) — A tube ruptured in a water tube boiler October 1, at the coke plant of the Lackawanna Steel Co., Lackawanna, N. Y. One man was killed.

(339.) — On October 1, a tube ruptured in a water tube boiler at the plant of the George Ziegler Co., Milwaukee, Wis.

(340.) — A tube ruptured October 2, in a water tube boiler at the coke plant of the Lackawanna Steel Co., Lackawanna, N. Y. This is a separate and distinct accident to that described above, occurring in a different boiler, though in the same plant.

(341.) — A tube ruptured October 5, in a water tube boiler at the plant of the Central Illinois Public Service Co., owned by the Middle West Utilities Co., Mounds, Ill. One man was injured.

(342.) — On October 6, six tubes pulled out of the drum of a water tube boiler at the plant of the Worcester Electric Light Co., Worcester, Mass.

(343.) — A section cracked October 6, in a cast iron sectional heater in a building belonging to the Broc Realty Co., Cleveland, O.

(344.) — A tube ruptured October 8, in a water tube boiler at the plant of the Nash Motors Co., Kenosha, Wis.

(345.) — Four sections cracked October 9, in a cast iron sectional heating boiler at the Keystone Theater building owned by the Standish Realty Corp., New York City.

(346.) — One man was severely burned as a result of a boiler accident October 10, at the Washburn-Crosby flour mill, Minneapolis, Minn.

(347.) — Four sections cracked in a cast iron sectional heater at the beer distributing plant of J. S. Wahl, Caruthersville, Mo.

(348.) — A tube ruptured October 13, at the plant of the Beveridge Paper Co., Indianapolis, Ind. One man was fatally injured.

(349.) — Two sections cracked in à cast iron sectional heater at the Charlesbank Homes, apartment house, Boston, Mass., on October 14.

(350.) — A slight explosion occurred October 15, in a heating boiler at Dubuque College, Dubuque, Ia. One man was injured.

(351.) — A tube failed in a horizontal tubular boiler October 15, at the Briggs Hotel, Chicago, Ill. One man was injured.

(352.) — On October 15, a tube ruptured in a water tube boiler at the plant of the Consolidated Gas, Electric Light and Power Co., Baltimore, Md. One man was injured.

(353.) — A section failed in a cast iron sectional boiler at the warehouse of the American Sumatra Tobacco Co., Chicopee, Mass., on October 16.

(354.) — A boiler exploded October 16, at the Yater stone quarry, Shelbyville, Ind. One man was fatally injured.

(355.) — A tube ruptured in a water tube boiler at the plant of D. Auerbach and Sons, New York City, on October 17.

(356.) — On October 18, a tube ruptured in a water tube boiler at the plant of the Terre Haute, Indianapolis and Eastern Traction Co., Terre Haute, Ind. One man was injured.

(357.) — Two sections cracked October 19, in a cast iron sectional boiler at the plant of Sommers Bros., Omaha, Neb.

(358.) — On October 19, a blow-off failed at the plant of P. S. Heacock and Sons, Falls City, Neb.

(359.) — On October 20, a blow-off failed at the plant of the Cochran Oil Mill and Ginnery Co., Cochran, Ga. One man was injured.

(360.) — The boiler of the saw mill of J. K. Barber exploded October 19, at Newton, Miss. One man was killed and two others injured.

(361.) — A boiler burst October 20, at Kelly's Institute, Westville, Ill.

(362.) — A boiler ruptured October 20, at the plant of Carver and Co., Celeste, Kans.

(363.) — A tube ruptured October 20, in a water tube boiler, at the power house of the Illinois Traction System, Bloomington, Ill.

(364.)— On October 21, two tubes ruptured in a water tube boiler at the plant of the Inland Steel Co., Indiana Harbor, Ind. Three men were injured.

(365.) — A tube ruptured October 21, in a water tube boiler at the building of the Butler Exchange Co., Providence, R. I. One man was injured.

(366.) — A header ruptured in a water tube boiler on October 21, at the plant of the Milwaukee Coke and Gas Co., Milwaukee, Wis. One man was injured.

(367.) — On October 22, a steam pipe failed at the paper mill of the Hammermill Co., Erie, Pa. One man was killed, one other fatally injured, and one less seriously injured.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1917.

Capital Stock, ... $2,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$346,803.88
Premiums in course of collection,		388,276.03
Real Estate,		90,000.00
Loaned on bond and mortgage,		1,554,570.00
Stocks and bonds, market value		4,362,015.45
Interest accrued		98,141.14
		$6,839,806.50
Less value of Special Deposits over Liability requirements,		34,518.75
Total assets,		$6,805,287.75

LIABILITIES.

Premium Reserve,		$2,738,563.68
Losses unadjusted,		67,528.30
Commissions and brokerage,		77,655.20
Other liabilities (taxes accrued, etc.),		166,969.55
Capital Stock,	$2,000,000.00	
Surplus over all liabilities,	1,754,571.02	
Surplus as regards Policy-holders,	**$3,754,571.02**	3,754,571.02
Total liabilities,		$6,805,287.75

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President. W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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

INSURES AGAINST LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Department.	Representatives.
ATLANTA,, Ga., 1025-1026 Hurt Bldg.	W. M. Francis, Manager and Chief Inspector. C. R. Summers, Ass't Chief Inspector
BALTIMORE, Md., 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. R. E. Munro, Chief Inspector.
BOSTON, Mass., 101 Milk St.	C. E. Roberts, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents. F. S. Allen, Chief Inspector.
CHICAGO, Ill., 160 West Jackson St.	H. M. Lemon, Manager. James L. Foord, Chief Inspector. J. T. Coleman, Assistant Chief Inspector.
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CLEVELAND, Ohio, Leader Bldg.	H. A. Baumhart, Manager and Chief Inspector. L. T. Gregg, Ass't Chief Inspector.
DENVER, Colo., 918-920 Gas & Electric Bldg.	Thos. E. Shears, General Agent and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Williams, Jr., General Agent. F. S. Allen, Chief Inspector.
NEW ORLEANS, La., 833-835 Gravier St.	Peter F. Pescud, General Agent. R. T. Burwell, Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnet, Assistant Chief Inspector.
PHILADELPHIA, Pa., 142 South Fourth St.	A. S. Wickham, Manager. C. H. Dennig, Ass't Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
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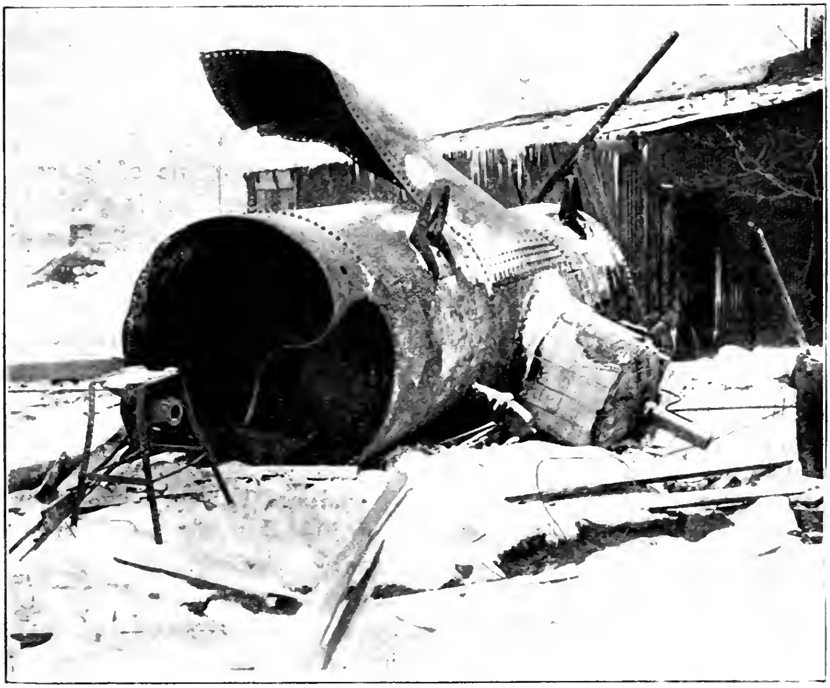
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. J. P. Morrison, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, General Agent.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

Vol. XXXII. HARTFORD, CONN., APRIL, 1918. No. 2.



Boiler Explosion at the Swansea, Ill. Municipal Lighting Plant.

Concrete Examples of Coal Conservation.*

By H. E. DART, Superintendent of Engineering Department.

The good, old days when we held the dealer to a "strict accountability" for the quality of the coal which we purchased are now only a pleasant memory. There is no longer any discussion of the advisability of buying coal on a heat-unit basis because there is no possibility of doing so. We are not at all fussy about what mine the coal comes from and we are willing to take any size from "egg" down to some of the soft stuff which looks like black dirt. We believe that the coal contains about twice as much refuse per ton as we used to get and this opinion is confirmed by analyses which have been made by the Bureau of Mines. Nevertheless, conditions are such that we gladly accept and pay for almost anything which is black and which has the general appearance of coal. If the man who made the wooden nutmegs should drive around with a load of crushed trap-rock nicely coated with tar, he would probably have little difficulty in disposing of it at the current rate of Ten-fifty per ton for coal. Even aside from any patriotic motives, therefore, it behooves us to be-Hooverize the coal supply for reasons of simple economy and actual necessity.

Much has been written and published recently concerning methods of saving coal,— most of it good but some of it more amusing than instructive. Included in the latter class is a widely circulated article in which was made the statement that "some of the coal that is coming from Pennsylvania into New England at this time contains only about eight hundred heat units to the ton and is very satisfactory." The tar-coated trap-rock mentioned above might have a heat value of approximately this amount, depending entirely upon the thickness of the tar coating. It is probable that the figure in the article should have been 16,000,000 instead of 800 as the statement presumably referred to a poor grade of coal carrying about 8,000 British Thermal Units per pound. Such coal would hardly be considered "very satisfactory" though it could be burned under proper conditions.

In most of the literature which has appeared recently, the general problem of saving coal has been considered from the standpoint of getting the maximum amount of heat out of each pound burned. With this object in view much excellent advice has been given and many valuable suggestions have been made in regard to proper means of firing coal, correct method of operating dampers,

* Printed in shorter form in THE HARTFORD COURANT.

removal of soot, scale and ashes, stoppage of air-leaks in setting walls, etc. Valuable information has also been printed relative to the proper design and construction of furnaces and settings though, in most heating plants, this information can not be applied during the heating season because the boilers must be kept in operation continuously. Supplementary to all efforts along the lines of burning coal properly, however, eternal vigilance should be exercised to save coal by saving heat, the opportunities for saving coal in this manner being fully as great as in any other way. It is, of course, impossible to formulate any general set of rules which can be used indiscriminately for saving heat. Each building presents a case by itself which requires careful study by someone having an intimate knowledge of all the conditions. By means of such a study The Hartford Steam Boiler Inspection and Insurance Company has reduced the average coal consumption in its office building by about twenty-five per cent. and a description of the methods employed may be interesting and suggestive to those who are trying to economize fuel under similar conditions.

The building is heated by means of a gravity-circulation hot-water system containing about 6600 square feet of radiating surface. Most of the radiating surface is of the direct type but there are some registers with indirect radiators. Much of the system was installed about twenty-five years ago and other parts have been added since, as the building was enlarged from time to time. In the old part, valves are lacking for the control of branch pipes and in many cases there are no control valves on the radiators. Features of this kind make the system more difficult to manage than would be the case with a new system which had been planned as a complete unit.

One of the first things we found out was that some small sections of the building were always hotter than they needed to be, even when the main part was cold. In the overheated rooms we turned off radiators wherever possible, even removing the valve wheels so that they could not be turned on again. A few of the radiators which we wanted to turn off had no control valves but we fixed these by attaching an automobile tire pump to the air-valves and pumping air into them so that the water could not circulate. Access to the third floor of the building and to the rear wing of the second floor is obtained by means of a hall with entrance on the north side of the building entirely separate from the main entrance in front. This hall had always been comfortably heated the same as any other part of the building and it was decided that here was an opportunity to save some heat. By installing two stop-valves we were able to shut off seven radiators having a total of about 450 square feet of heating surface; the water has been drained out of this part of the system and it will not be used at all during the balance of the heating season. The piping is so arranged that we also had to drain two radiators in one of our smaller rooms. This involved closing the room and moving the furniture and occupants to another part of the building but we feel that the inconvenience is worth while, for the amount of radiating surface which we have eliminated is enough to heat a small house. In connection with our indirect radiators we were also able to make some saving; wherever the conditions will permit we are taking the air for these radiators from the basement instead of admitting cold air from outside.

We realized from the start that our greatest opportunity for saving heat would be found in the proper regulation and control of the temperature inside the building and this principle applies also to many other buildings. In this part of the country heating systems are generally designed to maintain a temperature of seventy degrees inside when the outside temperature is at zero. Obviously, then, there will not be much opportunity for saving heat by this means when the temperature is down below zero and the wind is blowing hard; under such conditions most heating plants have to be forced to the limit to maintain even a fairly comfortable temperature. When the weather gets warmer, however, there is a general tendency towards overheating and a consequent chance to save heat by regulating the supply instead of opening windows. On February eighth with the outside temperature at forty degrees above zero, the writer counted eleven windows open out of forty-two in the front of a prominent Hartford office building on Main Street. Very few people in an office building ever think of closing a radiator valve and thereby saving a little heat; if the room gets too hot they open a window and the window is generally so located that a cold blast of air strikes directly on a radiator thus increasing the amount of heat radiated and the amount of coal burned. In factories the conditions are worse in some ways because the heating units are generally of much larger size and cannot be shut off without affecting a greater number of people; each workman therefore regulates the temperature to suit himself as well as he can by opening and closing the window nearest to him. Even though windows are not opened, our buildings are generally heated much hotter than is necessary and, except for an elaborate and expensive system of automatic temperature control, the only remedy is constant, conscientious and intelligent supervision with no reliance upon the individual occupants of a building for heat control. When the coal shortage became acute, therefore, the officers of The Hartford Steam Boiler Inspection and Insurance Company decided that the temperature in the main office should be maintained as nearly as possible at sixty-eight degrees during working hours and that no one should have any serious ground for complaint if it occasionally got as low as sixty-five degrees. When we started on this program we soon found that, with the desired temperature in the main office, a few of the smaller detached rooms were too cold. This indicated that the main office and some other rooms had always been overheated in order to maintain a comfortable temperature in a few other places. Of course, the obvious remedy was to install additional radiating surface in the rooms which were underheated and this is what we should have done except that it would involve drawing all the water from the system, — a process requiring several hours. The new radiators will be installed next summer and in the meantime we are getting along as best we can with the aid of an oil heater and two or three fireplaces which help out in the cold rooms. Some of our employees felt at first that a temperature of sixty-eight degrees was too low for comfort but they have come to realize the necessity for the order and we get no complaints now unless the temperature falls lower. Those who feel cold at that temperature dress a little warmer than they formerly did. We also find the same spirit of loyal co-operation among our tenants.

Our system of supervision includes primarily a record of temperatures and of the amount of coal consumed. We haven't sufficient space for a set of scales in our boiler-room but all of the coal is carefully measured in ash-cans and, of course, it is a simple matter to determine the net weight. A pad of paper and a pencil on a string are fastened to the door of the coal-bin in such manner that the fireman will see them every time he opens the door and will therefore not be liable to forget to make the record each time he brings out a can of coal. Temperature readings are taken every hour and these include the following: —

(1) Outside temperature.
(2) Temperature in main office.
(3) Temperature of water as it leaves the boilers.

These readings are recorded on forms prepared for the purpose; the readings are taken at night by the watchman as he makes his rounds, and during the day by the head janitor or a member of our Engineering Department. In this way we are able to follow the operation of the system closely and it is very seldom that the temperature in the main office varies more than one degree from sixty-eight in the daytime; at night we purposely allow it to get a little lower. From the hourly temperature readings, we have made a plot to show graphically how the three separate records vary from day to day and from hour to hour; a section of the plot on a reduced scale is shown in Figure 1. The complete plot makes a very interesting study, showing such features as the relation between hot water temperaure and outside temperature in order to maintain a given inside temperature, the time required to increase the inside temperature a certain amount under given conditions, etc. When we get a sufficient range of values we expect to be able to develop a schedule showing the fireman at what temperature he ought to maintain the water for any stated outside temperaure. Such a schedule will necessarily be subject to some modifications (depending, for instance, upon the strength of the wind), but it will at least serve as a guide. We do not intend to continue the plot indefinitely but we will keep up the hourly temperature readings and we have just installed a recording thermometer to give a continuous record of the water temperature; this instrument is sure to prove of value as it will give us an accurate record showing just how the boilers are operated. In addition to the thermometers mentioned above we have several others in various parts of the building which are read frequently but not recorded. This is part of the general supervision which we maintain over the entire system including the operation of the boilers.

We endeavored to follow closely the intent of the Fuel Administrator's order establishing heatless Mondays and believe that we saved considerable coal thereby. We have been operating only two of our three boilers and on Saturday mornings the fire was allowed to burn out in one boiler. The fire in the other boiler was checked shortly after noon, depending upon the heat in the water to keep the office warm until it was closed at 3.30. This

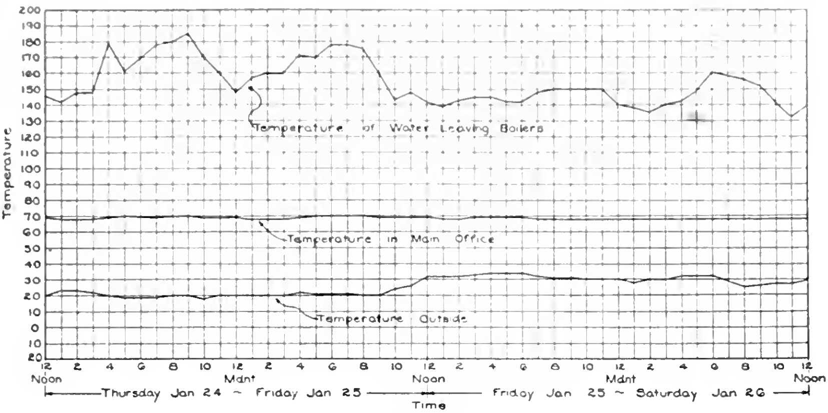


FIG. 1.

fire was then kept checked continuously until Monday night except that the watchman was told that he could open the dampers for a short time if he found the temperature getting much below forty degrees in any of the exposed parts of the building, a condition which was found on a few occasions. The fire was cleaned and coal added only as required to keep the fire from going out and to keep the water circulating a little. The time for starting the second boiler again depended upon the weather conditions; on February eleventh with an outside temperature of thirty-four degrees it was not started until midnight but on February fourth with the temperature around zero it was started about five o'clock Monday afternoon. It was thought that we might not save much coal by this means because it would take so much more to warm the building up again, but our experience showed that the period of shut-down was long enough so that the saving was worth while. On account of burning wood part of the time we haven't a complete record to show what the saving was but the following figures are at least significant. From noon of Friday, February first, to noon of Saturday, February second, we burned 2310 pounds of coal and it should be noted that this amount would have been somewhat larger if the fire in the second boiler had been cleaned, as is usual on other days, instead of being allowed to burn out. From noon of Saturday, February second, to noon of Tuesday, February fifth, we burned 4620 pounds; of this amount approximately 3200 pounds were used between 5 P. M. Monday and noon of Tuesday, the fire being checked during the remainder of the time as described above. Finally, from noon of Tuesday, Febru-

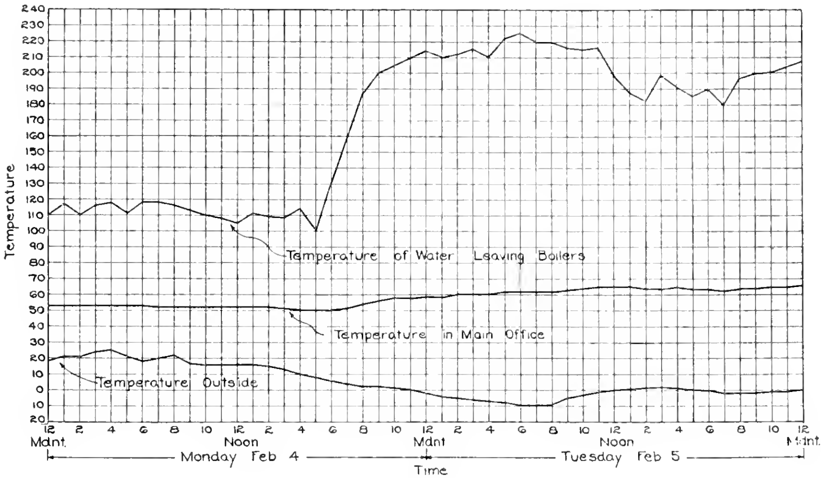


FIG. 2.

ary fifth, to noon of Wednesday, February sixth, the consumption increased again to 2310 pounds. If we average the 4620 pounds over the three-day period we will have a mean daily consumption of 1540 pounds which would indicate a saving of somewhat more than a ton on account of the shut-down. To determine just how much was saved would have required a careful test each week with due consideration to outside temperature and other conditions; the above figures are therefore not absolutely conclusive but we believe that they give a fair indication of what could be expected under the conditions which existed, and in this connection it might be stated that the conditions were unusually severe when the fires were started to heat the building up again Monday night. The thermometer dropped to ten degrees below zero during the night and the wind blew so hard that it was more difficult to heat a building than on other occasions during this winter when the temperature has been even lower. Figure 2 shows how the temperatures varied during this period.

One of the most obvious measures for decreasing the waste of heat in buildings consists in stopping the leakage of cold air into the building as much as possible; yet this feature is frequently given very little attention in office buildings and factories, due largely to lack of proper supervision. Of course most of the air leakage occurs around windows and the first step should be to see that all windows are provided with catches properly placed so as to draw the two sections of sash together; then periodic inspections should be made to see that the catches are kept locked. In cases where they are not locked it will frequently be found that the upper sash is not pushed up as far as it will go and there will be air leakage over the top of this sash as well as through the crack between the two sections of sash. In one office building which we recently investigated it was found that more than fifty windows had no catches and most of the others were not locked. Air leakage around windows is also often due to poorly fitting window stops, sometimes without any means of adjustment. A short time ago the writer visited a factory building on a cold day when the wind was blowing hard from the northwest. The building had a long western exposure and a strong blast of cold air could be plainly felt around many of the windows on that side. The stops were screwed in place without any means of adjustment and the large sashes had shrunken and warped enough so that the windows fitted loosely. When the owner's attention was called to these conditions he said that he would have all of the stops fitted with slotted adjusters at once; he also said that it was his intention to have the stops set up so tightly that the windows could not be opened during the winter without the aid of a crowbar. The expense of installing window catches and fitting stops is usually very small but a marked improvement will result in cases where these features have been neglected. Even better results will be secured by the application of weather strips or the use of storm sash; while the cost of equipping a whole building in this manner might not be justified it will generally be found advisable and profitable to use weather strips or storm sash in portions of a building which have a bad exposure or which are difficult to heat for some other reason. Cellar windows of houses usually fit loosely and allow considerable cold air to leak in at places where it will chill the floor above; storm sash can be used to advantage in such windows and good results can also be obtained at less expense by caulking the cracks around the windows with strips of cloth or other suitable material.

In two buildings which we have investigated recently it has been found that hot water from steam, condensed in the heating system, was being discharged into a sewer instead of being pumped into the boilers. In one case conditions were such that the water came back intermittently. For a time the water would not return fast enough and it would be necessary to pump cold water into the boilers in order to keep the water-level up where it should be; then, a little later, there would be too much water coming back and it would be wasted to the sewer. The trouble was due to insufficient capacity in the tank or receiver to which the water was returned; a larger tank would give the necessary storage space and the heat could be retained by properly covering the tank with magnesia or other insulating material. In the other case, the pump was located higher than the tank to which the water was returned so that the pump had to lift the water. It is a well-known fact that a pump cannot lift very hot water and it was therefore necessary to admit cold water and cool the return water to such a temperature that the pump could handle it, the surplus overflowing to the sewer. All of the hot water was saved by placing the pump in a pit at such a level that the water would flow to it. We find it hard to make some people realize that they are wasting coal by throwing away hot water in this manner, though it can be readily shown that, under average conditions of operation, there is a saving of one per cent. in coal consumption for every eleven degrees increase in the temperature of feed water entering the boilers.

It is not the present intention to discuss proper methods of firing but it might be mentioned in passing that one simple rule is frequently disregarded by firemen who leave the firing doors open in order to check their fires. This practice is sometimes followed in one building in Hartford which ought to be setting a good example for others.

Burning wood is an effective means of saving coal but at present prices it is a patriotic measure rather than one of economy. The Hartford Steam Boiler Inspection and Insurance Company has been burning wood under one boiler for some time; coal is used for the other boiler, the method employed being to get the maximum amount of heat from the wood-burning boiler and to burn only enough coal to supply the deficiency. In this way the coal fire is kept checked a large part of the time. The Company's experience would indicate that burning wood under present conditions is equivalent to burning coal at about fifteen dollars per ton. No difficulty is encountered in burning the wood in lengths of four feet, though some of it is quite green. We have several cords on hand and have ordered more.

It is fully realized that the ideas herein set forth cannot be applied to every heating plant but it is hoped that they may suggest other ideas and perhaps serve as a basis for starting investigations which will result in the saving of some coal. Certainly many of our buildings of all classes are overheated and much can be accomplished along the lines of temperature control even during the remainder of the present heating season. Furthermore, coal dealers and others who ought to know tell us that conditions will be as bad (or perhaps worse) during the next heating season and investigations should therefore be made now to determine what changes can be made during the summer so that every system can be operated on the least possible amount of coal.

Some Failures of Cast-iron Heating Boilers.

E. Mason Parry, Directing Inspector.

The failure of cast-iron sections which form the chief members of a cast-iron heating boiler are many and varied. They are due in practically every case to the overheating of surfaces exposed directly to the action of the products of combustion, through allowing the water level in the boiler to recede below that which has been predetermined by the designer. To verify this statement the writer will endeavor to explain the conditions which brought about the cracking of several sections in three specific cases which he investigated within a period of four days.

The first case was brought to our attention when on the morning of January 1, 1918, we received the following telegram: "Boiler blew this morning, send man at once, expect answer." Upon the receipt of this urgent demand, an investigation was made and the following conditions were found: Four sections of the boiler were cracked. Every indication pointed to the boiler having been permitted to become short of water. A careful examination was made of the piping through which the returns came back by gravity, but it was found to be free from defects. The attendant was closely questioned as to the amount of water he had noticed in the water gage glass previous to the accident. He stated that not only was there between three and four inches visible before the accident, but that he noticed about three inches in the glass after the accident which disappeared in a short time. Upon receiving this information, it was easily understood that the attendant had been deceived as to the actual amount of water in his boiler by a false water registration in the gage glass. When the glass was removed from its fittings it was found that its lower or water end had at some past date caused inconvenience by leaking, and to stop this leakage a piece of rubber packing, circular in shape, had been inserted in the stuffing box, which had practically closed up the opening so that water could not rise in the glass to show the level in the boiler. That the attendant saw water in the glass before and after the accident we have not the slightest doubt, and the presence of the water can be accounted as due to the accumulation of condensation coming from the upper or steam connection. Fig. 1 shows the packing nut used on the lower fitting for compressing the packing around the glass so that it will be water tight, and you will note that the orifice is completely filled up with rubber, except for a small hole (less than 1/16 inch in diameter), in the middle. It is also to be noted that at the time of the accident, sediment which had settled in the bottom of the glass had closed off the opening to a still greater extent.

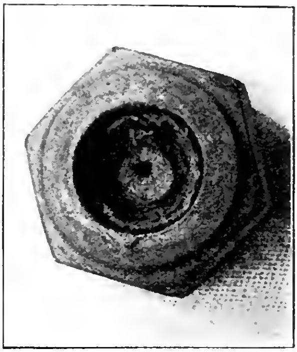


Fig. 1.

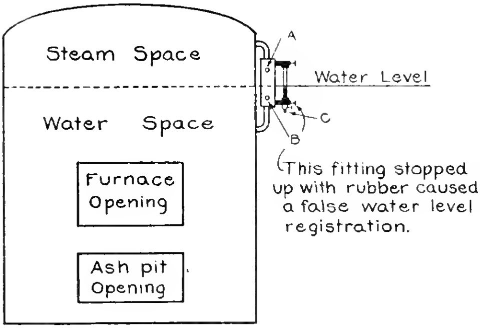


Fig. 2.

The water gage glass of a boiler is one of its most essential fittings. Safe and economic operation depends upon its accuracy. When it is not in order, the condition is like that of a watch from which the hands have been removed, in that the mechanism may be in perfect condition, but it is impossible to determine the hour of the day. Figure 2 shows the function a water gage glass is expected to perform. The attendant should check the accuracy of the water level shown in the glass from time to time by opening valve A, through which steam should escape. After closing it he should then open valve B, from which water should flow. Then the drip cock, C, should be opened to see that it is clear and workable. It is not only necessary for the attendant to do this, but all concerned with having a well heated building should frequently follow these instructions just as thoroughly as they would ascertain that there is an adequate amount of lubricating oil in the crank case, and a full supply of gasolene in the tank of their automobile before starting on a long journey.

With shipping facilities greatly hampered, as they are at present, with the large demands made on transportation by the government, and considering further the necessity that all steel and iron be diverted to the manufacture of munitions and implements of war, it is clear that more care than ever should be taken to avoid the destruction of cast-iron boilers through section cracking.

The second case shows that not only are the efforts of our Company devoted to the prevention of the failure of boilers, but that when accidents do occur, our long experience enables us to recommend and supervise repairs pending the receipt of new sections to replace those that fracture. For instance, the owner of a large apartment house notified us by 'phone that his cast-iron boiler had cracked and that there was danger of freezing all the water piping in the building. On examining the boiler it was found that the front section had cracked. The construction of the boiler in question was such that the sections were united by friction, or as they are sometimes known, push nipples, making it appear a somewhat perplexing problem to place it in commission while waiting for the delivery of the new section, as compared to the other types of cast-iron boilers, the sections of which are assembled by screwed nipples and manifolds, any of which can be easily disconnected and the holes plugged, should they fracture. After giving the situation some thought, it was decided to call in some steam fitters and the following changes were made. On the front section (the one which fractured), were located practically all the essential fittings. Fig. 3 shows the front section blanked off from the remaining eight sections by the introduction of three pieces of sheet iron, and a like number of pieces of asbestos mill board, after which the lateral bolts used as binder bolts, and extending from front to rear of the boiler were tightened and the joints at the three openings made perfectly tight. The manner in which the fittings were relocated can be more readily understood by referring to Figures 3 and 4. We can assure you that it was a source of great relief to the tenants of the building as well as to the owner to have it heated at 5.30 p. m. on the day of the accident, at which time the outside temperature was five degrees below zero.

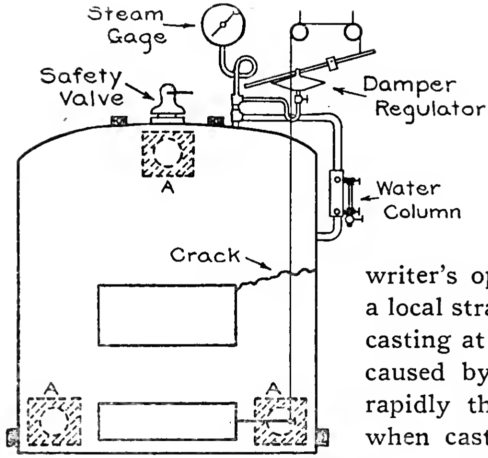


Fig. 3. Shaded Portions, A, Indicate Pads.

The general condition of this boiler when examined after the section cracked did not indicate that it had been permitted to become short of water, which would have caused overheating, but in the writer's opinion there was originally a local strain set up in that part of the casting at which the crack developed, caused by allowing it to cool more rapidly than the rest of the section when cast in the foundry, and that it was only a question of time and obtaining exactly the right temperature to bring about undue expansion, causing the rupture.

Case No. 3, differs considerably, and was located in a large

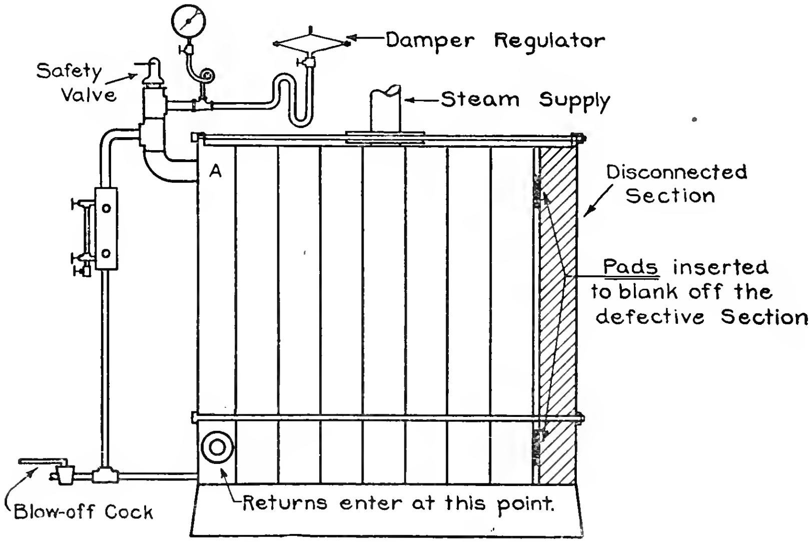


Fig 4. Showing Relocated Fittings. Plug at A to be Replaced When Fittings are Attached to New Front Section.

public school. On examining No. 2 boiler, it was plainly seen that the cracking of three of the sections was due to low water.

The school house was heated by two large cast-iron boilers which supplied steam for two methods of heating, known as direct and indirect systems. The latter was used for heating hallways and consisted of three large steel manifolds into which were

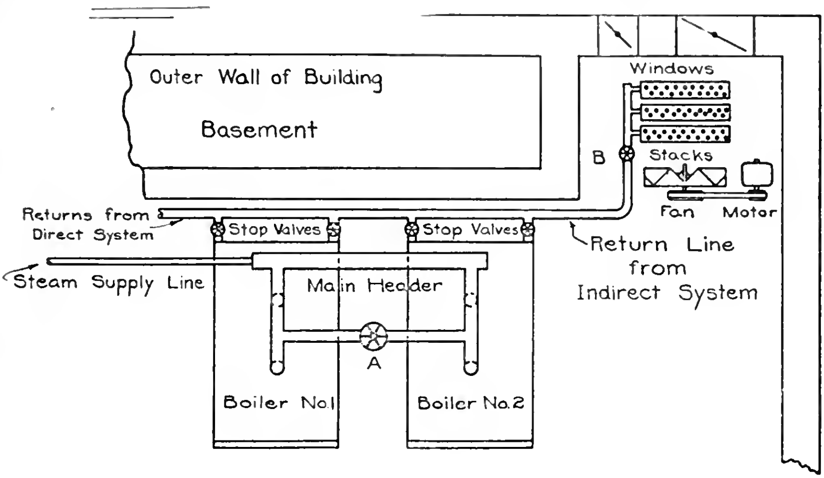


Fig. 5.

screwed a large number of one and one-quarter inch vertical tubes, fitted with return bends, and known as a stack heater. Air from the basement was drawn through and around this heater by an electrically driven fan and discharged through adjustable registers in different parts of the building, in accordance with the temperature required. After conversing with the janitor as to whether he had at any time noticed any unusual behavior of the boilers, he stated that at times he noted the water leaving the boilers, and that shortly after adding water to the contents of the boilers by opening the valve on the city water supply line, he noted the water rising very rapidly and was obliged to open the blow off valve. Not only was this a hazardous condition, but it was a very wasteful one, not at all in keeping with our patriotic duty with reference to fuel conservation. Before explaining the cause of the trouble it will be well to refer to Fig. 5, which shows the relative positions of the boilers, the stack heater and the fan. It appears that at times the temperature of the air supplied by the fan became excessive, and to relieve this condition the janitor was in the habit of opening the windows located within two feet of the stack heater. Just what happened can be readily understood. The steam in this heater became quickly condensed and by so doing created a partial vacuum, which not only retarded the flow of the returns to the boiler, but would syphon the water out of the boilers until such a time as enough water had been stored in the heater to break the vacuum, when it would quickly return to the boilers, causing them to be flooded. Naturally the surfaces of the sections in direct exposure to the fire would become overheated, and would then be quickly contracted when the cool return water came back. To avoid further trouble from this source a check valve was installed in the return pipe from the stack heater, and a recommendation made that the front of this heater be encased in a steel casing, provided with a slide, so that the amount of air heated can be regulated by the requirements of the building. Investigating further the installation of these boilers, it was seen that while they were connected together at the return line, there was no neutral or equalizer connection, between the steam spaces of the boilers. Therefore the connecting pipe and stop valve marked A was advised, located between the two risers from the boilers to the steam supply header. If at any time one boiler is operated alone, this valve would be shut, but when both boilers are operated together, the valve would be open. The reason for this connection is to keep the pressures in the two boilers balanced. If one boiler had a free burning fire, while that of the other was choked with ashes and clinkers, the free steaming boiler would tend, without the equalizer connection, to generate a higher pressure, because of its more rapid evaporation. The returns, however, would endeavor to flow into the boiler at the slightly lower pressure, as there would be less resistance to their flow. The result would be a condition of lowering water in the rapidly steaming boiler, resulting in overheating the sections, if the attendant did not notice the condition and rectify it. By the installation of the equalizer pipe mentioned, this could not happen. It is very gratifying to be able to state that these recommendations were carried out and that they apparently have the desired effect, and it can be safely said that aside from a rupture of the return pipe, or stoking the boiler in question too rapidly when cold, which would bring about unequal expansion, we do not anticipate any further trouble from this installation.

To sum up, the writer of this article wishes to say that he will feel fully repaid for his labor if the readers of it, whether owners or operators, take under consideration the nature of cast iron, which as you all know is brittle and non-fibrous, consequently has no ductility, and will stand but slight stress due to expansion and contraction, and that when exposed to furnace heat, it needs constant and careful attention.

With the Colors.

Elmer B. Haines, reported previously in this column as having received an appointment as Master Gunner, Coast Artillery, has been heard from as having arrived safely in France.

Graham R. Hart, now in France in the aviation service, has been advanced to the grade of Corporal.

L. M. Williams, an inspector In the St. Louis department, has entered the Naval Reserve Force, and is assigned as engineer on a submarine chaser.

Summary of Boiler Explosions, 1917.

We append our usual annual compilation of boiler explosions, listed by months, with the number of explosions, number killed, injured, and the total of killed and injured.

Summary of Boiler Explosions for 1917.

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	50	12	69	81
February	71	20	35	55
March	41	10	17	27
April	39	15	24	39
May	30	12	23	35
June	18	28	5	33
July	24	8	8	16
August	34	8	20	28
September	30	12	24	36
October	45	6	16	22
November	44	7	19	26
December	80	11	29	40
Totals	506	149	289	438

Summary of Inspectors' Work for 1917.

Number of visits of inspection made	215,625
Total number of boilers examined	389,410
Number inspected internally	153,778
Number tested by hydrostatic pressure	8,674
Number of boilers found to be uninsurable	1,011
Number of shop boilers inspected	10,404
Number of fly wheels inspected	20,026
Number of premises where pipe lines were inspected	1,645

Summary of Defects Discovered.

Nature of defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	29,415	1,792
Cases of adhering scale	44,519	2,049
Cases of grooving	2,978	334
Cases of internal corrosion	18,410	883
Cases of external corrosion	12,127	884
Cases of defective bracing	1,094	332
Cases of defective staybolting	2,255	508
Settings defective	1,211	829
Fractured plates and heads	3,427	578
Burned plates	4,190	552
Laminated plates	494	149
Cases of defective riveting	1,352	265
Cases of leakage around tubes	10,413	1,374
Cases of defective tubes or flues	17,309	6,658
Cases of leakage at seams	5,368	491
Water gages defective	4,229	890
Blow-offs defective	5,101	1,573
Cases of low water	421	171
Safety-valves overloaded	975	349
Safety-valves defective	1,935	469
Pressure gages defective	7,801	870
Boilers without pressure gages	910	910
Miscellaneous defects	4,367	642
Total	180,301	23,552

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1918.

Visits of inspection made	4,324,331
Whole number of inspections (both internal and external)	8,626,244
Complete internal inspections	3,383,129
Boilers tested by hydrostatic pressure	349,837
Total number of boilers condemned	26,912
Total number of defects discovered	5,067,997
Total number of dangerous defects discovered	538,170

Summary of Inspectors' Work since 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79,000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642
1910	177,946	347,255	138,900	12,779	169,202	16,746	625
1911	180,842	352,674	140,896	12,724	164,713	17,410	653
1912	183,519	337,178	132,984	8,024	164,924	18,932	977
1913	192,569	357,767	144,601	8,777	179,747	21,339	832
1914	198,431	368,788	145,871	8,239	190,882	23,012	756
1915	199,921	373,269	140,002	7,998	178,992	22,077	790
1916	204,863	386,245	146,971	8,273	184,635	19,219	926
1917	215,625	389,410	153,778	8,674	180,301	23,552	1,011

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. Perry, Editor.

HARTFORD, APRIL, 1918.

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The Locomotive of The Hartford Steam Boiler I. & I. Co.

The need for fuel economy on the part of the steam user does not end with the close of the heating season, indeed, it is just about beginning. If he has been at all resourceful he has done the greater part of his heating with exhaust steam and the matter of engine economy has not been all important, so long as no exhaust steam was thrown away. Now, however, the supply of exhaust steam is apt in many plants to exceed the demand. Every bit of white vapor escaping from an exhaust head is an arraignment of the patriotism of the plant owner. He can, and indeed should, use exhaust steam for practically every bit of heating, with the exception of a very few special processes, which may be necessary in the conduct of his business, and any steam left over should be utilized for heating feed water. Steam traps and drips which drip and leak, and exhaust heads which exhaust should be conspicuous by their absence this summer.

Personal.

Mr. J. F. Criswell, for many years senior Special Agent at Chicago, will have charge of the Chicago Department, with the title of Acting Manager, pending the selection by the Directors of the Company, of a man to fill the vacancy caused by the death of Manager H. M. Lemon.

Henry Martyn Lemon.

Obituary.

Henry Martyn Lemon.

It is with deep sorrow that we record here the death on February 20th, 1918, of Henry Martyn Lemon, Manager of the Chicago Department of this Company. Mr. Lemon had suffered a fainting turn in his office a week before. Following it, he was confined to his home by an illness which was not reported as serious. The news of his death came accordingly as a great shock to his friends and business associates.

Mr. Lemon was born in 1850. His father was a Presbyterian minister, who soon after the birth of this son, because of ill health, retired to a farm near Ripon, Wisconsin. There, Mr. Lemon's boyhood was spent and there at the early age of seventeen on the death of his father, he was forced to assume the responsibility of the family's support. This he did by his own efforts, working the farm for several years. Later, he attended Ripon College and then entered the drug business in Ripon where he became a partner in one of the leading drug stores.

Mr. Lemon had made the acquaintance of Mr. J. M. Allen, President of the Hartford Company, and in 1882, on Mr. Allen's invitation, joined the Company's force as a Special Agent. During the next ten years in this service he traveled extensively through the territory of the Chicago Department, and the broad acquaintance and friendship of steam-users and agents which he formed in that period continued his for the rest of his life. In 1893, Mr. Lemon became the head of the Chicago Department, filling the vacancy created by the death of his brother-in-law, Mr. H. D. P. Bigelow.

Mr. Lemon's administration of the largest department of the Company was marked by a continuous growth of its business and usefulness. During those twenty-five years, the use of steam and of steam boilers developed rapidly. Mr. Lemon's management kept abreast of this development. He was a firm believer in the value to steam-users of the insurance and of the inspection service which his Company afforded, and he was untiring in his efforts to inculcate this belief in others. His spirit and faith in his Company was an inspiration to those under him and the organization of his department has ever been characterized by the same quality of devotion to the Company's interest which was inherent with him. In his death the Hartford Company has lost an able administrator and his fellow officers, an honored associate on whose hearty cooperation they could fully rely. To each employee of the Chicago office, who in daily contact with him knew him for the kindly considerate gentleman he was, his death comes as a deep personal sorrow as for the passing of a dear friend.

Mr. Lemon was married in 1881 to Miss Harriet Brace of Janesville, Wisconsin. They have one son, Dr. Harvey B. Lemon, Assistant Professor of Physics at the University of Chicago. His widow and son and two grandchildren, Harriet Birkhoff Lemon and Henry Martyn Lemon, 2nd, survive him.

The following minute was adopted by the Board of Directors of The Hartford Steam Boiler Inspection and Insurance Company at a meeting held on March twenty-seventh nineteen hundred and eighteen:

In the death of Henry Martyn Lemon, which occurred on February 20th, 1918, after a brief illness, this Company sustained a loss of one of its oldest servants. On April 1st, 1882, Mr. Lemon entered the service of the Company as a Special Agent, a place which he filled so acceptably that upon the death of Mr. H. D. P. Bigelow, he was appointed, in March, 1893, Manager of the Chicago Department. This place he filled until his death.

The Directors would record their recognition of these years of faithful service and of their appreciation of Mr. Lemon's unselfish and loyal devotion and of his ability which during his administration of the Chicago Department more than doubled the volume of its business, and they direct the Secretary to inscribe this minute upon the records of the Company and to forward a copy to Mrs. Henry Martyn Lemon with an expression of the sincere sympathy which they feel for her and her family.

Charles D. Francis.

Charles D. Francis, one of the oldest inspectors of the Company, died suddenly at his home in Hartford, on Sunday evening, January 13, 1918.

Mr. Francis was born in Windsor, Ct., on July 8, 1845, a son of John and Mary (Camp) Francis. He learned the machinist's trade with the Woodruff and Beach Co., in Hartford, and later was an erecting engineer for Sawtelle and Judd, engine builders. In July 1880, he entered the employ of The Hartford Steam Boiler Inspection and Insurance Company as an inspector. He served the Company continuously from that time until some two years ago, when he retired from active service, first as inspector, and later as directing inspector at the Home Office.

Mr. Francis was very active in the Unitarian Church, and was a trustee of The First Unitarian Church of Hartford. He was also prominent in Masonic circles, and was a member of a large number of Masonic organizations.

Mr. Francis married Miss Hannah Sykes in 1868. Besides his wife, he leaves three sons, Manager William M. Francis of the Atlanta Department of The Hartford, Albert A. Francis of East Hartford, Ct., and Arthur D. Francis of Hartford. There are three grandchildren; Lieut. A. Phillip Francis, son of W. M. Francis and Charlotte Mary and Robert Sumner Francis, children of Albert A. Francis.

Mr. Francis was one of those genial friendly people whom every one knew and liked. Although he had not been in active service during the last few years, still he was a frequent visitor at the office, and his cheerful interest and friendship will be sorely missed even by the younger employees. The Company has lost a faithful servant, and every one in the Home Office a personal friend.

George C. Robb.

George C. Robb, former Chief Engineer and ex-President of The Boiler Inspection and Insurance Company of Canada, died March 8, 1918 at his home in Toronto, Canada.

Mr. Robb had been in failing health for some time and had not been actively associated with Steam Boiler Insurance for a number of years.

Boiler Explosions.

OCTOBER, 1917.

(Continued from Jan. 1918 Locomotive).

(368.) — A blow-off ruptured October 23, at the Warioto Cotton Mills, Nashville, Tenn. One man was injured.

(369.) — A section cracked October 24, in a cast iron sectional boiler at the plant of the Imperial Silk Works, Inc., Danbury, Ct.

(370.) — A tube pulled out, in a water tube boiler October 24, at the Sioux City, Ia. plant of Armour and Co.

(371.) — On October 25, a tube ruptured in a water tube boiler at the Consolidated Light and Power Co. plant of the American Gas Co., Kewanee, Ill.

(372.) — Two sections cracked October 25, in a cast iron sectional boiler at the Watkinson Farm School, Hartford, Ct.

(373.) — An air tank exploded October 26, at the Windsor, Ct., plant of the General Electric Co.

(374.) — Four sections cracked October 26, in a cast iron sectional boiler, at the restaurant of J. W. Welch, Omaha, Neb.

(375.) — A boiler ruptured October 27, at the plant of the Gale Mfg. Co., Albion, Mich.

(376.) — A section cracked October 27, at the automobile sales rooms of Oscar Rosenberg, Detroit, Mich.

(377.) — A blow-off failed October 27, on a boiler at the Arkwright Mills, Spartanburg, S. C.

(378.) — A header failed October 28, at the Colorado Springs Light and Power Co. plant of the United Gas and Electric Co., Colorado Springs, Colo.

(379.) — An accident occurred to an economizer October 29, at the mill of the Hammermill Co., Erie, Pa.

(380.) — Two circulating tubes pulled out of a water tube boiler October 29, at the plant of the California Packing Corp., Los Angeles, Cal. One man was injured.

(381.) — An accident occurred to a boiler October 31, at the Sugar house of E. P. Munson, Napoleonville, La.

(382.) — A boiler ruptured October 31, at the packing house of the John Seiler Co., Pittsburg, Pa.

NOVEMBER, 1917.

(383.) — On November 1, 18 sections cracked in a cast iron sectional heating boiler at the Warren County Almshouse, Monmouth, Ill.

(384.) — A slight accident occurred November 2, to a boiler at the sugar house of E. P. Munson, Napoleonville, La.

(385.) — On November 3, a main stop valve failed on a water tube boiler at the Buffalo Union Furnace Co., plant of M. A. Hanna & Co., Buffalo, N. Y.

(386.) — A boiler exploded November 3, in the basement of the Fairmont Hotel, Sacramento, Cal.

(387.) — On November 4, a feedwater heater failed at the plant of the Monsanto Chemical Works, St. Louis, Mo.

(388.) — A boiler ruptured November 5, at the plant of the C. A. Smith Lumber Co., Bay Point, Cal. One man was injured.

(389.) — Four sections failed November 5, in a cast iron sectional heating boiler at the Charlesbank Homes, apartment house, Boston, Mass.

(390.) — A blow-off failed November 5, at the Iowa Methodist Hospital, Des Moines, Ia.

(391.) — A boiler accident occurred November 5, at the plant of the Sioux City Gas and Electric Co., Sioux City, Ia.

(392.) — On November 5, a special pipe fitting failed in the line to the high pressure cylinder of the engine at the Massachusetts Mills in Georgia, Lindale, Ga.

(393.) — On November 6, a section failed in a cast iron sectional heating boiler at the Bank of New Rockford, New Rockford, N. D.

(394.) — On November 6, a tube failed in a boiler at the city water works pumping station at Baden, North St. Louis. Two men were scalded and the water supply cut off by the accident.

(395.) — On November 6, a tube cap blew off from a water tube boiler at the Waterside No. 1 station of The New York Edison Co., New York City. Two men were injured.

(396.) — A steam header failed November 8, at the plant of Niles and Scott, La Porte, Ind. The plant was largely shut down by the accident, and the property damage amounted to upwards of $2,000.00.

(397.) — On November 9, all the sections failed in a cast iron sectional heating boiler at the school of the Benedictine Society of West Moreland County, St. Mary's, Pa.

(398.) — Four sections failed November 10, in a cast iron sectional heating boiler at the church of St. Mary's Congregation, Burlington, Wis.

(399.) — On November 10, four headers ruptured in a water tube boiler at the plant of The North American Cold Storage Co., Chicago, Ill.

(400.) — A tube ruptured and two headers cracked November 10, in a water tube boiler at the plant of the Utah-Idaho Sugar Co., Idaho Falls, Idaho.

(401.) — On November 10, five sections cracked in a cast iron sectional heating boiler at the apartment house of the Rocky Crest Realty Co., New York City.

(402.) — On November 12, the boiler of a Chicago and Northwestern R. R. locomotive exploded near Gordon, Neb. Two men, the engineer and fireman, were badly scalded.

(403.) — A horizontal contractor's boiler exploded November 13, at Mohawk, Mich. Two women were hurt.

(404.) — On November 13, an accident occurred to a water tube boiler at the Cappon and Bertsch Leather Co., plant of Armour and Co., Holland, Mich.

(405.) — Three tubes ruptured November 14, in a water tube boiler at the Marseilles, Ill., plant of the Illinois Traction System. Four men were injured, one fatally.

(406.) — A tube ruptured November 15, in a water tube boiler at the plant of the Ohio Electric Railway Co., Medway, O.

(407.) — On November 15, a tube ruptured in a water tube boiler at the plant of the American Gas Co., Kewanee, Ill.

(408.) — On November 15, a tube sheet ruptured in a water tube boiler at the plant of Frederic B. Stevens, Detroit, Mich.

(409.) — On November 18, a section cracked in a cast iron sectional boiler at the restaurant of William Bauermeister, Omaha, Neb.

(410.) — On November 20, seven headers failed in a water tube boiler at the Colorado Springs Light, Heat & Power Co., plant of the United Gas and Electric Co., Colorado Springs, Colo.

(411.) — On November 21, a boiler ruptured at the plant of the Armour Grain Co., Milwaukee, Wis.

(412.) — A tube ruptured November 22, in a water tube boiler at the Southern Illinois Railway and Power Co., plant of the Middle West Utilities Co., Harrisburg, Ill.

(413.) — On November 23, a tube ruptured in a water tube boiler at the Milwaukee, Wis., plant of Swift and Co.

(414.) — On November 24, nine headers failed in a water tube boiler at the plant of the Diamond Alkali Co., Fairport, O.

(415.) — On November 26, a plug failed in a five inch tee at the plant of the Nash Motors Co., Kenosha, Wis. One man was fatally injured.

(416.) — The boiler of a locomotive exploded November 26, in the round house of the Texas and New Orleans R. R. Co., Houston, Texas. One man was killed and six injured, one fatally.

(417.) — On November 26, a tube ruptured in a water tube boiler at the plant of the New Orleans Railway and Light Co., New Orleans, La.

(418.) — A section cracked in a cast iron sectional heating boiler on November 26, at the apartment house belonging to the Estate of John J. Emery, New York City.

(419.) — A header failed November 26, in a water tube boiler at the plant of The Utah-Idaho Sugar Co., Sugar City, Idaho.

(420.) — A tube ruptured November 26, in a water tube boiler at the plant of Corrigan, McKinney and Co., Cleveland, O.

(421.) — A tube ruptured November 26, in a water tube boiler at the plant of the Columbia Tool Steel Co., Chicago Heights, Ill.

(422.) — A section failed November 27, in a cast iron sectional heating boiler at the office of the Southern New England Telephone Co., New Haven, Conn.

(423.) — On November 27, a tube collapsed in a horizontal return tubular boiler at the plant of the Schmidt and Ault Paper Co., York, Pa. One man was killed and another injured as a result of the accident.

(424.) — On November 29, a tube ruptured in a water tube boiler at the plant of the American Gas Co., Kewanee, Ill.

(425.) — A boiler ruptured November 30, at the greenhouse of the South Hills Floral Co., near Carrick, Pa. There was a considerable amount of damage to growing stock.

(426.) — The boiler at Firman Duplician's sawmill exploded November 30, in Allen Parish, La. Three persons were injured, two probably fatally.

December, 1917.

(427.) — On December 1, a boiler ruptured at the plant of The Chief Consolidated Mining Co., Eureka, Utah.

(428.) — Five sections cracked December 2, in a cast iron sectional heater at the apartment house and business block belonging to Annie S. Hanson, Worcester, Mass.

(429.) — A boiler exploded about December 2, in the garage of Joseph S. Haws, Pottstown, Pa. One man was badly scalded.

(430.) — On December 3, the cap of a superheater tube blew off, on a superheater attached to a water tube boiler at the plant of the Waterloo. Cedar Falls and Northern R. R. Co., Waterloo, Ia.

(431.) — Two headers failed December 4 in a water tube boiler at the Jersey City, N. J., packing house of Armour and Co.

(432.) — Four sections cracked December 4, in a cast iron sectional heating boiler at the warehouse of The American Sumatra Tobacco Co.. Floydville, Conn.

(433.) — On December 6, a head fractured in a horizontal tubular boiler at the plant of The Cleveland Steel Co., Cleveland, O.

(434.) — A tube ruptured December 7, in a water tube boiler at the plant of the St. Cloud Public Service Co., St. Cloud, Minn. Two men were injured.

(435.) — A header failed December 5, in a water tube boiler at the plant of The Industrial Works, Bay City, Mich.

(436.) — On December 9, a tube ruptured in a water tube boiler at the Hotel Taft, New Haven, Conn.

(437.) — An accident occurred to the blow-off of a boiler, December 9, at the greenhouse of The South Hills Floral Co., near Carrick, Pa. There was considerable damage done to growing flowers by freezing.

(438.) — On December 9, a tube ruptured in a water tube boiler at the Ohio Light and Power Co., plant of The American Gas and Electric Co., Ballsville, O. Two men were injured.

(439.) — A small hot water heater used to heat water for a barber shop exploded December 9, in the basement of the D. A. Fisher Building, Memphis, Tenn. The property damage was estimated at $7,000.

(440.) — On December 10, a portion of the central steam heating service of the Wilkes-Barre Company, Wilkes-Barre, Pa., was rendered inoperative due to tube failures.

(441.) — On December 10, a section cracked in a cast iron sectional heating boiler at the High School, Union Free School District, No. 1, Haverstraw, N. Y.

(442.) — On December 11, a tube ruptured and a heater cracked in a water tube boiler at the plant of the Stearns and Foster Co., Lockland, O. One man was injured.

(443.) — A tube ruptured December 12, in a water tube boiler at the plant of the Vulcan Crucible Steel Co., Alliquippa, Pa.

(444.) — On December 12, an accident occurred to a boiler at the greenhouse of Fred Uffman and Sons, Rossford, O.

(445.) — A boiler ruptured December 12, at the business block of Caroline White, Broadway and Franklin St., New York City.

(446.) — A tube ruptured December 12, at the plant of the New Orleans Railway and Light Co., New Orleans, La.

(447.) — On December 12, two sections cracked in a cast iron sectional heating boiler at the West Shore Embroidery Works, West New York, N. J.

(448.) — A boiler exploded December 12, at the Eppirt Garage, East Orange, N. J. No one was injured, but a fire was started which together with the explosion did about $1,000 worth of damage.

(449.) — A saw mill boiler exploded December 13, on the Heaton tract near Bellefonte, Pa. One man was injured.

(450.) — A boiler exploded December 13, at the plant of the Ley Company, Trenton, N. J. A destructive fire was started by the explosion.

(451.) — A section failed in a cast iron sectional heating boiler at the Lexington Hotel of Charles W. Greeble, Baltimore, Md.

(452.) — On December 13, a section cracked in a cast iron sectional heating boiler at the West Side McKinley School, Du Quoin, Ill.

(453.) — A section failed December 14, in a cast iron sectional heating boiler at the Sherwood Hotel, owned by the R. C. Taylor Estate, Worcester, Mass.

(454.) — A boiler exploded December 15, at a saw mill at Clanton, Ala. Two men were injured, one probably fatally.

(455.) — On December 16, a section failed in a cast iron sectional heating boiler at the Bank of New Rockford, New Rockford, N. D.

(456.) — On December 16, two tubes pulled from the tube sheet of a water tube boiler at the plant of the Robinson Clay Products Co., Akron, O.

(457.) — A number of tubes pulled from the tube sheet of a water tube boiler December 17, at the plant of the Weis Paper Mill Co., Quincy, Ill.

(458.) — A boiler ruptured December 17, at the Holy Rosary Academy of the Sisters of St. Dominic, Corliss, Wis.

(459.) — On December 17, a section cracked in a cast iron sectional heating boiler at the State Normal School, Athens, Ga.

(460.) — Eight sections failed December 17, in a cast iron sectional heating boiler at St. Hedwig's School, Toledo, O.

(461.) — On December 17, an accident occurred to a water tube boiler at the plant of The Columbus Railway, Power and Light Co., Columbus, O. One man was slightly scalded.

(462.) — Another section failed December 17, in a cast iron sectional heating boiler at Bardwell Hall, State Normal School, Athens, Ga. This is a separate accident from that noted just above.

(463.) — A tube ruptured December 17, in a water tube boiler at the plant of the New Orleans Railway and Light Co., New Orleans, La.

(464.) — The boiler of a locomotive operated by the George A. Boosier Stave Co., Corning, Ala., burst December 19.

(465.) — A nozzle failed December 20, on a cast iron sectional heating boiler in the apartment house owned by Charles A. and C. Herbert Newhall, Trustees, Brookline, Mass.

(466.) — A boiler exploded December 21, at the Millville Laundry, Millville, N. J. One man was fatally injured.

(467.) — A boiler ruptured December 21, at the plant of the Mills Mfg. Co., Greenville, S. C.

(468.) — On December 21, a section cracked in a cast iron sectional heating boiler at the office building owned by Mary S. Tuttle, Greenville, S. C.

(469.) — A section cracked December 21, in a cast iron sectional heating boiler at the plant of the Cling Surface Co., Buffalo, N. Y.

(470.) — The boiler of a Pennsylvania freight locomotive exploded December 23, at Angola, N. Y. Two men were injured.

(471.) — On December 23, a tube ruptured in a water tube boiler at the Interstate Public Service Co., plant of the Middle West Utilities Co., Edinburg, Ind.

(472.) — On December 23, a tube ruptured in a water tube boiler at the plant of the West Cache Sugar Co., Logan, Utah. One man was injured.

(473.) — On December 24, a tube pulled from the drum of a water tube boiler at the Consolidated Light and Power Co., plant of the American Gas Co., Kewanee, Ill.

(474.) — A tube ruptured December 24, in a water tube boiler at the plant of the United Railways and Electric Co., Baltimore, Md. One man was injured.

(475.) — The crown sheet of a New York Central locomotive exploded December 25, near Corfu, N. Y. Three men were injured, one perhaps fatally.

(476.) — A boiler exploded December 26, at the plant of The Beaver Clay Co., New Galillee, Pa. One man was injured, and large property damage done.

(477.) — The boiler of a saw mill exploded December 26, at Owl Creek, near Hot Springs, Ark. Five men were killed.

(478.) — On December 27, a section cracked in a cast iron sectional heating boiler at the flat building of Mary K. and George W. Layman, Des Moines, Ia.

(479.) — Four sections cracked December 27, in a cast iron sectional boiler at the St. Catherine's School, Du Bois, Pa.

(480.) — A range water back exploded December 28, in the home of S. S. Winter, Kutztown, Pa.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1918.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash on hand and in course of transmission, ...		$404,341.76
Premiums in course of collection, ...		414,595.11
Real Estate, ...		90,000.00
Loaned on bond and mortgage, ...		1,544,400.00
Stocks and bonds, market value, ...		4,601,456.00
Interest accrued, ...		104,020.74
		$7,158,813.61
Less value of Special Deposits over Liability requirements,		32,229.37
Total assets, ...		$7,126,584.24

LIABILITIES.

Premium Reserve, ...		$3,013,990.80
Losses unadjusted, ...		122,761.60
Commissions and brokerage, ...		82,919.03
Other liabilities (taxes accrued, etc.), ...		251,117.95
Capital Stock, ...	$2,000,000.00	
Surplus over all liabilities, ...	1,655,794.86	
Surplus as regards Policy-holders, . .	**$3,655,794.86**	3,655,794.86
Total liabilities, ...		$7,126,584.24

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FRANCIS B. ALLEN, Vice-President. W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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Incorporated 1866. Charter Perpetual.

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

INSURES AGAINST LOSS OF PROPERTY

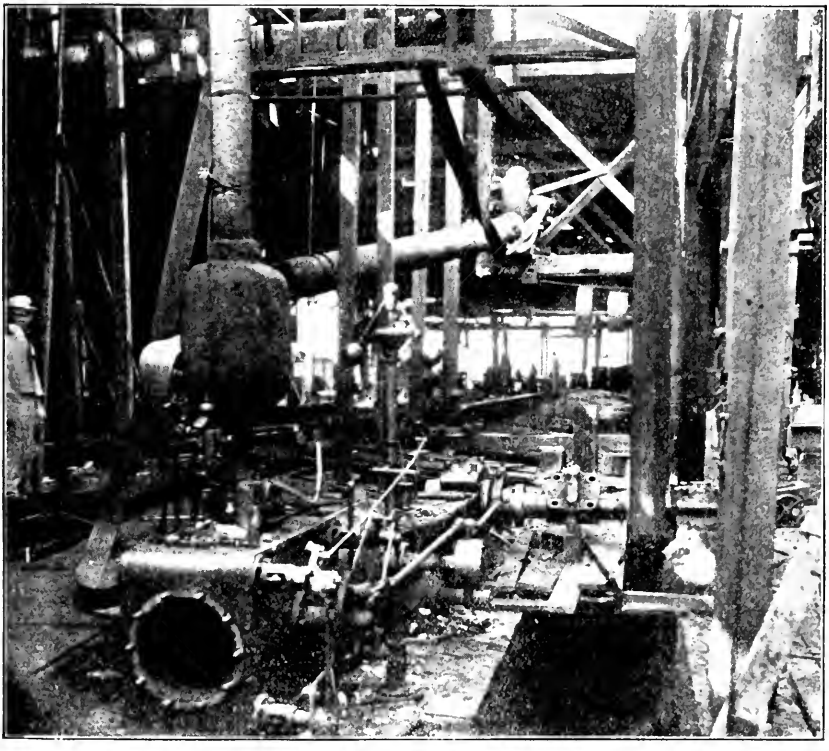
AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Department.	Representatives.
ATLANTA, Ga., 1025-1026 Hurt Bldg.	W. M. Francis, Manager and Chief Inspector. C. R. Summers, Ass't Chief Inspector.
BALTIMORE, Md. 13-14-15 Abell Bldg.	Lawford & McKim, General Agents. R. E. Munro, Chief Inspector.
BOSTON, Mass., 101 Milk St.	C. E. Roberts, Manager. Charles D. Noyes, Chief Inspector.
BRIDGEPORT, Ct., 404-405 City Savings Bank Bldg.	W. G. Lineburgh & Son, General Agents F. S. Allen, Chief Inspector.
CHICAGO, Ill., 160 West Jackson St.	J. F. Criswell, Acting Manager. James L. Foord, Chief Inspector. J. T. Coleman, Assistant Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	W. E. Gleason, Manager. Walter Gerner, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	H. A. Baumhart, Manager and Chief Inspector. L. T. Gregg, Ass't Chief Inspector.
DENVER, Colo., 918-920 Gas & Electric Bldg.	Thos. E. Shears, General Agent and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Williams, Jr., General Agent. F. S. Allen, Chief Inspector.
NEW ORLEANS, La., 833-835 Gravier St.	Peter F. Pescud, General Agent. R. T. Burwell, Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnet, Assistant Chief Inspector.
PHILADELPHIA, Pa., 142 South Fourth St.	A. S. Wickham, Manager. C. H. Dennig, Ass't Manager. Wm. J. Farran, Consulting Engineer. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa. 1807-8-9 Arrott Bldg.	M. M. Atherton, Manager. Benjamin Ford, Chief Inspector. J. A. Snyder, Asst. Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	McCargar, Bates & Lively, General Agents. C. B. Paddock, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. Mann & Co., General Agents. J. B. Warner, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. Ashcroft, Manager. J. P. Morrison, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. Roberts, General Agent.

The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Vol. XXXII. HARTFORD, CONN., JULY, 1918. No. 3.



Fly Wheel Explosion at Helena, Ala.

Fly Wheel Explosion at Helena, Ala.

A fifteen-foot fly wheel exploded February 27, 1918, at the plant of the Conners-Weyman Steel Co., Helena, Ala. The wheel was part of a corliss engine driving a stand of finishing rolls. Fragments of the exploding wheel went through the roof of the mill building, doing considerable damage to the columns and sills as well as to the roof, and in addition, large pieces tore up a side track of the Louisville & Nashville R. R., breaking a rail.

While the wheel itself was completely demolished, the engine did not suffer so severely as sometimes happens in like accidents. The pillow block was moved about two inches on its foundation, and the valve gear somewhat damaged, but aside from this the engine was unharmed. The accident is believed to have been caused by a key working out from the connection between the rocker arm, which transmitted the action of the governor to the valve gear, and the shaft to which it was attached. This failure removed the engine from the control of the governor, and so permitted the engine to race with the result illustrated on our front cover. No one was injured, but the property damage exceeded $3,000.00.

Summer Time Conservation in the Power Plant.

With the first realization of the likelihood of a fuel shortage last fall our attention was focussed at once on the furnace and the fireman, and our efforts were urgently directed toward burning coal with less waste. It is still important to burn coal with the least possible waste. We are coming more and more to the view that fuel is a public resource, to be conserved for the general good, rather than private property to be conserved or wasted at will.

CONSERVATION NOT CONFINED TO THE FIREROOM.

Coal conservation however, does not begin and end at the furnace. It is a much broader subject than that, and indeed it is only one part, though a most important part, of the whole problem of war time conservation and economy. Taking an average power plant, let us assume for the moment that all reasonable efforts have been made to save coal in the burning. That is, assume that fires of proper thickness are carried, properly cleaned, stoked at the intervals best suited to the furnace and the coal at hand, that air leaks in the setting have been stopped, that the furnace and boiler heating surface are kept clean, that the air supply has been adjusted to the kind of coal and the rate of burning and is admitted at the right place with as efficient mixing of air and gases as the condition of the installation will admit and that baffles and dampers are in first class condition. In fact, assume, that the coal burning equipment has been put in the best possible condition and fire room force on the best possible footing, what remains to be done? Has not this average plant "done its bit" for war conservation, and may not its chief engineer sit back with proper and pardonable pride in his achievement? If coal were burned in power plant furnaces solely to produce the maximum volume of heated combustion products at the maximum temperature, and if the conditions outlined above had been fulfilled, we should be compelled to answer yes.

The heat liberated from the burning of coal, however, is but a step in the process of power production and it is absurd to take extraordinary precautions for the economic production of heat if it is to be subsequently squandered by wasteful practices at other stages of the proceeding.

CLEAN BOILERS NEEDED.

The chances to waste the heat which we have been at such pains to produce with economy begin at the boiler. To properly absorb the greatest possible amount of heat, and to produce from it, with safety, the maximum quantity of steam at the desired pressure, and of the desired quality, is a pretty good definition of the function of a boiler.

The first requisite for economical heat absorption by the boiler is cleanliness, both external and internal. This means freedom from soot, ash, scale, mud, and oil. Absolute freedom from scale is, of course, an ideal to be approached as closely as possible, but in some locations, and with some feed waters, it is very difficult of attainment. However there are very few boiler plants in which a closer approach to the ideal is impossible. "Good enough" should in every case be made to give way to "as good as can be had."

Of equal importance with the degree of cleanliness maintained is the regularity and system with which it is kept up. Tube sweeping and blowing, and boiler cleaning should be attended to according to a regular schedule, based on the particular requirements of the plant and records should be kept so that the man in responsible charge knows definitely that these details have been attended to by the proper person at the proper time.

USE AND ABUSE OF THE BLOW-OFF.

The blow-off properly used is an essential aid to boiler cleanliness, but it may also become a source of great waste of fuel. A boiler is blown down to reduce the concentration of scale making solids by substituting fresh feed for the impure water withdrawn. Every drop of water, however, which leaves the blow-off is hot water, and every bit blown out beyond that necessary to keep the boiler clean and free from foaming is an unnecessary waste of heat. It is better to blow a little at fairly regular intervals, than to wait till a boiler bumps and foams from a too great concentration of solids, and then blow down a large amount. Another point about the blow-off which requires constant supervision is its tightness. Blow-off valves of necessity handle water charged with mud, sediment, and often small particles of actual scale. Such service is hard on the valve and in many cases they leak. A leaking blow-off valve is neither economical nor safe. A small dribble of hot water coming from the blow-off pipe may seem trivial, but remember that it is a twenty-four hour a day leak, and that it may represent a goodly amount of fuel in a month. Engineers should make a practice of inspecting their blow-offs daily. If several boilers blow into a common main, follow up a leak and see which boilers are the offenders, and arrange to have the valves overhauled and made tight. In many cases trouble with leaking blow-off valves would be overcome if valves adapted to this trying service were used in place of the ordinary commercial stop valves.

STEAM MAINS AND PIPING.

Coming now to the distribution of the steam from the boilers to the various steam consuming parts of the equipment, attention is naturally drawn to the main steam pipe. All steam piping deserves a proper non-conducting covering. Many plants have the piping effectively covered when installed, but subsequent repairs, additions, etc., may have caused the removal of portions of the covering which have been either carelessly replaced or not replaced at all. Many plants, also, have the straight lengths covered but have a fine collection of bare fittings, valves, flanges, etc., which go on radiating and conducting heat throughout the working life of the plant. These portions of the piping should be covered with plastic asbestos or magnesia as a war time conservation measure.

Another item of waste often found in steam piping is leaking joints and flanges. Joint leaks are sometimes attributable to poor original design, with insufficient allowance for expansion and contraction. Even when this is the case much can be done by careful attention to the choice of packing and its insertion, and in most plants steam leaks are a matter of careless packing, or neglect pure and simple. As steam mains cannot be repacked under pressure, the greatest care should be taken when joints are remade to do a thorough workmanlike job, and every engineer must do his utmost to keep his plant free from the annoying and wasteful "canary birds" whose song never ceases so long as the plant is in operation.

Every steam main presents a problem in the removal of the water of condensation. The longer the main, the more water to remove. Drain connections to main steam lines pass pure hot water, as no oil is ordinarily introduced into the steam up to the point at which it is lead to the engine or pump cylinder. This pure hot water must be effectively removed from the pipes for safety, but it should be so removed that only water flows.

STEAM TRAPS.

For this purpose, use is ordinarily made of a steam trap or a drip loop, though the number of open ended drains is unfortunately much larger than it should be. The object of traps and other devices attached to drains is to remove the water of condensation and hold back the steam, with or without the further function of returning this water to the boiler. Steam traps are frequent offenders against economy in that they require care and attention to keep them operating effectively, and they are easily by-passed so that the water will get by them anyhow, if they are not in good adjustment. It is so easy to by-pass a trap and then forget it, when it fails to work as it should, that a special routine of trap inspection is a desirable part of the duties of someone at every plant. It is a simple matter to arrange a test connection to the discharge of most traps, which will show if the trap is tight, that is if it properly holds back the steam. If a routine inspection and report is made daily on all traps the engineer is in a position to order and follow up the necessary repairs, and a continuously by-passed trap should not be tolerated under any circumstances. Low pressure drips can be cared for by means of traps or water seals, and one or the other device should be installed on every low pressure drain connection, no matter how small or how little used, as the expense of a water seal is negligible, and it will prevent the passage of steam if its height is suited to the pressure carried.

HOT DRIPS SHOULD BE SAVED IF CLEAN.

The discharge from all drain connections should be classified as either clean or dirty. If clean it is a valuable thing to be carefully saved and returned to the boiler with the feed in the shortest possible time so as to lose as little as possible of its valuable heat. Oily or contaminated drips must of course be treated in such a way that the oil or dirt is kept out of the boilers. However, an opportunity presents itself to every engineer who has oily or foul hot water flowing to waste, to see if some rearrangement of the piping, or the installation of separators may not avoid the source of contamination and permit a foul drip to become a clean one, with a consequent saving of fuel. When this is clearly impossible, then of course this hot water must be wasted, and in this case care should be taken to so insulate the piping and apparatus as to keep the quantity of hot waste as small as possible.

WASTE AT ENGINES AND PUMPS.

By far the greater part of the high pressure steam produced is used for driving engines or pumps. (Included in this general class are all sorts of steam motors, turbines, rotary engines, compressors, etc.)

In reciprocating engines, steam is often wasted by leakage at glands around piston and valve rods, leakage past piston packing from the working to the exhaust side, leakage through cylinder drips, indicator cocks, etc. To keep packing in good condition on piston and valve rods requires that wear and lost motion be taken up in crossheads so that the rods shall be properly centered in the stuffing boxes. It also requires that if the rods have become worn or badly cut or scored, they be made smooth again by draw filing or machining, or if too badly scored they may need replacement. Then attention should be given to the shape of the stuffing box and the end of the gland. It often happens that stuffing boxes and glands designed for one kind of packing are subsequently filled with packing for which they are not adapted and in some cases a soft metal or babbitt ring placed at the bottom of the gland to give the new packing the sort of support it requires will prove a simple and important step in maintaining a tight job. Not every kind of packing will succeed in any particular stuffing box. Often considerable study and experiment is needed to get the right packing for a difficult place. However the time is well spent, for the continual flow of high pressure steam from a rod gland is usually taken as an indication of carelessness or incompetence on the part of the operating force, as well as being an expensive luxury from the standpoint of economy.

VALUE OF THE INDICATOR.

Leaking pistons and poorly set valves are not so easy to detect as leaking stuffing boxes. This does not, however, signify that they are less wasteful. On the contrary quite the opposite is apt to be the case. Indicator diagrams are the most certain way of obtaining information on this head, though tests can be devised to give a pretty fair indication of the tightness of pistons, by admitting steam to one end of the engine, and noting the presence or absence of steam at a cylinder drain or indicator cock at the other end. The trouble with such a test is that it must be made with the engine at rest, securely blocked, and it tells only the condition at one point in the stroke with the piston not moving. This does not necessarily prove that the same condition will be found under running conditions with the piston in motion. Most engineers are now equipped to indicate their engines. Those plants not so equipped would find in most cases that the cost of the necessary apparatus would soon be returned to them with interest by the resulting saving through the better knowledge of cylinder and valve conditions, and the chance to keep machines working at the best economy of which they are capable. In this connection it may be well to point out that it is often interesting and valuable to indicate pumps as well as engines.

CONSERVING EXHAUST STEAM.

If the steam may be considered to have been economically produced, conveyed to, and used in pumps and engines, we must now consider what is perhaps the greatest potential source of either profit or loss in the whole power plant, namely the steam exhausted or rejected by these same pumps or engines. During the winter season exhaust steam has in most plants been used directly for heating buildings. In the summer, however, much of it may be wasted. This should not be the case. There are very few power plants where it is really impossible to utilize the exhaust steam in some way so that there will be a marked improvement in the overall economy.

INDUSTRIAL HEATING PROCESSES.

Consider first the various kinds of heating required for industrial processes. There is no excuse for using high pressure steam to heat the contents of any open vessel, if the contents are both open to the atmosphere and wet. Such a vessel can never be heated to a temperature in excess of the temperature of exhaust steam, and therefore to use high pressure steam when exhaust is available is inexcusable. This applies to a whole line of industrial processes in the textile industry, paper making, metal working, etc., which it is not the purpose of this article to enter into in detail. There is, of course, a chance that if a particular vat or kettle has been fitted with small pipe connections for high pressure steam, much larger connections will be required to get the amount of heat needed in the time desired, but that is all. The old idea that steam through a reducing valve at 2 or 5 or 10 lbs. pressure could not be replaced by exhaust steam at the same pressure has long since been proved a fallacy. Hence if there is not enough exhaust steam at a plant in winter to heat the buildings and supply the desired steam for industrial purposes, the piping should be so arranged that as soon as the requirements for building heating diminish, exhaust steam can replace high pressure steam in proportion so that no exhaust is wasted. This can easily be done by means of a reducing pressure valve in a connection from the boilers to the main which distributes low pressure steam. The valve should be set to open only when the pressure falls below that at which the back pressure valve on the engine is set by a predetermined amount, say two pounds. Then when there is sufficient exhaust, no high pressure steam will be admitted, but when any deficiency of exhaust steam occurs in extreme cold weather, or when engines are shut down, the flow will be maintained through the reduced pressure connection.

There are processes requiring steam for heating, which need a temperature in excess of that which the exhaust can furnish with any reasonable back pressure on the engines. These processes, of course, must be supplied with steam at the correct pressure, winter and summer, and do not enter the present discussion. Compared to the cases where exhaust steam will serve, they will be found relatively few. An effort must be made however, to see that all the condensation from such processes, if clean, is returned to the boiler feed.

OIL SEPARATORS NEEDED.

The utilization of the exhaust steam in place of live steam for heating is frequently believed to be impossible because of the oil which it contains. If the exhaust is permitted to carry a high oil content, this complaint is justified. On the other hand there are now available so many excellent devices for removing oil from exhaust steam that this excuse indicates that the separators are either poorly maintained or of insufficient size for the amount of steam which passes through them, and so is not particularly valid as a reason for failure to save the heat wasted when this steam is thrown away. It is well to remember also that whereas it is possible to rid steam of practically all the oil it contains, this is not the case after the steam has condensed, so that it is well to concentrate our efforts on removing the oil before the exhaust condenses, and escape the much more difficult if not impossible task of getting it out of the hot water after condensation.

FEED WATER HEATING.

Most plants will find that after the heating season is over, their industrial processes will not go far toward consuming their exhaust steam. Some plants are equipped for condensing operation and so will use some of the heat in the otherwise exhausted steam in doing work. In any plant, however, there will be exhaust from pumps and auxiliaries, if not from the main engines and turbines, which does not go, and indeed should not go to the condenser. This steam should be used for heating the feed water. No matter how much or how little exhaust steam is produced, it should be brought into a feed water heater, where it can heat the feed, mixed with the clean returns from the drips, to as high a temperature as the equipment is capable of producing.

CHOICE OF UNITS TO FIT LOAD CONDITIONS.

Much judgment may be exercised by operating engineers in picking out the best units to run, so that where several different units are available, that combination will be used at any time which can carry the load most economically. It is folly to run a reciprocating engine either much underloaded or much overloaded, if there is available another unit of such size as to run at about its best efficiency. This, of course, is not quite so important with turbines. The same thing applies in many cases to pumps and auxiliaries. A little extra effort in starting and stopping will in many cases save a lot of fuel.

STEAM WASTED IN IDLE EQUIPMENT.

Another feature, which though it is important is not always under the control of the engineer, is the practice of leaving soda kettles, steam heated glue pots, potash dips, dye becks, etc., with steam turned on full tilt when they are not needed. A prominent engineer made the statement that in a large plant under his charge, there was surprisingly little difference between the Sunday load and the weekday load on the boilers just because he had not been able to secure intelligent co-operation in shutting off these steam-consuming devices when the plant shut down Saturday night. In some cases flow meters might pay for themselves by charging the unnecessary steam used to the proper department, so that the executive in charge could place the blame on the proper parties and in the proper amount.

IMPORTANCE OF ENGINE ROOM ACCOUNTING.

Some larger plants with which the writer is more or less familiar run their steam department on such a basis. All steam used is metered and charged to the proper account. It is credited to power, heating buildings, pumping water for various purposes, or to each department in which it may be used for industrial heating. The power is also charged up to the departments using it, so that all power and steam can be accounted for and wastes eliminated. This is an ideal system, but is not, of course, practical in every plant. It is for each engineer to judge how far he can carry out any system, but some method of checking steam waste is needed in every plant.

CONSERVATION OF SUPPLIES AND TOOLS.

Steam, hot water and coal, while they are the things which may be wasted in the greatest amount in a power plant, are not the only things over which the engineer should cast a conserving eye. He has it in his power to use economically or wastefully, every bit of equipment, all supplies and all tools in his department. Conservation should be carried to the last handful of waste, the last scrap of packing and the most insignificant bolt or wrench. In other words, fuel and heat conservation should accompany a campaign of general good housekeeping. Years ago, a ship master who was thrifty and conservative in keeping his ship well found and in the pink of condition with the least expense to his owners was spoken of as a good "ship's husband," probably as compared with a thrifty "housewife." In this sense it behooves every chief engineer to be a good "husband" to his power plant and to see that order and economy, with well maintained equipment prevail in his department.

SUPPLIES.

When oil is issued from the stores it should be of the kind needed, and in the exact amount required for actual lubrication. Fly wheels, floors, ceilings, windows, etc., will do very well without an oil coat. Lubricators, oil cans, cups and all oil containers should be clean, tight and in good serviceable condition.

When either sheet, ring, or spiral packing is used, care should be given to getting the right kind for the job, using enough to secure a tight joint or stuffing box, and cutting it so that there is a minimum of waste. Sheet packing in particular, offers a fine field for careful planning, when it is cut up into gaskets. A full scrap box for packing is as undesirable as a full garbage pail.

Waste should be used intelligently. Rags are better for some work and used waste for other things. Clean new waste should be used where it is needed, and for no other purpose. Waste washing and reclaiming machines are factors of economy, even in small plants.

TOOLS.

Tools may be abused and wasted through unnecessary breakage and loss about as easily as any item of plant supplies. Good tools, in good workmanlike conditions are needed, but care should be taken that the right tools are used for a job and that they are not ruined before their time by over strain and abuse. A piece of pipe cannot make a two-foot wrench out of a ten-inch one, even if it gives the same leverage. The jaws and frame were never intended to take the greater strain, and are sure to suffer. Tools also should be kept in some definite convenient place, and it should be recognized as a direct breach of plant discipline to strew them around promiscuously for the next gang to hunt up. This is especially true of special wrenches and spanners, provided to get at difficult parts of particular machines. The tool check and crib system may be a nuisance in a small plant but it certainly serves to fix the responsibility for the use and return of tools, while the same boy who checks out tools can easily care for the issue of other supplies.

REPAIR THE OLD EQUIPMENT.

Unlimited opportunity is present to the engineer to use his skill and ingenuity in keeping all of his equipment, large and small, in good repair, and in condition for economical service. Replacements are difficult to effect. We cannot scrap the old machines as we have been in the habit of doing. We must keep on using the old tools and the old machines, and keep them repaired and fit as long as this is possible. Every engine, pump, boiler or tool which can be made to continue in operation at capacity, and with as good economy as it is capable of, having in mind its particular design, till after the war, means that skilled care and repair has effected a saving of transportation, of raw material, and of manufacturing capacity which becomes directly available for ship and munition production. Therefore, as engineers, let us keep the old wheels turning so that the new ones which might have replaced them shall be available to help establish freedom throughout the world.

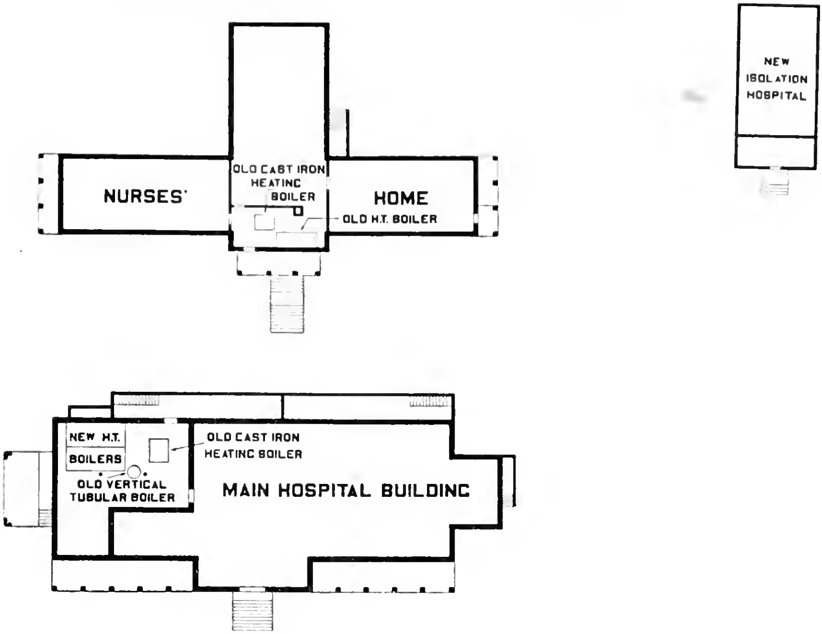
Fuel Saving and Other Advantages of Heating a Group of Related Buildings from a Single Boiler Plant.

H. E. DART, Superintendent of the Engineering Department.

Where buildings are grouped together, as in a hospital, sanatorium, college or school, the boilers are frequently installed without much regard for economy of operation, the common fault being that too many boilers are used. Instead of heating such a group of buildings from a central plant, it is often found that a boiler is installed in each building of the group and it is not unusual to find two or more boilers in some of the buildings. This arrangement helps to make business for the boiler manufacturers and the boiler insurance companies but it is very wasteful in the consumption of fuel and every case of the kind should therefore be thoroughly investigated in a time of coal shortage like the present. In a large majority of cases the central plant will prove to be a good investment as there will also be a saving in other directions besides fuel consumption — the labor item for instance, being of considerable importance. Furthermore, greater reliability will be secured with the central plant because a better type of boiler will ordinarily be used and the plant will have some reserve capacity while, as a rule, no surplus capacity is provided when boilers are installed in the separate buildings and the failure of a boiler may necessitate the closing of a building until repairs can be made.

SMALL INSTITUTIONS APT TO BE THE WORST OFFENDERS.

The use of separate boilers in each building of a group is more liable to be found in small institutions than in those of larger size, partly because the latter usually have the benefit of better engineering advice. It is on this account also, to some extent, that the buildings of manufacturing groups are almost always heated from



General Plan of Danbury Hospital Showing Boiler Installation.

One of the new horizontal tubular boilers does all the work formerly done by the four old boilers and heats the new Isolation Hospital besides.

central plants even when purchased power is used. Such buildings, too, are generally located close to each other and there is no serious objection to unsightly overhead piping so that the cost of installing a central system is not as great as in the case of an institution where long lines of underground piping must be installed. Initial cost is frequently a factor which prevents the installation of a central plant but the experience of a few years of operation will sometimes demonstrate that the extra expenditure would have been well justified.

A TYPICAL CASE.

The Danbury Hospital at Danbury, Connecticut, presents a typical case showing the advantages of a central plant over the former plan of separate boilers in each building. In the latter part of 1915 our Engineering Department was consulted by the president of this hospital who asked if we could make any suggestions for reducing the coal consumption at the plant. We found that the main hospital building covered a ground area of about 6,000 square feet and contained three stories above the basement. The only other building at that time was the Nurses' Home which covers an area of about 4,500 square feet; the central part of this building is three stories high but the two wings have only one story above the basement. Excluding the basements which are largely below ground level, there is a total floor area of about 26,500 square feet in the two buildings. The buildings are located on a high hill on the outskirts of the city and are fully exposed to winds from all directions so that proper heating is a more difficult matter than in cases where buildings are somewhat sheltered.

The Main Hospital Building was heated by means of a large cast-iron sectional boiler which was located in the basement. The boiler had a grate area of eighteen (18) square feet and was rated by the manufacturer at 8,000 square feet of radiating surface. It was operated at low pressure and was connected to a gravity heating system of the usual type, the condensed steam from the radiators being returned directly to the boiler. The Nurses' Home was heated by means of a similar system from a cast-iron sectional boiler in the basement of that building; this boiler had a manufacturer's rating of 4,400 square feet of radiating surface and its grate area was 18.4 square feet. In the basement of the Main Hospital Building there was also a 30 horsepower vertical tubular boiler which furnished steam at a pressure of about 35 pounds for use in the operating room, sterilizing room, diet kitchen and main kitchen. The laundry was located in the basement of the Nurses' Home, steam being furnished by a 30 horsepower boiler of the horizontal tubular type; this boiler was operated at a pressure of about 90 pounds and steam was used also at a reduced pressure of 45 pounds. Water for use in both buildings was heated by steam from the vertical tubular boiler in a combined coil heater and storage tank located in the basement of the Main Building. The vertical boiler and the horizontal tubular boiler were used throughout the year and, of course, all four boilers were in use continuously during the heating season. A three-inch steam pipe for emergency use connected the vertical boiler with the horizontal tubular boiler but each of the four boilers was operated entirely independently of the others. In case of a cracked section or other accident to one of the cast-iron boilers it would have required several hours' work to make even temporary arrangements for heating.

TWO BOILERS REPLACE FOUR SCATTERED ONES.

After a study of the general requirements, space conditions and other features, we recommended the removal of all four boilers and the installation in the basement of the Main Hospital of two brick-set horizontal tubular boilers each having a diameter of fifty-four inches (54 in.), a tube-length of fourteen feet (14 ft.) and a manufacturer's rating of approximately 75 horsepower. It was found that the existing chimney would not be large enough to develop the full capacity of both boilers but we expected that one boiler would furnish all the steam required and we therefore did not advise the erection of a new chimney. The executive committee of the Hospital accepted our recommendations and authorized us to proceed with the preparation of detailed plans and specifications to cover the construction of the new boilers, their installation and setting, and the necessary changes in the piping system. The boilers were arranged to operate at the highest required pressure (about 90 pounds) and they were connected to a six-inch main steam header from which branches were run with reducing valves as required. In general, no changes were made in the steam piping of the separate systems, the pipes from the new boilers being connected at the points where the mains left the old boilers. Steam was carried to the Nurses' Home at boiler pressure and reduced to the proper pressure in the basement of that building. Reducing valves for both heating systems were specified for a pressure of two pounds on the low side, with a range as high as ten pounds but it has not been found necessary to increase the pressure. All condensed steam from the heating systems and all uncontaminated drips and hot water from any source were piped back separately to a new automatic pump and receiver located near the boilers, steam traps being used where necessary on account of the different pressures. The exhaust from the pump was arranged to discharge either to atmosphere or through an oil separator to the heating system. An injector was also specified for emergency use. The boilers were equipped with shaking grates, a damper regulator was called for, and a temperature regulator with thermometer was applied to the water heater so that the steam would be automatically shut off when the temperature of the water reached the desired point. Conditions were such that a blow-off tank was required and we designed a good heavy one of plate steel with riveted joints. Insulating covering was specified for the tops of the boilers, for the smoke-flue and for all piping.

IMPROVED ECONOMY RESULTS.

It was decided not to go ahead with the installation of the new boilers until the end of the heating season in the spring of 1916. There was some delay in getting the boilers built but the new installation was completed in the fall of 1916 in accordance with our plans and specifications, as outlined above. Since that time the Isolation Hospital has been built and pipes have been extended from the main boiler plant to supply steam for 350 square feet of radiating surface in that building. Additional radiators have also been installed in the Main Hospital Building and in the Nurses' Home but it has never been found necessary to use but one of the two new boilers at a time, even in the most severe weather. The engineer of the hospital recently wrote us stating that "This system has given better satisfaction throughout for heating purposes and especially during the past winter which was an extremely cold one."

Regarding the economy of the new boilers, the hospital authorities state that there was a saving of $472 (practically 12 per cent.) in the cost of coal for the year 1916-1917 as compared with the year 1915-1916. It would seem, however, that the full efficiency of the boilers was not attained during the first months after their installation because it is stated further that there was a saving of more than 63,000 pounds of coal in the six months ending April 1, 1918, as compared with the corresponding six months just after the boilers were installed, the figures being as follows:—

October 1, 1916, to April 1, 1917, 777,000 pounds.
October 1, 1917, to April 1, 1918, 713,950 pounds.

The difference represents an additional saving of more than eight per cent., in connection with which it should also be remembered that more radiators were installed than formerly and that the recent winter was the coldest of which we have any authentic record. No accurate estimate can be made of the labor saved but it can be readily understood that one fire will require much less attention than four, especially when the four fires are located in two separate buildings. In this connection it is interesting to note that the active grate surface under the new operating conditions is about twenty (20) square feet as compared with approximately fifty-six (56) square feet in the old boilers. Less labor is required for handling coal and removing ashes while there is the further advantage that all dust and dirt incident thereto are now eliminated from the Nurses' Home. There is also an average saving of at least $25 per year in the cost of boiler insurance.

MANY SIMILAR CASES NOTED.

We have described the Danbury Hospital installation in detail because it is a fairly typical case and we have more data concerning it than for some other cases. We know of many cases, however, where similar improvements could be made with an aggregate saving of a large amount of coal. We have under consideration at the present time the case of a sanatorium in one building of which there are a large cast-iron sectional boiler connected to the heating system, a round cast-iron boiler furnishing steam at about ten pounds pressure for use in the kitchen and for sterilizing, and two "laundry" heaters to meet the large demand for hot water. These four boilers are located close together and all are connected to the same chimney; they operate independently of each other, the laundry heaters being connected to separate storage tanks. The heating boiler is about the proper size for the work which it has to do but the other steam boiler is larger than necessary and is operated a large part of the time in a wasteful manner with the firing door open. One of the laundry heaters is large enough but the other is too small and the fire-pot section has cracked three times on account of cold water being drawn into it when the demand exceeds the supply of hot water stored in the tank. The two laundry heaters and the steam boiler are operated continuously throughout the year and, of course, all four fires are kept burning during the heating season. We will recommend the installation of one steam boiler to take the place of the present round boiler and the two laundry heaters, the hot water to be supplied by means of a coil heater with suitable storage tank and with thermostatic regulator to control the temperature of the water. One fire will take the place of three with a consequent saving in coal consumption, and better service will result as an adequate supply of hot water will always be available, together with such steam as may be required for sterilizing, etc. This problem is somewhat complicated by the difficulty in obtaining a boiler of standard design which will fit into the available space.

We have just recommended the installation of a single boiler to replace three small boilers in a four-story building containing stores and offices; the three small boilers have been wasteful in coal consumption and have never heated the building satisfactorily. These three boilers are practically worn out anyway.

Another case coming under our observation is that of a private sanatorium consisting of four principal buildings each of which contains a boiler for heating and a "laundry" heater for furnishing hot water of which a large amount is required. The four water heaters are kept going continuously throughout the year so that there are eight fires which require attention during the heating season. We prepared plans and specifications for a boiler plant with two boilers either of which would furnish all the hot water required and all the steam necessary for heating except during extremely cold weather when both boilers might have to be used occasionally. These plans have not yet been carried out because of the high cost of brass pipe and other materials required.

ONE INSTANCE ON A LARGER SCALE.

On a somewhat larger scale is the case of the group of three large Connecticut State buildings at Hartford, consisting of the Capitol, the Armory and Arsenal, and the State Library and Supreme Court Building. The plans which we developed for a central plant for this group contemplate the erection of a boiler plant at the Armory with five boilers to replace the nine boilers in use now; it would not be necessary to operate more than four of the boilers at any time. Aside from the saving in coal consumption and labor in operating one plant instead of three, this plan would have many advantages over the present arrangement, one of which is the proposed construction of a railway siding so that coal can be delivered directly from the cars instead of being carted in trucks to each of the three buildings. Adequate coal storage space would be provided for a whole year's supply whereas none of the buildings now has room for storing more than a comparatively small amount. There would be no coal and ashes to be handled inside of any of the buildings and the smoke nuisance would be obviated by the installation of smoke-consuming furnaces. By the removal of the present boilers needed space would be gained in the Capitol and Armory and the beauty of the Library building would no longer be marred by the adjacent unsightly boiler plant and steel smoke-stack. The expense of this undertaking would be considerable under present conditions since it involves, among other items, the construction of about 1,400 linear feet of concrete subway and a concrete bridge over a river. The project came up for an appropriation at the last session of the State Legislature but action was postponed until a more favorable time, both as regards cost of the work and the fact that troops were then encamped on the Armory grounds and in the building.

CHANGES MAY PAY EVEN IN WAR TIMES.

We could mention other examples of "conservation by consolidation" but the cases cited above will, perhaps, be sufficient to indicate some of the more usual advantages to be gained from the use of central plants, aside from the saving in coal consumption which is the all-important consideration at present. In planning any group of buildings competent engineering advice should be sought in regard to the advisability of installing a central plant for heating or for light and power with proper provision for the future. In existing buildings careful investigations should be made at once to determine whether there is any possibility of simplifying the boiler equipment and thereby saving coal. There is a tendency to put off such investigations until the boilers begin to wear out and this tendency is justifiable to some extent under ordinary conditions. Under the stress of present circumstances, however, no opportunity for saving coal should be overlooked. Moreover, there is a good demand for second-hand boilers and the price of coal is so high that the saving is proportionately greater than formerly and the boiler purchaser can afford to pay more for new equipment. One of the Danbury Hospital boilers was less than four years old when it was taken out and the oldest of the four was built in 1909. There was no difficulty in disposing of the second-hand boilers but some money could have been saved if the plant had been properly laid out in the first place.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. PERRY, EDITOR.

HARTFORD, JULY, 1918.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Secretary Corson Appointed Advisory Engineer to the Connecticut Fuel Administrator.

The United States Fuel Administration proposes a campaign to secure greater economy in the use of fuel. They realize, however, that it is not feasible to exact the purchase of new and more efficient equipment on a large scale at this time. It is apparent that a considerable saving can be effected by the use of existing equipment in the best and most economical manner with such changes and improvements as will put it in the best possible condition for service. To this end an engineer will be appointed in each of the industrial States to advise the Fuel Administrator and to cooperate with plant owners. Mr. William R. C. Corson, Secretary of The Hartford Steam Boiler Inspection and Insurance Company, has been appointed in this capacity for Connecticut.

A questionnaire will be submitted to each plant owner which will enable him to inform the fuel administration of the condition of his plant and its facilities for the economic use of fuel. The questions will cover the boiler and engine equipment, the coal consumption during the year just past, and a record of any changes in progress to improve fuel economy. In addition, questions will be asked from which a knowledge can be had as to the firing methods in use, the records if any, which are kept, the facilities for heating feed water, cleaning heating surface, regulating the air supply with dampers, etc., and the use of both live and exhaust steam. The questions will yield a basis upon which plants may be rated as to their economic condition.

To assist plant owners in properly presenting the condition of their plants, and also to prevent misrepresentation or evasion, an inspection will be made for the purpose of checking up the answers to the questionnaire. The boiler insurance companies have offered the services of their inspectors for this work and the services of other engineers will also be utilized. The aim of the administration will be constructive and helpful, and every effort will be made to assist in the institution of good firing methods and the economic utilization of steam and hot water.

With the Colors.

Special Agents Dudley P. Allen and George A. Wassnung of the Atlanta Department are now in the service, Mr. Allen in the Ordnance department, and Mr. Wassnung in the National Army.

Inspector F. B. Taylor, also of the Atlanta Department, has entered the engineering service of the Naval Reserve.

Mr. C. L. Barrett from the Minneapolis office, has enlisted in the Coast Artillery.

From the Home office, Inspector Eugene Rang has entered the engineer service of the Naval Reserve. Arthur M. Johnson, from the drafting force, has enlisted as Machinist's Mate, 2nd class, in the Naval Reserve, and is stationed at Philadelphia, Pa. Thomas F. Barry, of the Home office clerical force, has also enlisted in the Naval Reserve, but has not as yet received his call, though it is not unlikely that he will have entered active service by the time this note appears in print. Miss Selina L. Winters, one of our stenographers, is so far our only young lady representative in this column. She has enlisted as Yeoman, 2nd class, in the Naval Reserve, and is stationed at the New London, Conn., naval station. She was very enthusiastic about her work when seen on a recent visit to the office on furlough.

FRANK SYLVANUS ALLEN.

Obituary.

Frank Sylvanus Allen.

Chief Inspector Frank Sylvanus Allen of our Home Office died Tuesday evening, June 18, at his home in Hartford. He had not been in robust health for the last few years, but continued the direction of his department, and though urged to rest and save his strength, would be found at his desk nearly every day. He was there on May eighth. On the evening of that day at his home he suffered a shock which occasioned his death six weeks later.

Mr. Allen was born in Lynn, N. H., August 3, 1842, of the old New England stock which included Ethan Allen of revolutionary fame. Although brought up on a farm, he early became connected with industry and power production. For a time he was employed as engineer and millwright in cotton and woolen mills in Massachusetts. Later, at or shortly after the time of the Civil War, he was engaged in opening up workings for the mining of cannel coal as a source of oil in the Cabin Creek region of West Virginia. Here he gained experience in mining and in oil and gas production, as well as in rough and ready surveying and engineering. Returning north he again engaged in millwright work, with some time spent in boiler making and erecting.

In 1871, at the invitation of President J. M. Allen, Mr. Allen came to our Company as Chief Inspector at Hartford. In 1878, he was appointed State Inspector of Boilers, for the First Congressional District of Connecticut. He continued to occupy that position in addition to his duties as an employee of the Company for about twelve years.

At first connected only with the Hartford office, Mr. Allen in 1891, was in addition, given charge of the inspection work of the Boston office and from then for over twenty years was at the head of the entire New England inspection force of the Company. In 1912 however, he was relieved of the arduous duties and tedious traveling involved in this dual supervision of widely separated offices, by the appointment of Mr. McNeill as Chief Inspector at Boston. Mr. Allen however retained his active connection with the work at Hartford until his death.

As a boiler inspector Mr. Allen had unusual powers of deduction and analysis, and with it a high sense of personal responsibility. He was absolutely fearless and indomitable in enforcing the discontinuance of practices or apparatus which he believed endangered boiler operation, and he was particularly adept in detecting an unsafe condition from often elusive and vague indications. His keenly analytical mind and constructive imagination enabled him to understand almost at a glance the causes for the failure in complicated systems of steam distribution, whether for power, industrial uses or heating. There are many instances where engineers were completely baffled by the failure of such a system to operate properly, and where he unerringly put his finger on the trouble and suggested a simple remedy with a promptness and accuracy almost uncanny.

Mr. Allen was a very successful designer of power plants. His designs were simple, strong and economical, and many New England mills and factories are operated by plants built from his plans and specifications. Some of the plants which he designed, such as that at the Wood Worsted Mill of the American Woolen Co., Lawrence, Mass (44 boilers), the plant for the Otis Company, Ware, Mass., and for the George H. Gilbert Manufacturing Co., Gilbertville, Mass., were especially noteworthy.

As a heating engineer his services were widely sought. The list of schools, hospitals, institutions and churches where his work has been tested by years of economical and useful service is a long one. The Hartford hospital will serve as an illustration. The heating system was at different times modified, enlarged and improved under his direction, services for which the directors presented him with an engrossed memorial. A few years ago an enlargement of the plant required a new study of the heating problem. At that time Mr. Allen was not only called in to serve as advisory engineer, but was made a Director of the hospital, and a member of its building committee, with oversight of the heating and general engineering.

Personally, Mr. Allen typified the New England stock from which he came. He was as modest and simple in his tastes as a child, but of a strong and rugged honesty. His energy was tremendous, no task was impossible, nothing which appealed to his sense of duty was too unpleasant or too hard for him to tackle, and he would fight for safety and fair dealing with a fierceness which no one who ever encountered it will forget. In his engineering there was no place for sham or complication. Simple means, tried methods and the absolute courage of his convictions marked his work.

To his friends he was sympathetic, generous, kindhearted. Sensitive and easily hurt, he was equally quick to forget the hurt. His generosity and help to those in need was boundless, but he took good care that no word or action of his should ever betray the fact of any particular assistance rendered. He possessed in a most unusual degree the friendship, respect and absolute confidence of the very large acquaintance he had formed.

Mr. Allen took a great deal of interest in the movement in Massachusetts for better boilers, and when the law was passed requiring boiler inspection and the licensing of inspectors, he received certificate No. 1, dated August 1, 1907.

He was prominent in Masonic affairs and had membership in both York and Scottish Rites bodies, having attained the 32nd degree, and at the time of his death was a trustee of the Masonic Hall Association of Hartford. He was also deeply interested in the Masonic Home at Wallingford, Ct., and had given to it much of his time and engineering knowledge.

Mr. Allen was twice married. His first wife died in 1903. His second wife, who was Miss Celia A. Rattray of Hartford, survives him. He also leaves a sister, Mrs. Warren S. Shurburne, who made her home with him, and a brother, the Rev. Fred. H. Allen of New York.

The following minute was passed by the Board of Directors of the Hartford Steam Boiler Inspection and Insurance Company, at a meeting held June 26, 1918:

"Frank Sylvanus Allen, long Chief Inspector of our New England departments, died at his home in Hartford on Tuesday, June 18, 1918.

"Mr. Allen came to this Company in 1871. He was a young man with a natural genius for engineering and peculiarly qualified to help in directing the inspection service which our Company had but recently inaugurated. He gave himself to this work with vigor and enthusiasm and unselfish devotion to the Company's interests.

"As the years passed his aptitude was augmented by experience and study into a broad understanding of boiler construction and of the utilization of steam and he became not only a prominent figure in the boiler inspection world, but a steam consultant whose advice and opinion was widely sought. To him and his ability the success of our inspection service is largely due. His influence secured the adoption of many of the standards of safe boiler construction and operation which we now advocate, and to his personal reputation as an engineer our Company owes in large degree the recognition which it enjoys in steam matters.

"Our Company has been fortunate in having the loyal service of many devoted and able men; among them Frank S. Allen will ever be held in grateful remembrance.

"The Board of Directors make acknowledgment of the Company's debt to Frank S. Allen, and direct that the Secretary spread this minute on the records of the Company and transmit a copy of it to Mrs. Allen and express to her the sincere sympathy which all the members of this Board feel for her in her great sorrow."

Boiler Explosions.

Dec., 1917

(Continued from the April Locomotive.)

(481.) — An economizer exploded December 28, at the plant of the Ithaca Traction and Light Co., Rewick, N. Y. One man was killed, and the economizer and building were demolished.

(482.) — A boiler ruptured December 29, at the city water works and electric light plant, Waynesboro, Ga.

(483.) — On December 29, a tube ruptured in a water tube boiler at the power house of the Gulfport and Mississippi Coast Traction Co., Gulfport, Miss. One man was injured.

(484.) — On December 29, a section cracked in a cast iron sectional heating boiler at the building at 217 Mechanic St., Worcester, Mass., belonging to the R. C. Taylor Estate.

(485.) — A domestic hot water boiler exploded December 30, in the kitchen of the home of George Kalconquin, West Hoboken, N. J. Mr. Kalconquin was fatally injured.

(486.) — A kitchen range boiler exploded December 30, in the home of John Barrett, 1824 South Front St., Philadelphia, Pa. Mrs. Elizabeth Gleason, 84 years old, was seriously injured.

(487.) — A similar explosion to the above occurred December 30 in the home of Samuel Fox, South Fifth St., Philadelphia, Pa. No one was injured.

(488.) — A range boiler exploded December 30, in the home of Lewis Groos, 1735 South Fifth St., Philadelphia, Pa.

(489.) — A range boiler exploded December 30, in the home of Mrs. Ida Monas, 3911 Pennsgrove St., Philadelphia, Pa. Mrs. Monas was seriously injured.

(490.) — A water back in a range exploded December 30, in the home of Mrs. Ole Aaronson, Collingwood, N. J.

(491.) — Five sections cracked December 30, in a cast iron sectional boiler at the building of Anna H. J. Taylor, New York City .

(492.) — A section cracked December 30, in a cast iron sectional heating boiler at the plant of Frank J. Holderried, Roxbury, Mass.

(493.) — A section cracked December 31, in a cast iron sectional heating boiler in a building owned by the Boston Real Estate Trust, Boston, Mass.

(494.) — A section cracked December 31, in a cast iron sectional heating boiler at the plumbing establishment of J. Lyon and Sons, Hartford, Conn.

(495.) — A tube ruptured December 31, in a water tube boiler at the plant of the Barnett Leather Co., Little Falls, N. Y. Two men were injured.

(496.) — A section cracked December 31, in a cast iron sectional heating boiler at the South St. School, Piqua, O.

(497.) — A blow-off failed December 31, at the plant of the Columbia Western Mills, Saginaw, Mich.

(498.) — A kier exploded December 31, at the Estes Mill, Fall River, Mass. The damage was estimated at $30,000.

(499.) — The boiler of a Chicago and Northwestern Locomotive exploded December 31, at Milwaukee, Wis. One man was scalded to death and two others less severely injured.

(500.) — A kitchen range boiler exploded December 31, at Cullman, Ala. A young lady who was in the kitchen was fatally injured.

(501.) — A range boiler exploded December 31, in the home of Mrs. Patsy Buccalo, Yonkers, N. Y. Mrs. Buccalo and two small children were seriously injured.

(502.) — A range boiler exploded December 31 in the home of Mr. Fred. Johnson, Lincoln Park, Yonkers, N. Y. Mrs. Hester Holm was injured.

(503.) — A range water back exploded December 31, in the home of Mrs. Mary Rickson, 15 Sherwood Ave., Yonkers, N. Y.

(504.) — A water back exploded December 31, in the home of Miss Mary O'Donnell, 137 Beach St., Yonkers, N. Y.

(505.) — A heating boiler exploded December 31 in the basement of Lendburg and Kohout's tailor shop, 1632 Walnut St., Philadelphia, Pa. One man was probably fatally injured.

(506.) — A water back in a range exploded December 31, at the home of Mrs. Sarah Owen, South Milville, N. J.

Boiler Explosions.

JANUARY, 1918.

(1.) — A tube ruptured January 1, in a water tube boiler at the plant of the Union Light and Power Co., Junction City Kans. Three men were injured.

(2.) — On January 1, a section cracked in a cast iron sectional heating boiler at the Indiana County Home, Indiana, Pa.

(3.) — Four sections cracked January 1, in a cast iron sectional heating boiler at the Turn Halle, Holyoke, Mass.

(4.) — On January 1, two sections cracked in a cast iron sectional heater at the Galt House, owned by the Thomas A. Galt Estate, Sterling, Ill.

(5.) — Two sections cracked January 1, in a cast iron sectional heating boiler at an apartment house belonging to Mrs. S. Georgiana Crabb, New York City.

(6.) — A tube ruptured January 1, in a boiler at the power house at the League Island Navy Yard, Philadelphia, Pa. Two men were instantly killed, six critically injured, and one more slightly hurt as a result of the accident.

(7.) — On January 1, a kitchen range boiler exploded in the home of Mrs. Thelma Peach, 2243 North Second St., Philadelphia, Pa. Mrs. Peach was slightly injured.

(8.) — A steam pipe failed January 2, in the inside stables at the McTurk Colliery, Shenandoah, Pa. Five men were in the room, but escaped, although seven mules were instantly killed and eight others so severely scalded that they were likely to die. The loss is set at $5,000.

(9.) — On January 2, two sections cracked in a cast iron sectional heating boiler at the building of L. Oransky and Sons, Des Moines, Ia.

(10.) — A blow-off failed January 2, at the Columbia Western Mills, Saginaw, Mich. Two men were injured.

(11.) — On January 3, a tube ruptured in a water tube boiler at the plant of the Phillips Sheet and Tin Plant Co., Weirton, W. Va.

(12.) — A header failed January 3, in a water tube boiler at the plant of the Avery Co., Peoria, Ill.

(13.) — Nine sections cracked January 3, in a cast iron sectional heating boiler at the City Hall, Savannah, Ga.

(14.) — On January 4, a tube ruptured in a water tube boiler at the plant of the Phillips Sheet and Tin Plate Co., Weirton, W. Va.

(15.) — A section cracked January 4, in a cast iron sectional heating boiler at the Liberty School, Canton, O.

(16.) — An accident occurred to a water tube boiler January 4, at the plant of the Kaul Lumber Co., Tuscaloosa, Ala.

(17.) — A boiler ruptured January 5, at the Cushing Public Service Co. plant of the Minnesota Electric Light and Power Co., Cushing, Okla.

(18.) — A section exploded January 5, in a cast iron sectional heating boiler in an apartment house belonging to Samuel Baumann, New York City. One man was injured.

(20.) — On January 6, a header ruptured in a water tube boiler at the plant of The National Malleable Castings Co., Chicago, Ill.

(21.) — On January 6, an air tank exploded on a mine locomotive at the Maple Hill Colliery, near Shenandoah, Pa. Two men were seriously injured.

(22.) — Three sections cracked January 7 in a cast iron sectional heating boiler at the Cochituate School, Wayland, Mass.

(23.) — A tube ruptured January 7, in a water tube boiler at the plant of the American Steel and Wire Co., Waukegan, Ill.

(24.) — On January 7, a section cracked in a cast iron sectional heating boiler at the 7th St. School, Henderson, Ky.

(25.) — Two sections cracked January 7, in a cast iron sectional heating boiler at the Findlay City Hospital, Findlay, O.

(26.) — A tube ruptured January 8, in a water tube boiler at the Hotel Chittenden, Columbus, O. Six men were injured, one fatally, and of the others the recovery of one was considered improbable.

(27.) — On January 8, the boiler of a Pennsylvania R. R. locomotive exploded at Metuchen, N. J. Two men were injured, one of them fatally.

(28.) — A boiler exploded January 8, at the Home Laundry, Delaware, O. T. E. Fox, the proprietor was killed.

(29.) — On January 9, a tube ruptured in a water tube boiler at the plant of the Walker-Weiss Axle Co., of the General Motors Corp., at Flint, Mich.

(30.) — Two sections cracked January 9, in a cast iron sectional heating boiler at the bakery of the Hegle Bread Co., Buffalo, N. Y.

(31.) — On January 10, a tube ruptured and seven headers cracked in a water tube boiler at the plant of the Grasselli Chemical Co., Tremley Point, N. J.

(32.) — A boiler ruptured January 10, at the Hotel Montague, owned by Fanny R. Grape, Brooklyn, N. Y.

(33.) — On January 11, a steam pipe used to produce force draft exploded at the Alamito Dairy, Omaha, Neb. One man was killed.

(34.) — A kitchen boiler exploded January 12, at the home of Mr. Stonebraker, Rich Hill, Mo.

(35.) — Two sections cracked January 12, in a cast iron sectional heating boiler at the First Baptist Church, Du Quoin, Ill.

(36.) — A boiler exploded January 12, at the electric light plant of the Village of Swansea, Swansea, Ill. Two men were killed, two injured, and the property damage amounted to $4,500.

(37.) — On January 12, a blow-off failed at the plant of Swayne and Robinson, Richmond, Ind. One man was injured.

(38.) — On January 12, a section failed in a cast iron sectional heating boiler at the Barrows St. Commercial Garage, New York City.

(39.) — On January 13, a fifteen-inch pipe flange failed on a steam line from boiler to the engine room header at the plant of the Kansas City Railways Co., Kansas City, Mo. Two men were killed and six others injured.

(40.) — On January 13, a tube ruptured in a water tube boiler at the plant of the West Penn. Traction Co., Connellsville, Pa. Four men were injured.

(41.) — The boiler of a locomotive exploded January 13 at Green River, Utah. One man was injured.

(42.) — A tube ruptured January 14, in a water tube boiler at the plant of the Kansas City Light and Power Co., Kansas City, Kan. Five men were injured.

(43.) — On January 14, a tube ruptured in a water tube boiler at the plant of the Tyler Tube and Pipe Co., Washington, Pa. One man was injured.

(44.) — A section cracked January 14, in a cast iron sectional heating boiler at the Findlay City Hospital, Findlay, O.

(45.) — A boiler failed January 14, at the sheet metal works of the David Luptons Sons Company, Philadelphia, Pa.

(46.) — A steam pipe failed January 16, in a building at 115 South State St., Salt Lake City, Utah. One man was injured.

(47.) — An accident occurred January 17, to a hot water heating boiler at the greenhouse of Fred Uffman and Sons, Rossford, O.

(48.) — On January 17, a boiler exploded belonging to the Robert Swan Co., contractors, at West Washington, Pa. The boiler was used to furnish steam to a pile driver, and was located on ground somewhat lower than the pile driver. While driving a pile an oil pipe line was broken. Oil gushed out of the ground, ran down to the boiler, and formed a large pool with the boiler in the center. The oil became ignited by the fire in the boiler furnace, and completely surrounded the boiler with an intense conflagration. The safety valve operated but was unable to relieve the steam as fast as it was formed by the burning oil, and the boiler exploded.

(49.) — A tube ruptured January 17, in a water tube boiler at the plant of the George Zeigler Co., Milwaukee, Wis.

(50.) — The boiler of a Lackawanna locomotive exploded January 17, at Port Morris, N. J. The engineer and fireman were seriously injured.

(51.) — A section cracked January 18, in a cast iron sectional boiler at the Liberty School, Canton, O.

(52.) — A boiler exploded January 18, at the Washkale Shingle Mill, Aberdeen, Wash. One man was killed and one other seriously injured.

(53.) — The boiler of Santa Fe locomotive No. 952 exploded January 18, at Keenbrook, Cal. The fireman was killed, the engineer seriously injured, and the train wrecked as a result of the accident.

(54.) — On January 19, a tube ruptured in a water tube boiler at the Williamsburg power station of the Transit Development Co., Brooklyn, N. Y. Two men were injured, one of them very slightly.

(55.) — The heating boiler exploded January 19, at the Geiger Bros. clothing store, Canton, O.

(56.) — A tube ruptured January 20, in a water tube boiler at the Kamm and Schilinger Brewery, Mishawaka, Ind.

(57.) — On January 20, a tube ruptured and three headers failed in a water tube boiler at the plant of the Diamond Alkali Co., Fairport, O.

(58.) — On January 20, a section cracked in a cast iron sectional heater at the repair shop of the City of Newton, Newtonville, Mass.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1918.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$404,341.76
Premiums in course of collection,		414,595.11
Real Estate,		90,000.00
Loaned on bond and mortgage,		1,544,400.00
Stocks and bonds, market value,		4,601,456.00
Interest accrued,		104,020.74
		$7,158,813.61
Less value of Special Deposits over Liability requirements,		32,229.37
Total assets,		$7,126,584.24

LIABILITIES.

Premium Reserve,		$3,013,990.80
Losses unadjusted,		122,761.60
Commissions and brokerage,		82,919.03
Other liabilities (taxes accrued, etc.),		251,117.95
Capital Stock,	$2,000,000.00	
Surplus over all liabilities,	1,655,794.86	
Surplus as regards Policy-holders,	**$3,655,794 86**	3,655,794.86
Total liabilities,		$7,126,584.24

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President. W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

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Vol. XXXII. HARTFORD, CONN., OCTOBER, 1918. No. 4.

Heating Homes and Beating Huns.

By H. E. DART, Superintendent of Engineering Department.

A nine-year old friend of mine who recently spent a year in Scotland told me that while there he had to eat from a plate decorated in brightly colored letters around its circumference with the homely but impressive words, "Be canny wi' the butter." This constant reminder seems to have made a deep impression on the youngster's mind, amounting almost to an eleventh commandment. In a similar way, "Be canny wi' the heat" would be very appropriate advice for our own people at this time and perhaps some of them might be influenced by placards suitably inscribed with this reminder and attached to the radiators. For use in the basement the expression could be Americanized to read, "Be scrimy with the coal" and it should be painted in lurid letters across the front of the boiler and over the opening to the coal-bin. "Keep the home fires burning *low*," "Don't be ashamed to close the radiator valves," and other variations of the general theme will readily suggest themselves, and the following recommendations may help to accomplish the desired results of saving as much coal as possible and of getting the maximum amount of useful heat out of the available supply.

A HEAT-UNIT IN THE HOUSE IS WORTH TWO ON THE OUTSIDE.

The first thing to do is to put the house in order so as to keep the warm air in and the cold air out. In modern houses a surprising amount of air leaks in around windows and doors and a good deal of coal is used to heat this air to the proper temperature. On exposed sides of the house when the wind is blowing hard the leakage is often enough to move the window shades and draperies and it can be plainly felt by holding the hand near a window stop or the joint between the two sections of sash. Properly fitted storm sash will not only stop the leakage of air but they will also reduce the radiation of heat through the glass. The writer had six storm windows installed on the west side of his house last fall at a cost of five dollars each, including delivery, hardware, painting, fitting, etc., and the results were so satisfactory that some will be placed on the north side this year. The cost can be considerably reduced if a person is willing to do the fitting and painting himself. Good results can also be secured by means of weather strips; they will stop the air leakage but will not affect the radiation loss through the glass itself. Weather strips should also be used around all outside doors and the cost of storm doors and vestibules will be amply justified for exposed locations.

Particular attention should be given to cellar windows. These windows are usually hinged at the top and fitted loosely so that they can be opened easily when they swell in damp summer weather. After they get thoroughly dried out in the winter the wind whistles merrily through them, cooling off the cellar and the floor above. Storm sash or weather strips can be applied to such windows but satisfactory results can be obtained at less expense by calking the cracks around them with cloth. In some cases the windows fit so loosely that two or three thicknesses of canvas can be placed around the inside of the frame and the window can then be closed with the canvas filling the joint.

It is hardly necessary to say that all windows should be provided with suitable catches and they should be kept locked. Window stops should be carefully adjusted and set up as tightly as possible.

KEEP THE HOT AIR CIRCULATING.

Considerable heat is wasted in connection with hot-air furnaces and indirect radiators as usually installed because air is drawn in from outside the building and it must be heated up to the inside temperature before it can begin to do any good. In such cases coal can be saved by re-heating the air within the building instead of taking fresh air from outside, since the air will then come to the furnace at (say) sixty degrees instead of a much lower temperature. In some instances no change is necessary other than closing the cold-air inlet and cutting a hole in the duct leading to the furnace or indirect radiator, thus admitting air from the basement. A better arrangement is to bring the air back from the rooms above through a special return duct properly connected into the main cold-air duct; the return register at the upper end of the duct may be located in the hallway so that it will take the cold air which comes in around the outside door. In any case a suitable arrangement of dampers should be provided so that the air supply may be taken either from the inside or outside and controlled as desired. Some people may object to re-circulating the air as described above, claiming that there will not be sufficient air for ventilation; this is a valid objection for a school-room or other place where there are many occupants in a comparatively small space but in the ordinary house plenty of air for ventilation will be supplied by leakage around windows and doors. As an indication of the possible saving it may be noted that the radiating surface required for indirect heating is about fifty per cent. greater than for direct heating.

A SUIT OF CLOTHES FOR THE HEATING SYSTEM.

Insulating covering for pipes, boilers and other parts of a heating system is intended to keep the heat in the system so that it will be given out only where it can do some good, as at radiators and registers. It was formerly the custom to speak of such covering as pipe "clothing;" following this idea to its logical conclusion, every owner of a heating system should see that it is properly dressed and not immodestly exposed.

We ordinarily think of the pipes in a heating system as conveyors of steam, water or air (as the case may be) and we take pains to repair any leaks which may become evident. We ought also to get the conception that these pipes are conveyers of heat and we ought to remember that bare metal pipes are poorly adapted to this purpose because they will allow many large and fully-developed heat units to leak away throughout every foot of length. We don't realize this because we can't see the heat leakage as we can the leakage of steam or water, but it is present just the same, day and night through the entire heating season, and considerable coal must be burned to make up for it.

All main pipes and branches should be covered and all risers which are built into outside walls of a building; it is not usually considered necessary to cover risers which pass through heated rooms. For hot-water pipes and low-pressure steam systems the so-called "air-cell" covering is very satisfactory. Coverings made of magnesia and some other materials are more efficient and will even more thoroughly prevent the leakage of heat but they cost more and the additional expense is not usually justified except for the higher pressures used in power plants. All pipe fittings should be carefully covered with plastic asbestos or mangesia and this kind of covering should also be applied to boilers and heaters. Asbestos paper makes a good covering for the pipes of hot-air systems.

Heating mains are sometimes left bare because the heat which they radiate can be used to warm a basement or other room through which they pass. In such cases it would be much better to cover the pipes and install radiators to do the heating because there is no way to control the heat when main pipes are used as heating surface; heat will therefore be wasted in moderate weather (or even in cold weather) because the room will be heated to a higher degree than necessary. Furthermore, the water formed in the pipes by the condensed steam will frequently have a detrimental effect upon the operation of the system. In the ordinary house, the basement will be sufficiently heated by the heat radiated from firing doors and other parts of the boiler which cannot be covered, the heat given off by the smoke-pipe, and the small amount of heat which will be radiated from the pipes even through the insulating covering.

While we are considering the general subject of "clothing" it would be well to mention a kind of overcoat for radiators. In many hot-water systems considerable heat is wasted because the radiators can not be turned off without danger of freezing and bursting. This is particularly true in sleeping rooms where it is desired to have a window open at night. Such radiators should be provided with a cover made from an old blanket, bed-quilt or other suitable material, fitted closely around the radiator and extending down to the floor. With this kind of a coat on, the radiator can be left with the valve open so that there will be no danger of freezing but the amount of heat lost (and coal burned) will be reduced to a minimum.

SAVE THE HEAT-UNITS AND THE COAL WILL TAKE CARE OF ITSELF.

In almost every household it is probably true that more coal can be saved by saving heat than in any other way and every possible effort should be conscientiously made along these lines, even though some sacrifice of comfort may be involved. In some cases it may be possible to re-arrange things so that one or more rooms can be permanently closed and not heated at all during the entire season; in other cases it will surely be possible to close some rooms and turn the heat off nearly all the time, using them only occasionally. In one house that we know about, rooms on the third floor were given up last winter and the water in the heating system was drawn down so that it would reach only into the second story, the third-floor radiators being empty all through the winter. As a matter of actual necessity only three or four rooms really need to be heated in the ordinary house and we would be healthier if our sleeping rooms were not heated at all. Former Ambassador Gerard states that 55 per cent. of the families in Berlin live, sleep, cook and eat in the same room; this is not an example which we want to follow but we ought to be willing to sacrifice a little of our usual comfort until the Hun is beaten.

At least 15 per cent. can be saved in coal consumption by keeping the inside temperature at 65 degrees instead of 72 degrees and it is estimated that not less than 1,000,000 tons of coal could be saved annually in the city of Chicago if everyone in the city would adopt this limit as a maximum for heating requirements; in England and Canada 60 degrees is the standard heating temperature. Of course it will be necessary to dress warmer than has been our custom and, even so, we can hardly expect many of our people to be willing to live in an inside temperature of 60 degrees. Sixty-five degrees seems reasonable, however, and it certainly ought to be considered a crime for anyone to maintain a higher temperature than 68 degrees in his home under present conditions as regards the coal supply. Any number of authorities can be quoted to prove that temperatures varying between the limits of 60 degrees and 68 degrees are much more favorable to health than higher temperatures.

Low temperatures are much more comfortable if the air is moist rather than dry. In hot-air furnaces the moisture can be supplied from a pan suitably located for the purpose. Such a pan should be installed with every hot-air furnace and care should be used to see that water is kept in it at all times. With steam and hot-water systems there is no simple and satisfactory method for humidifying the air; long, shallow pans filled with water are sometimes placed on top of the radiators and they serve the purpose fairly well though they usually do not furnish as much moisture as could be desired. Of course, the objection to their appearance should not be seriously considered if they will help to save coal. A large atomizer will also be of some service, but this is a rather crude and inconvenient method.

BY THEIR ASHES SHALL YE KNOW THEM.

A careful inspection of the contents of ash-cans when they are placed on the sidewalk to be emptied will make an interesting study of one way in which much coal is wasted. It will be found that the percentage of unburned coal in the ashes is greater by far in the best residential parts of a city where men are hired to attend the furnaces and boilers than in parts where the owners do this work themselves. In the still poorer sections the ashes will be picked over so carefully that the waste will be negligible. Some of the ash-cans noted last winter in the most prosperous part of the city contained so much unburned coal that a man ought to be ashamed to have them in front of his house under present conditions.

Poor firing and defective grates will account for much of the unburned coal which gets into the ashpit. Steps should be taken to improve these conditions but if it is impossible to get proper results, the ashes should be sifted and picked over so as to save all pieces that can possibly be burned.

There is a certain kind of rather poor coal containing some lumps which burn only on the outside, leaving a core of unburned coal at the center, and it has been found that these pieces can be reburned to advantage if they are soaked in water. As a general rule it is very bad practice to wet coal but with these pieces which have passed through the fire into the ashpit, the case is different. Steam which is generated from the water within the lump bursts it open so that the center can be burned.

AN OUNCE OF ATTENTION IS WORTH A POUND OF COAL — MAYBE MORE.

The most economical method should be chosen for firing the coal and for operating the dampers, and sufficient attention should then be given to insure that good results are being maintained throughout the heating season. It is beyond the scope of this article to describe the best method to be used with every kind of fuel and it is largely a matter anyway of experiment and study for each individual case. Some useful information along these lines is presented in plain language in Technical Paper 199 which can be obtained without charge by addressing the Director of the Bureau of Mines, Washington, D. C.

Soot and fine ashes are non-conductors of heat. In fact they are such good insulators that a very thin deposit will seriously reduce the amount of heat transmitted through the iron to the boiler contents. Consequently, if there is a layer of soot and ashes on the interior surfaces of the boiler less heat will be absorbed by the water, and the hot gases will go to waste up the chimney at a higher temperature than is consistent with economical operation. For this reason care should be taken to keep the boiler free of all accumulation of soot and dust on the heating surfaces and the surest way to accomplish this result is to have a regular time for cleaning the boiler and then make it a religious duty to see that the cleaning is always done at the stated time. Even under the most favorable conditions the soot should be brushed out at least once a week and more frequent cleanings are desirable. A wire brush should be used, and, if possible, the accumulation should be entirely removed instead of being brushed back into some other part of the boiler. The ashpit should be kept clean by removing the ashes every day.

PROCRASTINATION IS THE THIEF OF COAL.

All of the foregoing recommendations are perfectly reasonable and they should be adopted immediately by every patriotic household to which they can be applied. The suggestions regarding storm sash, weather strips, insulating covering for pipes, etc., should be carried out before the system is started up and the necessary plans should also be made to get along without heat in some rooms. In some cases it may be found advisable to install additional valves or make other slight changes so that the system may be controlled more efficiently. The smoke-pipe and boiler should be thoroughly cleaned and all necessary repairs should be made to grates and other parts of the system.

Two or three reliable thermometers should be placed around the house in the principal rooms to be heated and they should be watched to see that the maximum pre-determined temperature is never exceeded; in this connection it is most important that every member of the household should acquire the habit of operating radiator valves and registers. This will be a new experience for most people, particularly as regards closing the valves. Many people would rather open a window than turn off the heat.

All suggestions in regard to the operation of the heating system should be carried out conscientiously and methodically as a patriotic duty from the day that the fire is started. The great trouble with our people is their tendency to put off a thing of this kind, to wait a week or two before starting on a new plan which may involve a little inconvenience at first,— with the almost invariable result that they never start. Now this is a matter which requires the active support and earnest co-operation of everyone involved and there should be no excuse for any apathy. There should be no delay in adopting every means for reducing coal consumption even in the smallest degree. Procrastination and postponement of action should be tolerated only in the matter of starting the fire in the boiler or furnace and every effort should be made to put off that evil day as far as possible. Wood, gas and electricity can be used " to take the chill off " and by burning wood in the boiler or furnace, several rooms can be kept comfortable for a considerable time after the usual date of starting to burn coal.

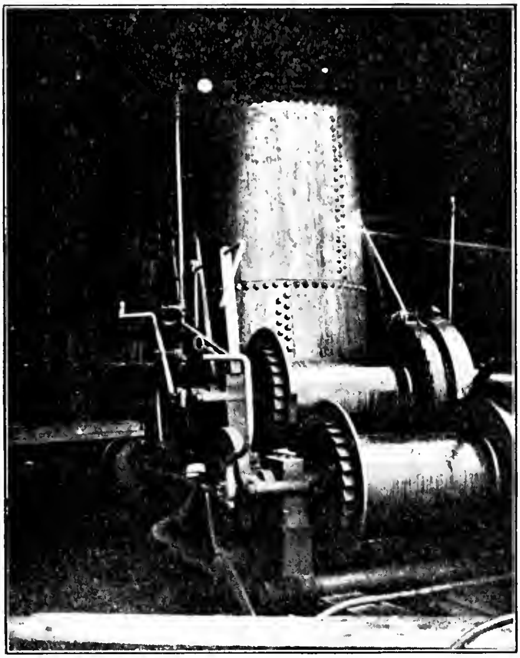

FIG. 1. WATER POURING FROM THE LAP CRACKED BOILER WHEN UNDER TEST.

Detecting a Lap Seam Crack.

E. E. Moore, Inspector.

On May 20th, the writer was sent for by a well known contractor of a large Massachusetts city to make an internal inspection and establish a safe working pressure on a boiler which they had hired to complete one of their construction jobs.

The boiler was 7 ft. long x 40 in. in diameter and contained forty 2 in. tubes and was apparently about 12 or 15 years old. It had been recently re-tubed and was used within a short time on a construction job in the centre of the city.

Information was furnished that the owner held a certificate of inspection on the boiler which was in force until July, 1918.

During the examination of the external surfaces a trace of leakage was noted which apparently originated at one of the rivets in the longitudinal seam of the upper course. On closer view a fine hair line was noted about 1 in. long on the outer side of the lap about 1½ in. from the centre of the rivet.

The boiler was filled with water, safety valve removed and opening plugged. A test pump constructed for this purpose, was connected to the blow-off. Two helpers manning the pump handle, quickly raised the pressure in the boiler to 150 lbs. Two or three sharp blows of the hammer in the vicinity of the supposed defect were sufficient to cause the almost invisible crack to open up for a length of 6½ in., water from same being thrown about 15 ft., as the accompanying photograph shows, and incidentally wetting down several spectators.

This form of rupture is what is known as the lap-seam crack and has caused many fatal accidents in the past, as we all know. The boiler apparently was about to make some history and an accident was only averted by the contractor's method of always having a boiler inspected before using it.

In the opinion of the writer, too much care cannot be exercised in the operation and inspection of these old lap-seam boilers.

The present tendency of some of the States is to slowly legislate this form of construction out of existence. These laws when fully enacted will lift a heavy load from the minds and shoulders of engineers and inspectors, causing the hair above our ears to retain its original color for a longer period.

The Proper Use of Cast Iron Boilers.

Cast iron is in some ways the least desirable of all the materials from which boilers are made. It is brittle, has little ductility or ability to stretch under load, and it is cracked with great regularity whenever one part of a casting is maintained at a higher temperature than an adjoining part. Moreover, because it is a cast material, there is an ever present possibility of the existence of defects due to the casting process, including thick and thin portions from the shifting of cores, cold shuts, porus spots, blow holes and sand inclusions, all of which are hard to detect until developed by actual service.

On the other side of the sheet it may be said for cast iron that it is cheap and can be cheaply formed into complicated shapes, and that it permits of the making of sectional boilers easy to install in a limited space, easy to ship and erect, and which permit the removal of a single section instead of repairing or replacing the whole structure. Finally cast iron is quite resistant to corrosion, both from the water and from the action of the soot and ash on the fire side when in the presence of moisture. The advantages have in many cases seemed so overwhelming that a very large proportion of our low pressure heating boilers are made of this material.

CAST IRON BOILERS MUST CONTAIN WATER.

A cast iron boiler must be kept filled with water to the steaming level at all times when a fire is burning on its grates or it will be ruined. So long as the surfaces of the boiler directly exposed to the fire are covered with water on the inside, the heat from the fire is absorbed by the water, forming steam or supplying hot water as the case may be, so readily that the iron itself does not attain a temperature much above that of the water within. Furthermore all parts of the boiler exposed to the fire on the one side and covered with water on the other side will remain at substantially the same temperature and so will not be strained by unequal expansion.

There is no tendency for a piece of cast iron, or a piece of glass for that matter to break when it expands, so long as it all expands at a uniform rate. But if one part expands faster than an adjoining part, a crack is started at the region between the hotter and cooler portions. So if the water level is permitted to get below the usual steaming level, and so expose a portion of the boiler directly to the action of the fire without the presence of water on the other side to serve as a heat absorber, that part tries to expand so much faster than the rest, kept cool by its contained water, that a crack develops at the point of greatest strain, depending on the design. This is the regular behavior of a cast iron boiler under these circumstances, just as it is the regular behavior if boiling water strikes cold glass, or if hot glass is suddenly plunged into cold water, and there is no more mystery about the fracture in the one case than there is about the other.

Coming back now to the subject we intended to discuss, let us consider the means by which a steady water level can be maintained with certainty in a cast iron boiler.

IMPORTANCE OF GRAVITY RETURN.

When boilers make steam for heating buildings the steam flows from the boiler to pipe coils or radiators. The radiators (including coils and exposed pipes) give out heat to the rooms which must be warmed. When the steam has given up its heat to the rooms through the radiators, it is again reduced, or as we say, condensed, to the liquid state, and if permitted, will flow away from the bottom of the radiator and back to the boiler. The pipe connections are of the simplest possible sort, and merely require that the radiators be higher than the boiler, that a pipe of suitable size lead directly from the top of the boiler to the radiator, and that another pipe lead directly back from the bottom of the radiator to the bottom of the boiler. If certain simple requirements are fulfilled as to the sizes and location of these pipes and necessary valves are in place, together with means for getting rid of the air when steam is turned on to the system, the thing forms a simple closed circuit. Water is boiled, flows out of the boiler as steam, condenses and runs back, and the faster it is evaporated, the faster it returns, so that a constant water level is carried automatically so long as there are no leaks. With such a system, known as the gravity return, it should be necessary to admit water from the city mains only at intervals of several days to make up for unavoidable but slight leakage.

WHEN A PUMP IS NEEDED.

If the system is laid out by a man who knows his business and installed by competent mechanics it is as safe an arrangement as can be had for heating with the steam formed in cast iron boilers.

Sometimes, however, it is impossible to have all the radiators higher than the boiler unless a pit is excavated, often at great expense, and the boiler located in the pit. Even that may not serve when buildings on ground lower than the boiler are to be heated. In that case the water will not flow back to the boiler simply by gravity and some other means must be adopted to get it back. One method which immediately suggests itself is to let the water flow into a tank which is lower than all the radiators and pump it back to the boiler as fast as it enters the tank. The pump may be driven in any convenient way, often electrically. So long as the pump continues to work as intended the effect is the same as if the water came back by gravity and the boiler continues to perform properly. However, we have introduced an element of uncertainty into the system. Electric power may fail, wind may blow down the wires, the fuses may blow or any one of a hundred things may happen to interrupt the pump. Then unless an attendant is at hand who understands the danger and admits water to the boiler so as to maintain a constant steaming level, the boiler will be ruined in short order. Of course a defect in the pump, its valves or connections will have the same result as a failure in the power.

In high pressure boiler plants, used for power, skilled men are kept in constant attendance to watch the water line among other things. Some one has the responsibility at all times of keeping water in the boiler and often that particular person has no other duty. In low pressure heating plants, however, we expect things to more or less take care of themselves with only infrequent attendance, and that not often by people skilled in engineering matters. Therefore while a pump and tank, or pump and receiver, is a useful and desirable affair in the high pressure plants using a part of the steam for heating, and having a skilled fireroom crew in constant attendance it is a menace to the relatively unattended low pressure cast iron outfit. Furthermore the high pressure boilers are built of steel which is less easily damaged by low water than cast iron, though it should not be inferred that a low water line and a hot fire are a healthy combination for a steel boiler.

It follows then, that one of the things not to do is to install cast iron boilers for heating where the condensation does not return by gravity.

CAST IRON BOILERS SUITED ONLY FOR HEATING.

There are many industries and buildings, some large, some small, where low pressure steam is required, but where little or no power is needed, and that power is perhaps more conveniently purchased than made on the premises. Restaurants, manufacturers of food products, canneries, dyers and cleaners, and tobacco warehouses may be mentioned as typical, though the list is not in any sense inclusive. These and many similar plants need steam to cook with, or to dry material, or to humidify the air, and in many cases the water of condensation cannot be returned to the boiler, for the system is not closed. Cast iron boilers never should be installed for such service; nevertheless as cast iron boilers are built for pressures from 15 to 25 lbs. per square inch, which is ample for these processes and as they are built in small sizes and are far cheaper than steel boilers, many of them have been so installed, often supplying the process steam in addition to heating the building. They are not as a rule attended by either more constant or more capable persons than are cast iron boilers used only for heating. A low pressure cast iron boiler is usually thought of as a sort of house furnace that any one who has the physical strength to wield a little half size coal shovel can take care of as a side line to his or her real job. The fact that steam is used and not returned as condensed water does not alter the situation in the owner's mind as the attendant only needs to let in a little water when it gets low.

These conditions are not theories but facts. Records of accidents to cast iron boilers used under conditions similar to those outlined above show that they occur and recur with distressing regularity wherever those conditions exist.

At the present time cast iron boilers are nearly impossible to obtain, they are tremendously expensive, and are needed for the legitimate purpose of heating buildings. For this purpose and this only they should be used, and they should be installed so that all the condensation may return by gravity in a well kept and well designed system.

When pumps are needed to return the condensation, or where steam is used for processes such that no condensation is returned, a steel boiler only should be used, and constant attendance by a skilled person who understands the requirements and the layout of the piping and valves is needed, just as much as it is needed by the high pressure power plant.

The Significance of the Rate of Combustion in Coal Conservation.

Every piece of power plant equipment which turns heat into power, or power into electricity or electricity back into power has some load at which it works at its best economy. This is as true of boilers and furnaces as it is of motors or engines. When coal is burned to produce heat for steam production, there are certain losses of heat, which prevent the possibility of realizing perfect, 100 per cent. efficiency. Some of these losses can be made less or even wholly removed, and some may only be made as small as possible, but there is in every case some rate of coal burning where, if other things are equal the unavoidable losses will bear the smallest possible proportion to the heat produced, or in other words, where the furnace will reach its highest efficiency. Obviously that is the ideal combustion rate to employ from the standpoint of coal conservation and while it is true that the combustion rate is determined by the demand for steam, still it is often possible to so control the number of boilers in use at any one time that each may work at a load approximating as nearly as possible this best rate.

THE BEST RATE DETERMINED BY TESTS.

The study of a vast number of boiler and furnace tests carefully made with various fuels has lead to the conclusion among engineers that usual grades of bituminous coal should be burned in hand fired furnaces at a rate of from 15 to 20 lbs. per square foot of grate per hour, and in mechanical stoker furnaces at rates of from 25 to 30 lbs. per square foot per hour to realize good working economy and these rates have been recommended as marking good coal burning practice by the United States Fuel Administration.

Without attempting to point out in a limited space all the reasons why this should be so, it may be said that the best fire on a hand fired grate with bituminous coal and natural draft has been found to have a thickness of from six to ten inches. Such a fire must be kept clean, fired often with small amounts of coal at each firing and maintained level in addition to which the air supply both through and over the fire must be properly adjusted for complete combustion with the least possible excess of air. When all of these points have been attended to our ideal fire will have passed on the greatest possible amount of heat for absorption by the boiler heating surface and this will usually burn from 15 to 20 lbs. of coal for each square foot of grate each hour.

A BOILER MAY OFTEN BE SHUT DOWN.

Keeping the average combustion rate at as high a point as is here indicated will mean shutting down one or more boilers in many plants. Not only will this increase the efficiency of the other boilers by bringing them up to their best load, but it will also cut off altogether such sources of loss as the heat radiated from the shell and setting of the extra boiler and the losses due to air leaking into that setting. In addition there will be a lesser wear and tear loss on the plant as a whole and an opportunity to have one boiler always clean and one furnace in excellent repair to start up when one of the working boilers needs attention. This will permit of keeping the whole boiler plant in a high state of repair, and should greatly lessen maintenance expense and depreciation.

To find out if such a change is desirable it is necessary to keep a record of the coal burned each day and the water evaporated so that both the rate of combustion and its result in evaporation may be calculated. If it is found from such a record that the furnaces are loafing along, as many of them are, at a rate of from seven to ten lbs. per square foot per hour, then the chances are that one should be shut down. If 15 or more pounds of coal are being burned, however, with proper attention to the air supply so that, say, 12 per cent. CO_2 is obtained without evidence of excess air loss and with little smoke, you are very likely getting pretty good results. This coal should be burned as we have stated above from 6 to 10 inches thick on the grate, fired often in small amounts and alternately on the two sides of the furnace, or better yet checkerboard style, covering first the right front corner, then the left rear corner, the right rear and the left front, with the addition of air over the fire after each firing, and with care to cover only bright spots leaving the dull ones to burn down. This will tend to keep a level fire without much raking.

CLINKER TROUBLES.

Several difficulties will doubtless come up when an increase in the coal burning rate is tried. In the first place the firemen may experience great trouble with clinker. If this is the case it usually indicates too thick a fire, too long an interval between firings and too much use of the slice bar which has a tendency to raise the ash up into the top part of the fire where it results in a clinker. The remedy has already been suggested, namely to carry a thin even fire, keep the slice bar out of it, and fire light and often. In addition, the ash pit should be kept clear and if possible a little water should stand in it. The ash pit door should not be used to control the draft which is best adjusted at all times by the uptake damper.

SMOKE PRODUCTION.

A second difficulty may appear in the production of clouds of black smoke and an inability to carry the desired load on the boiler. This, too, indicates too thick a fire and should respond to the same treatment recommended for clinkers. It must be borne in mind, however, that a thin fire must be level. Holes burn through quickly and cause trouble if the bright spots are not covered lightly at short and regular intervals. To burn coal at an economical rate and secure the benefit of the heat developed, a good draft and a clean boiler and setting are absolutely essential. The chimney, breeching and uptake must be kept clean. Tubes must be brushed and blown out at frequent intervals, the boiler must be free from scale and the combustion chamber and ash pit kept clean. However, these matters should be attended to regularly in a well regulated boiler plant, whatever the rate at which coal is burned.

REDUCING THE GRATE AREA OF A SINGLE BOILER.

There are many plants which have only one boiler, and for some reason that boiler is of excessive size for their requirements.

It may mean that a large boiler was installed to meet an expected growth which never came, or a large boiler may have been installed to give storage capacity for hot water so as to easily meet a sudden demand for steam in large quantities as in dye works or laundries. It frequently happens that the large boiler is needed, but that it does not need to be provided with as large a grate as is ordinarily furnished for a standard setting. In other places it may be that a boiler originally designed to furnish power has been diverted to the service of supplying a small amount of heating and process steam owing to the purchase of electric power from an outside source.

In all these instances the rate of combustion needed to give the steam supply required is low. The owner naturally wonders how he can burn more coal per square foot of grate without making needless steam or wasting heat. The answer in this case is to use less grate on which to burn the coal. Brick off some of the grate with fire brick laid up with fire clay so as to be air tight and cover this with ashes. Then a brisk economical fire may be carried on the remaining grate surface. When shaking grates are in use this becomes somewhat difficult owing to the interference of the brick covering with the shaking action, but it is by no means impossible, since the shaking grates are ordinarily arranged in sections from the front to the rear of the furnace and the section next the bridge wall can often be disconnected and bricked over, leaving the remaining sections operative.

BUCKWHEAT COAL MAY BE BURNED.

When a boiler is over large and the coal consumption is moderate, providing there is an ample draft, another solution of the conservation problem suggests itself. It is the possibility of using low grade anthracite screening mixed with some bituminous coal. Low grade anthracite is available. It is already above ground and does not require mining at this time, and its use helps relieve the pressure for freshly mined anthracite and bituminous of larger sizes. To be sure it is not as good a fuel, that is, there are not so many heat units to the pound as in good bituminous coal, but it is obtainable and its use conserves the good fuel for the plant which has not the excess grate surface and draft to burn the screenings and still carry its load.

Summing up, every steam user should investigate and see if he is burning coal at an economical rate. If not, he should endeavor to use such units of his boiler plant as will keep within the economical limit. If he has but one boiler and does not require steam enough to work his grate up to an economical rate with bituminous coal he should either brick off a part of the grate or, if possible, burn a lower grade of fuel such as anthracite screening. All these suggestion measures should appeal both to his patriotism and his pocket-book, for they are likely not only to conserve coal but to save money as well.

On the Value of a Plant Record of Coal Burned and Water Evaporated.

A successful business without bookkeeping is inconceivable, yet that part of many of our industries which make light and power is often run with so little bookkeeping that the only possible explanation for the continued existence of the industry is that the whole matter of power cost forms but a per cent. or two of the total cost and so no one has ever bothered much whether it is low, average or high, as compared with the economic possibilities of the equipment involved. That may justify the lack of interest in the coal economy and power cost from the standpoint of the management so long as it has no bearing on any one else. However, it is quite necessary in these times of administered fuel supply and Governmental engineering survey of power plants to point out that what may appear a mere incidental percent or two to the management may be a matter of commercial life or death to some other plant which can continue in operation or not, just in proportion to whether it can hope to get for its use the fuel unnecessarily consumed by the careless concern.

From the point of view which considers coal a national resource to be conserved to the maximum degree by all and wasted by no one there is an imperative need that every boiler and furnace shall work at as nearly 100% of its possible economic performance as human endeavor can secure.

DAILY RECORDS MORE VALUABLE THAN OCCASIONAL TESTS.

It is not enough to determine by a careful boiler test, supervised by a competent fuel and combustion specialist, that certain conditions of draft and air supply, thickness of fire, method and frequency of firing, etc., will be best for the particular plant and particular fuel available, important as it is that this information should be obtained. Some one or some system must be constantly on guard to maintain the desired results. It is not test results for a few hours but the same efforts day by day which will conserve coal.

To this end it is necessary to know that the performance is up to standard.

Poor work on any day or shift must show itself. The particularly good results of a certain shift crew ought to be credited to them and not serve to raise the average of the whole force so as to assist a less efficient group, on another shift, to escape discovery. When results first begin to fall off, or to improve, it should be possible to know that fact so that the reason may be found. The fuel should not be blamed for the carelessness of the firemen or the condition of the boilers and furnaces, nor should the firemen be blamed for the failure of an inferior fuel to meet expectations.

Experience will show what draft, fire thickness and method of firing will give the most efficient combustion and this can be checked by reference to the percentage of carbon dioxide in the flue gases. The court of last resort, however, is the amount of water evaporated per pound of coal burned, taking into account of course, the amount of load on the boiler and the character of the fuel itself. It does not need much technical training to see that steam is the thing sought in burning coal, that coal is expensive, and that the men who can make the most steam per pound of coal used are the ones who deserve most in the way of consideration from their employers.

WHY NOT KNOW BOILER ROOM COSTS?

There are few industries so small that there is no cost system in force to show the amount of time consumed by the workmen in each operation and the amount of material used or wasted, so that with the addition of other items of expense, the owner may know how much is the cost of his finished product and what should be his price to the trade to cover the cost plus a reasonable return on the investment.

There are unfortunately many plants where it is deemed unnecessary to see what kind of a return the firemen are making on the coal investment, and the excuse is that they are too small to keep records. The equipment required is neither complicated nor unduly expensive, although as the plant size increases more elaborate and accurate equipment will often make for better records and simplify accounts.

SIMPLE EQUIPMENT NEEDED.

To keep a coal record, a wheel-barrow, a pair of platform

(Continued on page 119)

The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

C. C. PERRY, EDITOR.

HARTFORD, OCTOBER, 1918.

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.

THE LOCOMOTIVE would emphasize the Message of the Cover:

COME ON!
BUY MORE
LIBERTY BONDS

We respectfully call the attention of heating boiler owners to the article on another page dealing with the proper use of cast iron boilers. Since that article was written, heating equipment has become even less easy to obtain, if that were possible. One matter was inadvertently omitted from the article and we wish to give it the added emphasis of a separate paragraph. It is the possibility of fractured sections in the case of boilers from which steam is drawn for cooking, steaming or other process work, which does not permit of the return of the condensate even when the boiler attendance is of the highest order, and where the water is never allowed to become low. Let us explain the situation.

All water contains dissolved solid matter. Some boiler waters, however, contain much more than others. This solid matter is, much of it at least, deposited on the inner surfaces of a boiler, and it tends to interfere with the free flow of the heat into the water. If a boiler has all its steam condensed and returned to it, with no fresh water added except to supply leakage, this deposit of solid matter is a negligible quantity. On the other hand if the condensate does not come back and the boiler is continuously fed raw water, scale will form which is a particularly unfortunate thing in a cast iron boiler as it causes local overheating and cracking.

Personal.

Mr. J. F. Criswell, Acting Manager of the Chicago Department, has been appointed Manager at that office. Mr. Criswell first became associated with The Hartford Steam Boiler Inspection and Insurance Company twenty-nine years ago, in May, 1889, as Special Agent in the Chicago territory, a position which he held until he was appointed Acting Manager last March, following the death of Henry M. Lemon. Mr. Criswell has traveled the territory of his Department and is familiar with field conditions, although latterly his activities have been largely in and around Chicago where his congeniality has made him well known and well liked by the agents and brokers. He will be assisted by Mr. P. M. Murray, who for nearly a year has been a Special Agent and Adjuster in the Chicago office. He was transferred there from Atlanta where he had served THE HARTFORD as Special Agent for a period of five years. Mr. Murray will have the title of Assistant Manager and will also continue to act as Adjuster for the Middle West. These appointments give every assurance of continued satisfaction in the conduct of the Company's business in this department.

Mr. E. Mason Parry has been appointed Chief Inspector in the Home Department of the Company to fill the vacancy caused by the death of Frank S. Allen.

Mr. Parry was born in 1876, in Menai Bridge, Isle of Anglesey, England, and was educated at the Menai Bridge and Beaumaris schools. He was apprenticed with Harland & Wolff, ship-builders and engineers at Belfast, Ireland, where he obtained a thorough foundation for his engineering work. He afterwards sailed as Assistant Engineer in the Dominion line of steamers, and in 1900 was awarded a first-class marine chief engineer's license by the Lords of Privy Council, for the Board of Trade, and for some years was engineer officer in the White Star Line.

In 1906 he became associated with The Hartford Steam Boiler Inspection and Insurance Company as inspector at its Boston office, and in 1913 was transferred to Hartford where he became the Directing Inspector for the Home Office. He is a member of the American Society of Mechanical Engineers.

Mr. Parry has had a wide engineering and inspecting experience. He is thoroughly familiar with the conditions in the Home Office territory dut to his five years' service as Directing Inspector and therefore becomes a fitting successor to Mr. Allen.

Better Firemen.

A fireman feeds ten tons of coal to a hand-fired furnace in the course of a day's work.

At four dollars per ton this is twelve thousand dollars' worth of coal per year of three hundred working days.

A good fireman can get through on twenty per cent. less than a poor fireman. This means that under the conditions cited a good fireman would save twenty-four hundred dollars' worth of coal a year.

In most cases firemen work more than three hundred days a year, shovel more than ten tons per day and their pay is around half of the above-computed saving.

In what other process would a manufacturer put twelve thousand dollars' worth of material into the hands of a common laborer as is so often done in power plants, to apply wastefully or usefully, as he wills or can?

One of the most immediately available ways to conserve coal is to improve fireroom methods. A good man at a little more money per week will save a lot more than his increased cost by the use of brains, simple tools and common material and will conserve coal without drawing upon our limited man power for new apparatus. *Power.*

The Riveter.

"We've never worked this way before," said Johnny at the blast,
"In all my standin' at the forge I've never gone so fast."
The riveter just looked at him an' mopped his sweaty brow
An' said: "We worked for wages then, but things are different now,
For we're licking of the Kaiser, so just keep the charcoal red
An' toss 'em fast and toss 'em straight; I'll hit 'em in the head."

"I'll never get no time to rest," said Johnny at the blast.
"You won't," the riveter replied, "so long as war shall last,
Just keep your bellows blowin' an' the rivets in the air
An' we'll get the ships to get the men an' cannon over there.
When we worked for common wages we could stop an' chew the rag,
But it's different this morning, for we're workin' for the Flag.

"It's two-for-one you're drivin'," said Johnny at the blast;
"You were off the line a little with the last one that you cast."
Said the Riveter: "Be careful, toss 'em straight up to me;
With a little better team work I can easy make it three.
O, it's speed an' ships we're after. We can stop an' take it slow
When the present job is finished an' the victory whistles blow."

Detroit Free Press.

On the Value of a Plant Record of Coal Burned and Water Evaporated.

(Concluded from page 115.)

scales and some form of tally sheets are required under the supervision of the Chief Engineer. It is probably better with average fire-room help to balance each barrow load at a set weight and keep a simple tally. One scheme recently brought to the writer's attention consisted of two boxes and some wooden blocks,— every time a barrow of coal was wheeled into the fire-room a block of wood was taken from one box and placed in the other, to be counted at the end of the shift by the engineer and entered on the records. Other schemes, equally simple and effective, could easily be contrived to eliminate any semblance of bookkeeping from the duties of the fireman if such a procedure seemed necessary.

Various sorts of hot water meters are available. Emphasis is placed on the term "hot water" as the cheaper sort of cold water meter, particularly the disc meters are quite unsuited to measure boiler feed. The only requirements for getting a record of water evaporated are first, — that the meter be so connected that all water returned or sent to the boiler, and no other water, pass through the meter; second, that the meter be reasonably accurate for the sort of service, and third, that someone be given the duties of reading the meter and recording the reading at stated intervals, at least once each shift. The V-notch meters, Venturi meters and various types of orifice and flow meters are undoubtedly more accurate than piston meters. They are also more costly and the choice of meter for any plant is a matter requiring careful consideration, and will bear some relation to the size of the plant.

The principal thing is to get and file records for each shift of the working day which will show the coal actually burned and the water which that particular coal evaporated.

DISADVANTAGES OF USING ONLY DEALERS' WEIGHTS.

Many owners of small plants are satisfied with a set of dealer's weight tickets to check their coal bills. They fail, however, to realize that the value of records of coal burned is not in helping them to check their coal bills, but to enable them to check up and understand the results obtained by their firemen with the boiler equipment, which is quite another matter. Without these records they can never be sure whether their boilers are overloaded or not, whether one boiler more or less should be used, nor whether coal is wasted in large or small amounts, for their best information will be a good guess and their worst a very poor one.

Boiler Explosions.

JANUARY, 1918.

(Continued from July LOCOMOTIVE.)

(59.) — Twelve sections cracked January 20, in a cast iron sectional heating boiler at Bardwell Hall, State Normal School, Athens, Ga.

(60.) — A boiler exploded January 21, in the basement of the Bowles Lunch building, Buffalo, N. Y. The engineer was instantly killed.

(61.) — On January 22, a boiler was damaged by firing it without water at the plant of the Buckeye Churn Co., Sidney, O.

(62.) — A tube ruptured January 22, in a water tube boiler at the State Hospital for the Insane, Norristown, Pa. One man was killed and one injured.

(63.) — On January 22, the boiler of a Rutland R. R. locomotive, attached to the Montreal-Boston express, exploded near Middlebury, Vt. The fireman was killed, the engineer fatally injured and passengers sustained minor injuries.

(64.) — On January 23 a tube ruptured in a water tube boiler at the plant of the Illinois Traction System, Decatur, Ill.

(65.) — A tube ruptured January 23, in a water tube boiler at the plant of the Chicago, Lake Shore and South Bend Ry. Co., Michigan City, Ind.

(66.) — A section failed January 23, in a cast iron sectional heating boiler at the plant of the Index Printing Co., Atlanta, Ga.

(67.) — A valve exploded January 23, at the boiler plant of the Mohawk Gas Co., Schenectady, N. Y. Four men were seriously scalded.

(68.) — A boiler exploded January 23, on Tugboat No. 19 of the "New Haven" Railroad. The boat was just passing the Statue of Liberty, in New York Harbor at the time of the accident. One man was killed and two others injured.

(69.) — On January 24, a tube ruptured in a water tube boiler at the Secor Hotel, Toledo, O. One man was slightly injured.

(70.) — On January 24, two sections failed in a cast iron sectional heating boiler at the greenhouse of the West Virginia Collegiate Institute, Institute, W. Va.

(71.) — A tube ruptured January 25, in a water tube boiler at the plant of the Illinois Traction System, Decatur, Ill.

(72.) — On January 25, two tubes ruptured in a water tube boiler at the plant of the Lackawanna Steel Co., Lackawanna, N. Y. One man was slightly injured.

(73.) — On January 25 a section cracked in a cast iron sectional heating boiler at the bank building of the Whitney Loan and Trust Co., Atlantic, Ia.

(74.) — On January 26, a locomotive type boiler exploded at the plant of the Leesburg Sand Co., Schollard, Pa. Two men were killed, one other injured, and the building wrecked.

(75.) — On January 28, ten sections cracked in a cast iron sectional heating boiler at the school of the Dunbar Township School District, Leisenring, Pa.

(76.) — On January 28, a section cracked in a cast iron sectional heating boiler at the Lowell School, Salina, Kan.

(77.) — On January 28, two sections cracked in a cast iron sectional heater at the Arthur Hotel of P. H. Swearingen, San Antonio, Tex.

(78.) — On January 29, four sections cracked in a cast iron sectional heating boiler at the machine shop of Elmer Burlingame, Johnsonburg, Pa.

(79.) — On January 29, a heating boiler exploded in the basement of the saloon of William Morrisey, State St., Bridgeport, Ct. The damage was estimated at $2,500.

(80.) — On January 30, a tube ruptured in a water tube boiler at the plant of the West Jersey and Seashore R. R., Westville, N. J. One man was injured.

(81.) — A non-return valve and cross pipe failed January 30, on a boiler at the plant of the Kansas City Light and Power Co., Kansas City, Mo.

(82.) — A blow-off failed January 30, on a boiler at the plant of the Georgia Marble Co., Marietta, Ga. One man was slightly injured.

(83.) — A kitchen range boiler, set in a horizontal position so as to be fired as a steam boiler by building a fire under it, and not provided with any safety valves, exploded January 30, at Spokane, Wash. The boiler was used for sterilizing milk bottles, and a sixteen-year old boy who was firing it at the time of the explosion was killed.

(84.) — A section cracked in a cast iron sectional heating boiler on January 31, at the main building, Marshall College, Huntington, W. Va.

February, 1918.

(85) — A section cracked February 1, in a cast iron sectional boiler at the Indiana County Poor Farm, Indiana, Pa.

(86) — On February 1, two sections cracked in a cast iron sectional boiler at the Second Ward School, Indiana, Pa.

(87) — On February 2, a section cracked in a cast iron sectional heating boiler at the "Inwood Court" apartment belonging to the Bemis Realty Corporation, New York City.

(88) — On February 2, a tube ruptured in the water tube boiler at the slaughter and packing house of Miller & Lux, Inc., San Francisco, Cal.

(89) — On February 2, a hot water heating boiler exploded in the basement of the home of Charles R. Haig, Merchantville, N. J. Mr. Haig was fatally injured by the explosion.

(90) — A section cracked February 4, in a cast iron sectional heating boiler at the Sun Theatre belonging to the World Realty Co., Omaho, Neb.

(91) — A tube ruptured February 4, in a water tube boiler at the Consolidated Light & Power Company Plant of the American Gas Co., Kewanee, Ill.

(92) — Two sections cracked February 5, in a cast iron sectional boiler at the greenhouse of A. M. Stackhouse, Minerva, O.

(93) — The water back attached to the kitchen range exploded February 5, in the home of Beatrice Daniels, Philadelphia, Pa. Three persons were severely scalded.

(94) — On February 5, a water back attached to a kitchen range exploded in the home of Linford Yarnall, Philadelphia, Pa. Four persons, two of them small children were injured by the explosion and the fire which followed it.

(95) — On February 6, a boiler exploded at the flour mill of H. A. Berk & Son, Wakeman, O. The loss was estimated over ten thousand dollars.

(96) — Four headers cracked on February 6 in a water tube boiler at the plant of the Oberlin Gas & Electric Company, Oberlin, O.

(97) — A section cracked February 6 in a cast iron sectional boiler at the High School, Garden City, Kansas.

(98) — The boiler of a locomotive drawing a freight train of the Seaboard Air Line Railway exploded February 1, at Dinwiddie Courthouse, Virginia. Three men were killed and thirteen cars derailed.

(99) — A heating boiler exploded February 7 at the greenhouse of Frederick Frank at Brookside, near Reading, Pa. The accident was said to have been caused by a frozen intake pipe.

(100) — On February 7, a water back in the kitchen stove exploded, severely injuring Mrs. Samuel Leap at Swedesboro, Pa.

(101) — A slight accident occurred to a boiler on February 8, at the plant of Bohlan-Huse Coal and Ice Company, Memphis, Tenn.

(102) — A section cracked February 6, in a cast iron sectional heating boiler at the Kelly School, Wilkinsburg, Pa.

(103) — A section cracked February 10, in a cast iron sectional boiler at the apartment house owned by Elizabeth J., Loretta E. and Thomas J. Glynn, San Francisco, Cal.

(104) — On February 10, one man was severely scalded as the result of a boiler accident at the plant of the International Cotton Oil Co., Houston Heights, Texas.

(105) — Four sections cracked in a cast iron sectional heating boiler on February 11, at the tobacco warehouse of Meyer and Mendelsohn, Hartford, Conn.

(106) — On February 12, seven sections cracked in a cast iron sectional heating boiler at the tobacco warehouse of the American Sumatra Tobacco Company, Floydville, Conn.

(107) — On February 12, a boiler exploded at the Croffett Oil Well, No. 2 on the Croffett plantation, near Bastrop, La. Two men were seriously scalded.

(108) — On February 13, a section cracked in a cast iron sectional heating boiler at the apartment house owned by Theodore and William D. Dellert, Pittsfield, Mass.

(109) — On February 15, a boiler exploded at the pumping station at No. 14 Mine of M. K. and T. Railroad. One boy was instantly killed, one fatally injured and several others were seriously injured by the explosion.

(110) — On February 17, a boiler ruptured at the Y. M. C. A. Indianapolis, Ind.

(111) — On February 18, a tube ruptured in a water tube boiler at the plant of the Mt Vernon, Woodberry Mills, Inc., Baltimore, Md. Two people were slightly injured.

(112) — A blow off pipe failed February 18, at King's Hotel, Hanford, Cal.

(113) — On February 18, a boiler exploded at the cotton gin of A. Stutevant, Glendora, Miss. One man was seriously scalded and two others slightly injured by the explosion.

(114) — On February 18, a boiler exploded at the mill of the Republic Iron & Steel Company, East Chicago, Ind. Four men were killed and twenty-five seriously injured by the explosion. The property damage was very large.

(115) — A tube ruptured February 19, in a water tube boiler at the plant of the Mac Sim Bar Paper Company, Otsego, Mich. One man was injured.

(116) — On February 20 an elbow failed in a blow off pipe at the plant of the Allen B. Wrisley Company, Chicago, Ill.

(117) — A section cracked February 20 in a cast iron sectional boiler at the Galt House, Sterling, Ill.

(118) — On February 21, a tube failed in a boiler at the Comestoga Building, Pittsburgh, Pa. One man was scalded.

(119) — A blow-off failed February 21, at the plant of the Baumann Rubber Company, New Haven, Conn. Two were slightly injured.

(120) — On February 22, two sections cracked in a cast iron sectional heating boiler at the plant of the Cling Surface Company, Buffalo, N. Y.

(121) — A blow-off failed February 26, at the Acme Steam Laundry, Fort Worth, Kan.

(122) — A section cracked February 25, in a cast iron sectional heating boiler at the building of the Metropolitan Furniture Company, Springfield, Mass.

(123) — Three sections cracked February 26, in a cast iron sectional heating boiler in the office building owned by the Schulte Realty Company, New York City.

(124) — A boiler exploded February 26, at the saw mill of James Roberts, near Clanton, Ala. Three men were killed and several others injured, while the force of the explosion wrecked the mill.

(125) — The boiler of a steam shovel employed on double track work on the Hocking Valley Railway exploded February 25, at Owens, Ohio. One man was killed.

(126) — On February 28, a tube ruptured in a water tube boiler at the plant of the Federal Light & Traction Company, Sheridan, Wy. One man was injured.

(127) — Six sections cracked February 28, in a cast iron sectional heating boiler at the theater owned by the Armstrong Real Estate and Improvement Company, Johnsonburg, Pa.

(128) — On February 28, the cover flew off from a kier at the Rome Bleachery owned by the Elmore-Brame Company, Rome, Ga.

(129) — On February 28, three sections cracked in a cast iron sectional boiler at the garage owned by Harriet M. Howe, Hartford, Conn.

March, 1918.

(130) — On March 1, a tube ruptured in a water tube boiler of the Interstate Public Service Company plant of the middle West Utilities Co., New Castle, Ind.

(131) — On March 1, a cast iron sectional boiler failed at the "Hazel Court" apartment owned by the Bemis Realty Corp., New York City.

(132) — On March 1, four headers failed in a water tube boiler at the Counties Gas & Electric Company plant of the United Gas Improvement Company, Wayne, Pa.

(133) — A blow-off ruptured March 1, at the plant of the Hayes Wheel Company, Jackson, Mich.

(134) — On March 2, an accident occurred to a boiler at the plant of the Berlin Construction Company, Berlin, Conn.

(135) — On March 2, a tube ruptured in a water tube boiler at the plant of the Capitol City Water Company, Jefferson City, Mo. One person was injured.

(136) — A hot water boiler exploded March 3, during a fire which destroyed four residences and a garage at Scranton, Pa. Four men were seriously injured by the explosion.

(137) — The boiler of a locomotive of the Sante Fe Railroad exploded March 3, near Willard, N. M. Two men were killed and one injured.

(138) — On March 5, a tube ruptured in a water tube boiler at the Marshall Electric Company plant of the Middle West Utilities Company, Marshall, Texas.

(139) — A header cracked March 6, in a water tube boiler at the Champlain Mills owned by the New York & Pennsylvannia Company, Willsboro, Pa.

(140) — On March 6, a section cracked in a cast iron sectional boiler at the meat market of Froehling & Heppe, Chicago, Ill.

(141) — An accident occurred March 8, to the fire box of a locomotive boiler owned by Craig Mountain Lumber Company, Winchester, Idaho.

(142) — On March 8, a boiler exploded on the farm of Robert Sharp in Plum Township, Pa. One man was killed and three others injured.

(143) — A section cracked March 9, in a cast iron sectional heating boiler at the store of A. F. G. and C. W. Godefroy, St Louis, Mo.

(144) — A boiler ruptured March 9, at the plant of Clendenin & Company, Richmond, Ind.

(145) — A boiler ruptured March 10, at the plant of the Toledo Rex Spray Company, Toledo, O.

(146) — Three headers failed March 11, in a water tube boiler at the office building owned by Samuel Mather and others, Cleveland, O.

(147) — Five tubes pulled from the tube sheet of a water tube boiler on March 15, at the plant of the Granselli Chemical Company, Grasselli, Ind.

(148) — The boiler of a Nashville, Chattanooga and St. Louis Railway locomotive exploded March 15 near Cowen, Tenn. One man was killed and four others severely injured.

(149) — On March 15, a boiler exploded at the tobacco factory of R. E. O'Flynn & Son, Owensboro, Ky. One person was injured.

(150) — On March 16, a mud drum failed on a cast iron sectional heating boiler at the Aven Theater of the American Motion Picture Company, Inc. Utica, N. Y.

(151) — On March 16, an accident occurred to a steam drum on a boiler at the plant of the Wheeling Steel & Iron Company, Wheeling, W. Va.

(152) — On March 8, a circulating pipe failed on a Scotch marine type boiler at the plant of the Continental Gas & Electric Corporation, Aurora, Neb. One man was injured.

(153) — A tube ruptured March 19, at the plant of the Cohankus Mfg. Co., Paducah, Ky.

(154) — On March 19, two headers failed in a water tube boiler at the plant of the New York & Pennsylvania Company, Willsboro, N. Y.

(155) — On March 20, a locomotive boiler exploded at the Bay Creek Lumber Company, Purvis, Miss. Two men were fatally injured and five others were severely injured.

(156) — On March 20, a garbage reduction tank exploded at the Municipal Reduction Plant, Syracuse, N. Y. Property damage resulted estimated at $80,000, but fortunately no one was injured.

(157) — On March 21, a tube ruptured in a water tube boiler at the Brunot's Island Plant of the Duqusne Light Co., Pittsburg, Pa.

(158) — A boiler exploded March 22, at the Aurora Creamery, Aurora, Ind. Two men were slightly injured.

(159) — The boiler of a Chesapeake & Ohio Railway locomotive exploded March 22, near Milton, Pa. Two men were badly scalded.

(160) — On March 23, a boiler ruptured at the plant of the Genessee Salt Company, Pifford, N. Y.

(161) — On March 23, a locomotive boiler exploded on the Fort Worth and Denver Railway near Electra, Tex. Two men were killed and one other fatally injured.

(162) — On March 24, a steam pipe failed at the power house of the Kansas City Railway Company, Kansas City, Mo. One man was injured.

(163) — A tube ruptured on March 26, in a water tube boiler at the Wheeling Electric Company plant of the American Gas & Electric Co., Wheeling, W. Va. One man was injured.

(164) — A boiler ruptured March 26, at the cotton gin owned by the Dexter Gin Company, Dexter, Mo.

(165) — On March 30, a tube ruptured in the boiler of a New York, New Haven & Hartford Railway Company's locomotive while leaving Springfield, Mass. Two men were badly scalded.

(166) — On March 31, two tubes ruptured in a water tube boiler at the Municipal Water & Light Plant, owned by the city of Knightstown, Ind.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1918.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash on hand and in course of transmission,		$404,341.76
Premiums in course of collection,		414,595.11
Real Estate,		90,000.00
Loaned on bond and mortgage,		1,544,400.00
Stocks and bonds, market value,		4,601,456.00
Interest accrued,		104,020.74
		$7,158,813.61
Less value of Special Deposits over Liability requirements,		32,229.37
Total assets,		$7,126,584.24

LIABILITIES.

Premium Reserve,		$3,013,990.80
Losses unadjusted,		122,761.60
Commissions and brokerage,		82,919.03
Other liabilities (taxes accrued, etc.),		251,117.95
Capital Stock,	$2,000,000.00	
Surplus over all liabilities,	1,655,794.86	
Surplus as regards Policy-holders,	**$3,655,794.86**	3,655,794.86
Total liabilities,		$7,126,584.24

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L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

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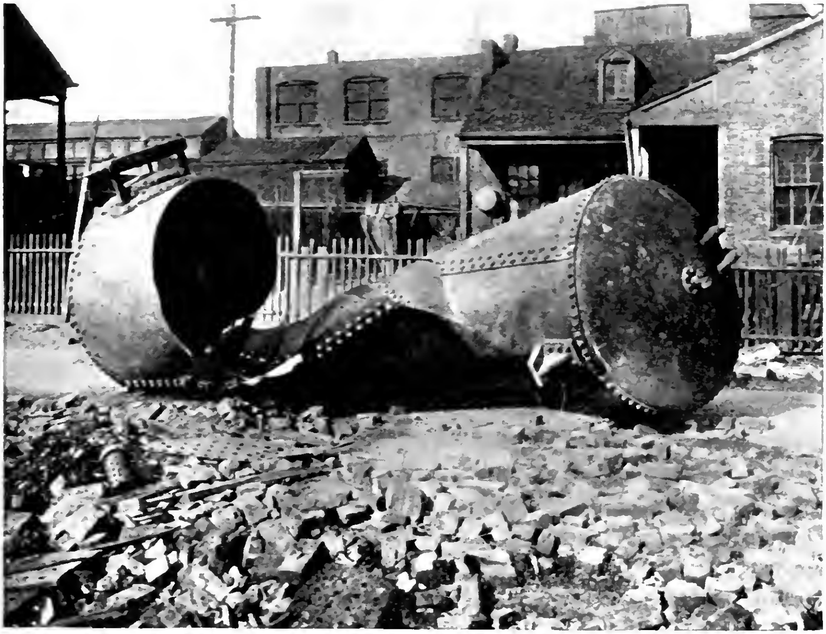
The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

Vol. XXXII. HARTFORD, CONN., JANUARY, 1919. No. 5.



Rendering Tank Explosion St. Louis, Mo

Rendering Tank Explosion at St. Louis.

The photograph on the cover of this issue shows a large rendering tank which exploded November 13th, 1918, at the plant of the St. Louis Hide and Tallow Company, St. Louis, Mo. The tank which exploded was one of ten which were employed for separating grease from garbage. The explosion was very violent. The buildings were badly wrecked and some of the remaining tanks were thrown from their settings. The damage to property exceeded $17,000.00; in addition to which, one man who was employed about the tanks was killed and another, an outsider, who happened to be in the plant at the time, was injured. A somewhat similar accident to the same plant was illustrated in the "Locomotive" for April, 1909.

Reinforced Concrete Supports for Horizontal Tubular Boilers.

By H. E. DART, Superintendent of Engineering Department.

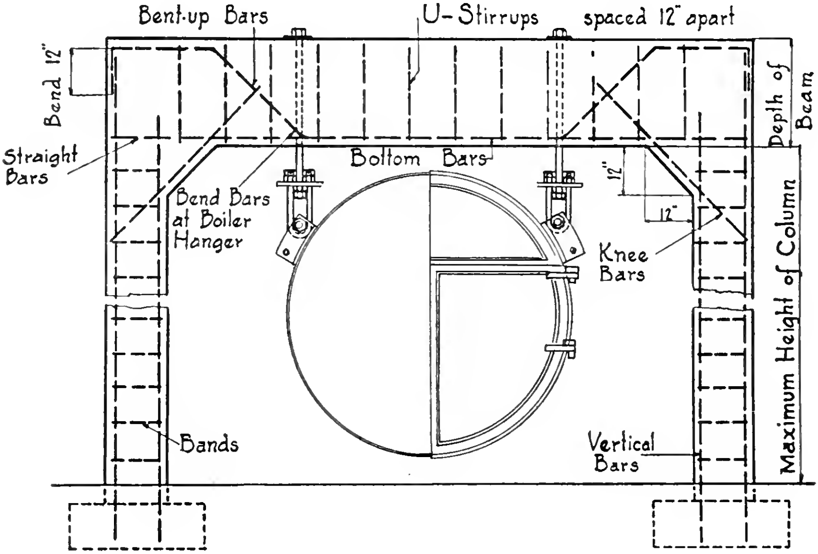
The support of horizontal tubular boilers by suspension from overhead has met with much favor in recent years and has become quite general practice in some sections of the country. For boilers of large size this method of support is now required by the laws of many states and it is also prescribed by the Boiler Code of the American Society of Mechanical Engineers. In one state there is a requirement that all boilers having a diameter of fifty-four inches (54″) or more shall be suspended. The older and more common method of supporting boilers from the setting walls by means of lugs or brackets riveted to the boiler shell is open to the criticism that the walls may not always be strong enough for the purpose. Our inspectors occasionally discover cases where the brickwork has not been kept in good repair so that the boilers are in imminent danger of falling down with consequent disastrous results, and in a few instances boiler explosions have been attributed to this cause. This source of danger is entirely eliminated when boilers are suspended independently of the brickwork and there are also other advantages in this method of support. The principal reason why the suspension method has not been used even more widely is that it is more expensive than the other way.

ADVANTAGES OF CONCRETE.

When horizontal tubular boilers are suspended, they are generally hung from structural steel I-beams or channels extending transversely over the boilers and carried by columns of structural steel or cast-iron placed at each side of the setting. On account of the difficulty at present (and for some time past) in obtaining cast-iron columns and structural shapes of the proper sizes, reinforced concrete has been used in a few instances for the support of suspended boilers and it would seem that this material might be used advantageously for the purpose in a great many cases. In the first place, all of the materials needed (including reinforcing rods, lumber for forms, cement, sand, stone, and water) are much more easily obtainable than structural steel shapes and cast-iron columns, even in normal times, and there is no delay such as is often experienced in waiting for structural steel to be fabricated. Another important consideration is that, except in certain out-of-the-way places and in places where local conditions are abnormal, concrete girders and columns are considerably cheaper than steel beams and cast-iron columns; the cost of the concrete construction under existing conditions in New England would probably be about sixty to eighty per cent (60% to 80%) of the cost of the other form of construction. Furthermore, under proper direction, concrete beams and columns can be constructed with cheap labor such as is ordinarily found around any manufacturing plant. On the other hand, concrete construction is at a disadvantage where the space is limited since the girders are necessarily deeper than steel I-beams or channels and the columns are larger than those of either steel or cast-iron. Also, if it were ever necessary to set the boilers in another location it would not be practicable to move concrete columns and beams on account of their size and weight while steel beams and columns could be used in a new location without any difficulty. There is the further disadvantage, too, that it is not possible to put a load on concrete girders for some time after the concrete has been poured.

DESIGNS ARE TYPICAL.

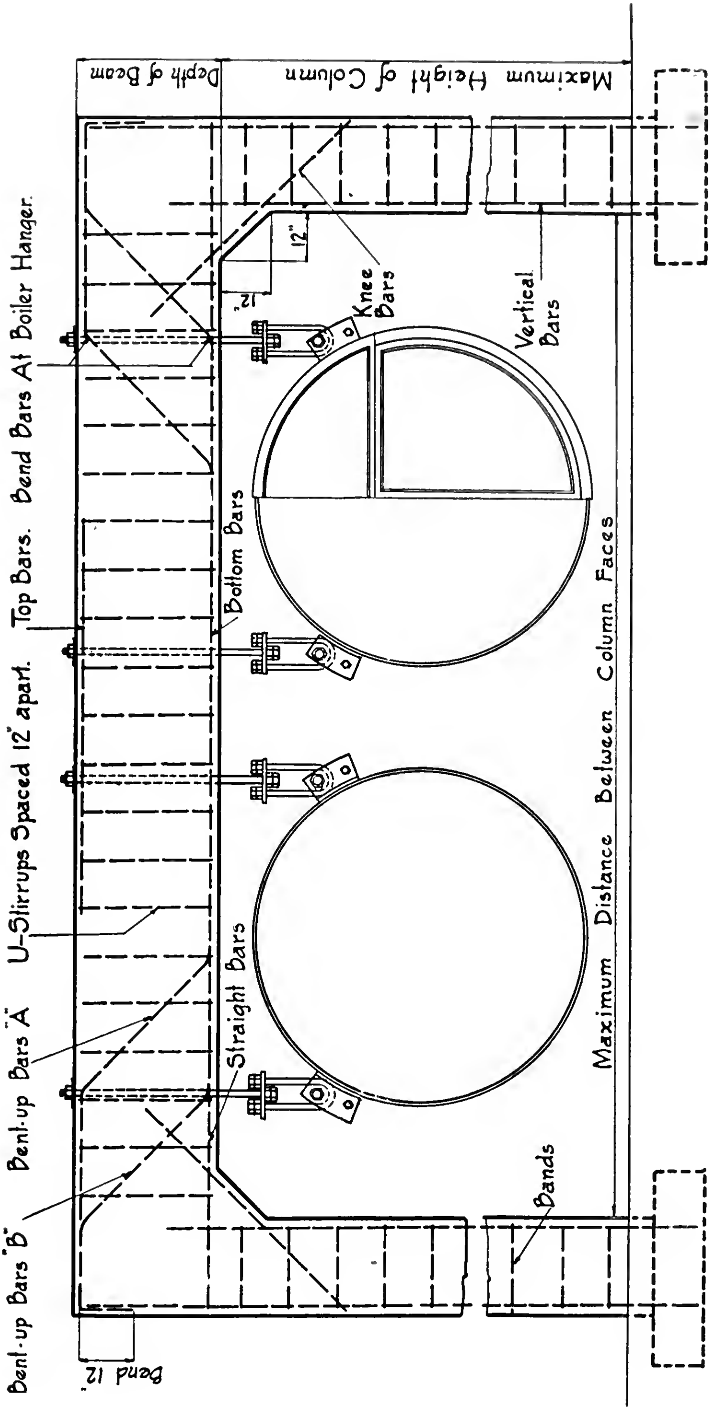
In spite of the disadvantages noted above there are undoubtedly a great many cases where concrete construction would prove to be entirely satisfactory for the suspension of boilers and we believe that it might be quite generally employed for the purpose if this fact were more fully appreciated. With this idea in mind we have therefore had prepared some simple designs to cover the construction of concrete beams and columns for the more usual sizes of horizontal tubular boilers. Figure 1 shows the typical design for



TYPICAL COLUMNS AND BEAM FOR ONE BOILER
See Tables "A" & "B" for dimensions

FIG. 1.

the support of one boiler while Figure 2 shows the arrangement for suspending two boilers. It has been the aim to make the designs as simple as possible so that no complicated forms will be required; square columns have been used and the beams have a plain rectangular cross-section so that the forms will consist practically of two square vertical boxes connected together by a horizontal box open on top. For the support of a single boiler the beams are of the same width as the columns but for a battery of two boilers it has been found advisable to make the beams two inches wider than the columns in each case. The forms for the beams and columns should be completely finished before starting to place the concrete. The footings for the columns may be made in advance, thus providing a suitable support for the forms, but it should be noted that the vertical reinforcing bars in the columns should extend down into the footings (as indicated in Figures 1 and 2) and should therefore be placed when the foundations are being built. For the sake of convenience, short bars (extending about three feet above the foundation) may be used if preferred, the main reinforcing bars being wired to these short bars later. The size of the column footings or foundations should be such as



TYPICAL COLUMNS AND BEAM FOR TWO BOILERS
See Tables "C" & "D" for dimensions
FIG. 2.

to properly support the load without exceeding the allowable bearing pressure on the soil, the required size for hard-pan or other firm and unyielding soil being much less than for a soft soil. For average conditions, the outside dimensions of the footings should be about two feet larger than for the columns but this rule should be used with caution and each case should be carefully considered by itself.

DIMENSIONS.

The accompanying tables give the necessary dimensions and other essential details for constructing beams and columns in accordance with Figures 1 and 2 for the usual sizes of horizontal tubular boilers. The headings used in the tables appear on the figures also so that there should be no difficulty in understanding what is meant. For convenience in tabulating, separate tables are given for beams and for columns although each beam with its two columns should be constructed as a unit. Tables A and B are to be used with Figure 1 for a single boiler while Tables C and D apply to two boilers in battery and should be used in connection with Figure 2. The "Maximum Distance Between Column Faces" (as given in Tables A and C and indicated on Figure 2) is made sufficient to allow for the construction between columns of a brick boiler setting having double walls with an air-space between; this dimension should not be exceeded. If the columns are set partly into the brick walls or if solid walls of less thickness are used, the distance between column faces will be shortened, thus reducing the span for the beam and adding a little to the safety of the design, but the difference in span would hardly be sufficient to warrant any change in the size of reinforcement or other details. In a similar way, the margin of safety will be increased somewhat if either the length of tubes or the height of columns is less than the maximum stated but we would not advise any change in the design under such conditions.

PLACING THE REINFORCEMENT.

The reinforcing bands in columns should be bent into square shape with ends projecting inwardly as shown on Figure 3 and the so-called U-stirrups for beam reinforcement should be bent in the manner indicated on Figures 4 and 5. Bends in "bent-up" bars should be made at the points of support for the boilers (See Figures 1 and 2) and the angle at which the bend is made should be about forty-five degrees (45°). No exact location can be given for the points at which boilers should be hung since such locations

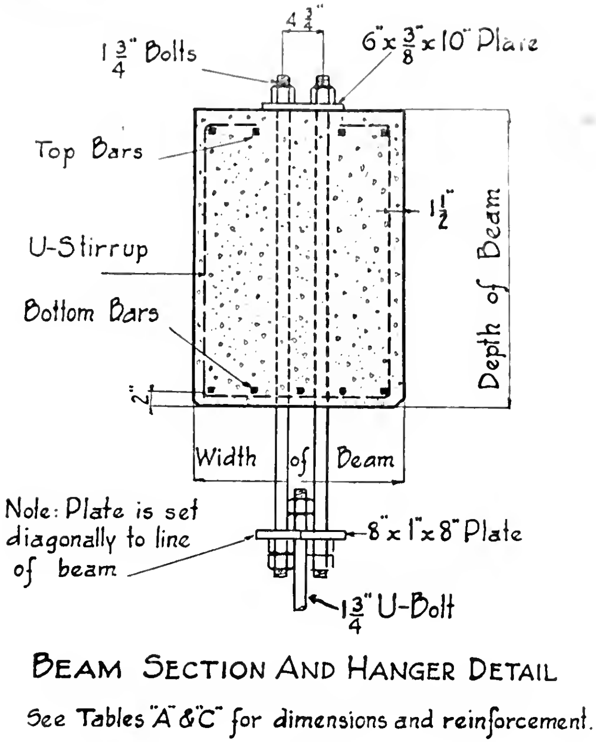
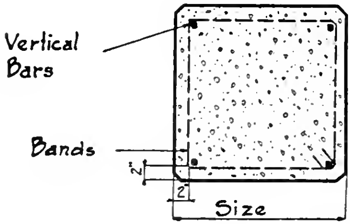


FIG. 4.

will be determined by the size of the boiler and the setting details; in general, it is assumed that the distance apart of the hangers for any boiler will be about six inches less than the boiler diameter and that the hangers will be located symmetrically with respect to the columns according to the general arrangement shown on Figures 1 and 2. Extreme care should be taken to insure that all reinforcing steel is accurately placed as called for and rigidly held in position; to this end the separate members should be wired together at every intersection and the whole system should be secured against displacement by wires, spacers and such other means as may seem best suited to each particular case. Bars may be spliced by wiring them together provided that the distance which they lap on each other is equal to at least thirty (30) times the diameter or average width of the bar. Concrete shrinks slightly as it sets and it is therefore best to fill the column forms and let the concrete set for a day or so before placing the concrete for beams. Before starting to pour the concrete for each separate



COLUMN SECTION

FIG. 3.

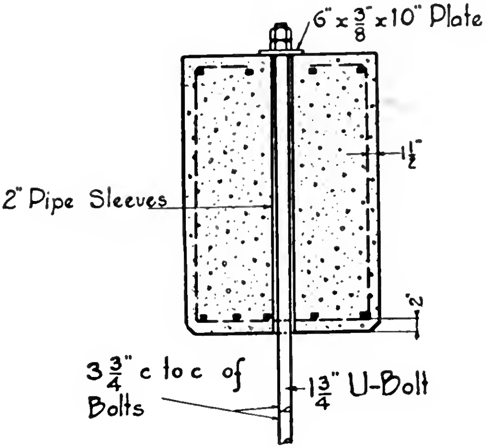
part of the work it is important and necessary to properly place all reinforcement which will be covered by concrete during the contemplated operation.

FORMS.

Forms should be strong and well braced, properly constructed and made tight enough to prevent the leakage of mortar. The forms should be thoroughly cleaned just before starting to place concrete, and for this purpose openings should be provided at the bottom of the column forms so that all shavings, saw-dust and other foreign matter may be removed. Shores should be placed at frequent intervals under each beam, and the columns which will support the beam should be stripped of forms and carefully examined before such shores are removed. If ample shores are provided under the beams, forms may be removed from columns under average conditions in four (4) days after the concrete is placed. At least three (3) weeks should elapse before shores and forms can be removed from beams even under favorable conditions as regards weather; in many cases five or six weeks will be required before it will be safe to fully load the beams. When building the forms it is a good idea to put a piece of triangular moulding in each corner so that there will be no sharp edges to break off.

MIXING THE CONCRETE.

Concrete should be mixed in the proportions of 1:2:4 viz.,— one part of Portland cement, two parts of sand or fine aggregate and four parts of stone or coarse aggregate. If a particularly dense concrete is desired the proportions can be made 1:2:3½ or even 1:2:3. The proportions should be carefully determined by volume and no careless or random methods of measurement should be employed. The concrete should be carefully and thoroughly mixed and should be wet enough so that it will flow sluggishly into the forms and around the reinforcement, leaving no pockets or voids. It should be rammed or otherwise agitated as much as may be necessary to insure compactness. Concrete should be placed in the forms as soon as possible after mixing and under no conditions should concrete be used after it has partly set. Each column should be poured for its full height in one operation and when beams are once started they should be entirely completed so as to leave no joints. In a dry, warm room the concrete should be wetted frequently during the first week or two. In freezing weather we would not advise pouring concrete for this kind of structure, though it can be done successfully if the ingredients are heated and other precautions taken.



ALTERNATIVE DESIGN FOR HANGER

Fig. 5.

MATERIALS TO USE IN CONCRETE.

Portland cement of an established and well-known brand is the only kind which should be considered and care should be taken to remove any lumps which may have formed in it on account of the presence of moisture during storage. The fine aggregate should consist of sand, crushed stone screenings or gravel screenings, graded from fine to coarse and passing, when dry, a screen having holes one-quarter inch (¼") in diameter; it should be clean and free from dust, soft particles, vegetable loam, or other foreign matter. For the coarse aggregate, crushed trap rock, crushed iron slag or washed and screened gravel may be used; it should be retained on a screen having holes one-quarter inch (¼") in diameter and should pass through a screen having 1½-inch holes. Gravel should not be used if either trap rock or slag can be obtained and, in any case, the coarse aggregate must be clean, hard, durable and free from all deleterious matter. Either medium steel or high carbon steel, made by the open hearth process, may be used for reinforcement; it should have an ultimate tensile strength of at least 60,000 pounds and a yield point of not less than 32,000 pounds per square inch. Water should be taken from city mains or some source of equal purity.

METHOD OF SUSPENSION.

We advise the use of U-bolts instead of eye-bolts for suspending horizontal tubular boilers and Figure 4 shows one method of using a U-bolt in connection with a concrete beam. The illustration shows a U-bolt made of 1¾-inch stock, this being a common size. It will be noted that two straight bolts are built into the concrete and that these bolts support a square plate having four (4) holes in it, one at each corner. These bolts which are built into the concrete extend down through two of the holes (diagonally opposite) and are secured with nuts underneath the plate while the two legs of the U-bolt are carried up through the other two holes with nuts on top. This arrangement provides ample means for adjustment together with flexibility. Figure 5 shows another method which can be used; in this case pipe sleeves are built into the concrete and the U-bolts extend directly up through the beam and are secured by means of a plate and nuts on top of the beam without any intermediate support. The disadvantage of this method is that the pipe sleeves must be located with extreme accuracy and then maintained absolutely in place. A two-inch (2″) pipe is the largest size which should be used. It is necessary to displace one of the bottom reinforcing bars from its central position, as indicated on Figure 5. For either of the methods described the bearing plate on top of the beam should be set in a bed of cement grout and the nuts should then be tightened so as to insure a perfect bearing on the concrete.

WORKING STRESSES.

The working stresses used in the design of these beams and columns are as follows:

Concrete in direct compression, in columns,	500 lbs. per sq. in.
Concrete in compression, extreme fibre stress in beams, ...	400 lbs. per sq. in.
Concrete in shear, with diagonal tension taken by steel, ...	90 lbs. per sq. in.
Tensile stress in steel, ...	14,000 lbs. per sq. in.

The modulus of elasticity for concrete is assumed to be one-fifteenth (1/15) of the modulus of elasticity for steel.

It will be seen from the above that the designs have been made on a conservative basis. A sufficient margin of safety has been allowed in every case and the structures will be found to be entirely satisfactory for the intended purposes if they are built in accordance with the directions contained herein.

TABLE A

BEAM DESIGNS FOR ONE BOILER

SIZE OF BOILER		Maximum distance between column faces	Width of beam	Depth of beam	BEAM REINFORCEMENT				
					Bottom Bars				Size of U-Stirrups
					Straight Bars		Bent-Up Bars		
Diameter of shell	Maximum length of tubes				No.	Size	No.	Size	
54″	16′	9′—0″	1′—2″	1′—8″	1	5/8″	2	5/8″	3/8″
60″	18′	9′—6″	1′—2″	1′—10″	1	3/4″	2	5/8″	3/8″
66″	18′	10′—0″	1′—2″	2′—0″	1	3/4″	{1 {1	{3/4″ {5/8″	3/8″
72″	18′	10′—6″	1′—4″	2′—0″	1	3/4″	2	3/4″	1/2″
78″	20′	11′—0″	1′—4″	2′—4″	1	7/8″	2	3/4″	1/2″
84″	20′	11′—6″	1′—4″	2′—4″	1	7/8″	{1 {1	{7/8″ {3/4″	1/2″

NOTE:—All reinforcement to be square twisted bars of sizes designated or other deformed bars of equivalent cross section.

TABLE B

COLUMN DESIGNS FOR ONE BOILER

Size of Boiler		Maximum height of columns	Size of columns (square)	Column Reinforcement				Knee Bars (in each knee)		
				Vertical Bars		Bands				
Diameter of shell	Maximum length of tubes			No.	Size	Size	Spacing	No.	Size	Length
54″	16′	10′—6″	1′—2″	4	5/8″	1/4″	6″ c. to c.	2	5/8″	3′—6″
60″	18′	11′—0″	1′—2″	4	5/8″	1/4″	6″ c. to c.	2	5/8″	3′—6″
66″	18′	12′—0″	1′—2″	4	7/8″	3/8″	8″ c. to c.	2	5/8″	4′—0″
72″	18′	12′—6″	1′—4″	4	5/8″	1/4″	8″ c. to c.	2	3/4″	4′—0″
78″	20′	13′—0″	1′—4″	4	3/4″	3/8″	12″ c. to c.	2	3/4″	4′—6″
84″	20′	14′—0″	1′—4″	4	7/8″	3/8″	9″ c. to c.	2	3/4″	4′—6″

NOTE: — All reinforcement to be square twisted bars of sizes designated or other deformed bars of equivalent cross section.

TABLE C

BEAM DESIGNS FOR TWO BOILERS

Size of Boiler		Maximum distance between column faces	Width of beam	Depth of beam	Beam Reinforcement									
					Bottom Bars						Top Bars			Size of U-Stirrups
					Straight Bars		Bent-Up Bars "A"		Bent-Up Bars "B"					
Diameter of shell	Maximum length of tubes				No.	Size	No.	Size	No.	Size	No.	Size	Length	
54"	16'	16'—0"	1'—6"	2'—0"	2	7/8"	2	3/4"	1	7/8"	2	7/8"	7'—0"	1/2"
60"	18'	17'—0"	1'—8"	2'—2"	2	7/8"	2	7/8"	1	7/8"	2	1"	7'—6"	1/2"
66"	18'	18'—0"	1'—8"	2'—4"	2	1"	2	1"	1	1"	{ 2 { 1	1" 1"	8'—0" 5'—0"	5/8"
72"	18'	19'—0"	1'—10"	2'—6"	{ 1 { 1	{ 1 1/8" { 1"	2	1"	1	1 1/8"	{ 2 { 3	7/8" 3/4"	8'—0" 5'—0"	5/8"
78"	20'	20'—0"	2'—0"	2'—8"	3	1"	2	1"	2	1"	{ 3 { 2	1" 7/8"	8'—6" 5'—0"	3/4"
84"	20'	21'—0"	2'—2"	3'—0"	{ 2 { 1	{ 1 1/8" { 1"	2	1"	2	1"	{ 2 { 3	1" 3/4"	8'—6" 5'—0"	3/4"

NOTE:—All reinforcement to be square twisted bars of sizes designated or other deformed bars of equivalent cross section.

TABLE D

COLUMN DESIGNS FOR TWO BOILERS

SIZE OF BOILER		Maximum height of columns	Size of columns (square)	COLUMN REINFORCEMENT						
				Vertical Bars		Bands		KNEE BARS (in each knee)		
Diameter of shell	Maximum length of tubes			No.	Size	Size	Spacing	No.	Size	Length
54″	16′	10′—0″	1′—4″	4	7/8″	3/8″	9″ c. to c.	2	3/4″	5′—0″
60″	18′	11′—0″	1′—6″	4	3/4″	1/4″	6″ c. to c.	2	3/4″	5′—0″
66″	18′	12′—0″	1′—6″	4	1″	3/8″	8″ c. to c.	2	3/4″	5′—6″
72″	18′	12′—6″	1′—8″	4	1″	3/8″	9″ c. to c.	2	7/8″	5′—6″
78″	20′	13′—0″	1′—10″	4	1″	3/8″	10″ c. to c.	2	7/8″	6′—0″
84″	20′	14′—0″	2′—0″	4	1″	3/8″	12″ c. to c.	2	7/8″	6′—0″

Note:—All reinforcement to be square twisted bars of sizes designated or other deformed bars of equivalent cross section.

The Draft Gage in the Boiler Room.

The rank and file of steam users have been brought face to face with several, to them, new wrinkles during the past year, and some of them are still a bit at sea as to what they are and why they should be considered essential to fire-room economy. Among others, perhaps the least understood and appreciated, as well as the simplest, is the draft gage.

There is nothing new or complex about a draft gage and its use on occasional tests to see if a chimney has draft enough has probably been known to every one about even a small steam plant for many years. However, when this simple contrivance is connected to a furnace instead of a breeching, or chimney base, it becomes in a way a new kind of animal. It indicates something, but the fire-room force are apt to be at considerable loss to know just what its indications mean, and how they may be used. Steam gages and water gages are well known and understood, and they have served so long as the beginning and end of boiler instruments that the humble draft gage comes as an intruder unknown, and perhaps not wanted.

It is the purpose of this paper to attempt to show in a simple way why a draft gage should be in every boiler-room, under the watchful eye of the fireman, and what service it can give him in his struggle to keep the steam gage pointer on the mark without wasting precious coal.

DRAFT DEFINED.

To go now to the fundamentals of the matter, a chimney draws because the air inside it is expanded by heat. If the air or gases inside are not warmer than the air outside, there is no draft, except perhaps in case of high wind, and this is not within the scope of our present discussion. Everyone knows that a cold chimney is apt to cause trouble in starting fires. The fire does not burn well, and smoke pours out at every crevice in the furnace and smoke-flue. If, however, a fire can be built for a few minutes in the chimney base, then, even if it is only from the burning of a handful of old newspaper, the chimney gets a draft and the fire burns up without the outpouring of smoke. The explanation of chimney draft is simple. Each cubic foot of gas in a hot chimney is lighter in weight than a cubic foot of outside air by an amount proportionate to its temperature as compared to that of the outside air. Therefore, as the column of gas in the chimney is lighter it is pushed up by the air outside entering through the furnace. The force available to push the gases up the chimney is measured by the difference between the pressure outside the chimney and that inside. This is most easily measured by bending a tube, preferably of glass, into the shape of a letter "U." If water is placed in the bend of the "U" and one end is connected by a rubber tube to the space inside the chimney, the other being kept open, the water will rise in the leg connected to the chimney until the weight of the water in this leg, added to the pressure inside the chimney, equals the weight of the water in the other leg plus the atmospheric pressure; or the difference in the height of the water columns in the two legs is the amount of water weight which must be added to the pressure inside the chimney to make it equal the pressure of the atmosphere. This could be interpreted in pounds per square inch if desired, but as the pressure as measured in these units is very small, and as we measure drafts chiefly in order to compare them with other drafts, or to watch how they vary from time to time, it is found that the mere measurement of the difference in height of the two water columns in inches is sufficient. Hence, we usually measure drafts in inches of water.

This is easily understood if we think of the "U" tube draft gage, and remember that a one-inch draft is a condition where the outside air pressure is enough greater than that in the chimney or flue so that an unbalanced column of water one-inch high must be added to the flue pressure to equal that outside.

WHY A DRAFT GAGE IS USED.

In the boiler-room we find it worth while to use a draft gage at several different points and for several different purposes. Primarily, we read a draft gage to tell us how the air is moving into a furnace or how the flue gases are leaving it. We have several times made the statement in these pages that if exactly enough air gets into intimate contact with fuel at the right temperature, we will get perfect combustion. Air is colorless, invisible stuff, and it moves toward our boiler furnaces slowly enough so that out in the fire-room, at least, we do not appreciate the variation in the rate of air flow to the furnaces by noting changes in the strength of the wind. But we are told that if we are to burn coal intelligently we must get just the right amount of air

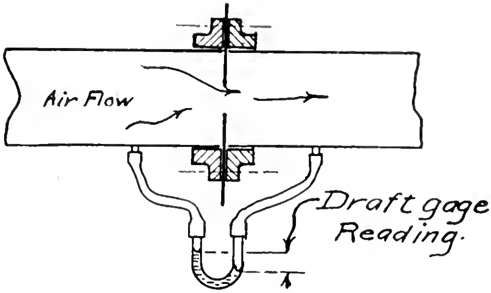


FIG. 2. DRAFT GAGE INDICATING THE FLOW OF AIR THROUGH AN OFFICE.

at the right place and at the right time. To some extent the draft gage enables us to keep track of the air flow.

Another way to check up is by testing the results of the combustion; that is, to analyze the flue gases. Then if there has been too little air there will be some unburned product (C O) in the gases leaving the boiler. If there has been just enough air, there will be no unburned product, no oxygen unconsumed, and a maximum possible amount of completely burned gas ($C\ O_2$). This condition is, however, ideal and not to be anticipated in practice as we would always have by choice a slight excess of air, although the flue gas analyses often show insufficient air.

DRAFT GAGE AN AIR METER.

Neither the draft gage, nor the apparatus for analysing flue gases, serve quite completely to tell the fireman what he needs to know about combustion conditions. In the first place, the draft gage indicates the amount of air passing through the furnace only if certain conditions are fixed. To illustrate this, — suppose a large diameter pipe to be carrying a certain flow of air. Now suppose that a piece of tin, having a hole in it of less diameter than the diameter of the pipe, is inserted at a flange so that it restricts the pipe diameter at this point to that of the hole in the sheet of tin. Now, if we keep the same amount of air flowing as we had before the sheet of metal was inserted, and if we connect a draft gage to holes tapped in the pipe, one each side of the partially closed off flange, the draft gage will show a pressure drop as the stream of air passes through the restriction.

With any given sized hole, or as it is frequently called, orifice, inserted in a pipe of a certain definite size, we may be sure that the reading of the draft gage will change with every change in the amount of air flowing, and whenever we get a certain fixed reading of the gage, say ½-inch, we may be sure that the same amount of air is flowing as at any previous time when the gage read ½-inch. This, indeed, is the principle on which many flow meters for steam and water operate. However, if a certain flow of air, say 100 cubic feet per minute, causes a pressure drop or draft gage reading of ½-inch of water through the orifice, it does not follow that if we had had a different orifice, of different size or shape, inserted in the same pipe that 100 cubic feet per minute of air flow would give a reading of ½-inch. That is, a draft gage can only measure the relative amount of air flowing past an orifice if the resistance of that orifice does not change. Now, if the orifice were a valve instead of a sheet of tin, the draft gage reading would change when the valve was slightly opened or closed, and would be less with the valve wide open than with it partly closed. That is, an increase in the draft gage reading may indicate not an increased amount of air flowing, but a greater resistance to the flow of air.

THE DRAFT GAGE AND THE DAMPER.

Now to return to our boiler furnace. We would connect a draft gage so that one side leads to the space over the grates, and the other side is open to the air in the fire-room. What is the connection between this arrangement and the pipe with an orifice? Simply this, that the ash-pit, furnace, boiler setting, breeching and chimney replace the pipe. The air consumed by the fire and the products of combustion become the air stream, while the grate and fuel bed replace our orifice, which offered resistance of the air flow. Now to carry the comparison still further, if the fuel bed is of a fixed thickness and clean, then we may assume that its resistance to air flow does not change much and so variations or changes in the draft gage reading mean changes in the amount of air coming through the fire. If we get a hole in the fire, the draft gage reading falls suddenly because the resistance of the fire-bed to the passage of the air has become much less. If the fire clinkers up and gets dirty, the draft gage reading will increase because the resistance is greater, and neither of these readings will mean anything as to how much air is getting into the furnace, while the hole is there, or while the fire is dirty. On the other hand, with a clean even fire, if we open the damper a bit, the draft gage reading increases because more air is flowing and the amount of increase tells us about how much more air is flowing. If the damper is closed a bit, less air flows and the reading of the gage falls off. One thing which the draft gage can show is at once apparent when the following simple test is made. Have the fire clean and even, free from holes. Do not open the furnace doors or close

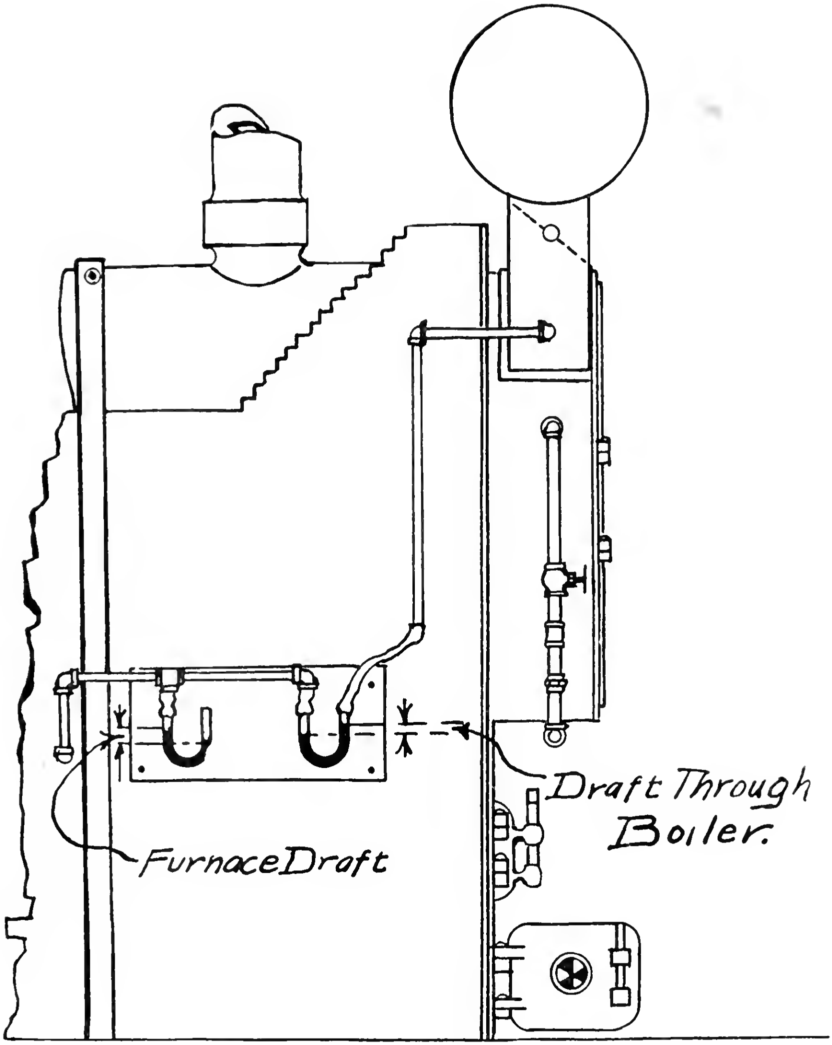


FIG. 2. DRAFT GAGES CONNECTED TO BOILER.

ash-pit doors. Close the damper and note the draft gage reading. Open it a certain amount, say one-fourth, note the draft gage reading. Open it one-half, note the reading; open it three-quarters, note again; and then open it wide. Now look over the set of readings. It will generally be found that the damper openings do not correspond to the changes in air flow, and it can usually be seen that the damper can be moved quite a bit from full closed

(Continued on page 150)

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

C. C. PERRY, EDITOR.

HARTFORD, JANUARY, 1919.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

During the year just past every plant owner has had his energies directed by the Fuel Administration to saving coal. He has been examined and rated and advised as to the best ways of using fuel economically. Not only has he been advised, but he can look back on this experience with satisfaction, knowing that coal has actually been saved and in the aggregate the savings were large. Steam users have submitted patriotically and wholeheartedly to this economy campaign as a war measure. They are now confronted with a new condition, for whereas the need of coal saving as a help to victory has passed, there still remains a strong and sufficient incentive for continuing the effort toward even greater coal economy as a matter of good business efficiency. We do not believe that steam users, as business men, will want to slide back to the old wasteful way of power production. The work so well started by the Fuel Administration must be continued by the steam users. During the fuel stringency of the last eighteen months, The Hartford Steam Boiler Inspection and Insurance Company has endeavored to be of the maximum possible service to its assured in helping them in their coal conservation. The Locomotive has been almost exclusively given over to articles on coal saving and combustion. Some of these articles were gathered together in a pamphlet carrying the title "Economy Hints," which has been in great demand. It has passed through three editions and is still going strong. In addition to this the Company has freely given the services of its officers and employees, particularly the inspection force, in helping to carry through the work of the Fuel Administration.

Now that the war is over, so far as active fighting is concerned, and the governmental agencies for fuel control and fuel conservation are withdrawing from the field, the Company is glad to state that it is still at the service of its assured through its engineering department, to help them solve any problems in fuel economy and efficient steam production, which may arise. The Locomotive also, will endeavor to keep the subject of fuel economy alive, and would welcome an expression of opinion from its readers as to the value to them of the articles which have already appeared, or suggestions regarding material which will be of service.

It is with some pride that we call attention to the leading article in this issue of the Locomotive, on the design of concrete columns and beams for suspending boilers. We have had some few inquiries for this type of structure, and as we knew of no published information on the subject we felt that it was the business of a Pioneer Company, such as ours, to investigate the matter and see whether it was practical or desirable. The designs published are the result of that investigation. We feel that they may be used with perfect confidence as regards their safety, provided that the limitations noted in the article are observed. We believe that many engineers may find these designs of interest to them, and our Engineering Department is prepared to furnish blue prints of the typical designs as published in this number, from the tracings which form the basis for our illustrations. These prints, with the dimensions in the tables should prove sufficient to permit any practical reinforced concrete contractor to undertake the work of suspending one or more boilers in this manner.

The other article, on draft gages, we believe will be welcome especially in the fire room as we believe that many plants have installed draft gages in compliance with the recommendations of the fuel administration, and desire some simple statement of the why and how of the instrument for the instruction of their fire room force. This we have endeavored to give.

Personal.

We beg to announce the appointment of Mr. J. A. Snyder as Chief Inspector at Pittsburgh. Mr. Snyder needs no introduction to the steam users of the Pittsburgh territory where he has served as inspector, and later as Assistant Chief Inspector for many years. Mr. Snyder's appointment came just after the October "Locomotive" went to press and we take this, our first opportunity since then, to publicly announce his appointment.

The Draft Gage in the Boiler Room.

(Concluded from page 147)

toward open before there is any marked increase in the flow of air. Also, as the damper is opened wide it will be found that the last part of its motion does not increase the flow of air. From this it can easily be seen just what part of the damper travel is useful. It is clear that there is no sense in moving the damper, either by hand or with a regulator, through that part of its travel which has no effect on the draft gage, as this motion is lost motion. If we confine the damper control so that it moves between stops, over its useful range only, we will get a closer regulation of the fire which will cause it to both pick up and check more promptly. This of itself, will help save coal and will tend to a more uniform boiler pressure.

USE OF SECOND GAGE.

There is, however, one more use to which the draft gage can be put, and that is to tell us how to set the damper for a certain fire thickness so that we will be using enough air, and not too much or too little. To get this information, however, we have to use a gas tester or analysing outfit, in order to give us the meaning of our draft gage readings. However, we can check up our draft gage and find out what it means, — after which the test information will hold good so long as we keep clean fires of the same thickness as when we made our check, assuming about the same kind of coal. So if we check up the draft gage against a portable flue gas analyzer for the different fire thicknesses which are needed to carry the load, we can get a value of the draft reading which is best for each fire thickness, and then the fireman may use the draft gage as a means of measuring air; that is, he can tell whether his damper is set for economy or not. Moreover, if the gage reading falls suddenly, he will know that he has burned a hole through somewhere and can attend to it, or if the readings rise slowly to a point which ought not to be reached with the damper setting he is using, he knows that the fire is getting dirty, or that he has let it get thicker than he intended.

DRAFT GAGE VS. GAS ANALYZER.

The question will at once arise, however, as to why we should clutter up a boiler-room with draft gages when they are only a sort of substitute for a flue gas analyzer, and not too accurate a substitute at that. The reason is this, that burning coal is a continuous process and a continually changing one. If its changes are to be followed closely so that an even pressure may be carried with good economy under the conditions of varying load, we must have some means of judging the completeness or efficiency of our coal burning, which can be depended on each instant to tell us what is taking place at that instant. This, the draft gage does. Its readings follow closely the changes in air flow from time to time, and do not lag behind the changes as they occur.

With a gas analyzing outfit, however, we draw a sample of gas out of the boiler setting into our apparatus and proceed to test it to find out how much of several different things it contains. This test is delicate, and to be at all accurate takes several minutes at the very least, so that the best we can hope to get from it is information of what happened ten or fifteen minutes before we finished the analysis. That is a long time in a furnace and conditions may have changed materially. Our draft gage, however, will have been on the job all the time, and if its readings have been interpreted by the sort of checking up which we described, we will know more about the changes which are taking place from it, and can meet sudden demands for changed conditions through it much more swiftly and accurately than any analysis would permit when used alone.

The exact value in the steam plant of draft gages, flue gas analyzers and CO_2 recorders, is this. The draft gage is a working indicator to the fireman of combustion conditions, and is his means of determining how to regulate his damper so as to get enough air and not too much to completely burn the coal which he has fired. It also serves to warn him if his fire begins to develop holes or clinkers, and so saves some of the necessity for observing the fire through the fire-doors and admitting excess air. The draft gage, however, is only an indirect and relative sort of an instrument, whose readings need to be interpreted by something which actually measures the results obtained. This purpose is served by the inexpensive, but accurate and satisfactory, portable flue gas analyzer or Orsat apparatus.

The CO_2 recorder is of very little service to the fireman in correcting furnace conditions, but it does produce a complete record of these conditions. The fact that the record is not made till some time after the conditions existed is of no consequence, since it is used as a continuous log of the day's work for study.

The writer is well aware that certain types of CO_2 recorders are provided with indicators distinct and separate from the recording part of the instrument, designed to show the fireman at a glance just what the instantaneous value of the CO_2 is. Moreover, these indicators are practically free from time lag. They are expensive, however, and therefore not so apt to be considered in connection with the smaller plants as in the large ones. For this reason they are not in direct competition with the draft gage in the average boiler-room, and in any case they do not entirely replace the draft gage as a practical help to correct firing.

CALIBRATING AND USING THE GAGE.

The process of calibrating or checking a draft gage is briefly, as follows: First, determine the several fire thicknesses which are to be regularly carried, and provide some sort of permanent marks inside the furnace or door-frame so that these thicknesses may be accurately carried at any time, and not guessed at. Have the fire clean and even, and at the desired thickness. Then do not open the fire-door or close the ash-pit doors, but note the draft gage reading and take a sample of flue gas. Analyze for CO_2, O and C O. If there is no C O, slightly close the damper and see if less air can be admitted with a higher CO_2 percentage and no C O. When the highest CO_2 has been obtained which is possible without producing C O, then that represents as nearly as may be, the correct amount of air for that fire thickness and combustion rate. The draft gage should have been read at the time each sample was taken, and the reading of the gage, which corresponds to the best sample, is the draft to carry for that particular fire thickness. Do this for several different fire thicknesses, and then in working the boiler vary the thickness with the load, but keep the draft right for that particular thickness.

So much for the furnace gage, which indicates the process of producing heat. The figure shows another gage connected to the furnace on one side and to a point in the breeching, just below the damper, on the other side. This gage tells us something about the heat absorbing side of the boiler. If the flues or tubes are clean, and the baffles, if any, are tight, this gage will register an amount depending on the volume of gases passing through the boiler. If, however, soot accumulates, the reading will gradually increase as the resistance to gas travel increases. This gage, then, can be made to show when it is time to blow or sweep the tubes free from soot. Moreover, in a baffled boiler, if leaks occur in the baffling the gage will fall off at once and indicate that attention is needed; whereas no other simple means is available to provide this information when the boiler is under steam. These two gages together, then, when properly understood and checked tell how nearly combustion conditions approach the ideal, and within limits, how well the heating surface is in a condition to absorb heat, two very important pieces of information to the boiler operator, and this is the story of the draft gage.

BEST TYPE TO USE.

It is perhaps well to add in closing, a brief description of one form of gage which is more sensitive and therefore much more useful than the simple " U " tube. It consists merely of a " U " tube, one of whose legs is of large diameter and vertical, while the other leg is of small bore and inclined so as to be nearly horizontal. In use it is connected exactly like the simple " U " tube, except that the inclined leg is always made the low pressure end of the instrument. The advantage of this form over the simple " U " tube is that the liquid in the inclined leg must travel a greater distance along the tube in order to rise to a given height than would be the case in a simple " U " tube. So that if the inclined tube were to rise one inch vertically for each ten inches of length then a draft reading of one-tenth of an inch would cause the water to move a full inch along the inclined tube, or the readings would be ten times as large and the instrument ten times as sensitive. This is a real advantage, and as draft gages of this sort are inexpensive, they are much to be preferred over the simple " U " type.

Boiler Explosions.

April 1, 1918.

(167) — A tube ruptured April 1st, in a water tube boiler at the plant of the Glenwood Cotton Mills, Easley, South Carolina.

(168) — Several tubes blew out from the tube sheet of a water tube boiler on April 4th, at the plant of the Superior Steel Corporation, Carnegie, Pa.

(169) — On April 4th, a blow-off pipe failed on a water tube boiler at the plant of the Louisville Water Company, Louisville, Ky. One man died of heart-failure shortly after the accident.

(170) — On April 5th, a crown sheet collapsed in the boiler of a locomotive belonging to the Clarke County Lumber Company, Glendon, Ala.

(171) — A boiler ruptured on April 5th, at the plant of the Pennsylvania Seaboard Steel Corporation, Chester, Pa.

(172) — On April 6th, a boiler exploded at the grist mill of Crouch Brothers, Irvine, Ky. Two men were instantly killed, and six others were injured.

(173) — A boiler exploded April 5th, at the meat packing plant of Utz Brothers, Wilkes-Barre, Pa. Three men were injured.

(174) — On April 5th, a boiler exploded on board the Steamer Annie, which was lying along side the dock at Elizabeth City, N. J. The explosion of the boiler demolished the vessel and killed five persons.

(175) — Two sections cracked April 8th, in a cast iron sectional heating boiler in a building owned by George Nunn, Detroit, Michigan.

(176) — On April 9th, two sections cracked in a cast iron sectional heating boiler in the overall factory of J. E. Walker, Kansas City, Mo.

(177) — A section cracked April 9th, in a cast iron sectional heating boiler at the cigar factory of William H. Kildow, Tiffin, Ohio

(178) — On April 10th, a tube ruptured in the water tube boiler at the plant of the Middle West Utilities Company, Marshall, Texas.

(179) — A boiler exploded April 10th, aboard the tow-boat "Lockport" while proceeding up the Mississippi River Nine-Mile Point. Two firemen were injured; — one fatally.

(180) — On April 12th, a section cracked in a cast iron sectional heating boiler in the River Crest apartment house, owned by the Manhattan Savings Institution, New York City.

(181) — On April 12th, four sections cracked in a cast iron sectional heating boiler located in the Longfellow School, Hastings, Nebraska.

(182) — On April 13th, a tube pulled out of a junction box in a water tube boiler at the plant of the George Ziegler Company, Milwaukee, Wis.

(183) — Two sections cracked April 16th, in a cast iron sectional heating boiler in the apartment house owned by Samuel B. Morrison, Denver, Colo.

(184) — On April 16th, a cast iron sectional heating boiler was severely damaged through the cracking of a large number of sections at the plant of the Manhattan Paper Company, New York City.

(185) — A boiler was ruptured April 18th, at the Barrow County Cotton Mill, Winder, Ga.

(186) — On April 19th, an accident occurred to a boiler at the plant of James R. Andrews, Talbot, Michigan.

(187) — A boiler ruptured April 23rd, at the plant of the Cambridge Ice Company, Federalsburg, Md.

(188) — On April 23rd, the crown sheet of a Gulf Coast Line Railway locomotive collapsed while the locomotive was standing on a track in Beaumont, Texas. Two houses were wrecked and nine men seriously injured; — one of them fatally as a result of the accident.

(189) — A boiler exploded April 26th, at the #1 plant of the Mount Vernon Woodbury Mills, Inc., Baltimore, Md. One man was killed; several were hurt, and more than $13,000 worth of property damage resulted.

(190) — On April 24th, a boiler used in connection with a gasolene absorption plant exploded at Taft, Cal. The boiler and the building in which it was situated were demolished and one man who was driving a team of mules from two hundred feet away from the boiler was injured by the explosion. One of the mules was also severely wounded.

(191) — On April 29th, an accident occurred to a water tube boiler at plant of the Alloy Steel Spring and Axle Company, Jackson, Michigan.

MAY 1918.

(192) — A boiler exploded May 7th, at the Saw Mill of Fred Keller near Dubois, Indiana. Two men were injured, one of them fatally.

(193) — Two tubes ruptured in a water tube boiler on May 10th at the plant of the Lackawanna Steel Company, Lackawanna, N. Y.

(194) — A boiler ruptured May 10th, at the plant of the H. W. Johns Manville Company, Wauwatosa, Wisconsin.

(195) — A boiler exploded May 15th, at the plant of the Austin Gas & Electric Co. Austin, Texas. One man was painfully injured

(196) — A tube ruptured May 17th, in a water tube boiler, at the plant of the National Cash Register Co., Dayton, Ohio. One man was injured.

(197) — An accident occurred May 18th, to a boiler at the plant of the Louisiana Gas Company, Cedar Grove, Louisiana.

(198) — A boiler accident occurred May 14th, to a boiler at the Training School at Vineland, New Jersey.

(199) — A tube ruptured May 20th, in a water tube boiler at the plant of the American Sheet and Tin Plate Company, Wheeling, W. Va.

(200) — A boiler exploded May 20th, in the basement of the store of the Emery, Bird, Thayer Company, Kansas City, Mo. One man was seriously burned.

(201) — Two tubes ruptured May 22nd, in a water tube boiler at the plant of the Citizens Electric Company, Battle Creek, Michigan. One man was burned.

(202) — An accident occurred to a water circulating device in a Scotch Marine type Boiler, at the plant of the Continental Gas and Electric Company, Aurora, Nebraska. One man was injured.

(203) — A hot water boiler exploded May 26th, at the home of Mrs. George Stalt, Albany, N. Y. Mrs. Stalt was badly burned.

(204) — The boilers of a freight engine on the Illinois Southern Railway, exploded May 27th near Nashville, Ill. One man was killed, and two other persons were injured.

(205) — A boiler exploded May 27th, at the Mill of the Hammer Lumber Company, 25 miles east of Conway, South Carolina. Five men were killed and five others injured, while the damage to the plant was large.

(206) — On May 29th, a tube ruptured in a water tube boiler at the plant of the Winona Copper Company, Winona, Michigan.

(207) — A boiler exploded May 30th, at the Automobile and Bicycle Rim Factory, at Onaway, Michigan. One man was killed.

(208) — A tank exploded May 30th, at the Monogram Laundry Company, Muskegon, Michigan.

JUNE 1918

(209) — On June 1st, the boiler of a mine locomotive engine exploded at Jackson Mine, Lonaconing, Maryland. The engineer and a miner who was riding on the locomotive were both injured.

(210) — On June 2nd, a boiler exploded at the plant of the Bartlett Lumber Company, at Shelldrake, Michigan. Ten men were killed and a number injured by the explosion.

(211) — A boiler ruptured June 3rd, at the plant of the Rockford Brick and Tile Company, Rockford, Iowa.

(212) — A plug blew from the crown sheet of the boiler of a road roller belonging to the City of Columbus, Ohio, on June 4th. One man was injured.

(213) — A header fractured June 6th, in a water tube boiler, at the Industrial Works, Bay City, Michigan.

(214) — A main steam pipe burst June 6th, at the plant of Jerome H. Sheip, Inc., Mobile, Alabama.

(215) — The boiler of a locomotive belonging to the Chicago and Northwestern Railway, exploded while standing outside the roundhouse at Fremont, Nebraska, on June 7th. Two men were injured, one of them fatally.

(216) — An economizer exploded June 10th, at the plant of the New Orleans, Railway & Light Company, New Orleans, Louisiana. One man was killed, one fatally injured and seven others less seriously injured, while the property damage was large.

(217) — The boiler of a locomotive exploded June 15th, on the Baltimore and Ohio Southwestern Railway, at Otisco, Ind. Two men were severely scalded.

(218) — A tube ruptured June 16th, in a water tube boiler at the plant of the Commonwealth Edison Company, Chicago, Ill.

(219) — A tube ruptured June 13th, in a water tube boiler at the plant of the United States Gypsum Company, Oakfield, N. Y.

(220) — A circulating tube failed in a water tube boiler at the plant of the Peckham Coal & Ice Company, Dayton, Ohio, on June 19th.

(221) — A boiler ruptured June 21st, at the plant of the Kinne Laundry Company, Buffalo, N. Y.

(222) — On June 22nd, a tube ruptured in a water tube boiler at the plant of the Baker Rauch & Lang Company, Cleveland, Ohio. One man was injured.

(223) — On June 25th, the crown sheet of the boiler of a logging locomotive collapsed at the operation of the Booth-Kelley Lumber Company, Wendling, Oregon.

(224) — Two tubes failed June 26th, in a water tube boiler at the Central Illinois Public Service Company's Plant of the Middle West Utilities Company at Mounds, Illinois.

(225) — A boiler ruptured June 25th, at the plant of the Taylorville Ice and Utility Company, Taylorville, Illinois.

(226) — Two tubes ruptured June 29th, in a water tube boiler at the plant of the LaFayette Box, Board and Paper Company, LaFayette, Ind. One man was injured.

(227) — A boiler exploded June 26th, at the plant of the Alton Lumber Company, at Shelbyville, West Virginia. Two men were instantly killed and two others seriously injured.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1918.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash on hand and in course of transmission, ...		$404,341.76
Premiums in course of collection, ...		414,595.11
Real Estate, ...		90,000.00
Loaned on bond and mortgage, ...		1,544,400.00
Stocks and bonds, market value, ...		4,601,456.00
Interest accrued, ...		104,020.74
		$7,158,813.61
Less value of Special Deposits over Liability requirements,		32,229.37
Total assets, ...		$7,126,584.24

LIABILITIES.

Premium Reserve, ...		$3,013,990.80
Losses unadjusted, ...		122,761.60
Commissions and brokerage, ...		82,919.03
Other liabilities (taxes accrued, etc.), ...		251,117.95
Capital Stock, ...	$2,000,000.00	
Surplus over all liabilities, ...	1,655,794.86	
Surplus as regards Policy-holders, . .	**$3,655,794.86**	3,655,794.86
Total liabilities, ...		$7,126,584.24

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

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BALTIMORE, Md., . . 13-14-15 Abell Bldg. . .	Lawford & McKim, General Agents. R. E. Munro, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq., Cor. Water St.	C. E. Roberts, Manager. Ward I. Cornell, Ass't Manager. Charles D. Noyes, Chief Inspector.
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CLEVELAND, Ohio, . . Leader Bldg. . . .	H. A. Baumhart, Manager and Chief Inspector. L. T. Gregg, Ass't Chief Inspector.
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NEW ORLEANS, La., . 833-835 Gravier St. . .	Peter F. Pescud, General Agent. R. T. Burwell, Chief Inspector.
NEW YORK, N. Y., . . 100 William St. . .	C. C. Gardiner, Manager. Joseph H. McNeill, Chief Inspector. A. E. Bonnet, Assistant Chief Inspector.
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PORTLAND, Ore., . . 306 Yeon Bldg. . . .	McCargar, Bates & Lively, General Agents. C. B. Paddock, Chief Inspector.
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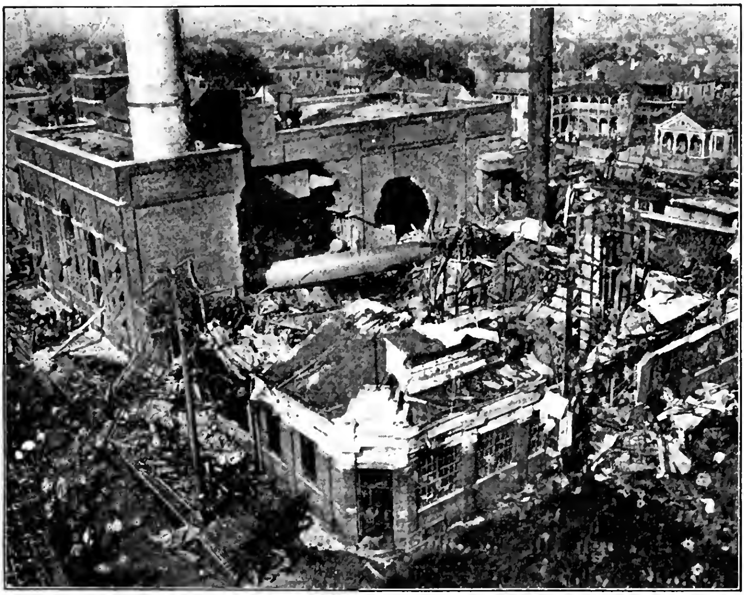
The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

Vol. XXXII. HARTFORD, CONN., APRIL, 1919. No. 6.



Boiler Explosion at Mobile, Ala.

The Boiler Explosion at Mobile, Ala.

About 8.20 P. M. on Friday, February 21st, a very violent boiler explosion occurred at the plant of the Mobile Electric Co., Mobile, Ala. Two boilers of different makes were concerned with the explosion; both boilers were of the water-tube type — one being a Heine and one a Stirling. Four persons were killed by the explosion, three outright at the time of the accident, and a fourth injured, whose death subsequently resulted. The explosion was followed by a fire which caused still further damage to the wrecked plant.

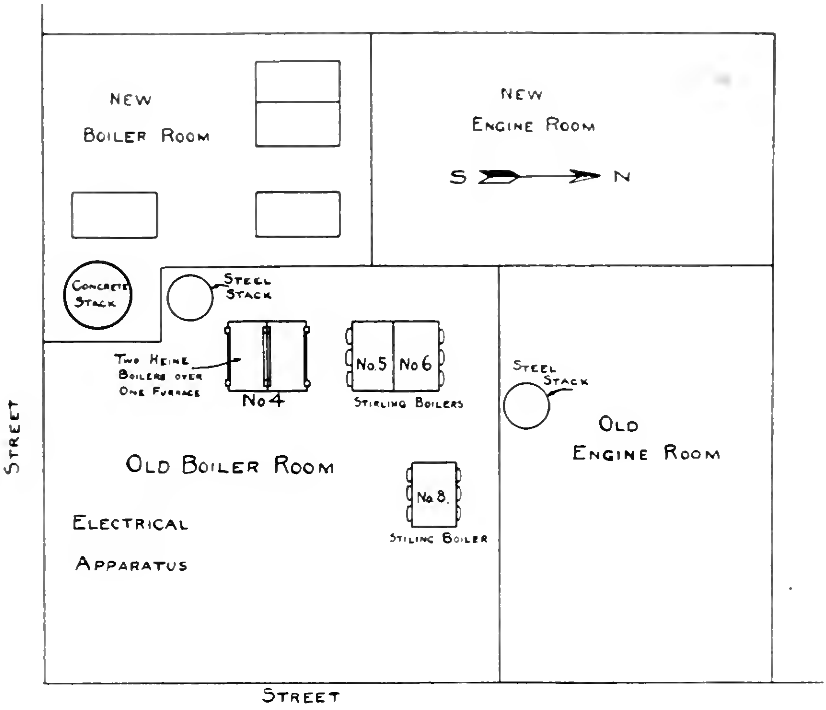
EXTENT OF THE DAMAGE.

As will be seen by the cut on the front page, the destruction of the portion of the plant, which was known as the old plant, was very complete. A heavy building wall running from north to south, dividing the old plant from the new, was a great factor in preventing more serious damage to the new plant. The equipment in the new plant was very little damaged and was made serviceable in comparatively a short time after the accident. The only point about this explosion which seems to be in doubt is the sequence of events in regard to the explosion of the two boilers. The pressure, as indicated by the recording gauge, was 161 lbs. and all boilers in the old plant were connected to the line at the time of the accident.

BOILER ARRANGEMENT.

There were two Heine boilers and three Stirling boilers located in the old plant. The two Heine boilers were set over one furnace and their steam spaces were connected together without intervening valves, but the water spaces were not connected and were separate and distinct. Each of the Heine boilers was provided with a water column, so that as far as water level was concerned they were operated as two separate boilers. Two of the Stirling boilers, Numbers 5 and 6, were set in a battery with a passage-way between this battery and the Heine boilers. The third Stirling boiler was set opposite the battery of two Stirlings, all of these boilers being connected through the medium of a steam header. The accompanying outline plan of the equipment, Figure 1, will show the location of the various units.

The boilers which exploded were the north boiler of the Heine unit No. 4 and the north Stirling boiler shown as No. 6. As will be seen by the diagram there was a No. 5 Stirling boiler located



Mobile Electric Company.

Fig. 1.

between these two, and it is understood that this boiler remained practically intact, although both Nos. 5 and 6 boilers were said to have been moved towards the north by the force of the explosion.

CONDITION OF THE EXPLODED BOILERS.

The Heine boiler, as far as the appearance of the parts shown after the explosion, seemed to be in good condition. The closed head on the mud drum of the Stirling boiler numbered 6, which was on the south side of this boiler next to number 5, was very seriously corroded; in fact, the lower half of the head on this boiler was reduced to approximately 3/16 inch in thickness. It appears that on this account the Government experts and others who examined the ruins decided that the Stirling boiler was the initial cause of the accident, and that the Heine boiler had exploded due to shock produced by the explosion of the Stirling. Notwithstanding this there are several reasons which seem to show that the

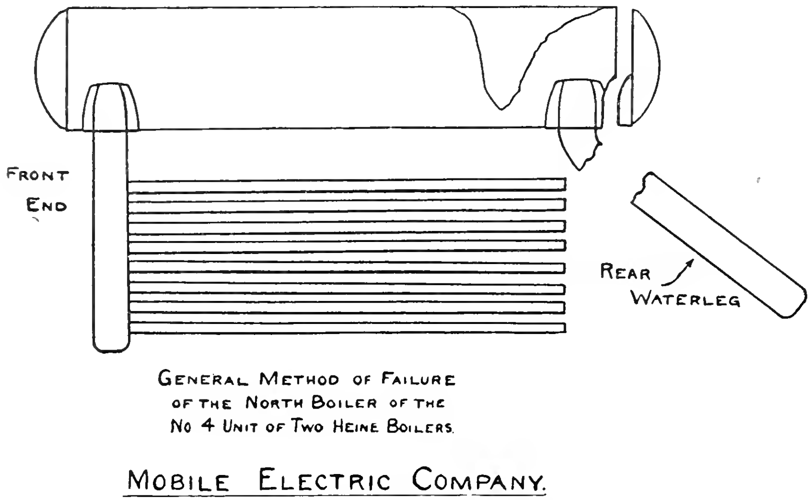


FIG. 2. METHOD OF FAILURE OF HEINE BOILER.

reverse of the above assumption was actually true. Almost the entire exploded Heine boiler — with the exception of the rear water leg and steam drum head — was blown forward to the east, while the bottom portion of the rear water leg, including all the material below the top row of tubes and the rear steam drum head, was blown backwards against the new boiler-house. Great force was exerted by this part of the explosion, as will be seen by the condition of the division walls in the vicinity, and the fact that a B. & W. boiler in the new boiler-house on the opposite side of the division wall, which was idle and undergoing repairs at the time, was moved on its foundation about 8 inches to the west.

PROBABLE MANNER OF FAILURE.

In separating from the drum it appeared clearly evident from the manner in which the header sheets of the Heine boiler were bent that this rear water leg parted from the boiler before the head was torn from the drum, or the drum itself disrupted. This would seem to indicate that the initial disturbance occurred in this rear water leg. Should the cause of this disturbance have been due to reaction caused by the breaking of the steam line, following an initial failure of the number 6 Stirling boiler, it would be natural to assume that the chief manifestations of water hammer action in the Heine boiler would likely have been near the front of the boiler rather than at the rear, because the steam connections from the Heine boilers were taken off very near the front head, and as is customary in this type, the drums are set at an angle with the horizontal so that the rear portion of the drum is entirely full of water. Any disruption of the steam line should have caused a rush of water to the front end which would naturally be expected to cause a disruption of the drum or header at this end.

Another significant fact pointing to the probability of the Heine boiler being the first to explode is that staybolt trouble had been experienced for sometime with these boilers, although at the time of the accident — so far as the operatives knew — no broken staybolts were in evidence. Another point of evidence to the same effect was that the head fireman, who was standing in the new boiler-house at the time of the explosion at a point where he could view the backs of the Heine boilers through an open door-way, stated that he saw the Heine boiler give way first. There must have been some appreciable time interval between the giving way of the water leg and the resulting explosion of the boiler, and such evidence of any eye witness should prove worthy of consideration.

POSSIBLE EXPLANATION OF THE SECOND EXPLOSION.

Assuming that the Heine boiler was the one to first explode, the resulting shock due to tearing down the steam lines, would without doubt have been sufficient to have caused the accident to the Stirling boiler in its weakened condition, or, as is more probable, from the positions of boilers numbers 5 and 6, the number 5 Stirling boiler may have been thrown against the number 6 boiler by the explosion of the Heine and have caused the defective head on the Stirling boiler to blow out. The drum head of the number 6 Stirling boiler was so weakened by corrosion that it could hardly have been expected to stand more than the direct load placed on it by the working pressure. This defective head separated entirely from the drum, parting in a line following the turn of the flange on the head.

Considering the location of this plant — almost in the heart of the City of Mobile — and the large amount of material projected on the adjacent streets at the time of the accident, it seems miraculous that no one outside the plant was killed or injured. The property damage caused by both the explosion and the fire was very heavy.

It was doubtful, in the opinion of our representative, who viewed these ruins, whether $100,000 would replace the damage caused by the explosion.

Flue Gas Analysis.

In the last issue of The Locomotive we tried to show what value the fireman could derive from the use of draft gages, and what the draft gage reading means. It is perhaps equally desirable to try and show what advantages can be derived from gas analyzing apparatus.

We shall not try to explain how gas analyses are made, nor to discuss the relative merits of different kinds of equipment in detail, but rather to discuss the general desirability and usefulness of gas analysis apparatus. To do this intelligently we must begin at the beginning, even at the expense of repeating much that has rather recently appeared in these columns.

THREE ESSENTIALS FOR COMBUSTION.

In order to burn coal three things are necessary. First, there must be coal. Second, air, and third a temperature high enough to ignite or kindle the coal. Moreover these three things must be brought together all at the same time. This undoubtedly seems so clearly obvious that it is almost absurd to waste the time and space required to state it. However, we shall attempt to show that there is a good deal of honest effort expended in trying to secure combustion with some one of these vital things missing.

HOW FURNACE GASES BURN.

The first thing which happens when coal is placed on top of a hot fire is for the coal to begin to be heated up to a temperature as high as that of the fire. When coal is heated, gases are driven off. These gases are combustible, they are indeed the same as the gases driven off when coal is heated in an iron retort to make illuminating gas. The gases driven off when the coal is first heated by being thrown on a hot fire, will or at least should, meet a stream of air flowing in through the openings in the fire door. The stream of gas and the stream of air mix or at least should mix, and, tumbling about in the furnace together, the gases will be lighted or at least should be lighted, by contact with the flame and hot fire bed or hot brickwork. Then this seething mass of flaming gas and air, still mixing and burning rolls and tumbles over the bridge wall, and gradually all the gas is burned up and only the hot air and the gases, no longer combustible, left from the burning of the coal, pass over or through the boiler tubes and so up to the chimney. Meanwhile the heat generated by the burning of the stream of gas, mixed with the stream of air, has been in some degree absorbed by the boiler, so that the combustion products, as we call what is left after this burning, enter the chimney greatly cooled. We have not forgotten the shovelful of coal, but merely left it for a moment to follow the somewhat more interesting gas which was driven off by the heat of the furnace. When the gas is driven from the coal in the iron retort of a coal gas plant or from the coal in a coke oven, or for that matter from wood in a charcoal pit, there is left a solid carbonaceous material which is a fuel. This is frequently coke and in the case of wood it is charcoal. Anthracite coal has so little combustible gas to give off on heating that it is practically all of it in somewhat this form.

THE BURNING OF THE FIXED CARBON.

Chemists have called what is left after the preliminary heating of coal, fixed carbon, that is carbon which is not made into gas fuel by merely heating it. So coke, charcoal and anthracite coal are largely composed of fixed carbon. Fixed carbon is combustible but it burns on the grate and not up in the space over the grate. Air is needed to burn fixed carbon too, but this air has to get to the fuel bed through the grate, from the ash pit, at least in the simple hand fired furnace. This air passes through the openings between the different lumps and particles of the solid fuel in thin streams. These are lighted by the other lumps and particles already burning, and so the fixed carbon burns with a bright incandescent glow, but with little if any flame, on the grates. When all the gas fuel, frequently called by chemists volatile matter, and all the fixed carbon, have burned completely, there is still left on the grates whatever earthy or mineral impurities there were in the shovelful of coal which were not capable of burning. This is ash. If the ash gets hot enough to melt, as it lies in and under the bed of burning fuel, it will stick other unmelted ash and pieces of rock or slate which may have been present with the coal, into a sort of hard concrete, which we call clinker.

INCOMPLETE BURNING MEANS WASTE.

Coal is burned under boilers to produce heat, and for no other purpose. Therefore, since we must pay rather dearly for the coal we want to burn all of it. Also, we have to pay for all of the coal, no matter whether it becomes gas or remains as coke or as we say, fixed carbon, when placed in the furnace. Hence we are just as much interested in burning all the gas as we are in burning all the fixed carbon, because if any unburned gas which might have been burned in the furnace passes up chimney, we have paid for an amount of heat which got away without being developed and so could not be absorbed by the boiler. Unburned gas which goes up the stack, and unburned coal which goes through the grates into the ashpit are clearly wasted, and no argument or explanation is needed to show the fact. Unfortunately there are other wastes not quite so obvious, though just as costly.

HOW MUCH AIR IS NEEDED.

We have said that no fuel will burn without air. This is true. We have also said that the air for the solid or fixed carbon comes through the grates and that that for the combustible gases must come in over the fuel bed. We expressed a little doubt as to whether this air and these gases became thoroughly mixed and also as to whether the mixture was completely burned before it entered the passages through or over the boiler heating surface. For the reason that a failure to secure this mixing, and to get the burning completed before the gases pass over the heating surface is a frequent cause for waste. Clearly the higher the amount in percentage of gas which may come from a given coal, the more chance there will be for an incomplete mixing or burning of this gas. The reason why the gas and air mixture should be burned out before it strikes the boiler surface, is that the boiler surface is so much cooler than the gases that it is likely to extinguish the flame, then of course there will be no chance for this flame to be rekindled before the gas and air are swept out into the chimney and so wasted.

This is the reason why engineers are at present recommending much more room over the grates, between the fire bed and the boiler, so that both the rolling about and tumbling action which results in a good mixture of gas and air, and the flame or burning, may be surely accomplished before there is any chance of the relatively cool boiler cutting the thing short and wasting possible heat.

PROPER MIXING AND THE WEIGHT OF AIR NEEDED.

Let us now look at this thing from a slightly different angle. Air and coal unite at a high temperature. This is what we call burning or combustion. A pound of coal can unite with about twelve pounds of air. These are approximate figures, but near enough. If we could arrange so that our pound of coal and the twelve pounds of air could get so intimately mixed up that every last ultra microscopic scrap of coal came in contact with just its proper particles of air, and neither coal nor air escaped, we could get complete combustion in a furnace with just this theoretical smallest amount of air. Such a fire would be the hottest fire which coal and air are capable of producing.

POWDERED COAL.

If coal is powdered very fine, as fine as the best Portland cement, for example, and blown into the air in a cloud, thoroughly mixed with the air, then if this dust cloud can be burned before it settles out, you will get a very hot, very violent combustion, almost if not quite an explosion unless precautions are taken to prevent this, and you can completely burn your coal with very little more than the theoretical minimum amount of air, because of the thorough mixing. Pulverized coal has been used with excellent results for some purposes but it fails sometimes because the combustion is at so high a temperature, due to the small excess of air over the theoretical, that the furnace brickwork cannot withstand the destructive temperature attained. In practice when we burn coal not so pulverized, we must use more than twelve pounds of air per pound of coal, because we must have enough air around so that with imperfect mixing all the coal and gas get in contact with air and burn, even at the expense of having an excessive amount of air go through the furnace.

EXCESS AIR WASTEFUL.

The question at once arises, why is an excess of air harmful? It has just been said that we must burn all this coal to get all the heat we have paid for, also, it has further been said that more than the theoretical amount of air must be used if we want to make sure of getting all the coal burned unless the coal is powdered tremendously fine, and perfectly mixed in a cloud with the air. Why not always use a lot of air and settle this complete combustion thing once for all? The answer is that a pound of coal only makes so much heat. This heat is nearly all given up to the gases formed by the coal burning, and to the extra or additional air, not really used in combustion, which accompanies the gases formed by combustion through the boiler. Every pound of air which goes through the boiler furnace and up chimney as air, that is, which is not actually used to burn coal, goes up chimney hot. If the heat in a pound of coal is passed on to forty or fifty pounds of air and combustion products instead of to about thirteen pounds this forty or fifty pounds of stuff is naturally going to strike the boiler heating surface at a much lower temperature than the thirteen pounds would have had and so the boiler is going to absorb must less of the heat actually set free when the coal burned, because the rate of heat absorption depends on how much higher the temperature of the gases is than the temperature of the water in the boiler. Therefore we must always measure out to the coal, and pass through the boiler furnace, exactly as little air, beyond the necessary twelve pounds per pound of coal, as will in the particular boiler and furnace completely burn the coal and no more. Of course the less air we use and still get complete combustion, the hotter the furnace will be. It may be that in some cases we could use little enough air, securing also complete combustion so that the furnace could get way above the melting point of the ash and make not isolated clinkers, but a regular clinker concrete bed over the grates. This would not do at all, and in such a case we would have to be content with the least air per pound of coal that we could supply and not melt the ash. We are, however, not usually troubled in this way as we usually reach conditions of incomplete combustion due to poor firing, before the clinker trouble gets too serious, if good firing methods are used.

HOW TO MEASURE THE AIR SUPPLY.

All this long-winded description of what happens in a furnace, and of why air is used and how much is needed for combustion is preliminary to the real purpose of this article. The meat of the matter we are now going to discuss. Just above, we purposely said that we were going to measure out the least amount of air which could be used in a particular furnace, with a given coal. What means shall we use with which to measure it? In the first place, we will suppose that we have stopped up every crevice through which air might leak into the setting or filter through the brickwork, except the ash pit doors and the openings in the fire doors, through which we want the air to travel. Also, let us suppose that the fire is even in thickness and covers the grate completely. We have shut all the holes in the ball ground fence, so to speak and every one must come in through the regular entrance. The air flow through the furnace can be controlled by the damper but how is it to be measured, especially as we are concerned in getting a certain number of pounds of air in for each pound of coal. Air is invisible stuff, hard to visualize and harder to weigh, how then are we to get at the facts?

USE OF GAS ANALYZING APPARATUS.

This is the purpose and the function of gas analyzing apparatus. When coal burns in air completely, there is left a gas called carbon dioxide, or CO_2 in the shorthand or symbolic notation of the the chemists. This symbolic notation merely indicates that the gas is formed when two particles or atoms of oxygen unite with one atom of carbon. Now the amount of oxygen in the air is well-known. About one-fifth of the air by volume is oxygen. If combustion was complete and there was no excess of air over the theoretical amount, then instead of the original one-fifth oxygen, the gas which would come away from the boilers would be a mixture of CO_2, and what was left of the air after the oxygen was all removed. As it so happens that the volume of the CO_2 is just exactly the same as the volume of the oxygen which enters into its composition, if air contains 20% of oxygen by volume, then when this air has had all its oxygen turned into CO_2, there would be 20% of CO_2 by volume. If only part of the air was used in burning the coal then there would be less than this 20% of CO_2 by volume and so if we can find what percentage of the flue gas is composed of CO_2, we could tell something about how much air we were passing through the furnace per pound of coal. There is another kind of gas which may be formed when coal burns in a limited amount of air. This gas represents a partial union of carbon and oxygen, one part of carbon to one part of oxygen or CO called carbon monoxide. This gas is a fuel, and if it has a chance it will burn to CO_2, and give off a lot of heat in doing it. A pound of pure carbon gives off about 14600 heat units when it is completely burned to CO_2. When it is only partly burned to CO, it only gives off 4450 heat units. Therefore, every pound of coal which only burns to CO wastes 10150 heat units which would be saved if the CO was burned to CO_2 in the space between the fire bed and the boiler. We must then be careful to get enough air so that there is no CO in the flue gas. Usually this will be true, that is, CO is not frequently found as we practically always need to use less, instead of more air to get better results. So a gas analyzing outfit, tells what sort of gas is leaving the boiler, and by seeing how much of this gas is CO_2, we can tell how much extra air went in outside of what was needed.

FORMS OF GAS ANALYZERS.

Gas analyzing apparatus comes in various forms and for various uses. It may be divided into two general classes. The portable hand outfit and the recording affairs. The portable outfits are usually capable of determining the amount of CO_2 in a sample of gas and also the amount if any of CO and of oxygen. The recording outfit works automatically, and determines CO_2 only. Perhaps the best way of showing those limitations and advantages of the two classes which determine the sort of equipment that would be chosen for any plant, is to show what, in a general way, each sort can be made to do. We shall, of course, avoid any detailed description of differences between the apparatus of different makers for we have no desire to express a preference. However, we believe that a disinterested statement of what may be expected from both hand and recording equipment would be of service to plant owners in choosing the class of equipment which they need in their particular plant.

USE OF THE HAND OUTFIT.

The hand outfit can be used for the rapid testing of samples of gas as they are drawn from the boiler uptake. If, as often happens, only CO_2 determinations are needed, the hand outfit can be used to quickly check up on what happens when the damper is opened or closed, what is the result of spreading coal in one way or in another, how much excess air comes through a particular hole in the fire, how long can a fire door remain open a crack, after firing without letting in any unnecessary excess of air, how much air can be shut out of the boiler by pointing up particular cracks, etc., etc. In other words the hand outfit is just what its name implies, a quick easy method of checking the combustion results following any sort of change in condition which you may wish to study. It also can be used on any boiler, provided each boiler has a sampling connection, and quickly changed from boiler to boiler. So far we have only considered the analyzing of individual samples, quickly drawn from the flue and tested. This is the principle field for this apparatus. However, you may wish to compare firemen. You may desire to see if one man on one boiler is better or worse than another man on another boiler. Considerable headway can be made with this question, by rigging up an outfit to slowly and evenly draw a small amount of gas from any boiler flue over a period of several hours. If the gas is drawn uniformly over, say eight hours, then the sample in the collecting bottle or tank should be a fair average of the gas which left the boiler during that time. This gas sample can be analyzed by the hand outfit and an average gas composition obtained by checking the relative performance of two boilers or two firemen or of the same boiler and firemen on different days. The success of this method depends on two very important factors. In the first place, the collector must be arranged to fill at a really constant rate, and not start fast and taper off to very slow at the end of the run. Also, the sample tube must be placed in the uptake where it will reach the center of the gas flow and get an average sample. The question of where to locate a sample connection will not be covered here, but any of our assured who desire advice on this subject can obtain assistance by writing our Engineering Department, at Hartford, and describing their boilers, settings and flue layout. From what has been said above, it will be seen that the portable or hand analyzer is the sort of outfit to use in setting draft gages and checking firing methods and air leaks.

THE FIELD FOR RECORDERS.

The recording equipment draws samples of gas from the boiler setting, and analyzes them automatically, either at definite periods. that is one sample every five or seven or ten minutes, as the case may be or else continuously. The results of these automatic analyzers are recorded on a clock driven chart. They have the great advantage over collecting an average sample, and making one analysis to get an average over several hours,— that they show whether the fireman was tending to his knitting and keeping the combustion condition as steady as possible, or whether he ran an excessively high amount of CO_2 for part of the time and let things go about as they chose the rest of the day. This latter course might result in the same average, but would not by any means represent the same economy. As an instrument for producing permanent and reliable records for study and comparison, day by day and month by month, the automatic apparatus is the thing. On the other hand all the automatic outfits, though to differing degrees, suffer in one way by comparison with the portable machines. That is the time which elapses between the taking of a sample and the recording of the analysis of that sample. There is always a lag, of course, even in the hand equipment. Some of the automatic devices announce their results much nearer the time when the sample was taken than others, but on the whole, the hand outfit can get there first and so is best adapted to studying changing condition with a view to determining what draft to carry or what effect changes in the firing methods, or fire conditions will produce. As a matter of permanent record for study alongside records of coal burned, water evaporated, and so on, the matter of lag is of no consequence and so should not be held up unfairly against the automatics. Also some recording machines are equipped with an indicator which is supposed to be sufficiently free from lag to show the firemen at a glance just what happens when he does certain things. This indication is, of course, the more valuable, the less the lag.

COSTS.

Finally, there is a question of price. As a class, hand outfits are cheap and recording outfits are expensive. Hence, it is a matter of choosing which equipment is best for a particular plant taking account of all the above limitations as well as the matter of price. One last consideration is perhaps not unimportant. After an automatic recorder is set up and working, it is free from the personal equation, and does not need skill to operate it. This cannot be said for the hand outfit, for while its operation is simple, intelligence and some experience are needed if it is to be relied on. On the other hand, the hand outfit ought to be used now and then to check up on the accuracy of the recorders, and see if they are properly adjusted.

ANY INSTRUMENT IS WORTHLESS IF UNUSED.

In closing we cannot avoid a word of warning that no instrument for use in a boiler room is earning a return on the investment it represents when it is reposing in a plush lined case on a shelf in the closet.

These instruments are useful because they show up vital and important conditions, which cannot be observed or realized in any other way. No fireman is skilled enough to tell what fire thickness, and what damper setting, or what interval between firing, which is another way of saying how much coal he should fire at one time. will actually get best results from a given boiler at a given load and with a given coal. A good fireman can do better than a poor one, of course. He knows the sort of changes in the usual methods of doing his work which have been shown to save coal, but no one can tell with his eyes or his ears, or his sense of taste, or smell or touch, when there is the very best state of combustion going on in a boiler. Nor can one tell from moment to moment just what is taking place on his grate, unless he keeps the fire doors open about all the time. It is the purpose of draft gages and flue gas analyzers to supply this defect and make visible and appreciable these subtle rapid changes that take place, so that the good fireman can maintain, if he will, conditions closely approaching the best all the time, and also these same instruments enable the chief engineer or whoever is responsible for supervising the work of the firemen, to make sure that he does keep up to the best conditions. In addition to this, they tell how good or how bad that best condition is, and serve as a basis for re-arranging the equipment, so that the possible economy of the plant may be raised. But as we said above, there is not much credit in owning, for example, a hand gas testing outfit, a fine flue gas thermometer and a draft gage, which are carefully stored in plush lined cases in a closet, when the three boilers in the plant are fired by methods approaching the worst, and the best percentage of CO_2 is around 7%, indicating almost three times the theoretical amount of air per pound of coal fired. One and one-half times or 18 lbs. of air per pound of coal is not at all impossible of attainment with the sort of equipment installed in the plant which the writer has in mind.

Since writing the above article it has been suggested that two points which would have added to its value have been left out, and, therefore, these paragraphs are added in the way of an appendix to complete the story.

SMOKE VS. ECONOMY.

The first of these points has to do with the relation of a smoky stack to efficiency. A smoky stack is an indication of incomplete combustion due to either too little air at the time when volatile matter is being distilled from the coal, or to an imperfect mixing of the volatile and air, without sufficient room for burning the volatile matter or perhaps most generally to a combination of all of these things. Such conditions of course, mean that fuel is being wasted. Why then can we not say that a smoky stack indicates poor combustion and that cleaning up the stack is proof that combustion conditions have been set right? This is a fallacy which is unfortunately strongly believed by many laymen and a few engineers. The trouble is just that which we have tried so hard to make clear in our article, namely — that you can get complete combustion easily if you pass through the setting a large excess of air and by the same token you can eliminate smoke with a large excess of air. Many, but not all smokeless furnace devices succeed only when there is a tremendous excess of air, with a loss of efficiency, measured in terms of the efficiency when smoke was made, which if it were known by the man who buys the coal should be startling. Smokeless conditions, of course, can be attained without waste due to excessive quantities of air by making a furnace on sound principles of combustion and operating it by equally sound methods. However, a stack which is not black with smoke nor yet perfectly clear, that is a stack showing a slight haze is in general an indication of the best combustion conditions. On the other hand the gas analyzing apparatus and not the appearance of the stack must be relied upon for this information.

WHAT CO_2 MEANS IN COAL SAVING.

The other point overlooked was a statement of the amount of saving which can be expected when an improvement is made in the quantity of CO_2 in the gases. We wish to emphasize the fact that the ordinary improvements easily had by anyone with almost any kind of setting, if it is tight, will make the greatest showing. The closer you approach the ideal, the less gain in economy for each additional percent. of CO_2. Therefore, do not despair because you think your condition will not permit you to realize 12 to 16 per cent. of CO_2. If you can gain 4 or 5% up to say 8 or 10% total, you will make a good big saving, and the added 2 to 4% possible above this while worth while, but more difficult to attain should not bar anyone from making the large improvements easily within their reach.

The improvements in coal economy to be expected are about as follows: If you have only 2% CO_2 and increase it to 6% you will save 57% of your coal. Raising the CO_2 from 6% to 10%, will save 12% more coal, while a further CO_2 increase from 10% to 16% will save 6% more fuel. A great many plants will show no more than 4% to 6% of CO_2 and for them 10% CO_2 is easily attained with no special expense. This, it will be seen is equivalent to a saving from 12 to 16% of the coal bill. Anyone can interpret that statement in dollars for his own particular plant.

The Metric System.

Nearly every issue of The Locomotive contains a brief note of a little volume published and offered for sale by The Hartford Steam Boiler Inspection and Insurance Company entitled The Metric System.

This little book size 3½ by 5¾ inches contains 196 pages, devoted to a history of the metric system, a discussion of the sources of information and the data used in the compilation of the tables. and finally, comprising by far the greater part of the work, to a set of exceedingly convenient tables for the conversion of quantities in any of the English units to their metric equivalents, and vice versa. No conversion tables have appeared more convenient than these for ready and quick reference and we feel sure that any one not familiar with the book who has occasion to convert from English to metric, or metric to English measure would be surprised at the saving in time gained by its use.

This little book is to be had bound in sheepskin by addressing The Hartford Steam Boiler Inspection and Insurance Company. Hartford, Connecticut, inclosing $1.25.

Summary of the Work of the Inspection Department for the Year 1918.

As is customary at this time of the year we are printing on the following pages our summary of the work of our Inspection Department, the details of which will be found fully displayed in the accompanying tables. There is little upon which to comment in this statement as nearly all the figures are usual. Our inspectors, as will be seen, examined during the last year 391,674 boilers in which they found 194,849 defects of which 21,847 were dangerous. It is perhaps important and certainly should cause our assured to feel that the Hartford Inspection Service is of real value to them, to note that in one particular the defects found and reported were greatly in excess of the usual number. We refer to the item "Settings Defective." It will be found that nearly 10,000 settings were reported defective in 1918, of which 828 were considered dangerous. Our readers should bear in mind that ordinarily a boiler inspector does not report a setting as dangerous, or as defective unless that defect carries with it an element of danger to the safety of the boiler. However, during the year 1918 boiler inspectors were working in conjunction with the efforts of the U. S. Fuel Administration and therefore they viewed settings not only from the safety standpoint, but from the standpoint of economy as well. In normal times we expect to have about 1,000 settings reported defective, of which perhaps 800 will be reported as dangerous. It will be seen that there are roughly ten times as many settings which are defective from the standpoint of economy as would normally be considered defective from the standpoint of safety. This surely should interest our assured and should show them to a slight extent, the efforts which our inspectors made to diminish their coal bill last year.

Summary of Inspectors' Work for 1918.

Number of visits of inspection made	205,351
Total number of boilers examined	391,674
Number inspected internally	151,659
Number tested by hydrostatic pressure	8,233
Number of boilers found to be uninsurable	896
Number of shop boilers inspected	6,889
Number of fly wheels inspected	19,434
Number of premises where pipe lines were inspected	6,741

Summary of Defects Discovered.

Nature of Defects	Whole Number.	Dangerous.
Cases of sediment or loose scale	30,597	1,952
Cases of adhering scale	48,026	2,073
Cases of grooving	2,389	246
Cases of internal corrosion	19,073	807
Cases of external corrosion	11,047	870
Cases of defective bracing	943	217
Cases of defective staybolting	2,337	523
Settings defective	9,890	828
Fractured plates and heads	3,375	594
Burned plates	5,026	615
Laminated plates	285	37
Cases of defective riveting	1,297	217
Cases of leakage around tubes	13,386	2,631
Cases of defective tubes or flues	17,578	5,339
Cases of leakage at seams	5,656	473
Water gages defective	3,906	821
Blow-offs defective	5,132	1,555
Cases of low water	465	172
Safety-valves overloaded	1,063	319
Safety-valves defective	1,796	377
Pressure gages defective	6,980	558
Boilers without pressure gages	526	102
Miscellaneous defects	4,076	521
Total	194,849	21,847

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1919.

Visits of inspection made	4,529,682
Whole number of inspections (both internal and external)	9,017,918
Complete internal inspections	3,534,788
Boilers tested by hydrostatic pressure	358,070
Total number of boilers condemned	26,797
Total number of defects discovered	5,082,545
Total number of dangerous defects discovered	560,017

SUMMARY OF INSPECTORS' WORK SINCE 1870.

Year.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1876	16,409	34,275	10,669	2,150	16,273	4,275	89
1877	16,204	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597
1894	94,982	191,932	79,000	7,686	135,021	13,753	595
1895	98,349	199,096	76,744	8,373	144,857	14,556	799
1896	102,911	205,957	78,118	8,187	143,217	12,988	663
1897	105,062	206,657	76,770	7,870	131,192	11,775	588
1898	106,128	208,990	78,349	8,713	130,743	11,727	603
1899	112,464	221,706	85,804	9,371	157,804	12,800	779
1900	122,811	234,805	92,526	10,191	177,113	12,862	782
1901	134,027	254,927	99,885	11,507	187,847	12,614	950
1902	142,006	264,708	105,675	11,726	145,489	13,032	1,004
1903	153,951	293,122	116,643	12,232	147,707	12,304	933
1904	159,553	299,436	117,366	12,971	154,282	13,390	883
1905	159,561	291,041	116,762	13,266	155,024	14,209	753
1906	159,133	292,977	120,416	13,250	157,462	15,116	690
1907	163,648	308,571	124,610	13,799	159,283	17,345	700
1908	167,951	317,537	124,990	10,449	151,359	15,878	572
1909	174,872	342,136	136,682	12,563	169,356	16,385	642
1910	177,946	347,255	138,900	12,779	169,202	16,746	625
1911	180,842	352,674	140,896	12,724	164,713	17,410	653
1912	183,519	337,178	132,984	8,024	164,924	18,932	977
1913	192,569	357,767	144,601	8,777	179,747	21,339	832
1914	198,431	368,788	145,871	8,239	190,882	23,012	756
1915	199,921	373,269	140,002	7,998	178,992	22,077	790
1916	204,863	386,245	146,971	8,273	184,635	19,219	926
1917	215,625	389,410	153 778	8,674	180,301	2[illegible],552	1,011
1918	205,351	391,674	151,659	8,233	194,849	21,847	806

The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

C. C. Perry, Editor.

HARTFORD, APRIL, 1919.

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.

Announcement.

During the past two years the Hartford Steam Boiler Inspection & Insurance Company has endeavored through the columns of the " Locomotive " to furnish its assured with information about firing methods and fuel economy which might be of direct service to them in saving coal. We feel that this effort has in some measure succeeded. Many of the Locomotive articles have been gathered together into a little booklet entitled " Economy Hints " for which there has been a brisk demand.

We believe, however, that the fireman is the most important element in coal saving. In many cases he does not do his work as well as he might merely because he has not been privileged to learn the simple fundamentals that underlie the reason for what he does.

Believing that our assured will be interested in an educational scheme for their firemen which will not only appeal to the fireman as a means of self-improvement but to his employer as well, since it directly affects his coal bill, we have prepared a simple correspondence course to cover the elementary principles of combustion, the methods of handling fires and producing steam in boilers. This course is offered to firemen through our assured.

It is planned to have each lesson go forward with a question sheet. When the questions have been answered and returned to us, they will be marked and sent back with helpful suggestions together with the next lesson and its question-sheet. This procedure will continue to the end of the course. The course is offered for the nominal sum of $5.00 and at its completion every successful student will receive a certificate, properly inscribed, stating that he has completed and passed the Hartford Steam Boiler Inspection & Insurance Company's correspondence course for firemen.

Columns Embedded in the Walls of Boiler Settings.

The trend of present day practice in supporting horizontal return tubular boilers is toward suspension from overhead beams, and away from the older form of lug support, resting on the setting walls. This of course is especially true of boilers in the larger sizes. We have always endorsed this method of support, and we do not desire to retract from this position. We do however wish to call the attention of boiler owners and engineers to one vital requirement in connection with the setting of suspended boilers, and that is the necessity of keeping the columns which carry the overhead beams from which the boilers are suspended outside the brickwork of the setting walls, so that they may not suffer from overheating. The usual plan is to have these columns entirely outside of the setting walls and completely exposed to the air. In some cases in order to meet conditions of limited space, a recess or chase has been left in the setting wall so that the column would be free from the wall, even though built into the recess. This plan is not so good as the arrangement which places the column quite outside the setting, but is possible when there seems no other way out, if provision is made so that a continuous circulation of air can be provided from the bottom to the top of this recess, along the whole length of the column, and of sufficient volume to keep the column cool.

EXAMPLES OF OVERHEATING.

When columns are solidly bricked up in the setting walls trouble is to be expected. We have on file photographs of steel I beam columns which were completely wasted away through overheating, at or near the level of the hottest zone of the fire. That is. just above the grate bars.

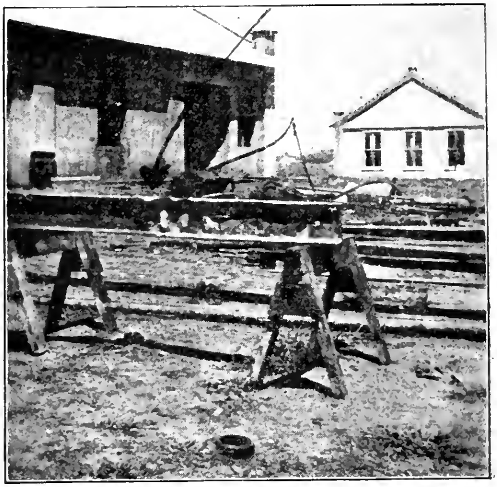


Fig. 1. The Crippled Column.

The accompanying photograph shows a somewhat similar condition. The beam, seen resting on horses in the photograph, is one which supported one end of a set of beams to carry two seventy-two inch horizontal return tubular boilers. It was a six-inch beam of usual section, and ten feet long. This beam was completely embedded in a twenty-four inch brick wall, and had been in service only eighteen months at the time when it was removed. The weakened condition of the beam was first discovered when a Hartford inspector noted that the boilers had settled to such an extent as to throw a severe strain on the pipe connections. The plant was shut down, the boilers cooled, and immediate steps taken to re-suspend and reset the boilers. The beam had been overheated for a short distance, at about the grate line of the setting which was some two feet above the foundation. The overheating had been so severe that the load imposed on the column by the weight of its share of the boilers had caused it to upset and buckle as shown in the photograph. The column was shortened six inches in its length of ten feet. Of course the stress imposed on the piping was very serious and it is a matter for congratulation that none of the connections parted while the boilers were under steam as a serious accident would have been likely as a result. The remedy, of course, as we pointed out at the beginning, is to put columns where they may be kept cool.

Fly-Wheel Explosions, 1917.

(26.) — A fly-wheel exploded November 14th, at the plant of The Cowin Company, Joliet, Illinois. One man was killed.

(27.) — A fly-wheel exploded December 29th, at the Fischer Ice Plant, Dubuque, Iowa. No one was injured, but property was damaged to the extent estimated at $1,000.00.

Fly-Wheel Explosions, 1918.

(1) — A fly-wheel exploded January 2nd, at the Municipal Electric Light Plant, Hawarden, Iowa. No one was injured, but property damage amounted to $4,000.00.

(2.) — A gear failed January 7th, at the plant of the Gutta Percha & Rubber Mfg. Co., Brooklyn, N. Y.

(3.) — On January 15th, a twelve foot fly-wheel exploded at the mine of the Logan Coal Company, Hanna City, Illinois.

(4.) — A pulley used on a Feed Cutter on the farm of William H. Stever. Bedminster, Pa., exploded about January 28th. Mr. Stever was seriously injured.

(5.) — A 35,000 K. W. steam turbine exploded January 31st, at the plant of The Boston Elevated Railway Company, South Boston, Mass. The property damage was estimated at an amount in excess of $250,000.

(6.) — On February 11th, a gear failed at the plant of the Gutta Percha & Rubber Mfg. Company, Brooklyn, New York.

(7.) — On February 15th, a fly-wheel burst at the White Tail Deer Mine, Bisbee, Arizona. One man was seriously injured.

(8.) — A 15-foot fly-wheel exploded February 27th, at the plant of the Connors-Weyman Steel Company, Helena, Ala. The property damage amounted to more than $3,000.00.

(9.) — On March 2nd, a band saw wheel exploded at the foundry of the E. J. Murray Mfg. Company, Wausau, Wisconsin. The wheel was being rotated at high speed, as a test and during this test exploded. It not only did damage to the plant in which it was being tested, but fragments of the wheel continued across the street to the factory of the J. M. Kuebler Company, broke through this building and damaged the boiler and heating system.

(10.) — An 8-foot wheel exploded April 20th, at the plant of the Newport Turpentine & Rosin Company, Bay Minnette, Ala.

(11.) — On May 3rd, a 25-foot wheel exploded in the engine room of the Sanitary Can Company's plant, Fairport, New York. One man was instantly killed.

(12.) — On May 11th, a fly-wheel of a turbo blower set exploded at the Sturtevant Blower Works, Hyde Park, Mass. The set was being tested at the time of the accident. Two men were killed and five others injured.

(13.) — On May 20th, an 18-foot fly-wheel exploded at the plant of Swift & Company, Union Stock Yards, Chicago, Ill.

(14.) — A fly-wheel exploded May 26th, at the Municipal Electric Light & Water plant of Clay Center, Kansas. One man was killed and property damage was estimated at $40,000.00.

(15.) — A fly-wheel 15 feet in diameter, which formed part of an ice machine, at the plant of the New South Brewing & Ice Company, Middlesborough, Ky., exploded June 11th. The property damage was estimated at between $3,000.00 and $3,500.00.

(16.) — On June 13th, a pulley failed at the plant of the Page Mfg. Company, New Bedford, Mass.

(17.) — A 10-foot fly-wheel exploded June 29th, at the plant of the Patent Vulcanite Roofing Company, Franklin, Ohio. Fragments of this wheel broke a five-inch steam pipe and struck the drum of a boiler under steam, but fortunately no boiler explosion resulted.

(18.) — On July 4th, a fly-wheel exploded at the Vandergrift, Pennsylvania plant of the American Sheet & Tin Plate Company. Five people were very slightly injured, which was considered a very fortunate escape in view of the large number of men employed in the neighborhood of the wheel at the time it exploded.

(19.) — A 10-foot wheel exploded July 7th, at the plant of the Rex Paper Company, Kalamazoo, Michigan.

(20.) — A large fly-wheel exploded July 10th, at the plant of the Southern California Iron & Steel Company, Los Angeles, Cal. Property damage was estimated at $50,000.00.

(21.) — A fly-wheel exploded July 12th, at the power house of the Eliza furnace of the Jones & Laughlin Steel Company, Pittsburgh, Pa.

(22.) — A 3-foot pulley exploded July 18th, at the plant of the Warrier-Pratt Coal Company, Porter, Ala.

(23.) — A fly-wheel exploded July 19th, at the Rubber Reclaiming Plant of the B. F. Goodrich Company, Kenmore, Ohio. One man was killed and one injured.

(24) — A fly-wheel exploded July 26th, at the power plant of the New Rockford Electric Light Company, New Rockford, N. D.

(25.) — A 35,000 K. W. steam turbine exploded January 30th, at the plant of the Commonwealth Edison Company, Chicago, Ill. The explosion was very violent and did a great deal of damage to the power plant, but fortunately no person was injured.

(26.) — On August 12th, a 12-foot fly-wheel exploded at the electric light station, of the Lakewood and Coast Electric Company, Lakewood, N. J. One man was injured.

(27.) — On August 21st, the fly-wheel of a concrete mixing machine exploded at Jersey City, New Jersey.

(28.) — On September 10th, a fly-wheel exploded on a high speed engine at the Princeton Coal Mine, Princeton, Ind.

(29.) — About September 10th, a fly-wheel exploded at the plant of the Chicago Coated Board Company, Chicago, Ill. One man was killed.

(30.) — On September 11th, an autogenously welded blower exploded at the plant of the Terry Steam Turbine Company, Hartford, Conn.

(31.) — On September 16th, a 12-foot fly-wheel exploded at the lumber mill of the Oregon-Pacific Lumber Company, at Astoria, Ore.

(32.) — On September 12th, the fly-wheel of a gas engine used for threshing exploded on the farm of L. C. Ridenaur, near Plentywood, Montana. One man was killed.

(33.) — The fly-wheel of an automobile exploded October 11th, at West Chester, Pa. Fortunately no one was injured.

(34.) — The fly-wheel of a threshing machine exploded October 21st, near Wawaka, Ind.

(35.) — A pulley exploded October 29th, at the plant of the Rhinelander Paper Company, Rhinelander, Wis.

(36.) — A fly-wheel exploded November 18th, at the plant of the North Western Lumber Company, Hoquian, Washington. One man was killed.

(37.) — A fly-wheel exploded December 8th, at the Wheat Ice Cream Company's plant, Akron, Ohio. One man was killed and one very seriously injured.

(38.) — On December 10th, a turbo generator exploded at the plant of the

Northern State Power Company, St. Paul, Minn. One man was killed, one man injured and property damage was done to the amount estimated at $35,000.

(39.) — A fly-wheel exploded December 15th, at the plant of the Ft. Wayne Corrugated Paper Company, Muncie, Ind.

FLY-WHEEL EXPLOSIONS, 1919.

(1.) — On January 11th, the fly-wheel of a railroad motor car exploded in the railway yard of the Illinois Central Road at Mattoon, Ill. One man was injured.

(2.) — On January 11th, a pulley failed at the plant of the Newport Turpentine & Rosin Company, Bay Minnette, Ala.

(3.) — A fly-wheel exploded January 18th, at the plant of the American Car & Foundry Company, St. Louis, Mo. Property damage was estimated at about $3,500.

(4.) — A fly-wheel exploded January 17th, on an engine at the Municipal Light & Water Plant of the City of McPherson, Kansas. The engine was just completing an acceptance test at the time of the explosion.

(5.) — A fly-wheel failed February 8th, at the plant of the West Virginia Pulp & Paper Company, at Tyrone, Pa.

(6.) — A fly-wheel exploded February 26th, at the plant of the St. John Lumber Company, Portland, Ore. Two men were rather seriously injured.

(7.) — A fly-wheel of a ditching machine exploded March 7th, near Markleville, Ind. One man was killed.

(8.) — On March 15th, the fly-wheel of an automobile exploded on 5th Street, Portland, Ore. Fragments of the wheel struck and ruined several plate glass windows. The damage was estimated at several thousand dollars.

(9.) — A fly-wheel exploded March 19th, at the plant of the Pascagoula Street Railway & Power Company, Pascagoula, Miss. One man was killed, one seriously injured, and property damage was estimated at $25,000.

Boiler Explosions.

JULY, 1918.

(228.) — The crown sheet of a railway locomotive, belonging to Perley & Crockett, Black Mountain, North Carolina, failed July 3rd. The locomotive was engaged in carrying a load of sightseers up the mountain. At the time of the accident the train was brought to rest, but as the hand brakes failed to hold, train and locomotive ran over a mile back down grade until the locomotive was derailed. From eight to ten persons were injured by the accident.

(229.) — A boiler used in connection with a pumping plant owned by A Melancon, of Crowley, Louisiana, exploded July 4th. One man was fatally injured, and the plant demolished.

(230.) — A boiler exploded on board government maneuver boat No. 1 at the foot of Tenth Street, Louisville, Ky., July 7th. The vessel was a complete loss, but no one was injured.

(231.) — On July 8th three men were killed and two seriously scalded by the explosion of a steam pipe in the fire room of Ann Arbor Car Ferry No. 5 at Frankfort, Michigan.

(232.) — The boiler of a Baltimore & Ohio Railway locomotive exploded July 9th, near Cumberland, Maryland. Three men were killed.

(233.) — Two tubes ruptured in a water tube boiler on July 10th at the

Southern Illinois Railway and Power Company plant, belonging to the Middle West Utilities Company, Harrisburg, Illinois.

(234.) — On July 10th a tube ruptured in a water tube boiler at the power plant of the Public Service Corporation of New Jersey, Newark, New Jersey.

(235.) — On July 13th a boiler exploded on the Spanish freight steamer Serantes. The accident resulted in the death of four men, and the serious injury of seven others, while the ship was nearly destroyed by fire.

(236.) — The crown sheet of a locomotive boiler owned by the Kirby Lumber Company, Houston, Texas, failed July 14th. Two men were injured.

(237.) — On July 14th a header cracked in a water tube boiler at the plant of the Ingersoll-Rand Company, Easton, Pa.

(238.) — A boiler ruptured July 15th at the operation of the Hanify Lumber Company, Raymond, Washington. Two men were injured.

(239.) — A tube ruptured July 17th in a water tube boiler at the plant of the Ætna Portland Cement Company, Fenton, Michigan.

(240.) — A boiler ruptured July 18th, at the creamery of Louis Kadans, Kelly Corners, New York.

(241.) — A tube failed in a boiler at the plant of the Herbrand Company, Freemont, Ohio, on July 18th. One man was killed and two others injured.

(242.) — The boiler of a threshing machine owned by Legrand Bros. exploded July 20th at Shelbina, Missouri.

(243.) — A tube ruptured in a water tube boiler July 23rd, at the Southern Illinois Railway and Power Company plant of the Middle West Utilities Company, Harrisburg, Illinois. One man was injured.

(244.) — A boiler exploded July 23rd, at an oil well at Plain Dealing, Louisiana. One man was badly scalded.

(245.) — An accident occurred to a water tube boiler on July 29th at the plant of the E. Z. Opener Bag Company, Braithwaite, Louisiana.

(246) — An ammonia tank exploded July 29th, at the meat market of Taylor & Routh, Logansport, Ind. Both the owners of the tank were seriously burned.

(247.) — A tube ruptured July 30th in a water tube boiler at the plant of the National Cash Register Company, Dayton, Ohio.

(248.) — On July 31st, a section cracked in a cast-iron sectional boiler in the building owned by Josephine M. & Louis Brown, Danvers, Mass.

August, 1918.

(249.) — An accident occurred August 1st, to a water tube boiler at the plant of the Montague Mfg. Company, Richmond, Va.

(250.) — A section cracked in a cast-iron sectional heating boiler on August 1st, at the Ferris Hotel, owned by the Stephenson Company, Rowlins, Wyoming.

(251.) — On August 2nd, two headers fractured in a water tube boiler at the plant of the Oliver Iron Mining Company, Tower, Minnesota.

(252.) — On August 2nd, a tube ruptured in a water tube boiler at the plant of the Michigan Alkali Company, Ford City, Michigan.

(253.) — A section cracked August 3rd, in a cast-iron sectional boiler at the Athletic Club of Philadelphia, Philadelphia, Pa.

(254.) —A tube ruptured August 3rd, in a water tube boiler at the plant of Armour & Company, Chicago, Ill. One man was injured.

(255) — A boiler exploded August 3rd at a small grist mill, at Moko, Arkansas. Two persons were killed and a third badly injured.

(256.) — An accident occurred August 6th to a water tube boiler at the plant of the Woodstock Iron & Steel Corp., Anniston, Ala.

(257.) — On August 7th a nozzle failed on a water tube boiler, at the plant of the Bemis Bros. Bag Company, St. Louis, Missouri.

(258.) — On August 7th, an accident occurred to a boiler at the plant of the Consumers Ice & Coal Company, Ocean City, New Jersey.

(259.) — A boiler ruptured August 7th, at the plant of the Bonham Ice Co., Bonham, Tex.

(260.) — A header cracked August 7th, in a water tube boiler at the Latter Day Saints Hospital, Salt Lake City, Utah.

(261.) — A tank exploded August 7th, at Magnolia, Maryland. One man was severely injured.

(262) — Two headers fractured August 9th, in a water tube boiler at the Houston Gas & Fuel Company plant of the United Gas and Electric Corp., Houston, Tex.

(263.) — A boiler ruptured August 10th at the Millenbach Bros. Company plant of the American Agricultural Chemical Company, Ecorse, Michigan.

(264.) — On August 12th, a section cracked in a cast-iron sectional boiler at the bakery of J. Makoff, Cleveland, Ohio.

(265.) — A tube collapsed August 3rd, in a fire tube boiler at the storage warehouse of Fred W. Morgan, Chicago, Ill.

(266.) — On August 14, a drier collapsed at the fertilizer plant of C. W. Swingle, Lincoln, Neb.

(267.) — A main steam pipe failed at the plant of the Crichton Lumber Company at Mobile, Ala., on August 15th.

(268.) — On August 15th, a flue collapsed in a boiler on pump boat No. 29 of the Pittsburgh Coal Company, Pittsburgh, Pa.

(269.) — A tube pulled from the tube sheet of a water tube boiler on August 16th, at the Camden coke plant of the Public Service Corporation of New Jersey, Camden, N. J.

(270.) — An ammonia tank exploded August 16th, at the packing house of Wilson & Company, Kansas City, Kansas. Two men were killed and others may have been seriously injured.

(271.) — The boiler of a threshing machine exploded August 19th, on the farm of Noel Willis, near Peggs, Okla. Three men were killed, and three seriously injured.

(272.) — An oxygen tank exploded August 19th, in the Capitol City Repair Garage, Austin, Tex. Two people were killed and three others seriously injured, while four more were less seriously injured.

(273.) — A tube ruptured August 20th in a water tube boiler at the plant of the Murphysboro Water Works, Electric Light & Gas Company, Murphysboro, Ill. One man was fatally injured.

(274.) — On August 21st, a section cracked in a cast-iron sectional heating boiler at the Parthenon Apartments, owned by Elizabeth J., Lortetta E., and Thomas J. Glynn, San Francisco, Cal.

(275.) — A tube reptured August 21st, in a water tube boiler at the plant of the Kellogg Toasted Corn Flakes Company, Battle Creek, Michigan.

(276.) — A boiler exploded August 22nd, at the plant of the Clarion Brick Company, St. Charles, Clarion Co., Pa. One man was killed and two others injured, one of them fatally.

(277.) — A boiler exploded August 23rd, in the home of Emil Schneider, Asbury Park, N. J.

(278.) — A section cracked August 26th, in a cast-iron sectional heating boiler at the University of Pittsburgh, Pittsburgh, Pa.

(279.) — The boiler of a traction engine exploded August 27th, near Mt. Eaton, Ohio. Two men were literally blown to pieces by the explosion.

(280.) — On August 28th, a boiler ruptured at the Great Northern Plating Works, Chicago, Ill.

(281.) — On August 29th, several headers cracked in a water tube boiler at the plant of the Vandergrift Electric Light & Power Company, Vandergrift, Pa.

(282.) — A tube failed August 29th, in a horizontal tubular boiler at the Sioux Valley Power Company, Canton, South Dakota.

(283.) — A blow-off pipe failed August 30th, at the Princeton Mill & Gin Company's plant, Princeton, Tex. One man was injured.

(284.) — A boiler exploded August 31st, aboard the tow boat Glen Cove, near Wallabout Canal, Brooklyn, N. Y. Four men were killed.

September, 1918.

(285.) — A tube ruptured in a water tube boiler September 1st, at the Massachusetts Mills in Georgia, Lindale, Georgia.

(286.) — On September 1st, an explosion occurred in the boiler room of the Stillwater Lumber Company's mill at Vader, Ore. Fire followed the explosion, doing a very large amount of damage to the mill.

(287.) — A boiler exploded September 3rd, at the plant of the Ralston Steel Car Co., East Columbus, Ohio. Two men were killed.

(288.) — A tube ruptured in a water tube boiler September 3rd, at the plant of the Northwestern Knitting Company, Minneapolis, Minn. One man was injured.

(289.) — A boiler exploded September 3rd, on derrick boat No. 2 operated by the Patton-Tully Transportation Company, in the Mississippi River, at Fox Island, 45 miles below Memphis, Tenn. Four men were killed and four hurt, while the derrick boat was wrecked and sunk.

(290.) — On September 4th, a crown sheet failed in a locomotive type boiler, at the plant of J. W. Dickson, Potosi, Miss. Four men were injured.

(291.) — A boiler ruptured September 4th, at the plant of the American Steel and Wire Company, Cleveland, Ohio.

(292.) — On September 5th, a header cracked in a water tube boiler at the plant of the Vandergrift Electric Light & Power Company, Vandergrift, Pa.

(293.) — On September 5th, the boiler of a Lehigh Valley locomotive exploded two miles west of Corfu, N. Y. Three persons were killed.

(294.) — A tube ruptured September 9th, in a water tube boiler at the power house of the United Light & Railways Company, Moline, Ill.

(295.) — A locomotive type boiler had its crown sheet dropped September 9th, at the yard of the Ship Construction & Trading Company, Stonington, Conn.

(296.) — On September 11th, a boiler exploded at a well of the Gulf Refining Co., near Gilliam, Louisiana. Four men were instantly killed.

(297.) — A tube ruptured September 12th, in a water tube boiler at the plant of the Pacific Gas & Electric Company, San Francisco, Cal. One man was fatally injured.

(298.) — A header fractured September 15th, in a water tube boiler at the plant of the Vandergrift Electric Light & Power Company, Vandergrift, Pa.

(299.) — Three sections cracked in a cast iron sectional heating boiler on September 16th, at the Elks Club building, at Sterling, Ill.

(300.) — On September 16th, a boiler exploded in the heading factory of W. B. Small, Corinth, Miss. Two men were killed.

(301.) — Two flues collapsed September 17th, in a boiler at the saw and fertilizer mill of Frank Lindsay, Norfolk, Va. One man was killed and three injured.

(302.) — A boiler exploded September 17th, at the Keystone Mills, Gulf Mills, Pa. Five men were injured.

(303.) — Four headers cracked September 18th, in a water tube boiler at Neuces Hotel, Corpus Christi, Tex.

(304.) — On September 19th, the boiler of a New York Central freight locomotive, exploded near Fonda, N. Y. Two men were killed and one injured, and the locomotive was badly wrecked.

(305.) — On September 20th, a blow-off pipe failed at the cold storage and fertilizer plant of the St. Lucie Products Co., Gosling Station, Fla. One man was injured.

(306.) — On September 20th, a tube ruptured in a water tube boiler at the New Essex Power Station, of the Public Service Corporation of New Jersey, Newark, N. J

(307.) — On September 21st, a small hot water heating boiler exploded in the cellar of engine house No. 2, Elizabeth, N. J. Two men were injured.

(308.) — A tube ruptured September 22nd, in a water tube boiler at the plant of the Dubuque Electric Company, Dubuque, Iowa.

(309.) — A tube burst September 22nd, in a boiler at the plant of the Rochester & Eastern Power Company, Rochester, N. Y. One man was injured.

(310.) — Four boilers exploded September 23rd, at the Rillton Mine of the Westmooreland Coal Company, Greensburg, Pa. One man was killed, one fatally injured, and two others are in a serious condition.

(311.) — A tube failed September 24th, in a water tube boiler at the plant of the Monumental Brewing Company, Highlandtown, Maryland.

(312.) — A section cracked in a cast-iron sectional boiler September 25th, at the Clinton National Bank, Clinton, Mo.

(313.) — On September 27th, a steam pipe failed at the plant of the Sharon Steel Hoop Company, Lowellville, Ohio.

(314.) — On September 28th, a tube ruptured and a header failed in a water tube boiler at the plant of Swift & Co., St. Joseph, Mo. Three persons were injured.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1919.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$361,295.49
Real estate		90,000.00
Mortgage and collateral loans		1,505,900.00
Bonds and stocks		5,121,486.85
Premiums in course of collection		654,112.42
Interest accrued		108,152.83
Total assets		$7,840,947.59

LIABILITIES.

Reserve for unearned premiums		$3,429,363.68
Reserve for losses		153,378.80
Reserve for taxes and other contingencies		367,147.68
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,891,057.43	
Surplus to Policy-holders,		**$3,891,057.43**
Total liabilities		$7,840,947.59

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS OF PROPERTY

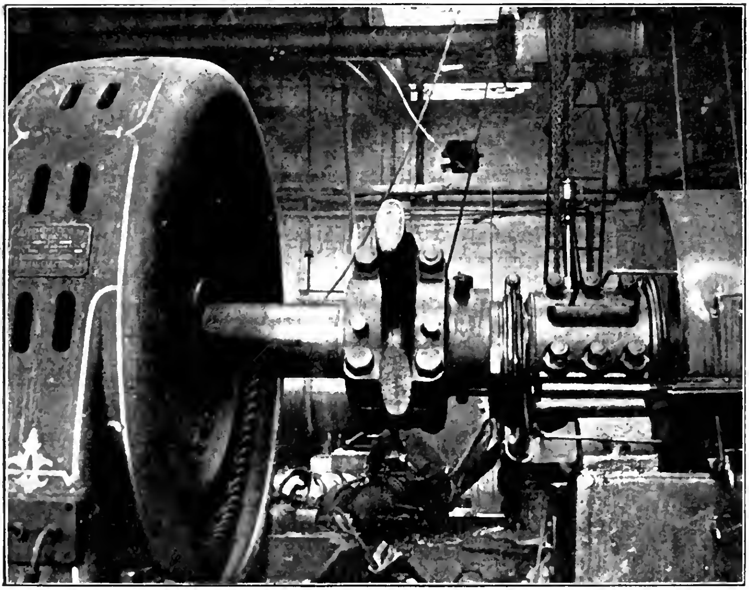
AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Department.	Representatives.
ATLANTA, Ga., 1314 Empire Bldg.	W. M. FRANCIS, Manager and Chief Inspector. C. R. SUMMERS, Ass't Chief Inspector
BALTIMORE, Md., 13-14-15 Abell Bldg.	LAWFORD & MCKIM, General Agents. R. E. MUNRO, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	C. E. ROBERTS, Manager. WARD I. CORNELL, Ass't Manager. CHARLES D. NOYES, Chief Inspector.
BRIDGEPORT, Ct., 404-405 City Savings Bank Bldg.	W. G. LINEBURGH & SON, General Agents E. MASON PARRY, Chief Inspector.
CHICAGO, Ill., 160 West Jackson St.	J. F. CRISWELL, Manager. P. M. MURRAY, Ass't Manager. JAMES L. FOORD, Chief Inspector. J. T. COLEMAN, Assistant Chief Inspector
CINCINNATI, Ohio, First National Bank Bldg	W. E. GLEASON, Manager. WALTER GERNER, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	H. A. BAUMHART, Manager and Chief Inspector. L. T. GREGG, Ass't Chief Inspector.
DENVER, Colo., 918-920 Gas & Electric Bldg.	THOS. E. SHEARS, General Agent and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. WILLIAMS, JR., General Agent. E. MASON PARRY, Chief Inspector.
NEW ORLEANS, La., 629-631 Common St.	PETER F. PESCUD, General Agent. R. T. BURWELL, Chief Inspector.
NEW YORK, N. Y., 100 William St.	C. C. GARDINER, Manager. JOSEPH H. MCNEILL, Chief Inspector. A. E. BONNET, Assistant Chief Inspector.
PHILADELPHIA, Pa., 142 South Fourth St.	A. S. WICKHAM, Manager. WM. J. FARRAN, Consulting Engineer. S. B. ADAMS, Chief Inspector.
PITTSBURGH, Pa., 1807-8-9 Arrott Bldg.	M. M. ATHERTON, Manager. J. A. SNYDER, Chief Inspector.
PORTLAND, Ore., 306 Yeon Bldg.	MCCARGAR, BATES & LIVELY, General Agents C. B. PADDOCK, Chief Inspector.
SAN FRANCISCO, Cal., 339-341 Sansome St.	H. R. MANN & CO., General Agents. J. B. WARNER, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	C. D. ASHCROFT, Manager. J. P. MORRISON, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. ROBERTS, President Boiler Inspection and Insurance Company of Canada.

The Locomotive
of
THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Vol. XXXII. HARTFORD, CONN., JULY, 1919. No. 7.



Fly-Wheel Explosion at Pascagoula, Miss.

FIG. 2. THE DAMAGED DWELLING.

Another Fly-Wheel Explosion on a Shaft-Governed Engine.

Our front cover shows the hub of a fly-wheel which exploded March 19, 1919 at the plant of the Pascagoula Street Railway & Light Co., Pascagoula, Miss.

The wheel was mounted on a shaft-governed engine direct connected to a generator. While we do not know the cause of the accident, it has been suggested that it resulted from the failure of the pin connection between the governor and the eccentric, which would free the engine from governor control, and permit the latest possible cut-off, resulting in a runaway. Fragments of the wheel tore through the station did considerable damage to a refrigerating system in the plant, and one fragment tore through the cottage of a negro, which stood near-by.

Figure 2 shows how this fragment cut the floor of this cottage practically in two. A meal was being prepared on the stove seen at the right, and several small children were sleeping in the adjoining room seen in back, yet no one in the house was injured.

The engineer of the plant was trying to shut down the engine and was instantly killed at the throttle, while another man was seriously injured, and the property damage has been estimated in the neighborhood of $25,000.

Water-Hammer Action in Boilers.

[A boiler or indeed any vessel or pipe containing water which is placed in communication, by a pipe for example, with steam at a temperature higher than the water is a source of very grave danger. The slightest agitation of the water surface is likely to result in the very sudden and violent demonstration which we call water-hammer. If the water is brought suddenly in contact with the steam, that event usually supplies the agitation. If the thing is gradual, as for instance, if a cold boiler is left connected to the same steam main as another boiler, and steam is very slowly raised in the second boiler without any opening or closing of valves in the first boiler, it is possible that nothing would happen. The combination however is potentially about equal to a small volcano, waiting only the slightest jar or agitation to start working. Several instances of this sort of combination have recently come under the observation of our inspection force. The danger of the thing, however, seems not to be as generally understood as it should, and therefore we think it wise to reprint a very clear and complete treatment of the subject of water-hammer in boilers which appeared in THE LOCOMOTIVE for July, 1910. This article not only discusses the theory of the starting of a water-hammer, but gives an idea of the amount of damage which can be anticipated from this source. We believe it will prove interesting and useful at this time.

Editor. —]

"Water-hammer action" is the action that occurs, in a steam boiler or in steam piping, when a mass of water is driven with a considerable velocity against a solid body, or against another mass of water, in such a way as to have its motion suddenly checked or destroyed. Under these circumstances a severe momentary pressure is generated in the region where the collision occurs, just

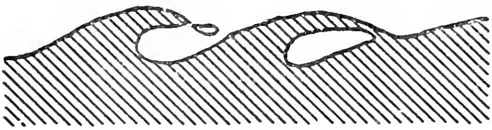


Fig. 1. — Formation of a Bubble.

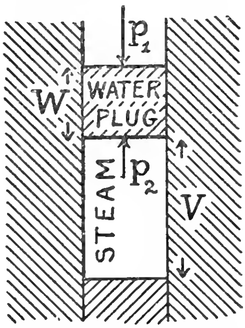


Fig. 2. — The Cylindrical Plug of Water.

as there is when we bring a heavy sledge hammer down forcibly upon an anvil. If the moving water strikes directly against the boiler shell, the pressure is also exerted directly against the shell; while if the moving mass is stopped by colliding with another mass of water, the pressure arises in the midst of the fluid, where the collision occurs. In the latter case, however, a pressure-wave is generated in the water, and this travels forward until it presently comes to bear against the shell of the boiler. In either case, therefore, the shell will be subjected to a shock, as the result of the sudden stoppage of the moving water; and under suitable conditions this shock may be very heavy indeed — quite sufficient, in fact, to rend the boiler in pieces.

CONDITIONS FOR THE DEVELOPMENT OF WATER-HAMMER ACTION.

It is plain, from what has been said, that the immediate conditions for the development of water-hammer action are two in number. (1) Some portion of the water must be caused to move with a considerable speed, and (2) this moving mass must strike against the boiler, or against another mass of water, in such a way that its own speed is suddenly checked or destroyed. The pressure that is generated is only momentary, but it may be of great intensity during the instant that it lasts.

The violent commotion which precedes and leads to the water-hammer effect cannot arise unless there are sensible differences of pressure or of temperature, within the boiler. There can be no water-hammer action, for example, in a boiler whose contents are everywhere at the same temperature and pressure.

In practice we find that the action develops in undrained steam pipes when steam is turned into them, and in boilers that are being cut in (*) with a steam main that is already in communication with other boilers; but in order to realize it, the conditions referred to above must be fulfilled. That is, the water and steam must be at different pressures, or at different temperatures.

When a boiler is cut into a steam main, it will be the difference in pressure that determines the action, provided the pressure in the boiler exceeds that in the main; for when we open the stop-valve under these circumstances, the water in the boiler will tend to "lift," and considerable masses of it may be thrown against

* For the benefit of the non-technical reader, it may be well to explain that "cutting in" a boiler is the act of putting a boiler that has been previously isolated, into full and free communication with a steam main that is already carrying the pressure from other boilers.

the shell, with a resultant shock that may be sufficient to produce rupture.

Conversely, if the pressure in the boiler is less than that in the main, the action will be primarily due to the difference in temperature between the steam in the pipe and the water in the boiler. (This will appear later.)

The case in which the pressure in the boiler is greater than that in the pipe, and the action consists in the lifting of the water, is undoubtedly the better understood of the two, and we shall therefore dwell, in this article, upon the second case, in which the pressure in the boiler is less than that in the main. This second case appears to be widely misunderstood by engineers in general, and yet it is the one that is most likely to arise in practice; for in firing up a boiler that has been out of service for a time, the attendant is far more likely to cut it in as soon as the pressure approaches that in the main, than he is to wait until it is higher than that in the main. In fact, it is a more or less common (though highly dangerous) practice, to cut in the boiler as soon as the pressure comes up to within (say) ten or fifteen pounds of that prevailing in the pipe line at the time.

Our attention has been called quite recently to a plant in the South, where the practice was, for a time, to fill up a boiler with comparatively cold water, and then to open its stop-valve at once, so that the steam in the main would assist in bringing the water up to the operating temperature. It seems incredible that this can be true, and the boiler still remain upon earth; but from the representations that have been made to us we are forced to believe it. At all events the practice has been discontinued in that particular plant, on account of certain emphatic counsel given by our inspector. The superintendent of the plant admitted, by the way, that the boiler occasionally "jumped some" while it was being warmed up. Why it didn't jump a couple of miles is a mystery that we cannot solve.

THE TWO POINTS OF VIEW.

We may look at the water-hammer problem from two different points of view. Thus we may ask ourselves (1) what pressure may be produced within a boiler by water-hammer action, or we may ask (2) what is the maximum mechanical work that can be performed, under given circumstances.

The first of these questions cannot be answered with any approach to precision, partly because we never know, in any given case, just how the water in the boiler is thrown about, and partly because the entire theory of impact is still in an imperfect state, as we have already explained at some length, in the issue of THE LOCOMOTIVE for July, 1909. The second question can be definitely answered, however, since, in solving it, we do not need to know the exact way in which the disturbance of the water takes place.

We shall take up these two questions in order.

NATURE OF THE DISTURBANCE IN THE BOILER.

In dealing with the momentary pressure that water-hammer can produce in a boiler, we have, first, to go over a line of reasoning very similar to that given in THE LOCOMOTIVE for July, 1909; so that we can here treat the matter more briefly than might otherwise be permissible, referring the reader, for a further elucidation of the principles involved, to the articles in the issue cited.

The steam that is discharged into the boiler from the main disturbs the surface of the water there, and generates waves; and the moment one of these waves breaks, so as to form a sort of bubble enclosing some of the steam, the water-hammer action begins. (See Fig. 1.) For, by hypothesis, the water is somewhat cooler than the steam (on account of the original pressure in the boiler being lower than that in the main), and it follows that the steam enclosed within the bubble will condense, leaving a partially vacuous space there. The pressure acting upon the surface of the water will then close the bubble up almost instantly, the water that forms its upper wall being brought down against that which forms the bottom of it, with great speed and corresponding violence. The hammering action thus initiated will increase the disturbance in the water, and larger and larger bubbles will be formed in the same way, with the production of increasingly violent shocks when they collapse.

A more concrete idea may be had of the action by considering the familiar operation of blowing steam into cold water from a small pipe. A bubble of steam forms momentarily, and is immediately condensed by the cooler water, the sides of the bubble coming together with a resounding crack. In the boiler the case is similar, save that the experiment is there performed on a terrible scale, with steam furnished by a battery of boilers, through a six-inch pipe (perhaps) instead of a quarter-inch one, and with the bubbles, quite likely as big as water-pails, collapsing under a pressure of 100 pounds or so, per square inch, instead of under simple atmospheric pressure.

IDEAL CASE OF A CYLINDRICAL PLUG OF WATER.

In order to estimate the magnitude of the momentary pressure that is produced in the water by these sudden shocks, we proceed as follows:

Consider first (as in our previous article of July, 1909, already cited), the case of a cylindrical plug of water, moving along the interior of a smooth cylindrical tube which it just fills. (See Fig. 2.) Underneath the plug there is a space which is filled, at the outset, with steam fresh from the main steam pipe, and having, therefore, a temperature higher than that of the water in the boiler. Now let us suppose that the imaginary tube in which the plug travels is surrounded by water at the temperature that prevails in the boiler, and that the walls of the tube are not real walls, of metal, but that they are imaginary, permitting the free passage of heat, while not allowing the water composing the plug to flow out sidewise.

Under these circumstances the steam under the plug, being surrounded by water cooler than itself, will partially condense. Its pressure will promptly fall, in fact, to the pressure corresponding to the temperature of the water.

If we represent the pressure in the steam main by p_1, and the reduced pressure below the plug by p_2, and if we also assume that the sectional area of the plug is one square inch, we see that (as indicated in Fig. 2) the plug is subject to a downwardly-directed force equal to p_1, and an upwardly-directed force equal to p_2. Since p_1 is greater than p_2, the resultant force acting on the plug is downward, and equal to $p_1 - p_2$. In forcing the plug downward through a distance of V inches, so as to cause the space under it to disappear, the work done by the steam is therefore $(p_1 - p_2) V$ inch-pounds.

As soon as the plug strikes the water below it, a pressure is produced at the surface where the two come together, accompanied by a local compression of the water along that surface, in the vertical direction. This pressure at the surface of contact acts downward on the free substratum of water, and upward on the water-plug. The motion of the plug is arrested at this point, but the rear (or upper) part of the plug will continue to press forward, for a moment, after the front part has become stationary. So far as the pressure within the water is concerned, the effect will be as though there were a wave of compression transmitted through the water, traveling with the same velocity as sound (since sound is only a succession of compression waves). As soon as the wave of compression has passed back through the plug and reached its rear (or upper) surface, this rear surface will also become stationary, and for an instant the entire plug will be motionless and in a state of uniform compression. The compressive stress to which it is subjected at this instant, by reason of its own sudden loss of momentum, is, in fact, the "water-hammer pressure" that we are seeking to determine.

The water below the plug will be compressed, in just the same way as is the water of the plug itself; and since the compression wave will have the same velocity, downward through the free water, as it has backward through the plug itself, it follows that at the moment when the pressure-wave reaches the back end of the plug (the length of which we will call W inches), it will also have penetrated the water below the plug to the same distance. Hence, at the instant the plug comes to rest, there will be a total volume of water under compression, equal to $2W$ cubic inches (the sectional area of the plug being one square inch); half of this being the volume of the plug itself, and the other half being the volume of that part of the free water which is also at the same time under an equal compression.

If we think of this volume, $2W$, as being under a momentary uniform compression equal to P lbs. per square inch, we may deduce the pressure, P, by the following process: Let C, be what is termed the "modulus of compressibility" of water. That is, C is the pressure, per square inch, that would suffice to compress the water to nothing, if its diminution of volume, at indefinitely high pressures, should follow the same law that holds for pressures that are moderate. (Of course there is no pressure that actually would compress the water to a zero volume; but the "modulus of compressibility," as defined above, is an exceedingly convenient thing to use, in practical computations.) Also, let x be the amount by which the volume $2W$ of the compressed water is reduced by the actual (though as yet unknown) pressure P. We then have the proportion

$$P : C :: x : 2W.$$

And solving this for x we find

$$x = \frac{2PW}{C}$$

The work done in compressing a liquid is very nearly independent of the way in which the compression is performed. (We mention this, because the fact is quite otherwise with a gas or vapor.) Hence the potential energy stored up in the compressed water will be the same (or sensibly the same) as it would be if we effected the compression slowly and uniformly, beginning with the pressure at zero, and gradually increasing it up to P. Now in this case the average pressure applied would be $\frac{1}{2}P$; and multiplying this by x (the height by which the volume $2W$ has been reduced), we find that the total work done would be $\frac{1}{2}Px$. And if we replace x by its value as just found, above, we see, finally, that the potential energy stored in the $2W$ cubic inches of water under compression is

$$\frac{P^2 W}{C}$$

Now since energy cannot be created nor destroyed, this must be equal to the work done by the steam in pushing the plug to the end of its cylindrical passage; and hence we have the equation

$$(p_1 - p_2)\ V = \frac{P^2 W}{C}$$

which, upon being solved for P, gives

$$P = \sqrt{\frac{(p_1 - p_2)\ C\ V}{W}}$$

This, it is to be remembered, is the expression for the pressure that may be produced in the ideal case, in which a plug of water is driven along a cylindrical channel so as to come suddenly and violently against another mass of water of equal cross section, and extending indefinitely in the direction of the length of the channel.

APPLICATION TO THE ACTUAL CASE.

In order to see how the foregoing formula for P applies in the actual case that arises in practice, let us consider a bubble of rectangular shape, such as is indicated in Fig. 3. This consists, as will be seen, of a sort of slab of water, of thickness W, raised to a distance V. Let us imagine the upper slab, the space below it, and the water that lies below the space, to be divided into imaginary cylindrical tubes, as suggested by the dotted lines. If, now, the top wall, or slab, comes down uniformly in all its parts when the bubble collapses, the water in each of these imaginary cylindrical tubes will act just as we have supposed the plug to act, in the ideal tube described above. There will be no sidewise flow of the water, or none of any account, provided the rectangular bubble is big enough in its horizontal dimensions. Hence the formula will be as applicable to this case, as it is to the case of the single plug in its cylindrical tube.

Finally, if the bubble, instead of being rectangular, is more or less oval or ellipsodial, as in Fig. 4, the pressure actually developed will agree with the calculated pressure to an order of approximation corresponding to the (unknown) degree in which the conditions in the actual case conform with those that were assumed to exist, in deriving the formula.

After the pressure that is due to the impact has been generated, it is transmitted through the water to the boiler shell. In this transmission it will be somewhat lessened in intensity, and it will be propagated mainly in the direction in which the top slab of the bubble collapses.

We have supposed, for the sake of simplicity, that the bubble collapses vertically; but since the water in the boiler is thrown about in an utterly indescribable manner, the actual collapse may take place horizontally or obliquely, and hence the maximum pressure may be exerted upon the boiler shell sidewise, or in any other direction.

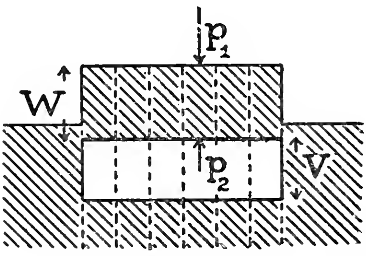


FIG. 3. — RECTANGULAR BUBBLE.

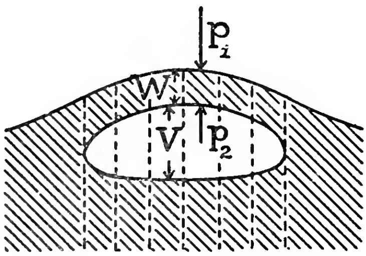


FIG. 4. — OVAL BUBBLE.

The formula may be expressed in words as follows: First find the difference $(p_1 - p_2)$ between the pressure in the steam main and that in the boiler before opening the valve, and multiply this by the modulus of compressibility of water (C), which may be taken as equal to 300,000 lbs. per square inch. Then multiply again by the depth (l'), in inches, of the steam inside of the bubble, measuring this depth in the direction in which collapse takes place. Finally, divide the product so obtained by the thickness of the upper layer (H') of the bubble, in inches, and take the square root of the quotient. The result will be the momentary pressure produced in the water by the collapse of the bubble.

This rule, be it understood, cannot be used to determine anything but the general order of magnitude of the pressures produced by water-hammer. No rule could do more than this, however, when applied to a problem as indefinite as the one with which we are dealing. Yet with all its limitations the rule has a considerable value, since it shows that water-hammer effects may be exceedingly serious, and that we need to guard against their production, with the greatest care.

NUMERICAL EXAMPLE.

Let us now apply the formula to the calculation of the maximum possible pressure that water-hammer might produce, in a particular case. We shall suppose, for this purpose, that a boiler is being cut in with others, and that the pressure it carries is less than that prevailing in the steam main at the time. We shall assume that the pressure in the main is 95 lbs. per square inch, and that that in the boiler is 88 lbs. per square inch.

In this example, as in all others of like nature, we shall have to arbitrarily assume the thickness of the bubble and of the top layer thereof. We cannot tell what these thicknesses were, but we must endeavor to choose values for them that might reasonably be expected to occur. Let us suppose that the thickness of the steam-filled portion of the bubble was 6 in., and that that of the slab, or top portion, was 3 in. Then our rule works out as follows: The difference between the pressure in the steam main and that prevailing in the boiler just before opening the stop-valve was $95 - 88 = 7$ lbs. per sq. in. This, multiplied by 300,000, gives $300{,}000 \times 7 = 2{,}100{,}000$. Multiplying again by the thickness of the steam space of the bubble, we have $2{,}100{,}000 \times 6 = 12{,}600{,}000$. Then, dividing this by the thickness of the top layer of the bubble, we have $12{,}600{,}000 \div 3 = 4{,}200{,}000$. And, finally, taking the square root of this last number, we have $\sqrt{4{,}200{,}000} = 2{,}049$ lbs.

per sq. in., which is the maximum pressure that could be developed by water-hammer action in the given boiler, under the assumed conditions. It is evident, here, that we may make very large allowances indeed for the fact that the conditions may not have been just like those pre-supposed, and yet we shall have a pressure quite sufficient to cause rivets, or any other part of the boiler, to snap at once — especially when we remember that the instantaneous pressure developed by the water-hammer action was in addition to the normal load of 95 lbs. per sq. in., which the steam exerted upon the shell directly, as soon as the stop-valve was opened.

Once again we may state that when a boiler is burst by water-hammer action, the pressure that is generated acts only for an instant, and its effect upon the boiler is similar to that of a sudden hydrostatic pressure. That is, it disrupts the boiler, but it does not throw the pieces about. The momentary water-hammer pressure having separated the parts of the boiler, it is the normal steam pressure within the boiler that does the rest of the work.

THE MAXIMUM AMOUNT OF MECHANICAL WORK THAT CAN BE PERFORMED.

We come now to the second aspect of the water-hammer question. Namely, we have to look at the case from the following point of view, which is more general than the one from which we have approached it above. A boiler containing a mass of water at a given temperature is placed in free communication with a steam main capable of supplying a practically unlimited amount of steam at a pressure higher than that due to the temperature prevailing within the boiler. As we have here two bodies, or substances, at two different temperatures (namely, the steam in the main and the water in the boiler), the theory of heat teaches us that a certain amount of mechanical energy can be developed, as an accompaniment to the process of temperature-equalization which at once begins. The quantity of mechanical energy that can be so developed, however, is strictly limited by the laws of thermodynamics; and it is not at all difficult to find an expression from which its maximum amount can be calculated.

Let t_1 be the temperature of the steam that is admitted from the steam main — this being constant throughout the entire operation, since the steam is furnished by outside boilers, at a constant pressure and temperature. Also, let t_2 be the temperature that the water in the boiler has at the outset, just as the stop-valve is opened. As soon as the steam, at the higher temperature t_1, enters the boiler, it comes in contact with the cooler water there, and begins to condense; and although the heat that it gives out in condensing may be partially converted into mechanical energy, available for throwing water in the boiler about, the major portion of it must go to the direct heating of the water, without the production of any such mechanical work. In fact, the principles of thermodynamics, upon which we have dwelt in many of the previous issues of THE LOCOMOTIVE, show that when, in the equalizing process, the incoming steam gives up a small quantity of heat — a quantity so small, namely, that it does not materially alter the temperature of the water in the boiler as a whole — we may find the maximum quantity of mechanical energy that can be developed, by multiplying this small quantity of heat (expressed in foot-pounds) by the fraction

$$\frac{t_1 - t_2}{t_1 + 459.7^\circ},$$

the constant number 459.7° being the Fahrenheit temperature of the Fahrenheit zero, on the absolute scale of temperature.

If, as in the example worked out above under the other rule, we take the pressure in the main at 95 lbs. per square inch, and that in the boiler before the stop valve was opened at 88 lbs., we find, by consulting a table of the properties of steam, that the temperature (t_1) of the steam in the main was 334.4°, and that the temperature (t_2) of the water in the boiler was 329.5° Fahr. Hence $t_1 - t_2 = 334.4^\circ - 329.5^\circ = 4.9^\circ$, and $t_1 + 459.7^\circ = 334.4^\circ + 459.7^\circ = 794.1^\circ$. With these values of the temperatures, the foregoing fraction becomes equal to $4.9 \div 794.1 = 0.00617$; so that when the entering steam begins to condense, the first foot-pound of heat that it gives up can generate 0.00617 of a foot-pound of mechanical energy, which can manifest itself by throwing the water about; but the remaining 0.099383 of the foot-pound must pass directly and quietly into the water, without appearing in the mechanical form at all.

As the water in the boiler rises in temperature, owing to the heat that it is receiving from the steam, the same sort of calculation can be made at every stage of the process. The only difference will be, that the value of t_2 will increase as the water warms up, while the value of t_1 remains constant. The fraction that expresses the proportion of the heat that can be converted into mechanical energy will grow less, therefore, as the temperatures become equalized. The average value of the expression given above for the efficiency of the conversion is

$$\frac{1}{2} \cdot \frac{t_1 - t_2}{t_1 + 459.7^\circ};$$

and if we multiply this last expression by the amount of heat given up by the steam, we shall have the total amount of mechanical energy that can be developed, within the boiler, as a result of cutting it into the steam line, at a temperature (or pressure) below that of the steam in the main.

Now the total amount of heat that is given up by the steam is equal to that absorbed directly by the water, plus that which is converted into mechanical energy. But since considerably more than 99 per cent. of that which the steam gives up is directly absorbed by the water, we shall not commit any error of the slightest practical importance if we assume, in this particular calculation, that the two are equal. If the average specific heat of the water between t_1 and t_2 is S, then each pound of water, in becoming warmed from t_2 to t_1, will absorb $S\ (t - t_2)$ units of heat. To express this quantity of heat in foot-pounds, which is a more convenient way for our present purposes, we have merely to multiply it by Joule's equivalent, which we will take at 780 foot-pounds per Fahrenheit heat unit. Moreover, we may take the specific heat, S, of the water as equal to unity. Hence the total quantity of heat absorbed by the water is $780\ (t_1 - t_2)$ foot-pounds. Assuming that this is equal to the amount given up by the steam (as explained above), we have merely to multiply it by the fraction given in the preceding paragraph, and again by the number of pounds (say w) of water in the boiler, and we have the total number of foot-pounds of mechanical energy that can be developed when the boiler is cut in with its fellows. Thus the expression in question becomes

$$\frac{390w\ (t_1 - t_2)^2}{t_1 + 459.7^\circ}.$$

In words, this may be expressed as follows: Find the square of the difference in temperature between the steam in the main and the water in the boiler, multiply this by the number of pounds of water in the boiler, and multiply again by the constant number

390. Then divide the product so obtained by the temperature of the steam plus 459.7°. (Fahrenheit temperatures are to be used.) The result is the greatest possible number of foot-pounds of mechanical work that the water can do, in being thrown about as a consequence of the boiler being cut in before the pressure within it has become equal to that prevailing at the time in the steam main.

APPLICATION TO A NUMERICAL EXAMPLE.

By way of illustration, we shall apply this formula to the same example as before. We have already found the difference of temperature between the water and the steam to be 4.9°. The square of this is $4.9 \times 4.9 = 24.01$. We shall throw away the small decimal, and call it 24. We next need to know the total weight of water in the boiler, and for the purposes of illustration we shall take this to be 12,000 lbs. Then proceeding with the application of the rule, we have $12{,}000 \times 24 = 288{,}000$; and $288{,}000 \times 390 = 112{,}320{,}000$. We have already found that $t_1 + 459.7° = 794.1$ Hence we have $112{,}320{,}000 \div 794.1 = 141{,}440$ foot-pounds, which is the maximum quantity of mechanical energy that could be developed inside of the boiler, as a consequence of cutting it in with the others before the pressure had become equalized to within less than seven pounds per square inch.

As before, this result is merely a maximum one, but in obtaining it we do not have to make any supposition respecting the proportions of the steam bubbles that are formed. The result is exact, save that we have made certain assumptions of a merely arithmetical nature, in the interest of simplicity — assumptions which certainly do not affect our conclusion by more than a few per cent.

A mere fraction of this maximum available amount of work would suffice, without doubt, to start the rivets shearing; and, as we have several times remarked, it is the steam pressure normally within the boiler that throws the parts asunder, when once the work of disruption has been well begun. The energy developed directly by the water-hammer does not have to account for any portion of the mechanical work of the explosion, save that which is required to stress some parts up to their breaking points.

We would direct attention particularly to the fact that the quantity of mechanical energy that can be developed within the boiler, and be manifested by throwing the water about with more or less violence, varies as the square of the difference in temperature between the water and the steam. Hence if this difference were twice as great as we have assumed, the quantity of mechanical energy that could be developed, under otherwise similar conditions, would be four times that calculated above.

CAN THE WATER-HAMMER ACTION BE DELAYED?

Water-hammer action, if the conditions for its occurrence exist, usually begins the moment the stop-valve is opened. If, however, the pressure in the main exceeds that in the boiler, and the stop-valve is opened cautiously, there appears to be no reason why the steam might not enter quietly. Part of it must condense, of course, on account of the chilling action of the water upon it; but this might conceivably occur without mechanical disturbance, the superficial layers of the water in the boiler becoming heated, so that a sort of equilibrium would be established. If nothing should occur to agitate the water, this state might persist until the entire bulk of the water became heated up to the temperature of the steam in the main; and after that no water-hammer would be possible.

The pseudo-equilibrium thus established would be highly unstable, however, and the least disturbance of the water, by bringing its deeper and cooler layers to the surface, would precipitate water-hammer action at once. It would be only under the most exceptional circumstances that delayed development such as we have suggested could occur, and yet such delay is manifestly possible.

PRECAUTIONS FOR THE AVOIDANCE OF WATER-HAMMER ACTION.

In conclusion, let us emphasize the fact that it is of exceeding importance, in cutting in a boiler, to be sure that the pressure upon it is as exactly identical as possible with the pressure that is prevailing, at the time, in the steam main. Mathematically exact equality can hardly ever be attained, however, partly because commercial steam gages will seldom agree to within a pound or so. Hence when the equality of pressure is judged to be exact, the stop-valve should be opened very carefully indeed — opened just a bare crack at first, and then, as the slight outstanding difference of pressure equalizes itself, opened wider, very slowly, until it is open full. The complete operation should occupy a couple of minutes or more, and the attendant should hold himself in readiness, at every instant, to close the valve at once, if there is the slightest evidence of any unusual jar or disturbance of any kind, about the boiler.

Cast Iron Heating Boilers Do Explode.

E. Mason Parry, Chief Inspector.

We are very often confronted with the statement that a cast-iron boiler used solely for heating a building cannot explode, especially when used in connection with a hot water system, and equipped with an expansion tank located at the highest point in the building. To prove that cast-iron boilers, if not suitably installed and equipped with the necessary safety appliances, can and do violently explode, the writer would call attention to an accident which he recently investigated.

The case under consideration was a large brick building, used as an Industrial School, and heated by two large cast-iron boilers located in an unfinished basement. These boilers were designed for a hot water heating system, and were subject to a static pressure of about 27 lbs., based on the altitude of the expansion tank above the top of the boilers. It was noted that the return water entered the rear end of both the boilers and was directly connected to each of the two lower manifolds. All return pipes were provided with a shut- off valve of the gate type; furthermore, it was noted that the supply pipes from the boilers to the heating system, which were connected to the upper manifolds, were also fitted with shut-off valves, and that no provision had been made to avoid a possibility of their being subjected to excess pressure by furnishing each boiler with a relief valve. It was found that the usual altitude or pressure gauge was absent, and the only way the attendant could determine just how much water there was in the heating system, was to visit the expansion tank to note if the water was visible in the gauge glass.

Owing to mild weather this winter, only one of the boilers had been in service, but when a cold snap arrived, it was decided to place the other boiler in operation. This was done in the forenoon, and about 4.00 P. M. of the same day, a violent noise was heard, accompanied by the falling of broken glass from various windows in the building, especially in the basement. It was reported that the whole building trembled. As soon as the vapor, formed by the liberation of a large volume of heated water disappeared, it was noted that one of the boilers had exploded. The rear section was found on the basement floor in small fragments.

That this accident was not attended by considerable property damage and loss of life or personal injury, can be attributed to the fact that the section which exploded was considerably below the

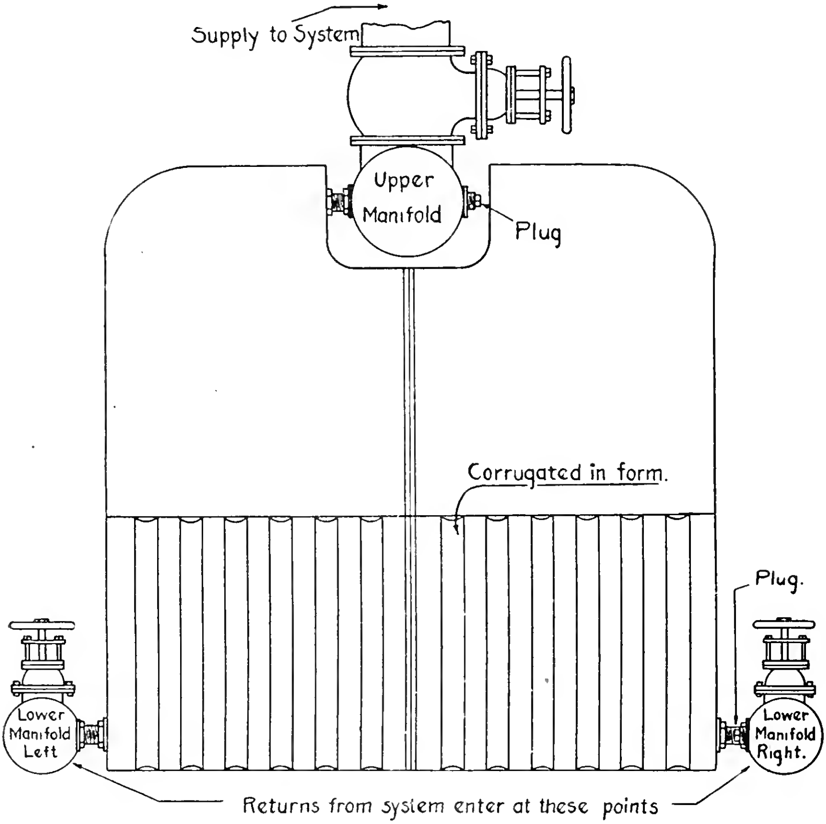


FIG. 1. — THE SECTION WHICH EXPLODED.

standard thickness in many places, which would indicate that the core used in the foundry for forming the casting shifted before the molten iron flowed into the mold during the manufacture of the section in question. The rear section of the type of boiler discussed in this article has quite a large area of flat surface, and to strengthen this form of construction the lower part of the section where it is exposed to the heated gases is corrugated. The upper part is provided with cast-iron stays, 7/8 inches in diameter, and pitched 6 inches by 6 inches on centers. It was noted that in some places the thickness of metal was only 3/16 in., furthermore the entire boiler showed a marked deterioration externally, due to surface corrosion incident to a very damp location. It was also noted that one-half of the rear section was blanked off from the remaining sections by plugging the openings in the upper and lower right hand manifolds as shown in the sketch, the presence of the plugs indicating that at some past date, the right half of the rear section had cracked.

On my arrival at the scene of this disaster, it was found that there was a slight fire under the other boiler, but that no hot water was being circulated through the building, notwithstanding the fact that it was a bitter cold day and that a large number of people were suffering from cold, also all water piping was exposed to freezing and possible rupture.

Having summed up the situation I asked the caretaker of the boilers why he was not furnishing heat for the building, and after talking with him for a while, it was evident that his experience of the previous day had entirely unnerved him, but after going over the connections carefully with him and assuring him that by following the instructions given, it was perfectly safe to raise the temperature of the water in the boiler to a point where it would heat the building, he proceeded to do so.

From the conditions noted, at the plant, and from the information obtained by talking with the attendant, it was found that the probable cause of the explosion was that the boiler, which exploded, and which had been idle most of the winter, was started up without opening up the stop valve in the supply pipe to the heating system. The stop valves in the return pipes, however, were open. Had the latter valves been closed a very violent accident undoubtedly would have taken place. It can be seen that when operating a boiler with valves arranged as stated, a steam pocket was formed in the rear section, which brought about unequal expansion of the metal in this section. This, together with the fact that some parts of the section were below standard thickness weakened this section to a point where it was incapable of sustaining the pressure to which it was subjected. After which, of course, the liberation of the heated water furnished a source of energy to complete the destruction of the section.

The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

C. C. Perry, Editor.

HARTFORD, JULY, 1919.

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The Locomotive of the Hartford Steam Boiler I. & I. Co.

Engine Insurance.

The breakdown of engines used for industrial power production has been for some years past an object of underwriting in other countries which has especially appealed to the owners of such apparatus. In England, particularly, engine insurance has been written in large volume and has been regarded an essential protection by manufacturers almost to the same degree as boiler insurance. As practiced there, it indemnifies for the accidental breakage of any of the important parts of an engine and thus relieves the assured of the loss of, or the expense of repairing an engine which has been totally destroyed or materially damaged by an accident. Generally, the English engine policy has been thus limited to the engine itself but some companies have for an additional consideration also assumed liability for damage to property other than the engine caused by its breakdown. In this way, insurance has been provided to a certain extent for the results of the explosion of a fly-wheel on the engine, but fly-wheel insurance generaly has not been a distinct line of underwriting as in our own country.

In the United States, on the other hand, the disastrous nature of a fly-wheel explosion has been so forcibly and frequently emphasized by the many instances in which it has occurred that protection against its hazards has been in demand. A fly-wheel explosion, like a boiler explosion, is the result of a sudden release of stored energy and its effect is similar. It was natural therefore, for the HARTFORD Company as well as other boiler underwriters in the United States to take up the fly-wheel line and underwrite a hazard similar to that which they were organized to inspect and insure. Fly-wheel insurance has accordingly become an established and well recognized line of insurance protection and because it afforded indemnity for the most dangerous disaster threatened by the operation of an engine, it has to a degree satisfied the requirements of American power plant owners.

This satisfaction has not, however, been universal, for many of the friends of the HARTFORD Company have urged it to afford them an insurance which would not only protect against the fly-wheel part of an engine but against the breakdown of any part and which would indemnify both for the property loss involved in an accident and the consequential loss to business suspended because of the stoppage of the power producing apparatus. The HARTFORD Company has had this matter under consideration and investigation for several years past. Its plans for offering a complete line of engine insurance combined with fly-wheel insurance were interrupted and their consummation postponed by the war conditions. Since the armistice, however, it has again taken up the matter with the result that we may now announce that our engine insurance policies are in preparation and we expect will be completed so that our agents may offer this line generally later this summer.

The HARTFORD engine policies, like its boiler and fly-wheel insurance, will be of two kinds, namely, one affording indemnity for damage to property and, if desired, for liability on account of personal injuries, and the other, granting indemnity for each day during which, because of an accident to an engine, the business of the assured is suspended and interrupted. The policy will afford the same full protection for the explosion of the engine wheel as do the fly-wheel policies of the company, but in addition any accidental breakage of any part of the engine, substantial and material enough to immediately prevent its continued operation, will be covered. The protection afforded will accordingly include all the features of the English engine policy and the American fly-wheel policy but will be broader than either, and it is believed that this new line of power plant protection will be cordially received by owners and industrial managers of this country.

We take the opportunity of this issue of THE LOCOMOTIVE to place our plans before our friends and fully expect that before the next issue of THE LOCOMOTIVE our printed circulars describing this insurance in detail with rates and policies will be in the hands of our agents.

The Correspondence Course.

In the last issue of THE LOCOMOTIVE, we announced that The Hartford Steam Boiler Inspection and Insurance Company was prepared to offer to firemen, through its assured, a correspondence course in combustion and firing methods.

This announcement has borne fruit. We have had a number of inquiries, and several men are now enrolled as students in this course. Their answers to the questions, which accompany the lessons, indicate interest and study, and we expect to see them make steady progress toward securing the certificate awarded those who complete the course successfully. This course has been prepared with great care, and we believe it is a good one which should prove interesting as well as profitable. We believe it will be valuable not only to the man himself by increasing his skill, but we feel sure it will profit the employer by helping improve his fire-room economy.

Several of our readers, interested in this course, have asked what ground the lessons covered, so that they might form a clear notion of its scope. As others may have wanted this information, we are printing here a brief summary of the ground that is covered.

The course starts out with the simple principles of combustion. It teaches by text and simple experiments the need for an air supply, the importance of volatile combustible and fixed carbon, the conditions for complete and incomplete combustion, and the losses due to both incomplete combustion and excess air. The air supply is treated as made up of two parts, — the air really needed for combustion, and the leakage air; and means are discussed for eliminating air leakage. At this point the behavior of the fuel in an actual furnace is taken up, the need for mixing air and combustible, and for a region of high temperature to ignite the gaseous combustible is explained; and this is followed by a study of how to fire the fuel and work the fire to get economy with minimum smoke and maximum freedom from clinkers. Ash and clinker formation are discussed fully and the importance of good firing methods in preventing clinkers are pointed out. After studying the methods and times best suited to cleaning fires, the use of draft gages and gas analyzing apparatus as they affect the work of the fireman are discussed, though no attempt is made to teach the manipulation of gas analyzing apparatus. It was felt that an understanding of what a CO_2 record means, and how to use this knowledge in firing was of more importance to the fireman than the care and manipulation of the apparatus itself, which would not usually be under his supervision.

The course is completed with a study of the care and management of the boiler and furnace from the safety standpoint, with suggestions for meeting emergencies as well as a study of the safest methods of regular routine operation. At the conclusion of the course, a set of examination questions will be sent out to follow a review of the whole course and to help fix the final grade of the students.

The course, as we announced in the last issue, is offered for the purely nominal charge of $5.00. We have had several applications from employers who have purchased courses for their employees. One chief engineer has written us with a suggestion which we think especially good. It is that he would endeavor to interest his firemen in taking the course at their own expense, with the understanding that each of them who would stick to it and complete the course with a passing grade, receiving a certificate, would have the five dollar fee refunded to him. In this way the interest of the man would, he hoped, be sustained to the end and result in his receiving the maximum benefit.

We believe the correspondence course idea is right, — that it is going to prove popular and valuable, and we will welcome inquiries, applications, and suggestions, which should be addressed to The Hartford Steam Boiler Inspection and Insurance Company, Correspondence Course Department, Hartford, Connecticut.

Personal.

Mr. Ward I. Cornell, who has been connected with the Boston Department since 1914, at first as Special Agent, and since January, 1916 as Assistant Manager, has been appointed Manager to fill the vacancy caused by the death of Mr. C. E. Roberts.

Mr. Cornell is well and favorably known to the assured in New England, and is well qualified in every way for his new position. Indeed as Assistant Manager, he has largely carried the burden of the office during the long period of Mr. Roberts' ill health. Prior to his connection with the Boston Office, Mr. Cornell had served several years as a Special Agent in our New York Department.

A branch office of the Hartford Steam Boiler Inspection & Insurance Company has been opened in New Orleans, located at 308 Canal Bank Building, to be known as the New Orleans Department.

Mr. Robert T. Burwell, who has served as Chief Inspector in this district since 1902, has been appointed Manager. He will continue to supervise the work of the inspection force, as Chief Inspector.

Mr. Burwell, who is a graduate of Cornell with the degree of M. E. has been continuously connected with the work of The Hartford at New Orleans, since about 1896, when he joined its inspection force. He was promoted to Chief Inspector, in 1902, and now assumes the joint duties of Manager and Chief Inspector. Mr. Burwell is too well known to our patrons in his territory to need any introduction from us. We feel that his success in administering our improved facilities is assured.

Mr. George S. Reynolds, who since 1913 has been a Special Agent in the Pittsburgh Department, was appointed Manager July 1st, following the resignation of Mr. M. M. Atherton. He is well acquainted both with the assured, and the agents of his territory, and we anticipate for him a well deserved success.

Mr. Thomas E. Shears, who has served the company so loyally during the last twelve years, as General Agent, and Chief Inspector at Denver has retired from active service because of ill health. He has been succeeded by Mr. J. H. Chestnutt who becomes Manager and Chief Inspector.

Mr. Chestnutt has had many years experience in our underwriting and inspection departments, and goes to Denver from the St. Louis Office where he has lately served as Special Agent.

Mr. J. P. Morrison becomes Chief Inspector in the Chicago Department. Mr. Morrison's transfer to Chicago results from the fact that Lt. Commander James L. Foord has been retained somewhat indefinitely in the Navy where he has now rendered exceedingly valuable service for nearly two years. Mr. Foord has been chiefly concerned with the maintenance and repair of the boiler equipment of a large fleet of ships, and his expert services in that connection are still in demand.

Mr. Morrison first entered the service of The Hartford as an

Inspector in the St. Louis Department in December, 1901. After the death of Manager Hugo he was appointed Chief Inspector, there, in April, 1913, which position he held until his transfer to Chicago.

Mr. Morrison's work has been very successful and his transfer comes as a promotion to a larger field.

Mr. Eugene Webb succeeds Mr. Morrison as Chief Inspector at St. Louis. Mr. Webb has been an inspector in the Chicago Department since 1904. For several years he has been in the Chicago Office, where he has acted as an assistant to the Chief Inspector. He is therefore well fitted by his experience for his new work, which in his case also comes as a well-earned promotion.

Obituary.

Christopher E. Roberts.

Mr. Christopher E. Roberts, Manager of the Boston Department of The Hartford Steam Boiler Inspection & Insurance Company, died Sunday morning, June 1, 1919, at his home in Cambridge, Massachusetts, after a prolonged illness.

Mr. Roberts was born in East Hartford, Connecticut, sixty-three years ago. He first joined the agency force of the Company as Special Agent at the Home Office, December 1, 1881. A little over two years later, on May 1, 1884, he was appointed manager of the Boston office, which position he held until his death. Under his charge, the business of the Boston office increased from a small beginning to its present large volume. He made many staunch friends, particularly among the textile men of the territory, and was a member of the National Association of Cotton Manufacturers, serving for several years as an auditor.

Mr. Roberts lived for some time in Newtonville, Massachusetts, where he was one of the founders of the Newton Club. He served as a member of the Common Council in Newton in 1895 and 1896. In 1897 he was an alderman. He was a Mason, a member of the Royal Arcanum, and belonged to the Exchange and Algonquin Clubs in Boston.

Mr. Roberts married Miss Elizabeth P. Allen, daughter of the late President J. M. Allen of the Hartford Steam Boiler Inspection and Insurance Company. Mrs. Roberts and a son, Harry A. Roberts, survive him.

Boiler Explosions.

OCTOBER, 1918.

(315) — A boiler ruptured October 1, at the oil operation of the Ethel D. Company, Maricopa, Cal.

(316) — A boiler of a Philadelphia & Reading freight locomotive exploded October 1, at Lebanon, Pa. Two men were killed, and three others seriously injured.

(317) — On October 2, two tubes ruptured in a water tube boiler at the plant of the Federal Light and Traction Company, Walsenburg, Col. One man was slightly injured.

(318) — On October 2, an elbow failed in a blow off pipe at the plant of the Dallas Steam Laundry & Dye Works, Dallas, Texas. Three persons were injured.

(319) — On October 2, nine sections cracked in a cast iron sectional heating boiler at the school and church of St. Patrick's Institute, Toledo, Ohio.

(320) — A mud-drum of a water tube boiler exploded October 3, at the plant of the Kansas Gas & Electric Company, Arkansas City, Kan. One man was injured.

(321) — On October 3, two sections cracked in a cast iron sectional heating boiler in the building used for stores and automobile exhibition rooms owned by Mary Schlesinger, James A. Parker, and others, Boston, Mass.

(322) — A boiler exploded October 4, at the Jump Cotton Gin, Dubois, Ga. Two men were instantly killed, one other probably fatally injured, and three mules were killed, while the gin was completely destroyed.

(323) — On October 5, a boiler ruptured at the plant of the Republic Creosoting Company, Minneapolis, Minn.

(324) — On October 5, the crown sheet of a locomotive boiler failed at the operation of the Fir Tree Lumber Company, Tacoma, Washington.

(325) — On October 5, a boiler exploded at the plant of the Consolidated Gas Company, 21st Street and Ave. A., New York City. Fourteen men were injured.

(326) — A section cracked October 7, in a cast iron sectional boiler at the school of the Children's Aid Society, 219 Sullivan St., New York City.

(327) — A boiler exploded October 7, at the Stave & Heading Mill of W. E. Small, Corinth, Miss. One person was killed.

(328) — A boiler ruptured October 7, at the cotton gin of the Farmer's Truck & Produce Company, Cheneyville, La.

(329) — On October 13, an accident occurred to a water tube boiler at the plant of the Utah-Idaho Sugar Company, West Jordan, Utah.

(330) — A boiler ruptured October 9, at the saw mill of the Fourche River Lumber Company, Bigelow, Ark.

(331) — A section cracked October 9, in a cast iron sectional boiler at the Jordan Hotel, Pleasant Unity, Westmoreland County, Pa.

(332) — A blow-off failed October 9, at the plant of the Gulf States Steel Company, Birmingham, Ala. One man was injured.

(333) — An ammonia tank exploded October 9, at the market of Thomas & Company, Pittsburgh, Pa. Two persons were injured.

(334) — A boiler ruptured October 10, at the plant of the Bosse Coal Company, Buckskin, Ind.

(335) — A section cracked October 11, in a cast iron sectional heating boiler at the Walker-Gordon Laboratory, Washington, D. C.

(336) — On October 12, a six inch angle valve failed at the Waldeck Packing Company plant of the St. Louis Independent Packing Company, St. Louis, Mo.

(337) — A main steam pipe failed October 13, at the plant of the Monsanto Chemical Works, St. Louis, Mo.

(338) — A tube ruptured October 14, in a water tube boiler at the plant of the Equitable Power Manufacturing Company, East Alton, Ill. One man was killed.

(339) — A tube ruptured October 14, in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Elsinore, Utah.

(340) — On October 14, four sections cracked in a cast iron sectional heating boiler at the plant of the Roberts Findlay Mfg. Company, Inc., Brooklyn, N. Y.

(341) — A boiler exploded October 14, in the saw mill of Sam Cousins, at Cameron, Mo. Two men were killed.

(342) — On October 15, two sections cracked in a cast iron sectional heating boiler in the office building of Louis C. Clark, Birmingham, Ala.

(343) — A header cracked October 16, in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Garland, Utah.

(344) — A steam pipe failed October 17, at the plant of W. A. Stevens, Kansas City, Mo.

(345) — October 21, a boiler ruptured at the Sugar House of the Lula Company, Inc., Belle Rose, La.

(346) — On October 21, a tube ruptured in a water tube boiler at the plant of the Norton Salt Company, Port Huron, Mich.

(347) — A boiler exploded October 22, at a salmon cannery at LaConner, Washington. Two people were severely burned.

(348) — A section cracked October 24, in a cast iron section boiler at the plant of the New Era Printing Company, Lancaster, Pa.

(349) — On October 25, two sections cracked in a cast iron sectional heating boiler in a building owned by the Estate of Elizabeth L. Townsend, New York City.

(350) — A flue ruptured October 26, in a Vertical Flue boiler at the sand mill of the Standard Silicon Company, Hartford, Ohio.

(351) — An elbow failed in a blow-off pipe October 27, at the pumping station of the East Bay Water Company, Berkeley, Cal.

(352) — On October 29, a tube ruptured in a water tube boiler at the candy factory of the George Ziegler Company, Milwaukee, Wis.

(353) — A head ruptured in a paper drying cylinder October 30, at the paper mill of the Hammermill Paper Company, Erie, Pa.

(354) — A hot water boiler exploded October 30, at Fire Engine House No. 26, Baltimore, Md. No one was injured.

(355) — Two sections cracked October 31, in a cast iron sectional heating boiler at the Lincoln School, Waverly, Iowa.

(356) — An accident occurred October 31, to a boiler at the mill of the North State Lumber Company, Charleston, S. Carolina.

(357) — A main steam pipe burst October 28, at the power plant of the Memphis Gas & Electric Company, Memphis, Tenn. Six men were injured and a very serious interruption of light and power to the city of Memphis resulted.

November, 1918.

(358) — A section cracked November 1, in a cast iron sectional heating boiler at the plant of the Silk Finishing Company of America, New York City.

(359) — Three sections cracked in a cast iron section heating boiler November 1, at the plant of the Sonken-Galambia Iron and Metal Company, Kansas City, Kansas.

(360) — On November 1, a section cracked in a cast iron sectional heating boiler at the plant of the J. P. Eustis Manufacturing Company, Cambridge, Mass.

(361) — Several sections cracked November 2, in a cast iron sectional heating boiler at a building owned by the Transit Building Corp., New York City.

(362) — A steam pipe burst November 2, at the mill of the Gardner Paper Box Board Company, Middletown, Ohio. One man was painfully injured.

(363) — On November 4, a boiler ruptured at the sugar house of the Lula Company Inc., Belle Rose, La.

(364) — On November 5, a boiler ruptured at the plant of the Corona Coal Company, Townley, Ala. One man was injured.

(365) — A section cracked November 6, in a cast iron sectional heating boiler at the restaurant of William Baumeister & N. Severenson, Omaha, Neb.

(366) — A tube ruptured November 6, in a water tube boiler at the plant of the American Sheet & Tin Plate Company, Monessen, Pa.

(367) — A tube ruptured November 7, in a water tube boiler at the plant of the American Sheet & Tin Plate Company, Monessen, Pa.

(368) — A tube pulled from the drum in a water tube boiler November 7, at the plant of the American Sheet & Tin Plate Company, Monessen, Pa.

(369) — A tube ruptured November 7, in a water tube boiler at the plant of the Leighvalley Transit Company, Allentown, Pa.

(370) — Four sections cracked November 9, in a cast iron sectional heating boiler at the Avon Theater of the American Motion Picture Company, Inc., Utica, N. Y.

(371) — A section cracked November 10, in a cast iron sectional heating boiler in the office building of J. E. Josey, R. C. Miller & J. S. Gordon, Beaumont, Texas.

(372) — Two furnaces collapsed November 11, in the dredge boat "Nelson Z. Gaves" belonging to P. Sansford Ross Inc., of Jersey City, New Jersey, but operating at the Army Supply Base, Norfolk, Va.

(373) — Two sections cracked November 11, in a cast iron sectional heating boiler in the bank building of the Exchange Bank of Albany, Albany, Ga.

(374) — A steam pipe failed November 11, at the plant of the Cincinnati Coffin Company, Cincinnati, Ohio.

(375) — A tube ruptured November 13, in a water tube boiler at the

Buckingham Ave. Station of the Public Service Corp. of New Jersey, Perth Amboy, N. J.

(376) — Four sections cracked November 13, in a cast iron sectional heating boiler in school No. 31, Jersey City, New Jersey.

(377) — Three sections cracked November 15, in a cast iron sectional heating boiler in the office building at 11-17 Central St., Boston, Mass.

(378) — A locomotive fire box failed November 16, in a locomotive owned by the Babcock Lumber & Boom Company, Vose, Tenn.

(379) — A section cracked November 17, in a cast iron sectional heating boiler in the apartment house of David Nissnewitz, New York City.

(380) — Three headers failed November 17, in a water tube boiler at the plant of the Hegeler Zinc Company, near Danville, Ill.

(381) — An accident occurred to an air tank due to an explosion in air pipe line with which it was connected November 17, at the Eddystone, Penn. plant of the Baldwin Locomotive Works.

(382) — Two sections cracked November 20, in a cast iron sectional heating boiler at the Elks Club, San Antonio, Texas.

(383) — A section cracked November 22, in a cast iron sectional heating boiler at the bolt manufacturing plant of the Garwood Company, Garwood, N. J.

The Metric System.

Nearly every issue of The Locomotive contains a brief note of a little volume published and offered for sale by The Hartford Steam Boiler Inspection and Insurance Company entitled The Metric System.

This little book size 3½ by 5¾ inches contains 196 pages, devoted to a history of the metric system, a discussion of the sources of information and the data used in the compilation of the tables, and finally, comprising by far the greater part of the work, to a set of exceedingly convenient tables for the conversion of quantities in any of the English units to their metric equivalents, and vice versa. No conversion tables have appeared more convenient than these for ready and quick reference and we feel sure that any one not familiar with the book who has occasion to convert from English to metric, or metric to English measure would be surprised at the saving in time gained by its use.

This little book is to be had bound in sheepskin by addressing The Hartford Steam Boiler Inspection and Insurance Company, Hartford, Connecticut, inclosing $1.25.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1919.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$361,295.49
Real estate		90,000.00
Mortgage and collateral loans		1,505,900.00
Bonds and stocks		5,121,486.85
Premiums in course of collection		654,112.42
Interest accrued		108,152.83
Total assets		$7,840,947.59

LIABILITIES.

Reserve for unearned premiums		$3,429,363.68
Reserve for losses		153,378.80
Reserve for taxes and other contingencies		367,147.68
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,891,057.43	
Surplus to Policy-holders,		**$3,891,057.43**
Total liabilities		$7,840,947.59

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS OF PROPERTY

AS WELL AS DAMAGE RESULTING FROM

LOSS OF LIFE AND PERSONAL INJURIES DUE TO EXPLOSIONS OF STEAM BOILERS OR FLY WHEELS.

Department.	Representatives.
ATLANTA, Ga., 1314 Empire Bldg.	W. M. FRANCIS, Manager and Chief Inspector. C. R. SUMMERS, Ass't Chief Inspector.
BALTIMORE, Md., 13-14-15 Abell Bldg.	LAWFORD & MCKIM, General Agents. R. E. MUNRO, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq., Cor. Water St.	WARD I. CORNELL, Manager. CHARLES D. NOYES, Chief Inspector.
BRIDGEPORT, Ct., 404-405 City Savings Bank Bldg.	W. G. LINEBURGH & SON, General Agents. E. MASON PARRY, Chief Inspector.
CHICAGO, Ill., 160 West Jackson St.	J. F. CRISWELL, Manager. P. M. MURRAY, Ass't Manager. J. P. MORRISON, Chief Inspector. J. T. COLEMAN, Assistant Chief Inspector.
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CLEVELAND, Ohio, Leader Bldg.	H. A. BAUMHART, Manager and Chief Inspector. L. T. GREGG, Ass't Chief Inspector.
DENVER, Colo., 918-920 Gas & Electric Bldg.	J. H. CHESTNUTT, Manager and Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. WILLIAMS, JR., General Agent. E. MASON PARRY, Chief Inspector.
NEW ORLEANS, La., 305 Canal Bank Bldg.	R. T. BURWELL, Manager and Chief Inspector.
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ST. LOUIS, Mo., 319 North Fourth St.	C. D. ASHCROFT, Manager. EUGENE WEBB, Chief Inspector.
TORONTO, Canada, Continental Life Bldg.	H. N. ROBERTS, President Boiler Inspection and Insurance Company of Canada.

The Locomotive of The Hartford Steam Boiler Inspection and Insurance Co.

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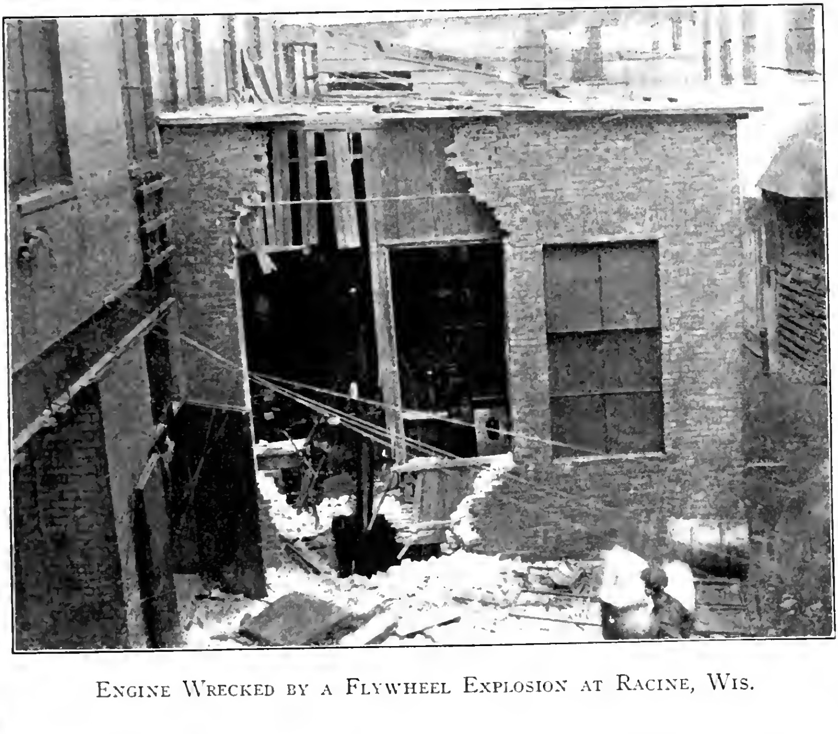

Engine Wrecked by a Flywheel Explosion at Racine, Wis.

Flywheel Explosion at Racine, Wis.

On our cover we show a photograph of the wreck caused by the explosion of a flywheel at the plant of the Racine Industrial Works, Racine, Wis., on August 15, 1919. The wheel which was 12 feet in diameter was belted to two generators by means of two belts, one riding on top of the other. The wheel in its explosion did a considerable amount of damage to buildings and to the generators to which it was belted. The extent of the damage is indicated by the fact that it was estimated at over $15,000. One man was instantly killed as he was trying to gain access to the boiler room to shut down the engine, and several others were injured. An interesting and very unusual feature of the accident is the fact that after the wheel exploded the Chief Engineer, who had been in another part of the plant, is said to have found the engine running quietly under control of the governor, and he proceeded to shut it down. This fact would seem to indicate that the governor was in no way responsible for the accident.

The wheel was not protected by insurance but we are glad to say that the wheel on another engine in the same engine room, which was not involved in the accident, now carries that very desirable form of protection.

Protecting Boiler Drums from Over Heating.

A bulged spot on a boiler shell is not an uncommon occurrence. We associate it usually with the fire sheets of horizontal tubular boilers, the crown sheet of locomotive boilers, and in general with the furnace tops of internally fired boilers. The cause may be either shortness of water or an accumulation of oil, mud or scale. When a steel plate or a steel tube is exposed to the hot products of combustion on one side, and is covered with water on the other side in a well designed boiler, heat is transmitted from the hot gases and from the radiating fuel bed through the metal to the water at a sufficiently rapid rate to keep the temperature of the metal well below the range at which it begins to lose its strength and become soft and plastic. If, however, some substance comes between the metal and the water which cannot remove the heat from the metal as fast as it is received from the fire and the hot gases, the metal becomes gradually hotter till a point is reached at which it is no longer able to withstand the stresses imposed by the steam pressure within the boiler and the plate or tube swells out into a bulge. If the bulged metal continues to receive heat at a faster rate than it can dispose of it the bulge increases in size and the metal wall gets thinner and thinner until it ruptures at the weakest point.

COMMON CAUSES FOR BULGING.

There are many different conditions which may result in a bulged spot in a boiler and since the portion of the boiler directly exposed to the action of the flame and combustion products is usually below the normal water line, we are apt to look for this condition only at such points. The most common cause for bulges below the normal water line of a boiler is of course a deposit of some sort of heat resisting material on the water side of the metal. This may be an oil film or it may be a deposit of mud or scale matter from the boiler water. In either case if it provides sufficient hindrance to the flow of heat, a bulge will result. These causes have been discussed in the columns of The Locomotive for years and they are very familiar to engineers. Another common cause for the bulging and rupturing of boilers is found in some abnormal working condition which permits the water line to become dangerously low. Under these circumstances as soon as steam and not water covers the surface of metal exposed directly on the opposite side to the heat of the products of combustion, overheating of the metal which will result in bulging and rupture is likely to start because heat cannot flow as readily through a metal and into steam as it can flow through the same metal and into water.

SUPERHEATING SURFACE

To be sure superheaters are made in various ways with special provisions for the rapid absorption of heat by the steam and for considerable reserve strength to resist the tendencies to bulge on the part of the metal, in which heat can be safely and profitably transmitted directly from the hot gases to steam through metal. It is also true that a properly designed vertical fire tube boiler may have a portion of the upper end of the tubes exposed on the one side to the steam and on the other to hot gases with no serious results. In general, however, a portion of a shell or drum of a boiler, whether of the fire tube or water tube type, which is exposed to combustion products on one side and is not covered by water on the other side is apt to prove troublesome if not dangerous.

THREE PASS SETTING.

Formerly it was common in some parts of the country to return the gases from an ordinary horizontal return tubular boiler from the front end after they had passed through the tubes directly back across the top of the boiler in a brick flue of which the upper surface of the boiler shell was a floor, to a stack connection at the back. This arrangement has been known locally as a three pass setting. It probably succeeded in running without serious injury to the boiler (when it did so succeed) chiefly because the gases were pretty well cooled before they emerged from the tubes at the front end and also because as the boiler shell formed the bottom of the third pass, it must inevitably become heavily blanketed with soot and fine ash in an exceedingly short time. Soot and ash are rather better insulators to heat flow than many forms of pipe covering and so the top of the shell usually became protected with soot. When it is remembered that if soot enough was deposited on the boiler top to protect the shell plates there would certainly be enough of it to practically prevent any possible economy through the additional absorption of heat from gases by the steam. Also since the supposed extra absorption of heat was the only reason for providing the extra gas pass, a matter of some expense and much inconvenience as such a pass greatly complicates the provision of proper and accessible manholes and the location of a safety valve close to the boiler shell, there is no great difficulty in seeing why its use is rapidly declining even in the regions where it had become a nearly standard method of installing boilers.

THE PROTECTION OF BOILER DRUMS.

When horizontal tubular boilers are set, care is taken that the brick work of the settings shall come close enough to the boiler shell so that the joints can be tightly packed with asbestos rope. The line at which the brick setting and the shell are joined through this packed joint is about where a horizontal plane through the horizontal diameter of the head would cut the shell and this is several inches below the usual working water line. In the event of low water, several rows of tubes would be exposed to the fire before any unprotected portion of the shell comes in contact with hot gases. However, in some sorts of water tube boilers, the settings are so arranged that parts of the space open to the gases are in contact with portions of the surface of steam drum, which are not always covered with water on the steam side. This condition may be aggravated at times of heavy load by the fact that the water line is not uniform throughout all parts of a water tube boiler, but may rise due to the effect of the rapid circulation in some of the tubes and drums or in some portion of the boiler, only to correspondingly fall at other points. The amount of this rise and fall varies with the rapidity of the circulation, and the load on the boiler. A further condition to be reckoned with is the fact that although where the rate of combustion is moderate and the furnace conditions good, combustion may be completed long before the gases reach the relatively out of the way corners where the shell surface is exposed above the water line. Still under overload conditions, or with poor firing, an entirely different set of circumstances may arise.

SECONDARY COMBUSTION.

It is not uncommon for a portion of the fuel bed to give off combustible gas in a solid stream at a rapid rate. This solid stream may easily pass through a considerable part of the combustion space without burning. It will do this for example if it is not properly mixed with air, for gas cannot burn without air, no matter how hot the surroundings. If such a stream of hot combustible gas gets up into the corners of the setting and there finds air which is perhaps leaking through small cracks in the brick or tile, it will often burst into flame and burn strongly at these points, notwithstanding that it has come a long way from the main part of the fire. Such burning of combustible gas when boilers are being forced on coming in contact with air, is the thing which is occasionally seen as a flame at the top of the stack, especially in the case of gas retorts and foundry cupolas and is known as secondary combustion. It should be clear that if secondary combustion occurs in a corner of a boiler setting alongside of a portion of the boiler shell and above the water line, serious and perhaps dangerous bulging of the shell is the result to be expected, probably also followed by a more or less violent rupture. Indeed such a rupture might easily be sudden and large enough to start a boiler explosion; for once released, there would be abundant energy stored in the hot water and steam within the boiler to continue the destruction.

THE OBVIOUS CURE.

In any case even if the rupture was a small one resulting only in the gradual release of the steam from the boiler, the accident would prove inconvenient and expensive. The means for preventing such accidents is simple and should be obvious. It consists merely in carefully studying the setting of a boiler to see if it is possible that the water line in ordinary operation can drop low enough to expose portions of the shell unprotected by water to the gases. If this is possible the setting should be changed immediately so that this contact will become impossible.

Some Mathematics of Boiler Construction

H. J. VANDER Eb.

In checking over the design of an ordinary horizontal tubular boiler, to see whether it conforms to the requirements of the A. S. M. E. boiler code, most of the details of construction involve calculations of a comparatively simple nature. With the help of the calculation rules of this excellent Code the experienced inspector can usually decide in quick order whether such a boiler conforms.

One of the details of horizontal tubular boiler design, however, that requires calculations of a somewhat involved nature is where use is made of angle irons or other members securely riveted to the rear head below the tubes for attaching the through stays as shown in fig 1.

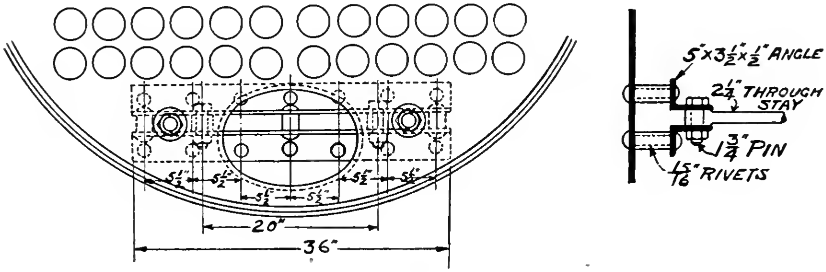

FIG. 1.

A worked out example of the necessary calculations to check this construction will best serve to illustrate.

The area to be stayed below the tubes in fig. 1 is 350 square inches and the working pressure is 150 lbs.

Then total load $P = 350 \times 150 = 52{,}500$ *lbs.*

The through stays have a least diameter of 2¼" so that according to paragraph 220*c*, on page 58 of the Code*) we may allow 9,000 lbs. fibre stress per square inch in these stays.

The least area required in each through stay is then: $\frac{52{,}500}{9{,}000 \times 2} = 2.92$ *sq in.*, which requires a least diameter of stay of 1.93 inch.

The two 2¼" stays are therefore within requirements.

The least required rivet area for attaching braces to head (according to par. 223-8 on page 60) equals:

$$2.92 \times 2 \times 1.25 = 7.3 \text{ square inches.}$$

*1918 Edition. A. S. M. E. Boiler Code.

In the design shown are used fourteen 15/16 inch rivets having a combined area of 9.67 square inches so that this rivet detail is well within requirements.

The pins in the stays are required (in paragraph 223-3) to have a least cross sectional area of:

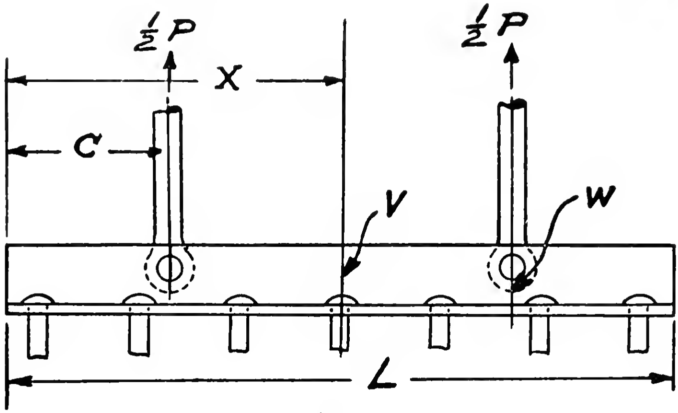

FIG. 2.

$\frac{3}{4} \times 2.92 = 2.19$ *square inches,* which requires a least diameter of pin of 1.67 inch. As these pins are 1¾ inch, they therefore are within requirements.

We now have to investigate the strength or stiffness of the two 5″ × 3½″ × ½″ angles. The requirements of this detail are covered by paragraph 201 on page 52 of the Code which states that "the transverse stress in such members shall not exceed 12,500 lbs. per sq. in." and furthermore that when "the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the boiler and provided that the spacing of these rivets attaching the members to the head is approximately uniform the members may be computed as a single beam uniformly loaded and supported at the points where the through stays are attached."

It is first necessary to determine M, the maximum bending moment these angles are subject to.

This may be either at point v in fig. 2 according to the formula:

$$M = \frac{PX}{2}\left(1 - \frac{C}{X} - \frac{X}{L}\right)$$

or at point w according to:

$$M = \frac{PX^2}{2L}$$

whichever is the greatest.

In this case the last formula gives the highest results.

Therefore $M = \dfrac{52{,}500 \times 8^2}{2 \times 36} = 46{,}660$ *inch lbs.*

The required resistance of the two angle irons against bending, also called the section modulus, which we will designate by S, can now be obtained from the formula:

$$S = \frac{M}{f}$$

in which f equals the fibre stress.

therefore $S = \dfrac{46{,}600}{12{,}500} = 3.74$

The cross section of the angles which has to possess this section modulus is at the pin holes, where the greatest moment was found to exist, and is shown in fig. 3.

The section modulus of a cross section of a beam is obtained by dividing the moment of inertia of that section by the distance of the outermost fibre to the neutral axis. This distance is marked a in fig. 3. The neutral axis is a line coinciding with an imaginary plane called the "neutral surface" which is supposed to pass through the center of gravity of the cross section.

To find the distance of the center of gravity of the section to the bottom line marked b in fig. 3, we can make use of the following rule:

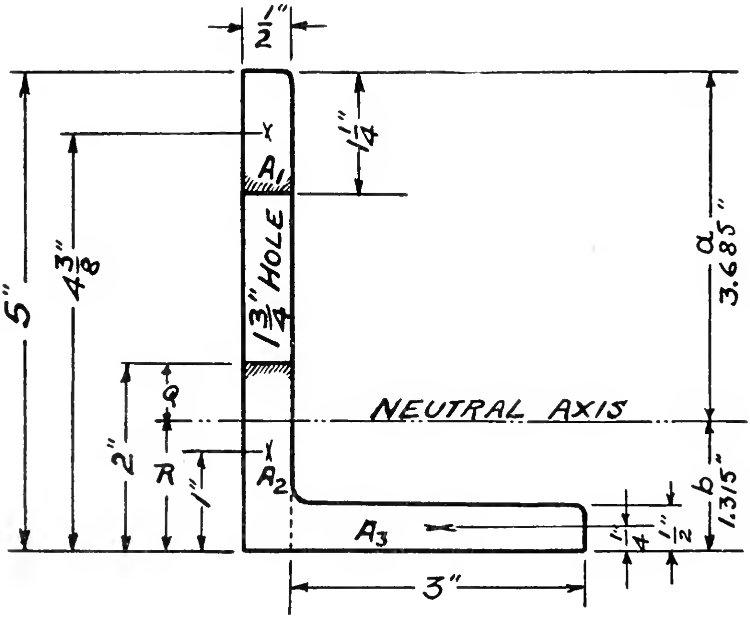

FIG. 3.

Taking the sum of the areas A_1, A_2 and A_3 each multiplied by the respective distances of their centers to the bottom line and divide this by the total area. The result is distance b.

We therefore have:

$$Y = \frac{\frac{1}{2} \times 1\frac{1}{4} \times 4\frac{3}{8} + 2 \times \frac{1}{2} \times 1 + 3 \times \frac{1}{2} \times \frac{1}{4}}{\frac{1}{2} \times 1\frac{1}{4} + 2 \times \frac{1}{2} + 3 \times \frac{1}{2}}$$

$Y = 1.315$ *inch*, and $X = 5 - 1.315 = 3.685$ *inch*

The moment of inertia (I) of the section can now be calculated in the following manner:

Moment of inertia of area A_1 with respect to its own center is

$$I_1 = \frac{bh^3}{12} = \frac{\frac{1}{2} \times 1\frac{1}{4}^3}{12} = .081$$

Moment of inertia of area A_3, with respect to its own center is

$$I_3 = \frac{3 \times \frac{1}{2}^3}{12} = .031$$

The two moments I_1 and I_3 will now have to be reduced to moments of inertia about the neutral axis of the whole section which can be done by the following rule:

Add to each of the moments I_1 and I_3 the product of their respective areas times the square of the distance of their centers to the neutral axis. The results are their moments of inertia about the neutral axis of the whole section.

According to this we have then:

I_1 referred to neutral axis of whole section

$$= I_1 + \tfrac{5}{8}\left(4\tfrac{3}{8} - 1.315\right)^2$$
$$= .081 + 5.86 \qquad = 5.941$$

I_3 referred to neutral axis of whole section

$$= I_3 + 1\tfrac{1}{2}\left(1.315 - \tfrac{1}{4}\right)^2$$
$$= .031 + 1.7 \qquad = 1.731$$

To this has to be added:

$$I_Q = \text{moment of inertia of area } Q \times \tfrac{1}{2}'' = \frac{\frac{1}{2} \times .685^3}{3} = .053$$

and

$$I_R = \text{“ “ “ “ “ } R \times \tfrac{1}{2}'' = \frac{\frac{1}{2} \times 1.315^3}{3} = .38$$

Then total moment of inertia $I = 8.105$

And the section modulus of 2 angles in the cross section through the $1\frac{3}{4}''$ holes is:

$$\frac{2 \times 8.105}{3.685} = 4.4$$

As the required section modulus was found to be only 3.74 this construction meets the requirements of the Code.

Table of Moments of Inertia of Rectangles

REFERRED TO THE BASE LINE AS AN AXIS

h (inches)	I	h (inches)	I	h (inches)	I
0	0.000	**5**	41.667	**10**	333.33
1/8	0.000	1/8	44.870	1/8	345.99
1/4	0.005	1/4	48.234	1/4	358.96
3/8	0.018	3/8	51.762	3/8	372.26
1/2	0.042	1/2	55.458	1/2	385.88
5/8	0.082	5/8	59.326	5/8	399.82
3/4	0.141	3/4	63.370	3/4	414.10
7/8	0.223	7/8	67.593	7/8	428.71
1	0.333	**6**	72.000	**11**	443.67
1/8	0.475	1/8	76.594	1/8	458.96
1/4	0.651	1/4	81.380	1/4	474.61
3/8	0.867	3/8	86.361	3/8	490.61
1/2	1.125	1/2	91.541	1/2	506.96
5/8	1.430	5/8	96.925	5/8	523.67
3/4	1.786	3/4	102.516	3/4	540.74
7/8	2.197	7/8	108.317	7/8	558.19
2	2.667	**7**	114.333	**12**	576.00
1/8	3.199	1/8	120.57	1/8	594.19
1/4	3.797	1/4	127.03	1/4	612.76
3/8	4.465	3/8	133.71	3/8	631.71
1/2	5.208	1/2	140.62	1/2	651.04
5/8	6.029	5/8	147.77	5/8	670.77
3/4	6.932	3/4	155.16	3/4	690.89
7/8	7.921	7/8	162.79	7/8	711.41
3	9.000	**8**	170.67	**13**	732.33
1/8	10.173	1/8	178.79	1/8	753.66
1/4	11.443	1/4	187.17	1/4	775.40
3/8	12.814	3/8	195.81	3/8	797.55
1/2	14.292	1/2	204.71	1/2	820.13
5/8	15.878	5/8	213.87	5/8	843.12
3/4	17.578	3/4	223.31	3/4	866.54
7/8	19.395	7/8	233.02	7/8	890.38
4	21.333	**9**	243.00	**14**	914.67
1/8	23.396	1/8	253.27	1/8	939.39
1/4	25.589	1/4	263.82	1/4	964.55
3/8	27.913	3/8	274.66	3/8	990.15
1/2	30.375	1/2	285.79	1/2	1016.21
5/8	32.977	5/8	297.22	5/8	1042.72
3/4	35.724	3/4	308.95	3/4	1069.68
7/8	38.619	7/8	320.99	7/8	1097.11
5	41.667	**10**	333.33	**15**	1125.00

Moments of Inertia and Center of Gravity.

An article on another page of this issue of The Locomotive describes a means of finding whether angle irons, which are used to distribute the bracing effect of through rods beneath the tubes of a horizontal tubular boiler are sufficiently strong to meet the requirements of the A. S. M. E. Boiler Code.

One of the quantities which enter into the calculation is the moment of inertia of the cross section of an angle iron taken through the point of maximum bending moment. This moment of inertia must be taken about an axis which passes through the center of gravity of the section in question. Moments of inertia and centers of gravity of sections of angle irons are not things which the boiler inspector has been accustomed to calculate, and the necessity for calculating these things may make a substantial stumbling block of the process of finding whether a particular set of angles is strong enough to satisfy the Code requirements.

THE USE OF THE TABLE.

In The Locomotive for July, 1905, there appeared a discussion of this same problem in connection with an investigation of the strength of digester or vulcanizer mouth piece rings, and a table was published which greatly simplified the calculation of the moment of inertia of a simple section such as an angle iron. Thinking that this table might prove useful in connection with the calculation of these rear head angle irons, we reprint the table in this Locomotive and will give a short description of the manner in which it may be used. This table gives the moment of inertia of any rectangle one inch wide, about an axis along its base. The side from which the dimension "*h*" is measured, as used in the table, is to be considered the base. Any rectangle up to 15″ in height — one inch wide may have its moment of inertia read directly from the table, but if its width is not one inch, the moment may be found by multiplying the value in the table by the width of the rectangle in inches. Sections which are not rectangular may often be divided up into rectangles, and so may have their moments of inertia calculated from the table by finding the moments of each of the parts by adding them together. As an example consider the " L" shaped figure in figure 1. It may be considered as made up of two rectangles A B F G and C D E F. Suppose it is desired to obtain the moment of inertia about the line G E which we will take as the base of the figure. Suppose the height A G is 4 inches and the width A B ½ inch, also suppose the height A G is 4 inches and the the height D E, ⅝ inch. From the table it is seen that the moment

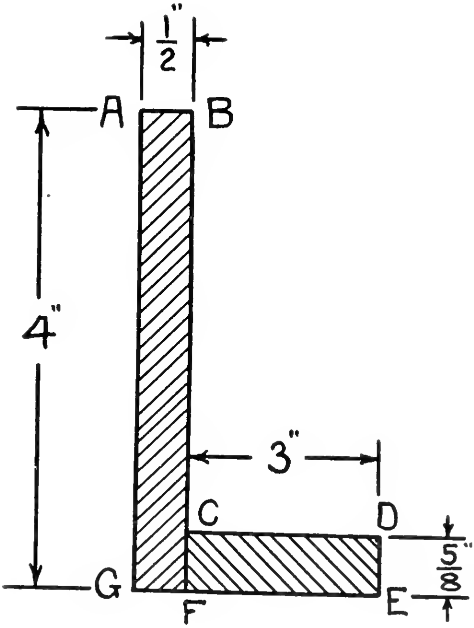

FIG. 1.

of inertia of a rectangle 4 inches long and one inch wide is 21.333. Now since the rectangle A B G F is only ½ inch wide its moment of inertia is half this amount or 10.666. Taking the short leg of the L, a rectangle ⅝ inch high and one inch wide has a moment of inertia of 0.082 and one 2 inches wide will be just twice this amount or 0.164. Then the moment of inertia of the whole figure about the line G E would be $10.666 + .164 = 10.830$.

ANOTHER CASE.

Suppose now that it is desired to calculate the moment of inertia of an angle iron like the one shown in figure 3 on page 232 which has a hole 1¾ inches in diameter in the leg at the point where the section is taken. Figure 2 shows how this section may be split up into rectangles as A K J B, C I E D and H G F E. We will now proceed to get the moment of inertia of the section about the line D F. Let us start with rectangle H G F E. Here the height is ½ inch and from the table we see that the moment of inertia for a rectangle ½ inch high and one inch wide is 0.042. As H. G. is 3 inches, $3 \times 0.042 = 01\ 26$, which is the moment required. Now let us consider C I E D. This rectangle is 2 inches high and if it were one inch wide its moment from the table would be 2.667. As it is only ½ inch wide its moment is ½ of 2.667 or 1.333. Now we have to consider rectangle A K B J. This rectangle is 1¼ inches high, but if we were to take from the table the value for 1¼ inches, we should get the moment of inertia of this rectangle about the line B J. We are interested, however, in the moment about the line D E. We must therefore go about it in a somewhat different way. We can get the moment of the rectangle A K D E from the tables, and it will be ½ of the value for 5 inches or 20.833. We can also get the moment from the table for B J D E and it is ½ of the value for 3¾ inches or 8.789. Now if we subtract the moment for B J D E (about the line D E) from the moment

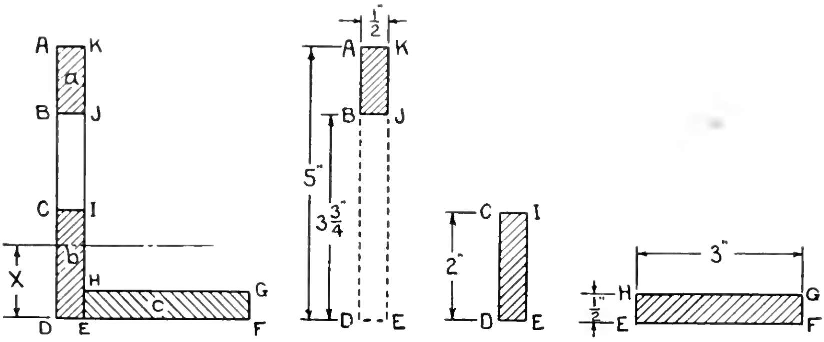

FIG. 2.

for A K D E (about the line D E) we get *20.833 — 8.789 = 12.044* as the moment of A K J B about the line D E. Now adding up *0.126 + 1.333 + 4.044 = 13.503*, which is the moment of inertia of the angle iron section about the line D F.

CHANGING THE AXIS.

For the purpose of getting the strength of a beam it is often necessary to get the moment of inertia of the section about some axis other than one through its base. When this becomes necessary the procedure is as follows:— First find the moment about the base, using the table as we have indicated. Then find the moment about the center of gravity of the section. To do this involves a knowledge of how far the center of gravity is from the base about which the moment of inertia has been calculated. Then use is to be made of a general rule or principle; namely that the moment of inertia of a figure about any axis is equal to the moment of inertia about a parallel axis through its center of gravity, plus the area of the figure multiplied by the square of the distance between these two axes. Hence if you once get the moment of inertia of a figure about its center of gravity, you can find it for any axis parallel to the one which you have used through the center of gravity. To find the location of the center of gravity of a figure such as this angle iron section, which is made up of rectangles, is comparatively simple. Here we do not care for the exact position of the center of gravity, we only want to know how far it is from the line D F. The center of gravity of any simple rectangle is located at the geometric center of the figure. Thus in A K B J the center of gravity is half-way between A K and B J or 4⅜ inches above D F. In C I E D the center of gravity is half-way between C I and D E or one inch above D E, and the center of gravity of H G F E is ¼ inch above E F. Now in a complex figure the center of gravity will lie at some distance X above the base line such that $X = \frac{am + bn + cp}{a + b + c}$ where a b & c are the areas of the component rectangle and m n p the distances of their centers of gravity respectively from the base line. In this particular case $A = 5/8$ sq. in. and $m = 4\frac{3}{8}$ inches, $b = 1$ sq. in. and $n = 1$ inch; $c = 1\frac{1}{2}$ sq. inches, while $p = \frac{1}{4}$ inch. Hence:

$$X = \frac{\frac{5}{8} \times 4\frac{3}{8} + (1 \times 1) + (1\frac{1}{2} \times \frac{1}{4})}{\frac{5}{8} + 1 + 1\frac{1}{2}} = 1.315 \text{ inches.}$$

Then to get the moment of inertia of the figure about an axis through its center of gravity parallel with the base we apply our rule as follows: The moment about the base is equal to the moment about the center of gravity, plus the area times X^2, or $I_{base} = I_{c.g.} + X^2A$, or the moment of inertia about the center of gravity equals the amount about the base minus X^2A.

$X = 1.315$
$X^2 = 1.73$
$A = 3.125$
$X^2A = 5.39$

The moment about the base equals 13.503. Subtracting 5.39, we find that the moment about the center of gravity equals 8.113.

WHAT A MOMENT OF INERTIA IS.

Nowhere in the above description of how to use the table in calculating moments of inertia have we said anything about what a moment of inertia is. Actually there is no such thing as the moment of inertia of an area or a figure because the very word "inertia" means mass or matter and an area has no thickness and no mass or matter in it. Perhaps a few words of description will prove of interest to our non-mathematical readers on this point. If a body is at rest and an effort is made to start it moving, the body resists being moved. The more material there is in a body the more it resists. In the same way if a body is in motion and we endeavor to stop it, or change its motion, it resists the change in its motion just as much as it resists being set in motion from rest. This property of a body of resisting a change in its condition of being at rest or being in motion we call inertia and as we have said, it is in some way proportional to the amount of matter in a body. When a body is set moving in a circle, or rotating, it is found that it is necessary to know something more than the amount of matter in it before we can tell how much it will resist being started or stopped. For example, suppose there are two wheels with exactly the same amount of iron in the rim of each, but one has a heavy thick rim of small diameter and the other has a light thin rim of larger diameter. Experience shows that the same amount of iron in the rim of large diameter is harder to start or to stop, or to speed up or to slow down, than when it is in the form of the thick rim of smaller diameter. Investigation has shown that what counts is to take each little particle of a rotating mass and multiply the mass of that particular particle by the square of its distance from the axis about which it turns, then add up all these quantities and their sum which we call *moment of inertia* is the measure of how hard it is to start or stop the thing or to change its speed of rotation.

It is a very important quantity in designing flywheels, and getting it right, in the case of a flywheel, is necessary if the wheel is to prevent speed fluctuation in the engine, which is one of the principal reasons why flywheels are used.

In the theory of the bending of beams a quantity has to be calculated to determine the stiffness or strength of the beam to resist bending, which is in form just like a moment of inertia, and which has been called the moment of inertia of a section on this account. This quantity is calculated by thinking of the area as made up of a great many small areas, which taken together equal the whole. Now if each little area is multiplied by the square of its distance from the axis about which the moment is to be taken and all the small products added up, a number is obtained which is in many respects like moment of inertia except that small areas have been multiplied by the square of their distance from an axis instead of small masses.

The method by which these small quantities may be added up and a value attached to their sum is one which belongs to the integral calculus. It is quite sufficient here to state that such a thing is possible and that by this means formulæ have been developed, from which such a table as that printed in this number of the Locomotive can be computed.

The James Watt Centenary.

On Sept. 16th, 17th and 18th, 1919, at Birmingham, England, commemorative exercises were held in honor of the one hundredth anniversary of the death of James Watt. An extended program was carried out consisting of lectures and visits to points of interest in connection with Watt's life and work, including excursions to two of Watt's engines which are still in existence. One of these engines located at Ocker Hill, near Wednesbury, was originally erected in 1776 at Smethwick for the Birmingham Canal Company and is the earliest pumping engine built for sale by Boulton & Watt. It was regularly working until 1892 and was re-erected in its present position in 1898. Through the courtesy of the owners this engine was to be exhibited working under steam and it was expected that cards would be taken from it with Watt's original indicator. The other engine was located at Bordesly and is still in the building in which it was erected.

In connection with this centenary commemoration is seems well to consider some of the contributions which Watt made to the development of steam power and the steam engine. With this in view it is well to note first the state of development of the steam engine when Watt began to study it and attempt its improvement. No steam engines were being used for turning shafting directly and in the form which had met some success as a means for pumping water from mines the atmospheric pressure and not the pressure of steam was the real driving force. It is true that in some cases water pumped by the cumbersome "atmospheric" engine was allowed to flow over a water wheel and so furnish power indirectly, but this was as far as the development of mechanical power from the energy of steam had gone when Watt commenced his experiments.

NEWCOMEN'S ENGINE.

The "atmospheric" engine, also known as the "Newcomen" engine was an interesting machine, but its water rate must have been startling to say the least. It consisted of a vertical cylinder, open at the top with a connection at the bottom to the boiler in which was a sliding valve arranged to be opened and closed either by hand or from the engine. A rather loose fitting piston was placed in this vertical cylinder and from it a chain extended upward to one end of a walking beam. The piston could be used to pull down on the walking beam, but it could not push, because of the chain connection so the engine could be single acting only. The other end of the walking beam was connected to the pump plunger which was made heavy enough to return to the bottom of its stroke and raise the engine piston after each working stroke.

The manner of working was about as follows: The steam valve between the steam cylinder and the boiler was opened. This equalized the pressure above and below the piston as the boiler pressure was seldom greater than that of the air and the heavy pump rod descended lifting the engine piston to the top of the cylinder. Then the steam valve was closed and a water connection opened which allowed water to spray into the steam in the cylinder and condense it. As soon as a partial vacuum was formed, the atmospheric pressure on the top of the piston caused it to fall, raising the pump plunger and pumping water. When the piston reached the bottom of its stroke, steam was again admitted to the lower part of the steam cylinder building up a pressure equal to the atmospheric pressure. The pump plunger again pulled up the piston and it was ready for another stroke. All together it was a pretty crude cumbersome affair. The piston was maintained tight by letting water run on top of it and leak down around the edges. This formed a water seal and whatever water leaked into the steam space merely helped condense the steam. As will be seen, the only work which the steam did was to equalize the pressure above and below the piston and to enable the water spray to create a vacuum through condensation. Such was the steam engine when Watt, an instrument maker by trade, engaged in repairing for the University of Glasgow, a model of Newcomen's engine, was struck by the fact that it required so much steam to work it that the boiler supplied with the model was not nearly large enough to keep it working, although the apparent relation between the size of the boiler and the size of the cylinder struck him as ample for the purpose. He was not satisfied till he found why the little boiler could not supply enough steam, and then he immediately set himself to work to devise an engine which would be without this serious defect.

WATT'S PATENTS.

In J. A. Ewing's textbook on The Steam Engine, the original specifications of Watt's patents are given and we quote as follows:

"My method of lessening the consumption of steam, and consequently fuel, in fire-engines, consists of the following principles:—

"First. That vessel in which the powers of steam are to be employed to work the engine, which is called the cylinder in common fire-engines, and which I call the steam-vessel, must, during the whole time the engine is at work, be kept as hot as the steam that enters it; first by enclosing it in a case of wood, or any other materials that transmit heat slowly; secondly, by surrounding it with steam or other heated bodies; and thirdly, by suffering neither water nor any other substance colder than the steam to enter or touch it during that time.

"Secondly. In engines that are to be worked wholly or partially by condensation of steam, the steam is to be condensed in vessels distinct from the steam-vessels I call cylinders, although occasionally communicating with them, these vessels I call condensers; and whilst the engines are working, these condensers ought at least to be kept as cold as the air in the neighborhood of the engines, by application of water or other cold bodies.

"Thirdly. Whatever air or other elastic vapour is not condensed by the cold of the condenser, and may impede the working of the engine, is to be drawn out of the steam vessels or condensers by means of pumps, wrought by the engines themselves, or otherwise.

"Fourthly. I intend in many cases to employ the expansive force of steam to press on the pistons, or whatever may be used instead of them, in the same manner as the pressure of the atmosphere is now employed in common fire engines. In cases where cold water cannot be had in plenty, the engines may be wrought by this force of steam only, by discharging the steam into the open air after it has done its office....

"Sixthly. I intend in some cases to apply a degree of cold not capable of reducing the steam to water, of contracting it considerably so that the engines shall be worked by the alternate expansion air after it has done its office.

"Lastly. Instead of using water to render the pistons and other parts of the engine air and steam-tight, I employ oils, wax, resinous bodies, fat of animals, quicksilver and other metals in their fluid state."

It will be seen that Watt invented the separate condenser, the steam jacket, expansive working, the driving of the piston of an engine by steam, instead of air pressure, and the application of high pressure steam.

He also arranged his engine for driving a shaft, but would not use a crank and connecting rod because someone else had patented that idea. Instead for many years steam engines drove shafting by means of a system of gearing known as a Sun and Planet motion. He applied the centrifugal governor to his engine, and invented and applied the steam engine indicator. Also later on he arranged the connection between his piston rod and the walking beam so that the engine could push as well as pull, which required a stuffing box and enabled the double acting engine to be made.

From this brief survey it is hoped that the tremendous advances made by Watt in the form and operating principles of the steam engine will be a little clearer to our readers. It is really astonishing that one man could have been responsible for producing at least the element of very nearly all the improvements in the steam engine as used today, starting from so crude an affair as the Newcomen atmospheric pumping engine.

Things You Ought to Know.

One of our Chief Inspectors favors the Locomotive with the item printed below. We are glad to print it as an example of American efficiency. American engineers are noted for their imagination, hence we suppose this description is a sample of high-grade kitchen engineering. However, that may be, we cannot help wondering what happened to the well-known aggressiveness of the Hartford's special agents. Here were, according to the item, 27 pile-drivers, 14 steam shovels, 19 concrete-mixers, all of which might have and probably did possess boilers. Besides there were 10 road-rollers and 67 steam fire-engines, also, of course, provided with boilers. This is a total of 137 perfectly good risks that they appear to have overlooked, not to mention at all the 600-gallon coffee tank. We can understand the engineers' imagination but we can suggest no explanation for permitting all these assorted boilers to remain uninsured.

The following from the Aerofoil, a Scott Field Publication was copied from a letter found near the Southern Railroad station, signed by a member of the air service from this field and supposed to have been written to his father:

"I have been appointed Mess Sergeant of the Flying Detachment, Scott Field, and to show of what my work consists, I will give some few examples of our tasks and efficiency.

"The kitchen range is 500 feet wide and 3,000 feet long, takes 27 experienced firemen to keep the heat at the necessary temperature, 400 cooks on duty at all times, 1,000 mechanical stokers for kitchen police and 1,000 assistant kitchen police who look after the stokers.

"Two hundred washing machines are used for washing the potatoes, 27 pile drivers mash them, 14 steam shovels shovel egg-shells away from the kitchen door. Twenty-two Liberty motors are used in the coffee mills. Dirty dishes are hauled out to 11 blast furnaces, as the dishes are all paper and are burned after each meal. Hot cakes are mixed with 19 concrete mixers and 46 men with bacon rinds attached to their feet continually skate over the large griddle to keep it greased.

"Soup is made in an artificial lake, which keeps 34 dump trucks busy hauling the necessary ingredients. Cooks use steel boats and are dressed in asbestos clothing. Every few minutes they row to the center of the soup lake and drop depth bombs to properly stir the mixture. Sixty-seven fire engines are used to pump soup

(Continued on page 245)

The Locomotive
of
THE HARTFORD STEAM BOILER
INSPECTION AND INSURANCE CO.

C. C. PERRY, EDITOR.

HARTFORD, OCTOBER, 1919.

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.

We desire to call attention to the articles in this issue on the computation of the Moment of Inertia of simple figures, and especially to the article on the investigation of the strength of angle irons to which through braces are attached at the back head of horizontal return tubular boilers below the tubes. This calculation is apt to be troublesome to anyone but a trained engineer, and the present articles were prepared in the hope that they might serve as a guide or model for the calculation of such angles as are to be found on boilers now built or building. It is likely that some cases will occur where the sample calculation does not fit exactly, but those cases are very hard to provide for in preparing an example for non-mathematical readers. It is unfortunte that this calculation cannot be further simplified.

The Correspondence Course of the Hartford Steam Boiler Inspection and Insurance Company appears to be meeting with great success. It has now attained the enviable dignity of repeat orders, that is, some of the firms whose employees have taken the course are so pleased at the improvement in interest and understanding of their work which these men have shown that they have enrolled additional men. This after all is the sincerest proof of its success. Why not investigate its merits for your firemen? Circulars and enrollment blanks on application to the Home Office.

(Concluded from page 243).

to the 954 tables. Bread is cut by 11 high-powered band saws. A perforated endless conveyor properly salts and peppers the victuals. Twenty large street sprinklers are used to place syrup on cakes. Coffee is made in a 600-gallon tank and pumped to the tables thru pipes by 17 centrifugal pumps. Ten five-ton rollers are used to roll the batter. To save labor and cost six-inch mains have been installed from 20 of the country's largest dairies for the supplying of milk.

"Radio telephones are used by the Mess Sergeant, who also uses a motor cycle in traveling around the dining hall and kitchen. All cooks wear gas masks. Ford trucks haul the silverware. Now, dear father, you can see just what I have to do and why I do not desire to quit the army."

OBITUARY.

Benjamin Ford.

On August 15th, 1919, Benjamin Ford, for many years Chief Inspector in the Pittsburgh department of the Company, died at his home in Crafton, Pa. at the advanced age of 87 years.

Mr. Ford was born in Worcestershire, England, in 1832, and came to America with his parents when about 9 years old. In his youth he worked with his father in the Malleable Iron Works of Samuel Reynolds, and later worked in various iron mills in and around Pittsburgh.

He later became an engineer on river steamers, and during the Civil War was an engineer in the Government service on boats plying the Ohio and Mississippi Rivers. He was appointed boiler inspector for Allegheny County, Pa. in 1879, and continued to hold this position until he became Chief Inspector for The Hartford Steam Boiler Inspection and Insurance Co. in 1893. In addition to his duties as boiler inspector for Allegheny County, Mr. Ford was Chief Inspector for the American Steam Boiler Insurance Co. at Pittsburgh from about 1884 or 1885 until the affairs of that company were taken over by the Hartford, and Mr. Ford came to the Hartford to fill a similar position, as we have stated above. Mr. Ford continued to serve loyally and faithfully for many years. Recently, however, advancing years and ill health had forced him to retire from active affairs, though he remained an employee of the Company until his death.

Mr. Ford left two sons, John B. and William J. Ford, and four daughters, Mrs. H. A. Mederich, Mrs. H. J. Taylor and the Misses Sarah and Margaret Ford.

Boiler Explosions.

(CONTINUED FROM THE JULY ISSUE).

NOVEMBER, 1918.

(384.) — Six headers failed November 25th, in a water tube boiler at the plant of the Grasseli Chemical Company, Tremley Point, N. J.

(385.) — A header fractured November 25th, in a water tube boiler at the Cameron Colliery, Shamokin, Penn., belonging to the Susquehanna Coal Company.

(386.) — Two sections cracked November 25th, in a cast iron sectional heating boiler at the City National Bank, San Antonio, Tex.

(387.) — A header cracked November 26th, in a water tube boiler at the rolling mill of Hughes & Patterson, Philadelphia, Pa.

(388.) — A boiler ruptured November 26th, at the Eclipse Laundry, Zanesville, Ohio.

(389.) — An accident occurred to a boiler November 26th, at the plant of the North Fort Worth Ice & Cold Storage Company, North Fort Worth, Texas.

(390.) — Three headers ruptured November 28th, in a water tube boiler at the plant of the Crocker Chair Company, Sheboygan, Wis.

(391.) — An accident occurred November 28th, to a boiler at the plant of the Utah-Idaho Sugar Company, Garland, Utah.

(392.) — A tube ruptured November 28th, in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Blackfoot, Utah.

(393.) — Two sections cracked November 28th, in a cast iron sectional heating boiler in the building used as store and apartment owned by Eleanor C. Gardner, New York City.

(394.) — A tube ruptured November 30th, in a water tube boiler at the plant of the Mulkey Salt Company, Oakwood, Mich.

(395) — A fire sheet ruptured November 30th, in a boiler at the plant of the Sioux Valley Power Company, Canton, So. Dak.

(396.) — An air tank exploded November 4th, used in connection with the City Water Works, Howard, S. Dak.

(397.) — A small rendering tank exploded November 7th, at the abattoir of August Swanson, Hurley, Wis.

(398.) — A heating boiler failed November 14th, in the basement of the Charlotte High School, Charlotte, N. Car.

(399.) — A boiler exploded November 15th, at a cotton gin at Eastover, twenty miles from Columbia, So. Car. Four persons are known to have been killed, and a large number injured.

(400.) — A boiler of a well drilling outfit which was drilling a gas well for the American Steel Company, on Bloody Run, Waynesboro, Penn., exploded about November 15th.

(401.) — A heating boiler exploded November 16th, at Camp Dix, New Jersey.

(402.) — A boiler exploded on November 21st, at the Scruggs Saw Mill, near Meridian, Miss. One man was painfully injured.

(403.) — The boiler of a Texas & Pacific locomotive exploded November 22nd, at Fort Worth, Texas. Four men were injured.

(404.) — A boiler exploded about December 1st, at the Donks Mine, Edwardsville, Ill.

(405.) — A boiler ruptured December 2nd at the shipyard of the Ship Construction and Trading Company, Stonington, Conn.

(406.) — A steam pipe failed December 2nd, at the City plant of the City of Garrett, Garrett, Ind. One man was fatally scalded.

(407.) — Five sections cracked December 4th, in a cast iron sectional heating boiler at the club house owned by the Elks Home Company, Akron, Ohio.

(408.) — A section cracked December 4th in a cast iron sectional heating boiler at the bakery of Jacob Magaziner, Springfield, Mass.

(409.) — An elbow failed December 4th, in a Hawley Down Draft Furnace at the plant of the G. Kramer Dry Plate Company, St. Louis, Mo.

(410.) — A section cracked December 4th, in a cast iron sectional heating boiler in the building at 37-47 Sudbury St., Boston, Mass., owned by the trustees of the Boston Real Estate Trust.

(411.) — A blow-off failed December 4th, in a boiler at the City Pumping Station of the City of Columbia, So. Carolina. Three persons were injured.

(412.) — A header cracked December 6th, in a water tube boiler at the plant of the Scovill Manufacturing Company, Waterbury, Conn.

(413.) — A tube ruptured December 6th, in a water tube boiler at the plant of the Little Rock Railway & Electric Company, Little Rock, Ark.

(414.) — Ten sections in two cast iron sectional boilers cracked December 7th at the tobacco warehouse of A. & S. Hartmann, Hartford, Conn.

(415.) — A boiler ruptured December 7th, at the plant of Swift & Company, Manzanola, Col.

(416.) — A tube ruptured December 7th, in a water tube boiler at the Perth Amboy, New Jersey, plant of the Public Service Corp., of New Jersey. One man was killed.

(417.) — An accident occurred to a boiler December 8th, at the plant of the Louisville Soap Company, Louisville, Ky.

(418.) — A section cracked December 8th, in a cast iron sectional heating boiler at the bakery of Jacob Magaziner, Springfield, Mass.

(419.) — A tube ruptured December 8th, in a water tube boiler at the plant of Roberts & Oake, Union Stock Yard, Chicago, Ill. Five people were injured.

(420.) — A section cracked December 9th, in a cast iron sectional heating boiler at the plant of the Mazer Cigar Manufacturing Co., Detroit, Mich.

(421.) — A tube ruptured December 9th in a water tube boiler at the Perth Amboy Plant of the Public Service Corporation of New Jersey.

(422.) — A section cracked December 11th in a cast iron sectional heating boiler at the Apartment Building, No. 57 East 110th St., New York City, owned by the Estate of Rachel Straus.

(423.) — Two sections cracked December 11th in a cast iron sectional heating boiler in the apartment house owned by Robert B. Dula, New York City.

(424.) — A tube ruptured December 12th in a water tube boiler at the Sioux City Gas & Electric Co. plant of the United Gas Improvement Co., Sioux City, Iowa. One man was fatally injured.

(425.) — Two sections cracked December 12th in a cast iron sectional heating boiler located at the Apartment Hotel owned by the Estate of Thomas B. Hidden, New York City.

(426.) — A boiler exploded December 13th at the plant of Natural Soda Co., Keeler, Cal. One man was killed, three were injured and property damage was done to an amount exceeding $13,000.

(427.) — A steam pipe burst December 12th at the plant of the Paul O. Reymann Packing Company, Wheeling, W. Va.

(428.) — A tube pulled from the drum of a water tube boiler December 13th at the plant of the Holland, St. Louis Sugar Co., St. Louis, Mich. One man was injured.

(429.) — An accident occurred to a boiler December 16th at the 4th Ward School, Latrobe, Pa. One man was injured.

(430.) — Twenty-six sections cracked in two cast iron sectional heating boilers December 16th at the Liberty Theatre owned by the Doan Square Realty Company, Cleveland, Ohio.

(431.) — A tube ruptured in a down-draft furnace December 16th at the plant of Alexander Smith & Sons' Carpet Co., Yonkers, N. Y. One man was injured.

(432.) — Two sections cracked in a cast iron sectional heating boiler at the Greenhouse on Brookside Farm, owned by the Estate of William Hall Walker, Great Barrington, Mass.

(433.) — A section cracked December 7th in a cast iron sectional heating boiler at the factory of the Mazer Cigar Co., Detroit, Mich.

(434.) — A tee failed in a feed pipe line December 17th at the New Marion Street Power House, of the Public Service Corporation of N. J., Jersey City, N. J. Four were slightly injured.

(435.) — A boiler used at the sawmill of John P. & Roy Hill exploded Dec. 18th at Clarksville, Ga. One man was killed and two others seriously injured.

(436.) — A tube ruptured December 20th in a water tube boiler at the plant of the Fitchburg Gas & Electric Co., Fitchburg, Mass. Three were injured.

(437.) — A tube ruptured December 21st in a water tube boiler at the building of the Union Savings Bank & Trust Co., Cincinnati, Ohio. One man was injured.

(438.) — A boiler exploded December 21st at the oil well of the United Petroleum Co. at Barber Hill, Texas. One was seriously injured.

(439.) — A tube ruptured in a water tube boiler at the plant of Armour & Company, Union Stock Yards, Chicago, Ill., on December 23rd. One man was injured.

(440.) — A tube ruptured December 26th in a water tube boiler at the Paper Box Factory, of G. K. Bisler, Philadelphia, Pa.

(441.) — A boiler ruptured December 26th at the plant of the Reliable and Dry Cleaning Co., Toledo, Ohio.

(442.) — Three sections cracked December 27th in a cast iron section heating boiler at the apartment house owned by Samuel Greenberg and Herman Weisstein, Omaha, Neb.

(443.) — A tube ruptured December 28th in a water tube boiler at the plant of the American Steel & Wire Co., Donora, Pa.

(444.) — Two sections cracked December 28th in a cast iron section heating boiler at the building of the University Club Association, Columbia, Mo.

(445.) — Nine sections cracked in a cast iron sectional heating boiler December 29th at the office building of Ralph Shulman, Syracuse, N. Y.

(446.) — A boiler ruptured December 29th in the Electric Light plant of the Village of Clifton Springs, N. Y.

(447.) — A steam pipe failed December 30th in the Hudson County Gas Company's plant owned by the Public Service Corporation of N. J., Jersey City, N. J. One was injured.

(448.) — A section cracked December 30th in a cast iron sectional boiler at the plant of the Index Printing Co., Atlanta, Ga.

(449.) — A tube ruptured December 31st in a water tube boiler at the office building and manufacturing plant owned by the E. W. Bliss Buildings, Inc., of New York City.

January, 1919.

(1.) — A boiler exploded January 1st, in the printing plant of the Long Beach Telegram, Long Beach, Cal. Three men were injured.

(2.) — A section cracked January 2nd, in a cast iron sectional heating boiler at the hospital of the Jewish Hospital Association, Louisville, Ky.

(3.) — On January 2nd, a section cracked in each of two cast iron sectional heating boilers at the Vonhof Hotel, Mansfield, Ohio.

(4.) — A section cracked January 2nd, in a cast iron sectional heating boiler at the Washington School, Canton, Ohio.

(5.) — On January 3rd, a section cracked in a cast iron sectional heating boiler at the plant of The H. H. Sturtevant Company, Zanesville, Ohio.

(6.) — On January 4th, four sections cracked in a Cast Iron sectional heating boiler at the restaurant of J. W. Welch, Omaha, Neb.

(7.) — On January 4th, a storage tank used to store hydrogen gas exploded at the plant of the Cudahy Packing Company, So. Omaha, Neb. One man was injured.

(8.) — A serious accident occurred January 5th, to a water tube boiler at the plant of The American Steel & Wire Company, Donora, Penn.

(9.) — On January 5th, five headers failed in a water tube boiler at the plant of the American Sheet and Tin Plate Company, Leechburg, Penn.

(10.) — A tube ruptured January 6th, in a water tube boiler at the plant of the Thomas Devlin Mfg. Company, Burlington, N. J.

(11.) — On January 6th, eight headers fractured in a water tube boiler at the plant of the Kohler Company, Kohler, Wis.

(12.) — A boiler ruptured January 7th, at the plant of the E. Waldeck Company, Inc., Jersey City, N. J.

(13.) — On January 7th, a slight accident occurred to a boiler at the plant of the Chapman Steel Company, Indianapolis, Ind.

(14.) — On January 8th, a section cracked in a cast iron sectional heating boiler at the plant of the Review Publishing Company, Alliance, Ohio.

(15.) — On January 9th, a boiler exploded at the Faller Flour Mills, Newton, Ill. Two men were badly scalded.

(16.) — Three sections cracked January 9th, in a cast iron sectional heating boiler at the Sacred Heart Church, Aurora, Ill.

(17.) — On January 9th, three sections cracked in a second cast iron sectional heating boiler at the Sacred Heart Church, Aurora, Ill. This is a distinct and separate accident to a different boiler from that reported in item 16.

(18.) — A boiler exploded January 10th, at the Duffy-Means plant, Lafayette, Ind.

(19.) — A tube ruptured January 10th, in a water tube boiler at the plant of the Peoria Water Works Company, Peoria, Ill. Two men were injured.

(20.) — Two sections cracked January 5th, in a cast iron sectional heating boiler at the West School, Dennison, Iowa.

(21.) — On January 11th, a boiler exploded in the basement of a building at

300 Richardson St., Greenpoint, L. I. The explosion set the building on fire and did considerable damage.

(22.) — On January 11th, a blow-off pipe exploded at the Alamita Sanitary Dairy, Omaha, Neb. One man was fatally scalded.

(23.) — On January 13th, a tube ruptured and several headers fractured in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Garland, Utah.

(24.) — On January 13th, three sections cracked in a cast iron sectional heating boiler at the plant of the Worcester Baking Company, Worcester, Mass.

(25.) — On January 13th, a tube ruptured in a water tube boiler at the plant of the Illinois Vinegar Manufacturing Company, Chicago, Ill.

(26.) — On January 15th, two sections cracked in a cast iron sectional heating boiler at the Illinois Masonic Orphan Home, LaGrange, Ill.

(27.) — On January 15th, a very large steel tank 90 feet in diameter and 50 feet high used for molasses storage, collapsed in Boston, Mass. Nine people were killed, two million gallons of molasses flooded the streets demolishing two buildings and damaging the structure of the Elevated Railroad. The accident was of a very serious character.

(28.) — Three sections cracked January 16th, in a cast iron sectional heating boiler at the plant of the Gustin-Bacon Mfg. Company, Kansas City, Mo.

(29.) — A tube ruptured January 16th, at the plant of the Ralston Purina Company, St. Louis, Mo. Two men were killed.

(30.) — On January 17th, a steam vulcanizer exploded at the tire shop of Samuel Brothers, Philadelphia, Penn. Two men were seriously injured.

(31.) — A tube ruptured January 17th, in a water tube boiler at the plant of the American Steel & Wire Company, Waukegan, Ill.

(32.) — Three sections cracked January 17th, in a cast iron sectional heating boiler at the Rosslyn Apartment owned by the Dayton Investment Company, Minneapolis, Minn.

(33.) —A tube ruptured January 18th, in a water tube boiler at the power house of the Intermountain Railway and Power Company, Scottsbluff, Neb. Two men were injured.

(34.) — Two sections cracked January 18th, in a cast iron sectional heating boiler at the Electric Automobile Station owned by Harriet M. Howe, located on Church Street, Hartford, Conn.

(35.) — A blow-off pipe ruptured January 19th, in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Garland, Utah.

(37.) — A section cracked January 20th, in a cast iron sectional heating boiler at the plant of the H. Pauk & Son Mfg. Company, St. Louis, Mo.

(38.) — A boiler exploded February 20th, at the Hotel Lorenz, Redding, Cal.

(39.) — Three sections cracked January 21st, at the plant of the Liberty Screw Company, owned by Arnold J. Booth, Worcester, Mass.

(40.) — A tube ruptured in a water tube boiler January 22nd, at the plant of the Florida Ice & Coal Company, Jacksonville, Fla. One man was injured.

(41.) — A boiler exploded January 22nd, belonging to a well drilling outfit near Vera Cruz, Ind.

(42.) — A water column connection ruptured January 24th, in a boiler at the plant of the Clyde Creamery Company, Clyde, N. Y.

(43.) — A furnace collapsed in a Scotch boiler January 24th, at the plant of the Consumers Ice and Cold Storage Company, Key West, Fla. One man was killed.

(44.) — A blow-off failed January 24th, at the plant of the Cramer and King Company, Patterson, N. J. One man was injured.

(45.) — A section cracked January 25th, in a cast iron sectional heating boiler at the Robert E. Lee School, San Antonio, Tex.

(46.) — Two boilers ruptured January 25th, at the sugar house of the Cleophas LaGarde Company, Thibodaux, La.

(47.) — The boiler of a Western Pacific freight locomotive exploded January 26th, near Portola, Cal. One man was killed and two others badly injured.

(48.) — A throttle valve failed in a main steam pipe at the plant of the Artman, Nichols & Cox Lumber Company, Metropolis, Ill., on January 27th. One man was killed.

(49.) — A boiler exploded January 27th, at the boys branch of the Bedford Y. M. C. A., Brooklyn, N. Y.

(50.) — A small steam boiler used for tire vulcanizing exploded January 28th, in the Vulcanizing Shop of Bruce Freeland, Elkhart, Ind.

(51.) — A blow-off failed January 28th, in a boiler at the Mills Building, El Paso, Tex.

(52.) — A slight accident occurred to a boiler January 29th, at the Illinois, Northern Utility Company plant owned by the Middle West Utilities Company, DeKalb, Ill.

(53.) — On January 30th, three tubes failed in a water tube boiler at the plant of the Utah-Idaho Sugar Company, Garland, Utah.

(54.) — On January 31st, three sections cracked in a cast iron sectional heating boiler in the business block owned by A. B. Wilson & Co., Hartford, Conn.

February, 1919.

(55.) — A tube ruptured and a header failed in a water tube boiler February 3rd at the plant of M. A. Hanna & Co., Dover, Ohio.

(56.) — On February 3rd five tubes ruptured in a water tube boiler at the plant of the Utah-Idaho Sugar Co., Garland, Utah.

(57.) — On February 3rd a boiler exploded at the sawmill of the Kingsland Lumber Co., Kingsland, Ga. Three men were killed and two injured.

(58.) — A header fractured February 4th in a water tube boiler at the plant of the National Mallable Castings Co., Chicago, Ill.

(59.) — On February 4th six tubes ruptured in a water tube boiler at the plant of the Utah-Idaho Sugar Co., Garland, Utah.

(60.) — A blowoff pipe failed February 4th at St. Joseph's Female Academy, St. Paul, Minn.

(61.) — On February 5th a cast iron mud drum burst in a water tube boiler at the plant of the Dwight Mfg. Co., Alabama City, Ala. Three men were injured.

(62.) — A boiler exploded February 5th in the sawmill of George F. Miller, near Hamburg, Pa. One man was killed.

(63.) — On February 6th a boiler exploded at the plant of Plymouth Gas Light Co., Plymouth, Mass. One man was probably fatally injured.

(64.) — A header fractured February 6th in a water tube boiler at the plant of the Utah-Idaho Sugar Co., Garland, Utah.

(65.) — Three sections cracked February 6th in a cast iron sectional heating boiler at the Dancing Academy of Chalif, Inc., New York City.

(66.) — A section cracked February 7th in a cast iron sectional heating boiler at the Greenhouse of C. B. & A. J. Stevens, Shenandoah, Iowa.

(67.) — On February 7th a boiler used by contractors in constructing a bridge across the Arkansas River below Morrilton, Ark., exploded. Two men were killed and five were seriously injured, while six men were less seriously injured.

(68.) — A section cracked February 8th in a cast iron sectional heating boiler at the Liberty School, Canton, Ohio.

(69.) — A tube ruptured in a water tube boiler on February 8th at the plant of the Shutz-Baujan Co., Beardstown, Ill. One man was injured.

(70.) — On February 8th a boiler exploded in the Forehand Building at Platteville, Wis. Eight persons were killed and twelve or more others are missing because of the accident.

(71.) — A 10,000 gallon steel water tank exploded February 9th on the Emery estate at West Newbury, Mass.

(72.) — A tube ruptured February 10th in a water tube boiler at the plant of the Philadelphia Rapid Transit Co., Philadelphia, Pa.

(73.) — Eight sections cracked February 11th in a cast iron sectional heating boiler located in the Hall and Bank building owned by the Temperance Hall Ass'n, Beaumont, Texas.

(74.) — A boiler ruptured February 12th at the plant of the Ware Shoals Mfg. Co., Ware Shoals, N. C.

(75.) — A section cracked February 13th in a cast iron sectional heating boiler at the restaurant of Silverman & Harkavy, Bridgeport, Conn.

(76.) — On February 13th a section cracked in a cast iron sectional heating boiler at the wholesale grocery house of R. A. Bartley, Toledo, Ohio.

(77.) — A section cracked February 14th in a cast iron sectional heating boiler at the Tauraine Hotel, Denver, Colo.

(78.) — On February 15th an air tank exploded at the welding plant of P. Saracco & Co., San Francisco, Cal. Three men were injured.

(79.) — On February 17th a rendering tank exploded in the plant of the Falls City Hide and Tallow Co., Louisville, Ky.

(80.) — A steam vessel used in chemical work exploded February 17th at the plant of the Mallinckrodt Chemical Co., St. Louis, Mo. One man was seriously injured.

(81.) — A boiler exploded February 17th in the Cheese Factory of Arthur Jenks, Marshfield, Wis. One man was killed and one man probably fatally injured.

(82.) — Three sections cracked February 17th in a cast iron sectional heating boiler at the West School, Denison, Iowa.

(83.) — Three sections cracked February 17th in a cast iron sectional heating boiler at the Apartment House, No. 2 West 67th St., New York City.

(84.) —One tube ruptured and six headers failed February 17th in a water tube boiler at the plant of the New York Mills Corporation, New York Mills, N. Y.

(85.) — On February 17th a circulating tube pulled from the drum of a water tube boiler in the plant of the Utah-Idaho Sugar Co., Garland, Utah.

(86.) — A furnace collapsed in a marine type boiler February 18th at the Municipal Electric Light & Water Works, Lake Providence, La.

(87.) — A boiler exploded February 19th at the plant of the Windsor Steam Laundry, Detroit, Mich. One man was badly scalded.

(88.) — A blow-off failed February 21st in a boiler at the laundry of A. Betsher, Eureka, Kansas.

(89.) — On February 21st two water tube boilers exploded violently at the plant of the Mobile Electric Co., Mobile, Ala. Four persons were killed and the damage was estimated to be in excess of $100,000.

(90.) — A tee failed in a steam pipe February 21st at the plant of the Standard Paper Co., Kalamazoo, Mich.

(91.) — A tube ruptured February 22nd in a water tube boiler at the power house of the Newport News & Hampton Railway, Gas & Electric Co., Hampton, Va.

(92.) — On February 22nd the boiler of a freight locomotive belonging to the Baltimore & Ohio Railroad exploded, near Philson, Pa. Four persons were injured.

(93.) — A tube ruptured February 24th in a water tube boiler at the plant of the Beaumont Mfg. Co., Spartanburg, S. C.

(94.) — A tube ruptured February 25th in a water tube boiler at the plant of the Federal Laundry Co., Chicago, Ill.

(95.) — A firebox failed in a locomotive type boiler February 26th at the plant of the United Natural Gas. Co., Gaylor Farm, Pa.

(96.) — A blow-off failed February 27th at the plant of Columbia Tire & Rubber Co., Columbiana, Ohio.

(97.) — A steam pipe failed February 27th at the Glasgow Plant of the Nagle Steel Co., near Pottstown, Pa.

(98.) — An accident occurred to a boiler February 28th at the plant of the Chapman Steel Co., Indianapolis, Ind.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1919.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$361,295.49
Real estate		90,000.00
Mortgage and collateral loans		1,505,900.00
Bonds and stocks		5,121,486.85
Premiums in course of collection		654,112.42
Interest accrued		108,152.83
Total assets		$7,840,947.59

LIABILITIES.

Reserve for unearned premiums		$3,429,363.68
Reserve for losses		153,378.80
Reserve for taxes and other contingencies		367,147.68
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,891,057.43	
Surplus to Policy-holders,		**$3,891,057.43**
Total liabilities		$7,840,947.59

CHARLES S. BLAKE, President.

FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. S. BERRY, Assistant Secretary and Counsel.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

BOARD OF DIRECTORS.

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LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, Vice-President, United States Bank, Hartford, Conn.

MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.

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CHARLES P. COOLEY, Hartford, Conn.

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The Locomotive

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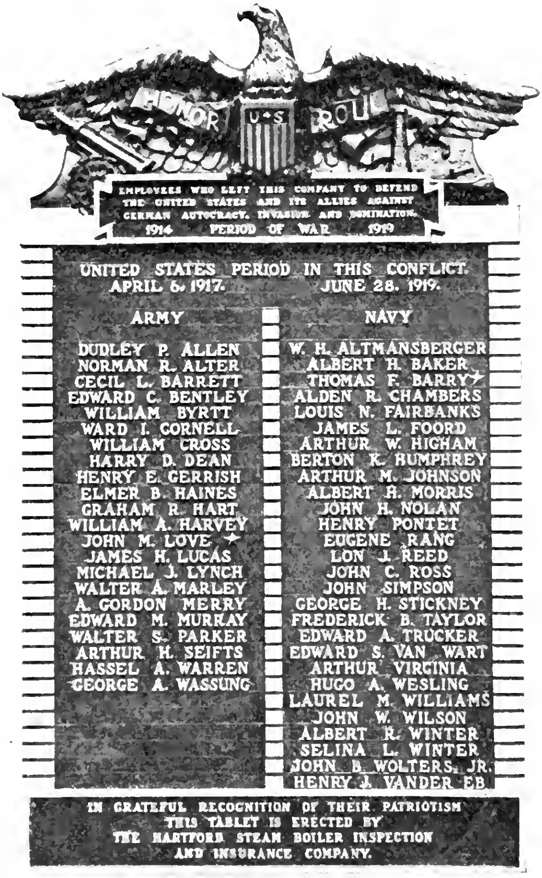


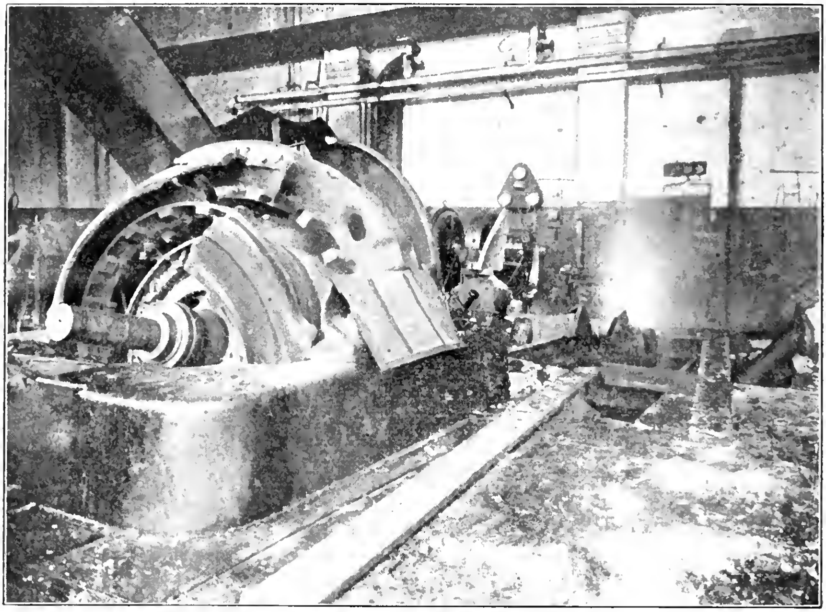


FIG. 1. VIEW OF GENERATOR

Explosion of a Large Steam Turbine.

THE accompanying illustrations are of parts of the wreck of a 3,000 K. W. turbo generator at the plant of the Connecticut Light & Power Company, Waterbury, Connecticut. This machine was destroyed by an accident which occurred on November 19, 1919, in which, most unfortunately, two men were killed and nine others more or less severely injured. The cause of the accident has not yet been definitely determined, we believe, but that it was of a violence and suddenness characteristic of an explosion is evidenced by the complete disruption of the machine, as our illustrations show.

The accident has been the subject of an investigation by the Connecticut Public Utilities Commission. According to a published abstract of the report of the Commission's engineer, Mr. A. E. Knowlton, the machine was in operation at 1:15 p. m. on November 19th, and apparently carrying its load in a normal manner. At about that time, the station lights dropped to a low brilliancy and then faded out. The report continues, " There was a definite time interval, not far from an actual minute, between the dimming of the lights and the wrecking of the turbine." This report goes on to say that the dimming of the lights was caused by the loss of excitation on two and perhaps all of the four generating units and that thus these units were suddenly relieved of load. Two of the turbines, after the accident, were found with their automatic speed limits tripped and the steam shut off. It would appear from the report also that the investigator was satisfied that there was no material increase in speed of the wrecked turbine in the interval between the dimming of the lights and its destruction. The evidence to substantiate this negative conclusion was not given in the published report. It, however, must have been convincing to the

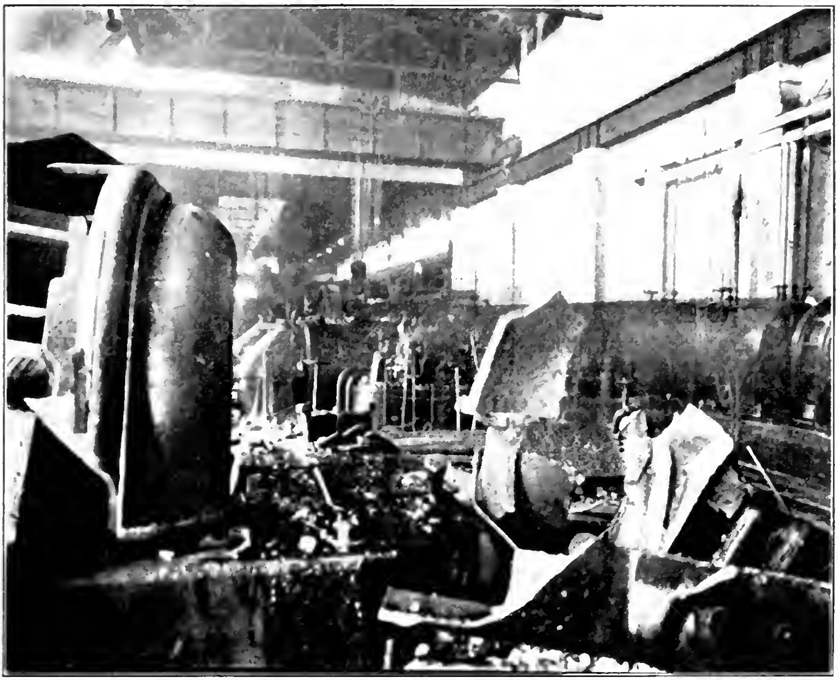


FIG. 2. TURBINE END OF WRECKED MACHINE

investigator for, without definite evidence to the contrary, he would naturally attribute the wreck of a high speed apparatus, suddenly relieved of load, to the excessive forces of over speed.

The wreck of the turbine itself was so complete and its remains consist in the main of such small fragments that from them it was impossible to determine at the examination made by a representative of our company what part failed first. The frame of the generator and its bearing pedestals were broken up and even the bed plate was

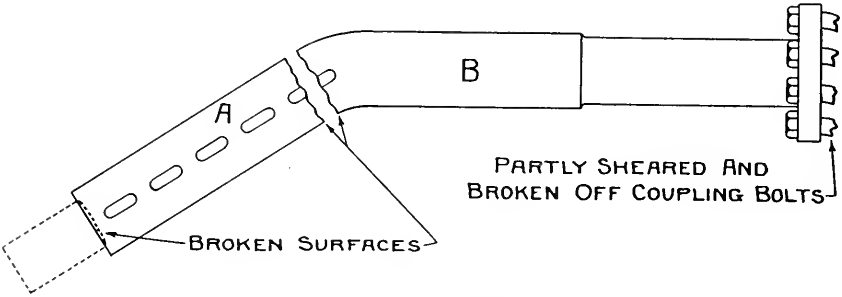


FIG. 3. SKETCH OF BROKEN TURBINE SHAFT

not spared. A peculiar and perhaps significant relic of the machine is the turbine shaft. This shaft was approximately 13″ in diameter. It was broken in two places and the bolts of the flange coupling between the turbine and generator had partly sheared and broken off. One piece of this shaft, about 4 ft. in length, marked "A" in Fig. 3, after an extensive air flight, lodged in the basement under the turbine. Another piece, 8 ft. long, with the flange coupling, was hurled through a window into the yard. This latter piece, shown at "B" in Fig. 2, has a considerable offset, doubtless received an instant before the shorter piece of shaft was broken off. From the appearance of the bore of the turbine discs, all of which were considerably enlarged and belled out and from the fact that the piece of shaft on which they had been mounted was found after the wreck at some distance from the discs, there is reason to believe that the discs had slid off the shaft and started on their journey through roof and wall before the pieces of shaft commenced their respective flights. Of course, the blading in the turbine was broken up into small pieces. The rim of one of the discs, in which the blading was fitted, was completely ripped off.

Perhaps it was the character of the breaks in the turbine shaft in addition to other evidence against the over-speed theory which led the engineer of the Public Service Commission to the conclusion that the machine did not destroy itself by running away. As has been said, in such a complete break-up of all parts, as in this accident, one cannot determine where an initial failure occurred. The breaking of the very heavy shaft in two parts may, however, be significant and indicate that it first failed perhaps at the shouldered end shown in dotted lines in figure 3. If so, the portion of the shaft on which the discs were mounted would have had then one unsupported end and with the combined weight of the discs under such circumstances would have commenced to sag or bend. Only a slight amount of sagging or bending of the shaft would have caused the discs to rub and the blading to break up and at the great velocity at which it was running, the shaft, out of center at its free end, would begin to whip around with increasing radius until it took the sharp bend and broke off through the keyways of the innermost disc as shown in our diagram. In such a theory of the accident, the next step would have been the breaking of the inner turbine bearing and a repetition of the whipping around of the remaining piece of shaft until the coupling bolts gave way. Of course in any such theory of the accident there still remains to be explained the cause of the original break of the shaft at the point shown in the dotted lines of figure 3. It is difficult to attribute such failure to any shock received by a sudden release of load or from any other condition which the circumstances of the accident can supply. It perhaps seems to dodge the issue to suggest that fatigue of metal was the ultimate cause of the catastrophe, but if it is certain that over-speed did not occur, no other explanation seems possible. The machine had been in operation for several years during which, undoubtedly, it had carried its loads and over-loads without mishap and had been subject to and had successfully withstood the usual strains and shocks of public service operation. That after such service it was unable to bear the not very severe shock of a relief of load can only suggest that it had been weakened by the strains of those many years service.

We have ventured this rather long discussion of this turbine accident because of its unusual character even though we are unable to express a conclusion as to its cause. We trust our article may be suggestive of the unexpected dangers which threaten such high velocity, modern power producers. When anything goes wrong with such a machine, things happen in an exceedingly short space of time, usually without opportunity for human intervention to prevent the destruction or at least serious damage to costly pieces of property or to avoid death or injury of those in attendance. A turbine accident is, therefore, likely to be, as in the case we have written about, a catastrophe, and we feel that it is not improper for us to remind our readers that our company affords insurance against catastrophes of this kind.

On the Burning of Fuel Oil.

H. J. VanderEb.

THE shortage of coal and abnormal rise in coal prices of the last few years has given rise to a lively interest in the use of fuel oil under power boilers. Quite naturally, comparison as regards cost of coal and oil is the principal factor in this. For certain localities such a comparsion is at present favorable to the use of oil. Especially is this true for New England and other points on the Atlantic coast, remote from the coal fields. Add to this the uncertain delivery of coal of the present time from causes we need not here mention, and you have a fair index to the oil fuel situation.

As to how long these price relations can possibly continue, it is practically impossible to make a reasonably safe guess. From the present knowledge of the available world supplies of oil and coal which necessarily is rather vague, it seems however to be generally taken as a foregone conclusion that the oil supply will have ceased many centuries before coal will show signs of exhaustion. Undoubtedly at some future day, which may be in the lifetime of the present generation, the operation of the inexorable law of supply and demand may give back to coal the nearly undisputed monopoly it so long has enjoyed in the field of steam power generation. So long as the price remains favorable, however, oil will be a big factor in power plant operation and the present indications are that this may be for a number of years to come.

It is the purpose of this article to give a few helpful hints, gathered from the best information available, to steam users who desire to look into the desirability of changing from coal to oil for their boiler plants. In every case it is desirable that a reliable estimate be made in advance, of all the cost involved in making the necessary changes in the equipment. While the cost of the actual oil burning apparatus is light as compared with, for instance, mechanical stokers, there may be costly changes necessary in the boiler settings in order to obtain a reasonably high efficiency, which may drive the cost up to a disappointing figure. In addition to this, account should be taken of the possible necessity of installing extensive storage tank capacity depending on the proximity of the plant under consideration to an oil distributing center. For plants that are a considerable distance away from such an oil depot it is suggested to have a storage capacity of from thirty to forty days supply to take care of any interruptions of the regular delivery of the oil. Steam plants that have the good fortune of being located right near an oil depot can of course avoid a heavy investment in storage tanks and for such plants a week's supply on hand might be considered sufficient. But even for such installations, especially if they be public service plants with contracts for their power output, business foresight may suggest the desirability of the right proportion of reserve supply to insure continuous service under unusual circumstances. With a further view to the possible serious interruption of the oil supply at the source it has been suggested that no oil burning installation should be undertaken that would not permit changing back to the use of coal in a reasonably short time. In making estimates on proposed oil installations and comparing the cost of the oil itself with that of coal, use can be made of a handy approximate rule, sufficiently accurate for practical purposes, which is the simple relationship between the cost of the two fuels as pointed out by Mr. W. M. McFarland. This is, that for equal steam production the fuel cost will be the same when the number of dollars of the price of coal per ton (of 2,240 lbs.) is double the number of cents of the price of oil per United States gallon. This rule is based on the respective average heat values of oil and coal per lbs. and takes into account the better efficiency obtainable with oil than is possible with coal. Any other possible economies incident to the use of oil such as the lower labor cost of handling fuel oil as compared with that of coal and ashes are not included in this rule.

The fuel oil that is at present sold for power purposes is, with very little exception, the heavy residuum that remains after taking off by partial distillation from the crude oil the valuable lighter hydro-carbons, naphtha, gasolene and kerosene. This so-called "topping" of the crude oil enhances the value of it as fuel rather than diminishing it, as the flashpoint is thereby raised to a point where the fuel can be handled with greater safety especially after being heated to the temperature necessary for properly atomizing it at the burners. The calorific value of the "topped" oil is not any less than that of the crude oil, in fact it is even a little higher.

THE ADVANTAGES OF OIL OVER COAL

From a number of viewpoints oil is an attractive fuel for steam generation. As already indicated in the foregoing it is possible to obtain a higher efficiency with oil than with coal. It is comparatively easier, so far as physical effort is concerned at least, to obtain almost perfect combustion with oil burning and keep out of the furnace unnecessary excess air from the fact that there are no furnace doors opened every few minutes as with the hand firing of coal and there is no cleaning of fires with its attendant serious cooling off of the furnace. The required intensity of the heat from the burners is under practically instantaneous control to meet changes in the load. There is furthermore possible a considerable saving of labor in an oil burning plant as compared with that required for the handling of coal and ashes and there is a complete absence of dust.

For the small plant of one or two boilers a saving in the labor item should not be expected since of course for such an installation the same number of men will be required to tend to the burners as would be to shovel coal in the furnace. There are however many small plants where it could be expected of one man, with more justification from a safety standpoint, to tend to both the engine and boiler, if oil were used, than where he has considerable coal shoveling to do. But for the larger plant the labor economy is a real factor. One man can tend a considerable number of oil fired boilers with almost the same facility as he can one boiler. One other feature that may be mentioned in favor of oil fuel as compared with coal, is that the troubles of spontaneous combustion, so common with coal of high sulphur content, are entirely excluded with oil fuel.

There are almost no real disadvantages connected with oil burning to offset the several advantages mentioned. The one serious obstacle that can be mentioned is that in congested city districts the use of oil may be made prohibitive by local ordinances requiring special conditions with regard to location and isolation of storage tanks with a view to safety in case of fire. Some of this trouble however may be overcome by piping the oil underground to the plant from a point where oil can be conveniently stored with better safety.

The oil as received may contain a certain percentage of moisture which must be eliminated by giving it time to settle to the bottom of the storage tanks. It is therefore desirable to have always more than one tank for any conditions of required storage capacity so that the oil as it is used may always be pumped from a tank in which the settling of the moisture is as complete as practicable. Each tank should be provided with a bottom drain cock at its lowest point to run off any collected water or dirty oil.

At the ordinary outdoor temperatures, especially in the northern latitudes, it is necessary to heat the oil in the storage tanks to reduce its viscosity to a point where it can be pumped. As it is too wasteful to attempt to heat the whole tank to the desired temperature it is entirely practicable to accomplish this by placing a steam coil right near the point where the suction pipe enters the tank. On all piping used for the transmission of oil it is desirable to have a steam connection so that they may be blown through and cleared of any accumulations of silt which is more or less present in all fuel oil. It is absolutely essential to have some effective form of strainer placed in the suction pipe leading to the pump in order to catch the fine grit and so to prevent undue wear of the pump cylinders. In order to eliminate the pulsations of the pump, so that a steady flow may be had at the burners, the pumps should be provided with an ample air chamber.

Heating of the oil is furthermore a necessity to aid in the proper atomization at the burner. It is most convenient and economical with the heavy oils now being used to do the heating of the oil in two steps, namely, to raise the temperature of the oil near the suction outlet of the storage tank sufficiently to reduce its viscosity to a point where it can be pumped and to have in the fireroom a separate heater in which the oil can be given the desired temperature for proper atomization. The final temperature of the oil just before atomization is usually about 140° to 160° Fahrenheit, where the oil is atomized by means of steam, but it is best to find by trial the most suitable temperature for each particular oil used to effect the best economy. Great care should be exercised to not heat the oil above its flashpoint. The flashpoint of an oil is the temperature at which inflammable vapor begins to be liberated at its surface. Thermometers should be present on the suction pipe leading from the storage tank to the pump and on the pressure pipe between the pump and the burners so that at all times proper control of the temperature may be had. The inflammable vapors referred to are a distinct danger and may give rise to disastrous explosions in the combustion space of the boilers, when for instance the oil valve to a burner is inadvertently left partly open under an idle boiler. Such gas explosions are known to have done great damage to the setting walls and serious personal injury. Aside from this danger the proper operation of the burners is affected by the presence of vapor in the pipes as the oil will under such conditions flow irregularly causing sputtering of the flame.

SOME DETAILS OF THE BURNERS

The function of an oil burner is to scatter the oil in a spray of minute particles to make it possible for the oxygen of the air to come in intimate contact with as much surface of the fuel as it is feasible to expose to it. A solid stream of oil has a small surface as compared with the aggregate surface of all the minute oil drops that result when the solid stream is broken up into a fine spray. The work performed by the atomizing agent is simply the work of stretching the surface of the oil, hence the finer the spray the better are the chances for perfect combustion. The only limitation on the fineness of spray is the cost involved in producing it.

The burners that are most commonly used can be classified under two general types: 1st, spray burners in which the oil is atomized by means of a jet of steam or air, and 2nd, mechanical burners in which the oil is forced under considerable pressure through a small aperture of particular shape causing it to break up into small particles. As the small aperture of the mechanical burner will wear quickly larger by any grit in the oil, thus rendering it useless, the thorough straining of the oil is especially important when mechanical burners are used. It is however well for any type of burners to have a strainer in the pipe between the pump and the burners to catch any gritty or solid substance that may pass by the strainer in the pump-suction line.

Mechanical burners have an advantage over those that atomize the oil by means of an air jet because of the necessity of an air compressor with the latter type. They also have, theoretically at least, an advantage over steam spray burners because of the fact that all steam that is introduced into a furnace leaves the furnace (when combustion is complete) as steam, which carries with it some of the heat generated from the fuel, entailing a certain amount of loss. It is sometimes asserted that the burning of the hydrogen that is set free when the steam is decomposed by the high furnace temperature into hydrogen and oxygen, will add a certain amount of heating value to that of the fuel. The fallacy of this will be obvious when one considers that it takes just as much heat to decompose the steam into its component elements, hydrogen and oxygen, as can possibly be realized when these elements are again united by combustion.

Another advantage of mechanical burners over steam spray burners is that they are generally better adapted to take care of wider variations of load which necessarily is conducive to better economy under certain conditions of operation. However, the extreme simplicity of the steam atomizing burner and the excellent economy obtained with it when constructed on correct principles together with the comparatively low oil pressure and temperature it requires has made this type the favorite for stationary work. Burners using air as an atomizing agent are in successful operation but steam atomizing burners are used more generally. Wherever the loss of fresh water is not a vital factor the latter are usually the most satisfactory. The steam consumption has been found for the better make of burners to be approximately 2% of the total steam generated.

From a safety standpoint a so-called flat-flame burner is preferable over a burner producing a cone shaped flame for most types of boilers as it is simpler with the former to avoid the impinging of the flame on portions of the heating surfaces of the boiler. Localization of the intense heat of the flame on tubes or shell of a boiler will invariably result in overheating and blistering of the metal and should be carefully guarded against. Space forbids a detailed description here of the different types of burners on the market. Such of our readers as are interested in further perusal of this detail are referred to "The Science of Burning Fuel Oil" by W. N. Best and "Oil Fuel" by E. H. Peabody.

AMPLE COMBUSTION SPACE AN ABSOLUTE REQUIREMENT

The selection of the right type of burner, while of course important, is of less significance in obtaining the proper boiler efficiency than is the proper furnace volume and general design of the furnace. The ideal conditions of an oil furnace are that the particles of burning oil have an opportunity to linger just long enough in the furnace to be completely consumed before coming in touch with the relatively cool boiler surfaces which would extinguish them with the possibility that they are re-ignited higher up in the setting or in the uptake with a resultant waste of heat.

Ample space must therefore be provided in the primary combustion chamber; more indeed than for almost any other fuel. This extremely important fact may make the change from the use of coal to oil prohibitive for boilers that are set low.

It has proved feasible with existing coal burning boilers, in which the distance above the grate is not less than about 40 inches, to form a chamber for the oil flames by placing a layer of firebrick over the gratebars, leaving a sufficient number of openings in this layer of brick for air admission. It is safe to say however that it is best in any case, both from a safety and an economy standpoint, to remove the grate bars and install a flat checkerwork of firebrick to take the place of the grate, but placed close to the ashpit floor, leaving only sufficient space under the checkerwork to form an air duct.

The bridgewall should then be cut down to about the top of this checkerwork. In view of the high temperature to which the brickwork in an oil furnace is subject, which may reach 2800 degrees to over 3000 degrees Fahrenheit, only the best quality of firebrick should be used. It is impossible to give any sort of a definite rule for the proper amount of required combustion space. This can best be determined for each individual installation and its surrounding conditions by someone having extended experience with oil burning.

For water tube boilers of the inclined tube type the so-called "rearshot" burner should be used. This name applies to location of the burner rather than to type. It simply means that the burner is placed just in front of the bridgewall and shoots the flame toward the front of the boiler. The objects gained by this are that the flame projects in the direction in which the furnace increases in volume due to the fact that the tubes are inclined toward the front and the possibility of the flames impinging on the tube surfaces is practically excluded.

Fuel oil is successfully being used under vertical firetube boilers of the Manning type, but it is found that there is a tendency that not all the tubes participate in transmitting the products of combustion. The tubes directly over the burner proper are apparently idle while the tubes in the rear or the direction of the flame transmit all the heat. In such a case, good use may be made of retarders, consisting of spirally twisted strips of sheet metal, placed in the rear tubes which will have the effect of distributing the hot gases more uniformly.

FUEL ECONOMY HINGES LARGELY ON DAMPER ADJUSTMENT

The proper amount of draft through an oil burning furnace is a matter of great importance and on it hinges largely the success or failure of the installation in competition with coal. Less draft is required for the successful burning of oil than in the case of a coal furnace of the same relative capacity. The reasons for this are that with oil burning the draft does not have to overcome the same retarding influence as is produced by a fuel bed, and the action of the oil burner itself is moreover to some extent that of a forced draft. The volume of gases for a given rating is smaller with oil burning than with coal. From this it follows that it is not necessary to have as large a stack area for oil burning boilers, nor does the stack have to be as high as for coal burning of the same capacity. The proper amount of draft to be allowed when changing over an installation from coal to oil burning can be taken care of by keeping the stack damper partly closed, but it is better, and it makes the installation more fool-proof, to contract the area of the gas passage of a stack of too large capacity by means of a fixed plate with an opening in the center of the required size.

On the other hand there must be a sufficient draft suction to steadily carry off the products of combustion at a certain maximum rate which can only be determined by test for the best obtainable economy of fuel. If an insufficient amount of draft is allowed at the stack so that the action of the burner as a draft producer is relied on to push the gases, the action of the heat on the brickwork of setting walls and baffles will cause them to rapidly deteriorate. It is, therefore, a case of striking a happy medium between the evil of too much draft causing waste of fuel and that of not enough draft involving high upkeep cost.

As stated before the question of allowing just the right amount of draft is very important for proper economy and because of the fact that resistance to the draft is considerably less through an oil burning boiler than through a coal fired boiler, the handling of the damper is a much more sensitive operation with oil than it is with coal. It is, therefore almost needless to state that a suitable draft gauge, located so that it can be conveniently read, is practically indispensable when economy is desired. Carelessness in manipulating the draft will invariably lead to gross waste of fuel.

In one installation, that recently came to our notice, the records of oil consumption showed a "mysterious" gradual increase, until finally it was nearly double what it had been at first, although the steam output from the boilers was practically unchanged. The reason for this marked increase in the oil consumption was not far to seek. The emphatic and careful instructions, given at the time the oil equipment was installed, had "wore off" and the firemen had come to regard the close regulation of the draft as a useless bother. Consequently they were running with the stack damper and ashpit doors wide open causing a short white flame, which they no doubt regarded as hotter and therefore more efficient. The result was, as stated, a doubling up of the oil consumption. Here was a case where, with practically no effort, about ten barrels of oil per day could have been saved over a considerable period.

A clear stack on an oil burning installation is usually an indication that too much draft is passing through the furnace with a resultant low efficiency since all the unnecessary excess of air simply acts as a cooling agent and carries heat up the stack that ought to have served in making steam.

A slight haze coming from the stack indicates that conditions are more nearly ideal. In order to establish the best furnace conditions for any given load, the most satisfactory method is, of course, by means of flue gas analysis but in the absence of the proper apparatus for this, use can be made of a reasonably reliable and simple rule. When the furnace is well alight and the walls uniformly heated up to a high temperature, the draft should be pinched down by gradually closing the stack damper to a point where the flames have a slightly smoky fringe, when the damper should be opened again just sufficiently to clear the flames.

An Unusual Flywheel Accident.

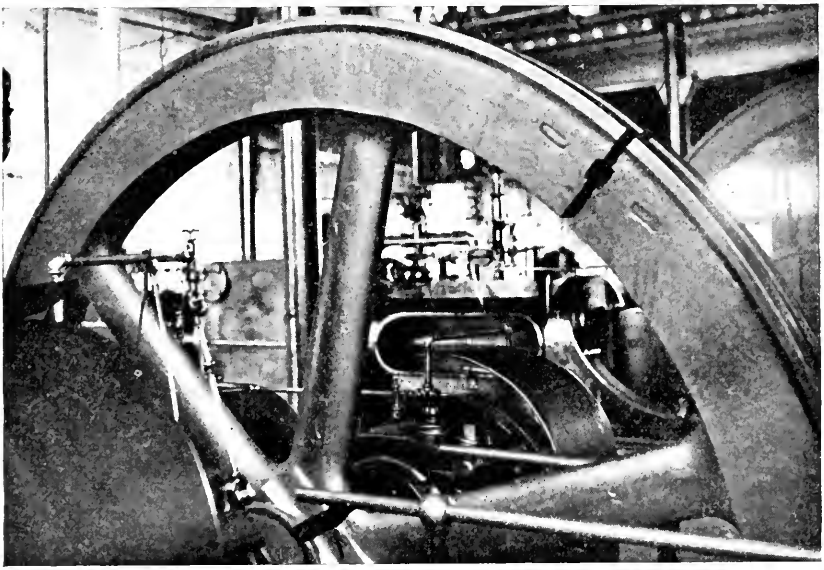
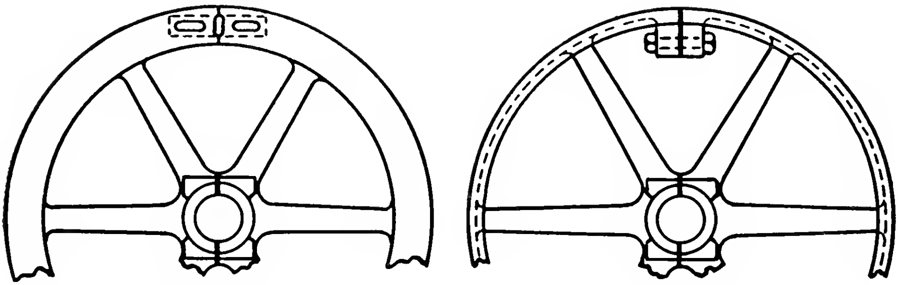


FIG. 1

FLYWHEEL explosions are almost as a rule fraught with spectacular damage to the surrounding property and not infrequently with distressing loss of life and personal injury. It is rare indeed for a flywheel to go to pieces without heavy masses of metal being projected through roofs and building walls producing the effect of shell fire.

However, in the above illustration we show a case of genuine flywheel disruption due to centrifugal force, but there was no damage beyond some major fractures of the hub and arms of the wheel. The only usable picture we were able to secure of the wrecked flywheel does not clearly show that it was a complete loss. Such, however, was the case. The wheel in question was nine feet in diameter and was used in connection with a refrigerating engine. By the lucky coincidence that someone happened to be near the trottle and closed it at the moment the engine started to race, a complete disruption of the wheel was prevented. The wheel rim must have attained a considerable velocity as the links forming the rim-joints had stretched fully an inch due to the centrifugal force tending to separate the two halves of the wheel.

These links, which are round and of steel, are inside of the rim, a suitable recess being left in the rim to receive them, and they are secured to the rim sections by means of cotter keys. The only visible parts of the rim joint, therefore, after the wheel is assembled, are the ends of the cotter keys. They can be distinctly seen in the illustration, as can also the separation of the rim at the joint due to the stretch of the links.



FLYWHEEL WITH LINK JOINT

FLYWHEEL WITH FLANGE JOINT

FIG. 2

When the links commenced to stretch, such a severe strain was transmitted through the arms to the hub-bolts that two of them broke off and one section of the hub itself split in two, while one arm was completely broken free from the rest of the wheel.

While this is a good illustration how a flywheel of this type will explode if given sufficient speed, the case strikingly demonstrates the superiority of the link type of rim joint over the kind of joint formed by bolted flanges that are located in the rim midway between arms.

From the experience had with flywheel rims of the two types shown in Figure 2 it is safe to say that, had it been of the flange joint type, the rim would have disrupted before reaching anywhere near the velocity which produced the considerable stretching of the steel links.

The link type of rim joint when properly proportioned is the strongest possible joint. In calculations of allowable speed it is usually credited with 60% of the strength of a solid rim section. The reason why it is not used more extensively is that a comparatively heavy cross section of rim is required to apply it.

A flange type joint cannot be considered to possess a greater strength than 25% of that of the solid rim, while tests have shown that even this low percentage may not always be fully realized. Its greatest source of weakness is to be found in the fact that a bending action is produced in the rim by centrifugal force tending to throw the mass of metal constituting the bolted flanges out of the rim circle.

Explosion of an Auxiliary Steam Turbine.

AMONG the accidents reported to The Hartford Steam Boiler Inspection and Insurance Company was one of explosion of a small single stage steam turbine belonging to the Oliver Iron and Steel Company, Pittsburgh, Pa.

This little turbine stood in a sub-basement of the plant and was directly coupled to a centrifugal pump which was used for pumping water from the river. There had been some trouble with the water end of the unit due to fouling of the suction pipe, and at the time of the accident this was just thought to have been overcome and there were still a number of men standing near the little machine. The chief engineer, who was directing the starting up, stood near the water side of the machine and after it had been running for a short while he signalled to the man at the throttle to shut off the steam. At about this moment the rotor burst and the flying fragments cut an opening through the casing all the way around its circumference. One man was killed outright and four others were badly scalded by the escaping steam. One of the latter, the chief engineer, died the following day from his injuries.

The cause of this accident has been attributed to derangement of the speed governor.

The Hartford Correspondence Course.

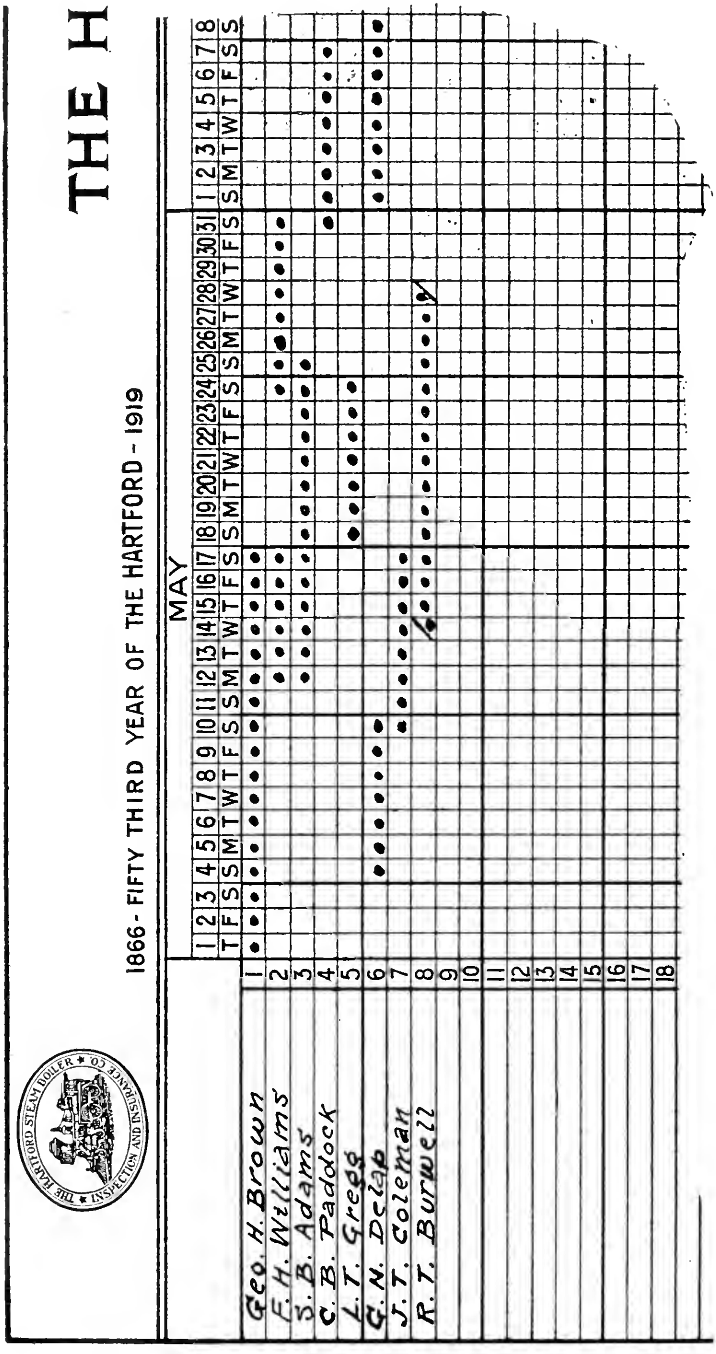
THE Firemen's Correspondence Course on combustion and boiler handling of the Hartford Steam Boiler Inspection and Insurance Company has taken its place as one of the established features of Hartford Service. The number of men now enrolled is well up into the hundreds, and some of the earlier students are finishing the course and receiving their certificates.

One thing, which is especially noticeable, with nearly every student is the marked improvement shown both in understanding and expression after the first two or three lessons. Apparently many of the men feel a bit awkward about the work at first and feel that they possibly may not be able to do it justice, but as they get into the swing of the first few lessons on combustion, which by the way is a subject of absorbing interest to most any one, they gain confidence and improve their work wonderfully. As soon as they have done, say, four or five lessons they become enthusiastic and the work not only improves but it comes in much more rapidly. This fact which has been very striking indeed has been a source of deep satisfaction to those who designed the course, and are responsible for its maintenance.

As an instance of how this course commends itself, we quote from the written opinion of an old and experienced fireman in the employ of one of our assured, a large corporation in the Southwest. This opinion was secured by our client to ascertain to what degree this method of study appealed to a man, who, from long experience, was an expert in firing matters. It was so satisfactory that it was circulated among the firemen of all our client's plants in an effort to interest the men to take the course. The employee whose opinion was asked, wrote the following:

"Will say in reply to your inquiry about Firemen's Educational Course from Hartford Boiler Insurance Company that it is O. K. I have not finished the course yet, but what few lessons I have received have helped me quite a lot. Although I have been a fireman for about fifteen years, I learn something new from each one of these lessons. I believe it a real good thing, and am glad that I took the course. Think it would benefit anyone who wishes to learn more about combustion."

Needless to say, we since have had the pleasure of enrolling a



Upper Left Hand Corner of Vacation Schedule considerable number of employes in the other power plants of this client of ours.

To anyone desiring to avail himself of this highly useful educational work we shall be pleased to mail descriptive circular and enrollment blank.

Vacation Schedule Blanks.

OUR Company has for several years past been publishing for the benefit of its policyholders a convenient blank form for recording vacation periods. It has been our practice in various years to mail these out to all of our clients. The circumstances of many of our policyholders probably prevent their use of this blank to advantage, while to many in turn they are of such convenience that their omission now would be a matter of regret. We have felt that this year we should not waste paper and expense in the indiscriminate distribution of these blanks. We will publish them as usual and furnish a supply to each of our department offices and general agents listed on the back of THE LOCOMOTIVE. In those departments they will be available for forwarding to such of our policyholders as have found them useful and wish the blanks for the vacation season of 1920. Accordingly, those who want them should apply to the nearest office or general agent of the company.

The cut on opposite page will indicate to those who are unfamiliar with this blank how it may be used. At the left the names of officers or employees entitled to a vacation are listed in column. The chart is divided into months, weeks and days by vertical lines. The vacation is recorded by a dot or cross for each day of the period on the line with the individual's name. When the record is complete, not only is the vacation clearly shown recorded but also at a glance it may be determined how many employes will be absent at any given time.

"The graspin'est man I ever knowed," said Uncle Jerry Peebles, "was an old chap named Snoopins. Somebody told him once that when he breathed he took in oxygen and gave out carbonic acid gas. He spent a whole day tryin' to find out which of them two gases cost the most if you had to buy 'em. He wanted to know whether he was makin' or losin' money when he breathed."—*Safety Hints.*

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

HARTFORD, JANUARY, 1920.

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.
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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

THE two turbine explosions recorded in this issue of THE LOCOMOTIVE will be of absorbing interest to many who in the past have had misgivings about the claims that have been put forward at times that steam turbines can be made proof against explosion. A number of conspicuous turbine accidents have occurred in the last few years and, as their number in use becomes greater, failures of large turbo-generators as well as of the smaller types of turbines used for auxiliaries may be more frequently heard from.

The larger one of the two turbines whose failure is described in this issue has the unique distinction of being the first large steam turbine, so far as we know, to completely run to destruction beyond the possibility of any of its parts being salvaged and it would seem in this instance that this is to be laid to the breaking of the shaft.

This feature of shaft breakage would appear to be deserving of more than passing notice. The stresses in a turbine shaft are of two kinds, namely, there is a torsion stress and a bending stress, the former being a steady stress, but the latter is one of complete reversal from a compressive stress to one of tension during every revolution of the shaft and it is likely to be accentuated by any vibration present, however slight.

For both of these stresses the usual design of turbine shaft has a very high factor of safety. However, from the research work done with varying and repeated stresses we know that the ultimate failure of the material may be brought about by apparently harmless loads if such reversing stresses are repeated a number of billions of times.

It appears barely possible that the billions of repetitions of the reversal of stress that take place in certain portions of a turbine shaft during its continuous operation over a time period of say a decade needs the serious attention of engineers responsible for the safe operation of this type of prime mover.

After the United States entered the world war over 10% of all the employes of this Company entered active service in the Army or Navy of this Country. In addition at least two enlisted in the service of the Allies.

The war is over, many of the employes have returned to the Company, some are at this writing still in the service, and just two will never return. Lieutenant John M. Love was killed in the Argonne Forest while leading his company, his Captain having been killed, and Yeoman Thomas Barry died on shipboard on what was to be his last trip before his retirement.

The officers of this Company, appreciating the patriotism of these employes, and in recognition of the event, have caused to be erected a bronze honor tablet at the Home Office of the Company.

With a desire to further honor these men and one woman, we have the pleasure of illustrating on the front page of this issue of THE LOCOMOTIVE a picture of the tablet. May all respect be paid to these people for their service to their Country.

Personal.

It is with regret that we announce the resignation of Mr. C. C. Perry, who, since July 1st, 1912, has been the Editor of THE LOCOMOTIVE.

Mr. Perry accepted a position in the Engineering Department of the Ætna Casualty & Surety Company of Hartford and entered on his duties there on December 1st, 1919. Mr. Perry, by education and experience, had a broad acquaintance with engineering matters, and his ability as a writer on technical subjects is shown by the issues of THE LOCOMOTIVE which have appeared during the last six years. We congratulate the Ætna Company in securing his services, and wish him the best success in his new position.

Mr. C. R. Summers has been appointed Chief Inspector of the Atlanta Department. For several years past Mr. Summers, as Assistant Chief Inspector, has directed the inspection work of the Atlanta Department with excellent results. During the fourteen years of his connection with the Company he has built up an enviable reputation as a thorough mechanic and boiler expert among our clients in the South. His new appointment comes as a well-earned promotion.

Mr. L. T. Gregg has been appointed Chief Inspector of our Cleveland Department. Mr. Gregg came into the service of The Hartford Steam Boiler Inspection and Insurance Company in 1911, serving a number of years as an inspector. In the last three years the active part of directing the inspection work of the Cleveland Department has been largely done by Mr. Gregg as Assistant Chief Inspector. His long experience with the Company, as well as his previous training, eminently fit him for his new responsibilities.

One other appointment was occasioned by the recent establishment of a branch office at New Orleans. The large amount of work and the rapid expansion of business of our New Orleans Department made necessary some assistance in the supervision of the inspection work. To fill that need, Mr. Eugene Unsworth was appointed Assistant Chief Inspector. Mr. Unsworth has had a long experience as an inspector, having been in the employ of The Hartford Steam Boiler Inspection and Insurance Company since 1906.

A Correction.

In spite of the careful editing and proofreading of all matter entering in THE LOCOMOTIVE, an error has slipped by in the October issue, on page 233 at the top.

In the equation there stated the symbols X and Y were erroneously used for a and b.

The equation should have read:

$$b = \frac{\frac{1}{2} \times 1\frac{1}{4} \times 4\frac{3}{8} + 2 \times \frac{1}{2} \times 1 + 3 \times \frac{1}{2} \times \frac{1}{4}}{\frac{1}{2} \times 1\frac{1}{4} + 2 \times \frac{1}{2} + 3 \times \frac{1}{2}}$$

$b = 1.315$ *inch*, and $a = 5 - 1.315 = 3.685$ *inch*

so that it may correspond with the symbols in Fig. 3 on page 232 and the text just above the equation. To those who preserve the article in question for future reference we suggest that they make this correction.

Flywheel Explosions, 1919.

(Continued from April 1919 Locomotive, page 185.)

(10.) — A shaft governor located in a flywheel disrupted due to a fulcrum pin shearing off, at the plant of the American Linoleum Company, Lenoleum, Staten Island, N. Y. on March 19th. The damage to the engine on which the wheel was mounted was considerable.

(11.) — On April 21st a rope drive failed at the plant of the Ashgrove Lime and Portland Cement Company, Chanute, Kan., causing the breaking up of two 7 foot wheels.

(12.) — On April 23rd an 8 ft. driven wheel and one 22 ft. driving wheel of a rope drive exploded at the Steel Works of the Interstate Iron and Steel Company, Marion, Ohio, doing great damage to the mill.

(13.) — On April 28th a 6 ft. wheel on a gas engine exploded at the planing mill of Elias Bros., Buffalo, N. Y.

(14.) — A flywheel on a buzz-saw exploded on May 16th at the Johnson farm about two miles distant from Avon, N. Y. Fragments of the wheel were thrown a quarter of a mile. One man was severely injured.

(15.) — On May 22nd a flywheel exploded in the plant of the Consumers Company, Chicago, Ill. One man was killed.

(16.) — A 14 ft. flywheel exploded on June 15, at the plant of the City Electric Light Company, Douglas, Ga., due to a run-away when the governor belt broke. The damage was several thousand dollars.

(17.) — On July 10th a 16 ft. flywheel exploded at the plant of the International Rubber Cloth Company, West Barrington, R. I. Four men were injured. The damage was $7,700.00.

(18.) — A large pulley on a dynamo burst on July 11th at the refrigerating plant of the J. W. Hester Company, Savannah, Ga. One man was mortally injured.

(19.) — The governor balance weight located in a flywheel broke off damaging the wheel beyond repair at the plant of the Dodge Steel Pulley Corporation, Oneida, N. Y. on August 19th.

(20.) — On August 29th an engine wheel failed at the plant of the Broadway Coal Mining Company, Simmons, Ky.

(21.) — A 12 ft. flywheel exploded on Sept. 2nd at the Racine Industrial Works, Racine, Wis.

(22.) — A 13 ft. flywheel exploded on Sept. 3rd in the 10″ Chill Mill of the Pittsburgh Steel Company, Glassport, Pa. Two men were injured. The damage was $17,000.00.

(23.) — A 54″ pulley failed on Sept. 11th at the plant of the Clayville Paper Mills Company, Clayville, Oneida County, N. Y.

(24.) — On September 15th a gas engine wheel exploded at the Municipal Power Plant, Norwood, Ohio. A fragment of the wheel broke a gas main. The fire that followed did damage estimated at $50,000.00.

(25.) — A 6 ft. flywheel on a variable speed engine exploded on Sept. 27th at the plant of the Ironsides Board Company, Norwich, Conn.

(26.) — On October 6th a 3 ft. pulley failed at the plant of the Northern Paper Mills, Greenbay, Wis.

(27.) — On October 13th a flywheel burst at the plant of the Pacific Coast

Coal Company, New Castle, Washington. One man was killed by escaping steam from a steam main broken by a fragment of the wheel. One other man was seriously injured.

(28.) — A 12 ft. wheel burst on October 13th at the plant of the Imperial Sugar Company, at Sugarland, Texas.

(29.) — A large gear failed on October 17th at the plant of the Apsley Rubber Company, Hudson, Mass.

(30.) — On October 24th a 20 ft. wheel exploded in the Puddle Mill of the Penn. Steel and Iron Works, Lancaster, Pa. One man was killed and 6 men were severely scalded by escaping steam and otherwise injured by flying debris. One section of the exploded wheel went up through the roof and upon returning to earth glanced the side of a boiler cutting a hole in the shell 3" wide by 14" long.

(31.) — On November 9th a flywheel burst on the Wolf Spring Oil Lease, near Allentown, N. Y. Two men were instantly killed.

(32.) — On Nov. 19th a steam turbine exploded at the plant of the Connecticut Power and Light Company, Waterbury, Conn. (For detailed account of this accident see page 2 of this issue.)

(33.) — On December 2nd a small turbine exploded at the plant of the Oliver Iron & Steel Company, Pittsburgh, Pa. (For detailed account see page 16 of this issue.)

(34.) — On December 7th a flywheel left the engine of a sawmill of Mr. Tom Young, near Ambrose, Ga., when at full speed. One man was killed.

Boiler Explosions.

March, 1919.

(99.) — One section cracked in a cast iron sectional heating boiler on March 3rd at the Elizabeth's Industrial School, New York, N. Y.

(100.) — A 4-inch nipple pulled out of the drum on a water tube boiler doing damage to brickwork on March 1st, at the veneer and lumber mill of C. B. Willey, Chicago, Ill.

(101.) — A boiler exploded on March 3rd in the shop of the Syracuse Corner Block Co., Syracuse, N. Y.

(102.) — On March 3rd the blow-off pipe pulled out of elbow at the Kissel Motor Car Company's plant at Hartford, Wis., resulting in the severe injuries of one of the firemen.

(103.) — When starting an engine on March 3rd the cast iron steam separator ruptured due to water hammer at the Bergman Knitting Mills, Philadelphia, Pa.

(104.) — A boiler ruptured on March 3rd at the main plant of the State Penitentiary, Joliet, Ill.

(105.) — A tube ruptured March 4th in a water tube boiler at the plant of the Ebensburg Coal Co., Colver, Cambria County, Pa. Two persons were scalded, one seriously.

(106.) — On March 5th a tube ruptured in a water tube boiler at the plant of the Scovill Mfg. Co., Waterbury, Conn.

(107.) — Three sections cracked on March 6th in the cast iron sectional boiler belonging to J. W. Welch, Omaha, Neb.

(108.) — A section cracked March 6th in a cast iron sectional heating boiler at the Bellevue Hotel, Denver, Colo.

(109.) — An air receiver exploded on March 9th at the Rendering Plant of Swift and Company, Harrison, N. J.

(110.) — Five sections cracked on March 10th in a cast iron sectional boiler belonging to R. H. Gardiner and Philip Dexter, Trustees, due to low water.

(111.) — On March 10th a rupture occurred in the flange turn of a drum head of a water tube boiler at the plant of the Buckeye Cotton Oil Co.

(112.) — Five sections cracked in a cast iron sectional boiler belonging to W. T. Duker Co., Quincy, Ill., on March 10th.

(113.) — Three sections cracked on March 10th in a cast iron sectional boiler of Louis L. Friedman, Perth Amboy, N. J.

(114.) — A furnace flue collapsed in a marine type boiler on March 13th in the basement of office building belonging to Henry L. Corbett et al., Portland, Oregon, causing fatal injuries to the engineer and two of his assistants.

(115.) — Five sections cracked in a cast iron sectional boiler on March 15th at the Magaziner Baking Corporation, Springfield, Mass.

(116.) — A rendering vessel exploded on March 13th at the abattoir of Charles Maybaum & Son, Newark, N. J. The building in which it was contained was completely wrecked.

(117.) — A heating boiler exploded on March 16th in the basement of the Hoiles Block, Alliance, Ohio.

(118.) — While cutting in a boiler the blind end of a steam header was blown off by water hammer action on March 16th at the plant of Greenwood Cotton Mills, Greenwood, S. C.

(119.) — A tube ruptured in a water tube boiler on March 16th in the plant of the Chicago Coated Board Co., Chicago, Ill.

(120.) — On March 17th a tube failed in a Hawley Furnace under a boiler of the Central Ice & Cold Storage Co., New Orleans, La. Two men were scalded, one fatally.

(121.) — A tube ruptured on March 19th in a water tube boiler of the Cohankus Mfg. Co., Paducah, Ky.

(122.) — A tube ruptured in a water tube boiler on March 18th at the Blue Grass Plant of the International Agricultural Corporation, Mount Pleasant, Tenn., injuring and scalding two men.

(123.) — A drier exploded on March 19th at the plant of Mulsen, Klein and Krouse Mfg. Co., St. Louis, Mo.

(124.) — On March 19th a steam pipe burst at the plant of the L. Candee Rubber Co., New Haven, Conn.

(125.) — On March 20th a tube ruptured in a vertical water tube boiler at the plant of the Fletcher Paper Co.

(126.) — On March 20th, a blow-off let go under a boiler at the Rhode Island Institute for the Deaf, Providence, R. I., scalding two of the attendants.

(127.) — A tube ruptured in a water tube boiler on March 20th at the Public Service Corporation at the plant at Passaic River & Coal Sts., Newark, N. J., causing slight injuries to one man.

(128.) — A heating boiler exploded on March 20th in the garage of L. C. Muss, Weatherly, Pa., blowing the roof from the building.

(129.) — A boiler of a freight locomotive of the D. L. & W. Railroad blew up on March 22nd, a mile west of Cresco. Three men were instantly killed.

(130.) — On March 22nd, a cast iron head of a paper drying cylinder blew up, doing considerable damage to the paper mill of the Hammermill Paper Co., Erie, Pa.

(131.) — A boiler blew up on March 22nd, at the Yokohama Laundry, San Mateo, Cal. The Japanese proprietor and a laundry worker were instantly killed.

(132.) — On March 22nd a 20 H. P. power boiler operating a sawmill outfit blew up in Sharpsburg Township, North Carolina. The boiler belonged to Lewis Scott, who was running the mill but escaped injury. One other man was badly scalded.

(133.) — Ten sections cracked in a cast iron sectional heating boiler on March 25th in the basement of the Beaver County Court House, Beaver, Pa.

(134.) — On March 26th a tube ruptured in a water tube boiler belonging to the American Gas & Electric Co., at Wheeling, W. Va. One man was injured.

(135.) — When cutting in a boiler which had been out for repairs a sizable piece blew out of the stop valve body at the main boiler house of the Dare Lumber Co., Elizabeth City, N. C. on March 26th. Two men were severely scalded.

(136.) — On March 29th a cast iron hot water heating boiler exploded at the House of the Good Shepherd, Hartford, Conn.

(137.) — A section cracked in a cast iron sectional boiler on March 29th at the garage of the Standard Tire & Auto Co., New Britain, Conn.

(138.) — Three sections cracked in a cast iron boiler on March 29th at the Home Club, Richmond, Va. Six sections cracked in the boiler next to it at the same time.

(139.) — Two sections cracked on March 30th in a cast iron sectional boiler at the garage of William Krauss Garage Co., New York City, New York.

(140.) — A tube ruptured on March 29th in a water tube boiler at the plant of the Industrial Iron Works, Bay City, Mich.

(141.) — The fire sheet ruptured due to low water on March 30th in a boiler belonging to the St. Paul Coal Company, Cherry, Ill.

(142.) — A safety valve fitting was blown apart March 31st on a small boiler at the Star Confectionery Company, Boston, Mass.

(143.) — One cast iron header cracked on March 30th on a water tube boiler of the American Bridge Company, Elmira Heights, N. Y.

(144.) — Two tubes burst in a water tube boiler on March 31st in the plant of the Water & Light Department, Knightstown, Ind.

April, 1919.

(145) — A blow-off pipe ruptured and pulled out of a fitting on April 2nd at the plant of the North American Chemical Company, South Milwaukee, Wis.

(146) — A large tank used in the making of dyes exploded on April 2nd at the plant of the California Ink Company, Berkeley, Cal. It crashed through

the second floor and the roof of the building and after an air flight fell down through the roof of an adjoining building. The damage was very large.

(147) — A boiler ruptured on April 2nd at the plant of H. Murphy and Son, Pittsburgh, Ohio.

(148) — On April 3rd an ammonia tank exploded at the plant of the Rieck-McJunkin Dairy Company's plant, New Castle, Pa. Of the three men that were working on the tank when the accident occurred, one was almost instantly killed and two were very seriously injured.

(149) — A boiler exploded on board the steamer "Cape Breton" while four miles out from St. John, Newfoundland on April 6th. The Chief Engineer with two Chinese firemen were killed while two other men were seriously injured.

(150) — A section in a cast iron boiler cracked on April 5th at the plant of the Snowflake Axle Grease Company, Fitchburgh, Mass.

(151) — A cast iron boiler cracked on April 5th at the Garfield School, Bridgeport, Conn.

(152) — A section cracked in a cast iron sectional boiler on April 7th at the Library Building, Alliance, Neb.

(153) — On April 8th a boiler exploded at the plant of the Sinclair Oil Refining Company, Buffalo, N. Y. The damage was very large.

(154) — A kier in the dye house of the Joslyn Mfg. Company, Olneyville, R. I. exploded on April 7th, one man was very severely injured, and the damage to the property was very large.

(155) — A shell of a drier failed on April 10th due to wear at the plant of the Point Milling & Mfg. Company, Mineral Point, Mo.

(156) — Three sections cracked on April 10th in a cast iron sectional boiler at the Baxter Hotel, Idagrove, Iowa.

(157) — Three cast iron headers of a water tube boiler failed on April 11th at Nueces Hotel, Corpus Christi, Tex.

(158) — An autogenously welded air tank exploded on April 11th at the plant of the York Mfg. Company, York, Pa.

(159) — The shell plate of a boiler failed on April 12th at the plant of the Clawson Chemical Company, Ridgeway, Penn.

(160) — A cast iron header of a water tube boiler cracked open on April 12th at the plant of the Rochester & Lake Ontario Water Company, Rochester, N. Y.

(161) — A boiler exploded on April 13th at the Locust Gap Plant of the Philadelphia & Reading Coal & Iron Company. Two men were killed.

(162) — A boiler ruptured on April 13th at the plant of the Hurni Packing Company, Sioux City, Ia.

(163) — A tube ruptured on April 16th in a water tube boiler at the Buckingham Ave. Power Station, of the Public Service Corporation of N. J. Perth Amboy, N. J.

(164) — On April 16th a crown sheet collapsed in a locomotive boiler of the Kirby Lumber Company, Houston, Tex.

(165) — A shell ruptured of a boiler of the Boonville Creamery & Cold Storage Company, Boonville, N. Y. on April 17th.

(166) — On April 18th a boiler explosion occurred on the U. S. S. Beaukelsijk. Two enlisted men were killed.

(167) — A boiler exploded in a Turkish Bath House, New Haven, Conn., on April 17th; two men were injured.

(168) — A boiler exploded on April 19th at the plant of Otto Zovler & Co., Chicago, Ill. One man was killed and five others injured.

(169) — The blow-off pipe failed on a boiler at the Lufkin Ice Company, Lufkin, Tex., on April 20th.

(170) — Two brace rivets snapped off their heads and were blown out of the tube sheet of a water tube boiler on April 20th at the plant of the Hess & Hopkins Leather Co., Rockford, Ill.

(171) — A tube ruptured in a water tube boiler on April 20th at the plant of the United Electric Company, Lexington, Neb.

(172) — A tube burst on April 20th in a water tube boiler belonging to the Pacific Gas & Electric Company, Fresno, Cal. One man was severely scalded.

(173) — A tube ruptured on April 22nd in a water tube boiler of the Columbia Chemical Company, Barberton, Ohio.

(174) — A hot water boiler exploded in the basement of the Anhilde Apartments, New York City, on April 22nd.

(175) — A tube burst in a water tube boiler on April 25th at the plant of the Timkin Detroit Axle Company, Detroit, Michigan.

(176) — A section cracked on April 27th in a cast iron sectional boiler of the Holyoke Supply Company, Holyoke, Mass.

(177) — A sizable piece blew out of a tube on April 29th in a water tube boiler of the D. C. Shepard Strong & Warner Company, St. Paul, Minn.

(178) — A tube ruptured on April 30th in a water tube boiler of the Florida Ice & Coal Company, Jacksonville, Fla.

May, 1919.

(179) — A tube burst in a water tube boiler of the Public Service Corporation of Perth Amboy, N. J., on May 4th.

(180) — A vertical cast iron sectional boiler cracked on May 4th at the Pinehurst Hotel, Laurel, Miss.

(181) — A tube ruptured in a water tube boiler at the Perth Amboy plant of the Public Service Corporation of New Jersey on May 6th.

(182) — A hot water boiler burst in the basement of the McKinley Apartments, Patterson, N. J. on May 9th. The two children of the janitor of the building were slightly injured.

(183) — While standing on a siding the boiler of a locomotive blew up of the Seaboard Air Line R. R., Raleigh, N. C. Three men were instantly Killed, May 13th.

(184) — On May 14th a blow-off pipe of a pulp digester of the Atlantic Paper & Pulp Company, Savannah, Ga., broke between the vessel and the gate valve allowing the contents to escape. Three men were injured, one of them seriously.

(185) — On May 14th a steel elbow of a blow-off pipe ruptured on a boiler of the American Candy Company, Milwaukee, Wis.

(186) — A tube burst and four cast iron headers fractured on May 14th in a water tube boiler of the Illinois Northern Utilities Company, Freeport, Ill.

(187) — On May 14th a cast iron header fractured in a water tube boiler at the Dodge Mfg. Company, Mishawaka, Ind.

(188) — A tube burst on May 14th in a water tube boiler at the plant of the Emmerling Brewing Company, Johnstown, Pa. One man was injured.

(189) — On May 15th a tube burst causing the cracking of two cast iron headers in a water tube boiler belonging to Swift & Company, Union Stock Yards, Chicago, Ill.

(190) — On May 19th a tube burst in one of the water tube boilers of the Noblesville Heat, Light & Power Company, Noblesville, Ind. One man was severely injured.

(191) — On May 22nd a boiler of a locomotive belonging to the Pennsylvania R. R. blew up near East Palestine, Ohio. Two men were instantly killed and another was severely injured.

(192) — A boiler blew up on May 22nd at the plant of the Humble Ice & Power Company, Humble, Tex. One man was killed, and one was severely injured.

(193) — On May 23rd an air tank exploded at the plant of the Central States Granite Company, Huntington, W. Va. One man was so severely injured that he died a week later.

(194) — On May 23rd a rupture occurred due to bulging out of the top of drum shell of a water tube boiler of the Nebraska Cement Company, Superior, Neb.

(195) — A tube burst on May 25th in a water tube boiler of the Nichols Cooper Company, Newtown, L. I., N. Y.

(196) — On May 30th a tube ruptured in a water tube boiler at the plant of McKinney Steel Company, Josephine, Penn.

(197) — On May 29th while cutting in a boiler water hammer action occurred blowing off the top of an 8″ non-return stop valve at the Bleachery Power Plant of the Lonsdale Company, Providence, R. I. One man was scalded to death.

(198) — A furnace collapsed on May 31st in a boiler belonging to Truax's Criterion Laundry, Omaha, Neb.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1919.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$361,295.49
Real estate		90,000.00
Mortgage and collateral loans		1,505,900.00
Bonds and stocks		5,121,486.85
Premiums in course of collection		654,112.42
Interest accrued		108,152.83
Total assets		$7,840,947.59

LIABILITIES.

Reserve for unearned premiums		$3,429,363.68
Reserve for losses		153,378.80
Reserve for taxes and other contingencies		367,147.68
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,891,057.43	
Surplus to Policy-holders,		**$3,891,057.43**
Total liabilities		$7,840,947.59

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The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

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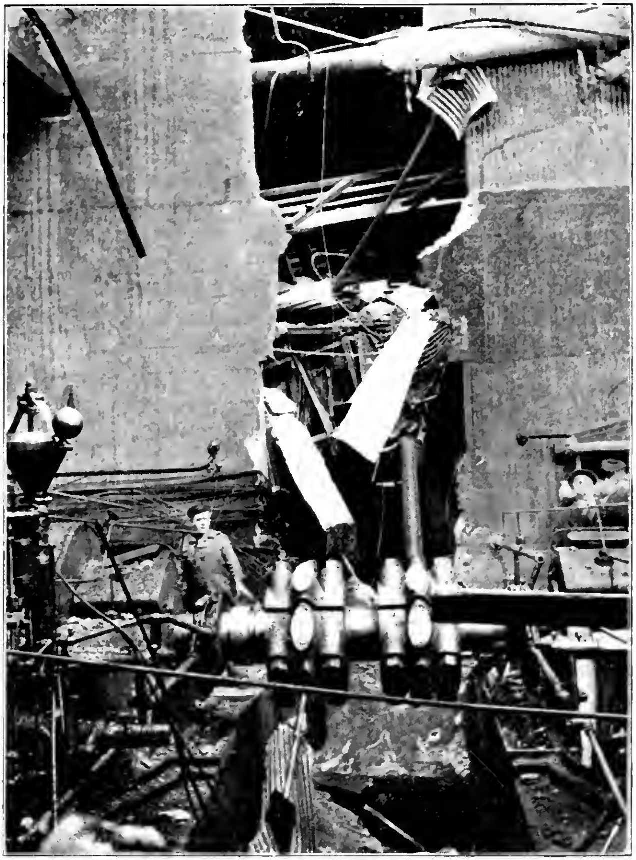


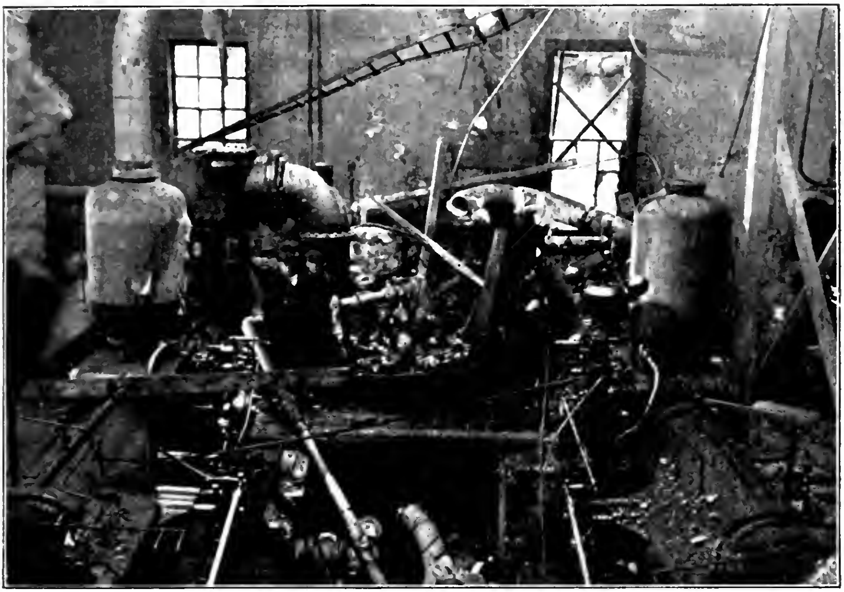
Flywheel Explosion at Scotia, Cal.

DAMAGE TO ENGINE HOUSE BUILT OF 12" CONCRETE WALLS.

THE illustrations on the front cover and next page of the present issue of the LOCOMOTIVE show some of the resulting damage when a 16 foot flywheel exploded on February 23rd at the sawmill of the Pacific Lumber Company, Scotia, Cal. The property damage was quite heavy but fortunately there were no fatalities as is so often the case with such disasters. Of the five men who were only slightly injured, four did not even stop working.

The wheel was of the flange joint type, made in four sections and really consisted of two wheels bolted together which formed a total rim face of 5 feet. The engine on which the exploded wheel was mounted was of the twin type with releasing type of valve gears, both cylinders receiving steam at approximately boiler pressure. One fly-ball governor regulated the cut-off for both cylinders with the usual arrangement of a rockershaft extending from one side of the engine to the other and this feature appears to have had a more or less prominent part in the cause of the engine running away.

The leading cause of the accident was a sudden release of all load from the engine by the breaking of the main driving belt which is thought to have been brought about by a piece of wood wedging between the belt and the face of the wheel. The broken main belt knocked off the governor-driving belt from its pulley so that the governor stopped revolving. If the trouble had terminated there the dire results shown in the illustrations should have been averted by the so-called safety cams on the valve gear which come into play when the governor drops to its lowest position and prevent the further admission of steam to the cylinders. However, as the big belt coiled up into the wheel pit, it broke the afore-mentioned governor rockershaft, which



General View of Cylinders and Valve-gear.

had the effect of preventing the safety cams on the north cylinder from functioning so that this cylinder continued to receive steam during a portion of each stroke and the speed of the engine increased rapidly.

We are advised that when the trouble began one of the operators ran to the throttle valve wheel and succeeded in closing the valve to within ⅛ inch after which he ran for safety just in time to escape with his life. This throttle valve was located overhead in the steam-line at the point where the steam-line forked into the two pipes that led to the cylinders, and moreover, on each cylinder stood a spacious steam separator so that the volume of steam between the throttle and the cylinders was very large and in all probability was sufficient to run the engine at a destructive speed, so that it is extremely doubtful whether his courage would have been crowned with success even if he had shut the valve tight.

The loss was estimated between twenty-five and thirty thousand dollars and was covered by insurance.

Horizontal Tubular Boiler Settings and Details of Installation.

H. E. Dart, Superintendent of Engineering Department.

OUR Engineering Department is now engaged in making new drawings of setting plans for horizontal tubular boilers. In past years there has been a big demand for such setting plans and some of the tracings for the more common sizes of boilers are literally worn out. In making the new drawings, advantage is taken of the opportunity to show certain features in greater detail than was formerly the case and the scope of the plans has also been extended so as to include typical methods of piping and the proper manner for installing the usual fittings and attachments. Figures are also given to show the quantities of bricks required for setting the boilers in accordance with the plans. For each of the common sizes of boilers, it is the intention to make four drawings, two with overhanging fronts and two with flush fronts, one of each style showing boilers suspended independently of the setting walls and the other showing boilers supported by means of brackets resting on the walls. The complete set of plans is not yet finished but drawings are ready for many of the ordinary sizes of boilers and blueprints can be furnished from such drawings as are finished. Requests for such blueprints should be made preferably through the chief inspector of the department in which the boilers are located (see list of departments on back of THE LOCOMOTIVE) rather than directly to the Engineering Department, because our chief inspectors are familiar with the conditions which exist and are generally able to submit the data which we need to determine which drawing is best adapted to each particular case.

The most important features in connection with the new setting plans are described below. While many of the features mentioned will apply equally well to the design of settings for any other type of boiler, it should be remembered that this description is concerned primarily with hand-fired horizontal tubular boilers using coal for fuel, and is written from that viewpoint.

WALL CONSTRUCTION.

On our old setting plans the outside walls are shown as indicated by Type I, Figure A, but on the new plans we are showing all of the four types of construction described in Figure A, leaving it to the boiler owner to make his choice between these designs. Complete dimensions are given on the drawings for each type of construction.

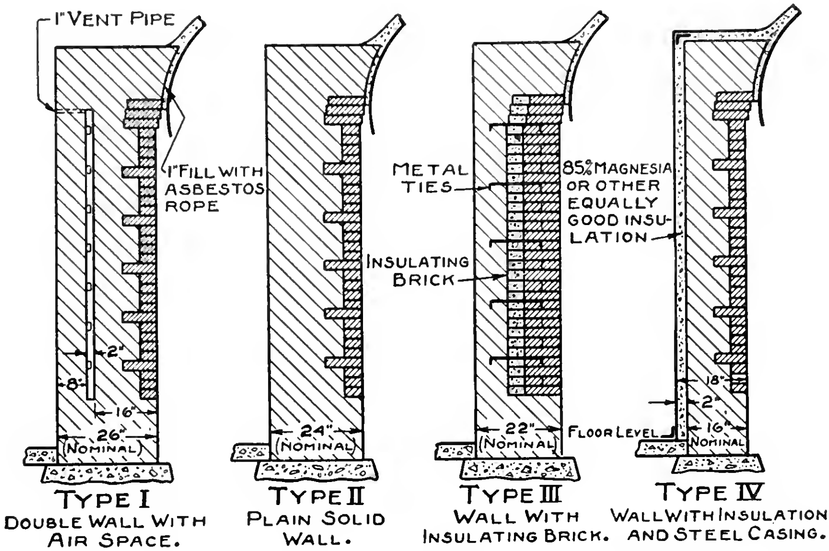


FIG. A. DIFFERENT TYPES OF CONSTRUCTION FOR SETTING WALLS.

The design shown by Type I involves the construction of two separate brick walls, bonded solidly together for a distance of about sixteen inches at the top and at the bottom, but separated by an air space two inches wide for the remainder of the height. It is thought by many people that this air space acts as a heat insulator but such is not the case; experiments by the Bureau of Mines have shown that a wall of this type will transmit just as much heat under given conditions as a solid wall of the same total thickness. As regards air leakage into the furnace, however, the double wall with air space has a distinct advantage over the solid wall shown by Type II because the cracks will occur principally in the inner wall, leaving the outer wall intact. With a solid wall, the cracks will extend clear through the brickwork, thus greatly increasing the probability of air leaks and thereby decreasing the efficiency on account of excess air. Not long ago we had occasion to make an examination of a solid-wall setting which had been built in the same boiler room with two older settings of the air space type. Although the new setting had been in use only a few months the test with a candle flame showed more leaks than were found in the other settings which had been used several years. Of course such a test is not entirely conclusive, since there are other features which should be considered, but we believe it gives a fair indication as to what may be expected in the average case. In constructing setting walls with an air space it is advisable to insert a few ventpipes as indicated in the cut, these pipes being especially desirable if the bricks contain much moisture when they are laid. After the setting has thoroughly dried out, all ventpipes should be permanently sealed so as to prevent air leakage into the setting and heat radiation from the inner wall.

Type III in Figure A makes use of insulating bricks to reduce the amount of heat that is transmitted through the wall and thereby lost. These insulating bricks are made of different materials by different manufacturers and they are cut to the proper size to lay up evenly with ordinary bricks and fire bricks. They have little mechanical strength in themselves so that it is best to use metal ties, as shown in the cut, for bonding the inner firebrick section to the common brick on the outside. It is also advisable to use a uniform thickness of nine inches for the firebrick lining in place of the 4½ inch lining with headers as shown for the other types. This type of construction makes a very good setting, costing somewhat more than either Type I or Type II.

Type IV is similiar to Type I with a steel casing substituted for the outer wall and the air space filled with magnesia or other good insulating material. This makes a most excellent form of setting, the only drawback to its more general use being its greater cost as compared with other types. The insulating material reduces the heat radiation loss to a minimum and the steel casing prevents the even greater loss due to air leakage through the setting walls. Furthermore, a setting of this kind presents a very neat appearance and requires less space than any of the other types illustrated, there being a saving of eight inches in length and sixteen inches in width as compared with Type I. Number 8 U. S. gage steel plates should be used for the casing with angle irons placed about 3½ feet apart along the sides and back and with similar angles at the top, bottom, corners and elsewhere as needed for stiffness and stability.

For the division walls between boilers set in battery the style of construction shown in Figure B is satisfactory, regardless of what type of construction is used for the outside walls. The vertical slot shown in the center of the wall does not indicate an air space like that in Type I but is intended to show that the two walls should be built separately and not bonded together in the center. This is advisable to make allowance for expansion when there is a fire on only one side of the wall.

The sections in Figure A apply to the side walls at the rear of the bridge wall. For the furnace section in front of the bridge wall, we advise that the walls be battered from the grate level to the closing-in line near the middle of the boiler shell. Our drawings show a batter of six inches in this height, thus making the walls that much thicker at

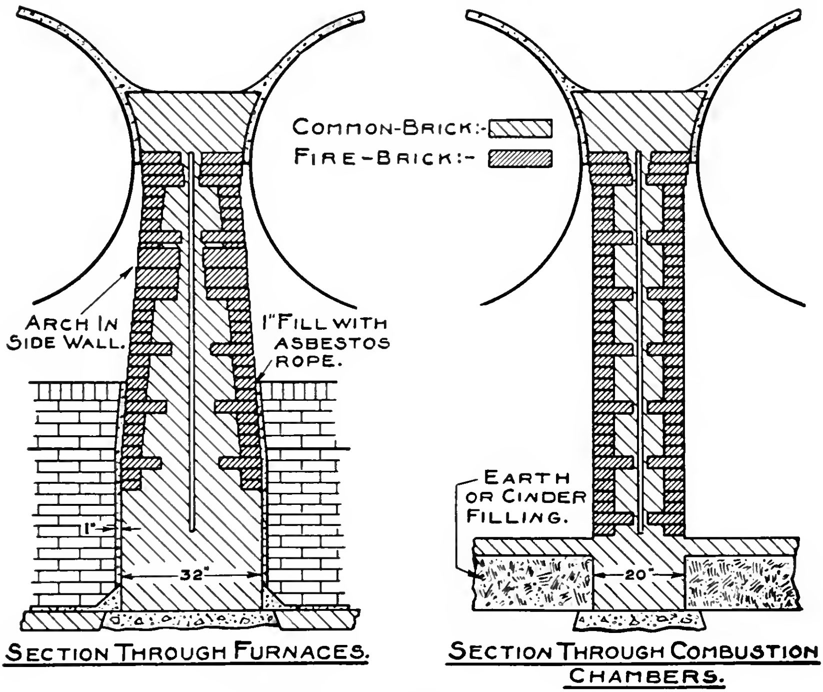


FIG. B. DIVISION WALLS BETWEEN BOILERS SET IN BATTERY.

the bottom. A reference to Figure B will make this point clear. The section at the left shows the battered wall while that at the right shows the straight form which can be used back of the bridge wall. This figure shows sections for the division wall between boilers but the same idea should be applied to the outside walls.

In constructing side walls and division walls it is a good idea to build an arch in the firebrick lining at a height of about three feet

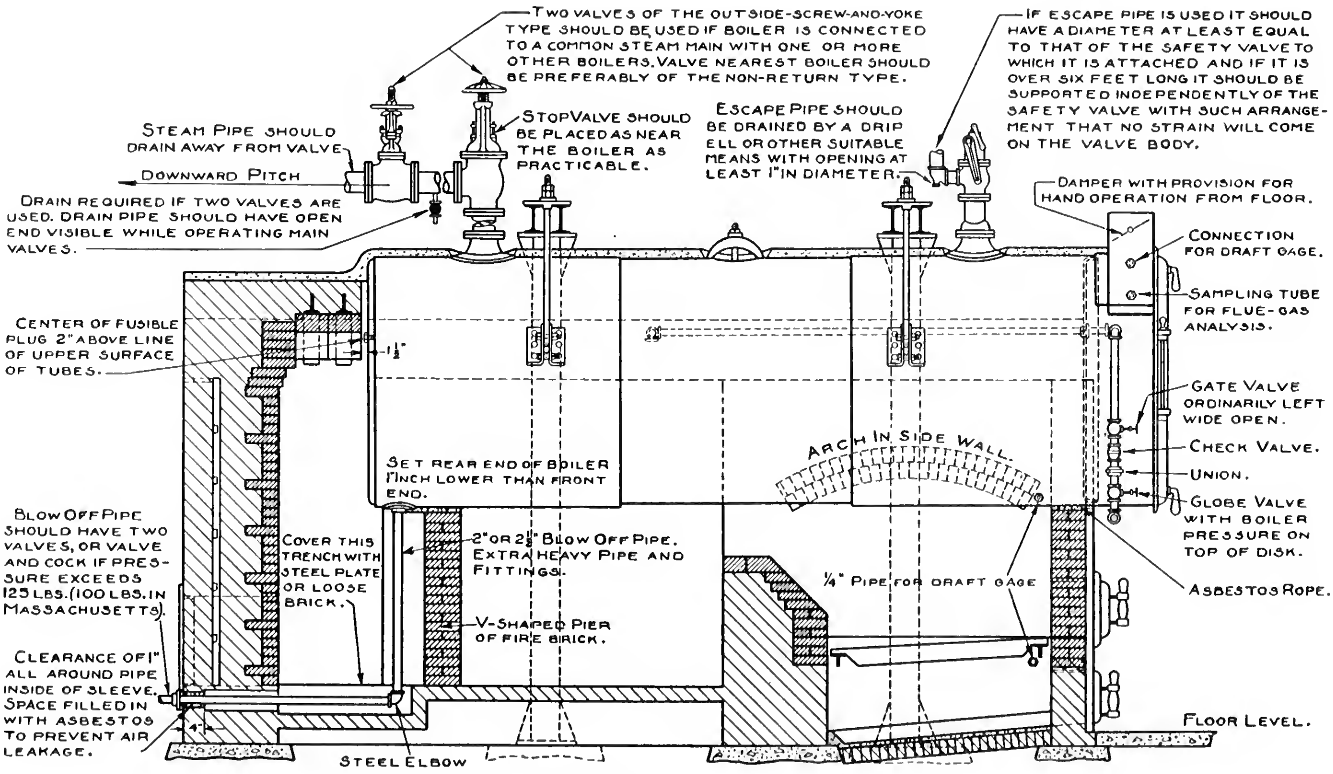


FIG. C. LONGITUDINAL SECTION THROUGH CENTER OF SETTING.

above the grates, as illustrated in Figure C. When it is necessary to replace firebrick this arch supports the brickwork above and prevents it from falling down.

For construction like that shown in Types I, II, and IV, where the firebrick lining is only 4½ inches thick, headers should be used for every fifth course or even more frequently. In all firebrick work the joints between the bricks should be made just as thin as possible. For this reason a trowel should not be used but the bricks should be dipped in thin fire-clay and then rubbed down into place so as to make "brick-to-brick" joints.

ALLOWANCE FOR EXPANSION AND PREVENTION OF AIR LEAKS.

Ample provisions should be made throughout to allow the boiler and the setting to expand without cracking the brickwork or opening up places where air can leak into the setting. If the brickwork is built tight up to the boiler shell at the closing-in line, cracks are sure to develop when the boiler is heated up and there will also be an opportunity for air to leak in between the boiler and the brickwork. It is best, therefore, to leave the brickwork about an inch away from the boiler and fill this space with asbestos rope or some similar material, as illustrated in the different sections of Figure A. In a similar way, the brickwork and the ironwork of the boiler front should be kept about ¾ inch away from the boiler shell (and concentric therewith) and this space should be filled in with asbestos rope. To prevent cracking due to endwise expansion of the bridge wall, it should be built separately from the side walls, leaving a space of about one inch at each end. This space should be filled with asbestos rope to prevent the accumulation of ashes which would become solid and nullify the advantage to be gained by building the bridge wall independently of the side walls.

At the rear end of the boiler, a space of about 1½ inches should be left between the boiler head and the brickwork; this space can best be sealed against air leakage by extending the insulating covering down over it as shown in Figure C. There is a tendency for the covering to crack open at this point as the boiler expands and contracts but this difficulty can be largely overcome by the use of a piece of sheet iron, formed to fit over the rear end of the boiler shell and bent down over the head to extend out on top of the brickwork. With the piece of sheet iron in place under the covering the probability of cracking is lessened and, if a crack does develop, the sheet iron will tend to prevent air from leaking into the setting. We advise the use of insulating covering for the boiler top instead of the brick arches which are sometimes used. The covering is a better heat insulator and it can be removed and replaced more readily in case repairs or inspections of the boiler shell are required. The covering can best be applied in the form of blocks which can be held in position with mesh wire and then finished with plastic magnesia or other insulating cement to make a smooth finish and fill the joints between the blocks. A harder surface can be secured by using a little Portland cement in the final coat. The total thickness of the insulation should be at least two inches.

The loss due to excess air is generally greater than that from any other cause in hand-fired boilers of the type under consideration, and it is also the most difficult to prevent because it is such an intangible sort of thing that the firemen cannot be made to realize its importance. Much of this excess air leaks in through the setting walls and efforts to prevent such leakage by the methods outlined above will be well repaid. It is not sufficient merely to construct the setting as described, however; inspections and tests should be made at frequent intervals to be sure that the asbestos remains in place and that the joints are properly sealed at all points. We have made a number of investigations of this kind and we almost invariably discover air-leaks at some of the places mentioned above as well as around blow-off pipes, firing doors, clean-out doors, etc.

There are several different paints and coatings on the market which can be used to good advantage in the prevention of air leaks. Such compounds are usually composed of asphalt, asbestos and other materials, combined to produce a thick elastic coating which will stretch without cracking as the setting expands when it is heated up. The coating is usually applied to the entire surface of the setting, care being taken to work it into all cracks, joints and openings around door-frames, boiler fronts, or other similar places. A very satisfactory home-made substitute can be prepared to take the place of the commercial compounds.

PROTECTION OF BLOW-OFF PIPES.

The proper protection of the blow-off pipe is an important feature in connection with any setting for a horizontal tubular boiler. There are many ways of providing such protection and in making a choice between different methods one important principle to be kept in mind is that the pipe should be easily accessible for inspection. For this reason a simple pipe sleeve around the blow-off pipe is not satisfactory because such a sleeve cannot be removed without disconnecting the blow-off pipe. Split sleeves of cast iron are better but it is usually rather difficult to remove them after the connecting bolts have been exposed to the heat and flames. Several patented styles of blow-off covering are available and these give good results as a rule. In general, such blow-off coverings are made of some refractory material and applied in sections with an interlocking arrangement so that they are easily removable.

Except under extraordinary conditions, the method of installation shown in Figure C provides ample protection for blow-off pipes. The principal features of this method are a V-shaped pier of firebrick which prevents the flames from impinging upon the vertical portion of the pipe, and the location of the elbow in a covered trench where it will be well protected. Blow-off pipes are more liable to fail at the elbow than at any other point and the location of the elbow in this position is therefore highly desirable. The best arrangement is to build the bottom of the combustion chamber at a somewhat higher level than the boiler-room floor so that there will be space enough to install the blow-off valve or cock without cutting into the floor. It is advisable also to locate the cleaning door at one side of the center where there will be no interference with the blow-off valve when the door is opened. Plenty of space to permit freedom of movement, due to expansion or settlement, should be left around the pipe where it passes through the setting wall. For this purpose a pipe sleeve about four inches long should be built into the brickwork at the outer end but a larger opening can be left around the pipe through the remainder of the wall thickness, without any sleeve. The sleeve should have a diameter two inches greater than that of the blow-off pipe and it should be filled with asbestos to prevent air leakage. A set-screwed collar on the pipe makes a good finish against the brickwork together with provision for a gasket of sheet asbestos or other suitable material to more thoroughly seal the opening against air leakage. The V-wall should be left a little below the boiler shell to allow for expansion and settlement, and the space should be filled with asbestos to keep the flames from impinging upon the flange where the pipe is connected to the boiler. Blow-off valves should always be located so that there will be ample opportunity for a man to get away in case of a break in the blow-off piping while he is operating the valves.

ARCH-BARS.

The rear arch-bars shown on our setting plans and in Figure C are of the so-called "HARTFORD" type, designed by this Company several years ago. Bars of this type extend transversely of the setting, spanning its width and bearing upon the side walls. Except for large boilers, only two of these arch-bars are needed for a single setting but a different pattern is required for each size of boiler. In some sections of the country the "quadrant" type of arch-bar is more popular and it is just as acceptable; this style of arch-bar is made in the form of a quadrant or ninety-degree arc of a circle. The bars rest on the rear wall, arching over to the rear head, and some means must be provided to support the upper ends, so as to permit the boiler to expand without developing air leaks. Several of these bars are needed for a single setting, the exact number depending upon the diameter of the boiler, but the same pattern can be used for all sizes of boilers where the distance from the rear head to the rear wall of the setting is the same. Both types of arch-bar described above are so designed that the metal is protected by the firebrick and not exposed to the action of the flames and hot gases; this feature should be a requirement in the design of any arch-bar.

Arch-bars should be set so as to leave a full, free opening through all the tubes, with proper provisions for inspecting and removing the fusible plug but, at the same time, care should be taken that no part of the head above the lowest permissible water level is exposed to the heat. We recently heard of a case where a head was burned, due either to poorly designed arch-bars or to placing the arch-bars so high as to expose the upper part of the head to extreme heat.

GRATES.

We believe that there is a general tendency to use larger grates than necessary with hand-fired boilers of the horizontal tubular type and this belief is borne out by our experience in several cases where we have found that coal was being burned at a rate of ten to twelve pounds per square foot of grate area per hour whereas better results would be obtained with a rate of fifteen to twenty pounds of coal per square foot per hour. In some cases we have advised blanking off the rear part of the grates by covering them with fire brick and a gain in economy of coal consumption has been secured in such cases. Furthermore, it has been common practice to use the same size of grates for a given diameter of boiler regardless of the tube length though it is obvious that if a certain area is proper for a boiler eighteen feet long it would not be correct for a sixteen-foot boiler in which the heating surface would be about eleven per cent less. Assuming an evaporation of about nine pounds of water per pound of coal, the ratio of heating surface to grate area should be about 40 to 1 in order to develop the full rated capacity of a boiler when burning coal at the rate of fifteen pounds per square foot of grate per hour. In designing our new setting plans we have used this ratio to determine the grate area, within the limits imposed by commercial standards as regards length of grates. Provision for overloads and allowance for a lower rate of evaporation can be taken care of by burning the coal at as high a rate as twenty pounds per square foot of grate per hour, this rate being attainable with proper draft and good firing methods. On the other hand, many horizontal tubular boilers in small plants are never operated at their full capacity and in such cases the grate area could be even smaller. It is fully realized that a larger grate area may be desirable in certain special cases but it is believed that the ratio of 40 to 1 will give good results for the average case and, of course, this is all that a set of general plans can be expected to cover; special cases should be considered in the light of all the data available in each instance.

With battered furnace walls, as described in the foregoing, the width of grates will be six inches less than the boiler diameter while with straight walls, as frequently used, the grates have a width equal to the diameter of the boiler. As explained above, the grate area is generally larger than it should be and the smaller dimension for width is therefore generally satisfactory. For the sake of simplicity and uniformity, stationary grates are shown on all of our setting plans but we recommend the use of shaking grates under ordinary conditions.

HEIGHT ABOVE GRATES.

Remarkable savings in fuel consumption have been claimed in many cases as a result of setting horizontal tubular boilers at extreme heights above the grates but, as a general rule, these claims do not seem to be fully substantiated because all of the credit for any increased efficiency is laid to the greater height of furnace whereas there are usually other factors which should also receive consideration. In a typical case of this kind, a new boiler is installed in a plant where there are one or more older boilers and perhaps the new boiler is set at a height of 5 feet above the grates while the corresponding height of the old boilers is only 28 inches. More or less careful tests are made and it is found that the new boiler is more economical in coal consumption than the old ones. It is then almost invariably assumed that the gain in economy is entirely due to setting the boiler at a greater height above the grates; although the old settings may be twelve or fifteen years old and full of cracks and openings which permit the entrance of a large percentage of excess air while the new setting is tight, this fact is completely disregarded. Furthermore, it seems to be generally assumed that the height chosen in any such case is the proper height to give the best results although there is usually no information available to prove that just as good results would not have been obtained with a height of 3½ feet, for instance, instead of 5 feet. In attributing a gain in economy to higher settings there are other factors also which may be ignored such as a change in the fuel used, an improvement in the proportions or design of the new boiler as compared with the older ones, better firing methods, improved draft conditions and method of draft control, a better type of grates, etc.

For any set of fixed conditions as regards size of boiler, character of fuel and other details, it is evident that there must be some limit in height of furnace beyond which there will be no gain in economy. It would probably not be possible to fix such a limit very definitely but much interesting information could be obtained from a series of carefully conducted tests carried out by some agency such as the Bureau of Mines which would have the necessary apparatus and technical skill, together with the means for insuring that all other conditions remain constant while the height of the furnace is varied.

The combustion volume, and therefore the height from grates to boiler shell, should be varied in accordance with the character of the fuel used, more volume being required for fuels containing a large proportion of volatile matter than for those which contain a relatively greater percentage of fixed carbon. On our setting plans we do not show any fixed dimension for the furnace height but we recommend certain dimensions as determined from our experience and best judgment. For a 72-inch boiler with tubes 18 feet long, for instance, the heights which we advise would be as follows:—

For anthracite coal and semi-bituminous coals containing less than 18 per cent. of volatile matter (Pocahontas, Georges Creek, etc.)—36 inches.

For bituminous coals containing from 18 per cent. to 35 per cent. of volatile matter (Pittsburgh)—40 inches.

For bituminous coals containing more than 35 per cent. of volatile matter (Illinois, etc.)—44 inches.

For other sizes of boilers the figures are varied so as to maintain approximately the same ratio of combustion volume to grate area. In this connection it might be mentioned that the ratio of combustion volume to grate area would be nearly 19 to 1 for a 72-inch boiler with 18-foot tubes, set as shown in Figure C and with a height of 44 inches from grates to boiler shell. Although the setting is designed only for hand-fired horizontal tubular boilers, this ratio is considerably in excess of that ordinarily used for stoker-fired water tube boilers which may be forced to 100 per cent. or more above their nominal rating.

It would therefore seem that these combustion volumes ought to be more than ample and that no gain in economy should be expected from an increase in the ratio.

METHOD OF SUPPORT.

When boilers are suspended in battery it is best to place the supporting columns entirely outside of the setting walls, using only four columns with beams of sufficient strength to support the boilers in a single span. With standard I-beams it is possible to support in this manner three boilers of any diameter not exceeding 78 inches or two boilers of larger diameter. If the installation involves more boilers it is best to set them in separate batteries of two or three boilers each, rather than to use columns in the division walls between boilers; if it is absolutely necessary to use such intermediate columns, an air space should be left all around each one with a suitable ventilating duct to admit air at the bottom. We know of several cases where columns have been burned off or otherwise damaged when built solidly into setting walls.

Our setting plans show the proper sizes of I-beams to use for suspending boilers, together with alternate designs for both round and square cast-iron columns, structural steel H-beams and built-up columns made of plates and angles. In general it will be found that these designs are heavier than those usually employed by boiler manufacturers, but we think that these sizes are needed in order for the columns to have a strength equal to that of all other parts of the installation where it is customary to use a factor of safety of 5. Boiler columns are loaded entirely at one side and the stresses are therefore greater than when the loading is symmetrical as assumed in the tables published in structural steel handbooks. Furthermore, proper consideration should always be given to the "ratio of slenderness," a heavier section being needed for a long column than for a shorter one carrying the same load. I-beams are frequently used for columns but they are not well adapted for the purpose as the distribution of metal in the I-beam section does not make a good column design. Our Engineering Department can furnish designs for reinforced concrete columns, if desired.

Boilers having a diameter of 78 inches or less can be supported by brackets which rest upon bearing plates built into the setting walls but the suspension method is better, particularly for the larger sizes. Four brackets (two on each side) are sufficient for boiler diameters of 54 inches or less but eight brackets should be used for boilers larger than this size; the brackets should be located in pairs with a single bearing plate for each pair. Brackets at the front end should rest directly upon the plates but rollers should be used under the brackets at the rear end to permit free expansion of the boiler. As a rule, not enough care is used in setting the bearing plates with the result that a good bearing is not obtained over the entire surface of both brackets. In an extreme case the bearing may be only along one edge of one bracket. The boiler should be supported by blocking or other suitable means while the setting is being built and its weight should not be allowed to come upon the walls until the mortar has thoroughly hardened so that there will be no settling.

INSTALLATION OF BOILER PIPING, VALVES, FITTINGS, ETC.

Figure C shows a typical longitudinal section through a suspended boiler with overhanging front. Several self explanatory notes will be found on this drawing relative to the proper installation of piping, valves and other details. In addition to the items mentioned the following details should receive attention in any well planned installation.

The steam gage should be graduated at least 50 per cent. in excess of the maximum allowable working pressure and it should be piped up with a siphon, union cock, drip cock, and connection with stop valve for test gage, brass pipe and fittings being used throughout.

A water glass and three gage cocks should be used. The lowest visible part of the water glass should be at least two inches above the center of the fusible plug and the gage cocks should be located within the range of the visible length of the glass. Brass pipe and fittings, 1¼ inch size, should be used for the water connection to the water column except for small boilers where the minimum size may be 1 inch. To facilitate cleaning, plugged crosses should be used in these water connections in lieu of tees or elbows.

A blow-down pipe should be provided for the water column with a gate-valve or cock. This pipe should have a diameter of at least ¾-inch and should be connected to the ash pit or some other safe and convenient point of waste. It should be secured to the boiler front near the bottom by a pipe-clip or other suitable means.

All valves and fittings should be of extra heavy pattern if the pressure exceeds 125 pounds per square inch. In Massachusetts a State law fixes this limit at 100 pounds.

A sampling pipe for flue gas analysis and three ¼ inch pipes for draft gage connections should be placed in position when the setting is being built even though it is not expected to use them. The expense is insignificant and they may prove useful.

The foregoing description is intended to cover the more important

(Continued on page 54)

The Low Pressure Boiler Hazard.

A CASUAL glance through the bound volumes of THE LOCOMOTIVE of the last dozen years reveals the fact that during that time illustrated accounts were published of not less than fourteen very serious low pressure boiler explosions, as distinguished from a large number of lesser accidents of this nature. One or more persons were killed in eight of these fourteen selected cases, and serious personal injury resulted in several of the remaining number.

There is not available a census or even a reasonably reliable estimate of the number of either power — or low pressure heating boilers in the United States, but as a broad guess we may assume that there are more low pressure heating boilers than power boilers, and when the number of power boiler accidents of a serious nature occurring annually is considered, it is really not remarkable that one should be able to pick out this number of conspicuous low pressure boiler explosions, notwithstanding the fact that the list from which they are gathered cannot even be considered in any sense complete.

It is popularly not appreciated as well as it might be that with the low pressure house heating boiler all the essential elements, that eventually may enter into a real boiler catastrophe, are present, and in this the kind of material of which the low pressure boiler may be constructed does not seem to be a significant factor.

There are, to be sure, several features connected with such boilers that could be mentioned to controvert this statement, such as for example the much higher factor of safety of the structure of a low pressure boiler as compared with the usual factor of safety of power boilers. Also the fact that the low pressure boiler does not get so much of the forcing that the modern power boiler may be subject to. The explosion of a low pressure boiler, however, can usually be traced, not to lack of strength of its structure, but to ignorance and carelessness with the fitting up and the attendance. Over-pressures will occur in them in cases in spite of the most complete advice of the boiler manufacturer as to how they must be connected up and regarding the best way to operate them. During the heating season just passed, reports and news items reached us of a number of serious low pressure boiler accidents. One case in point is the explosion of the boiler shown in the accompanying illustration, which, from the information obtainable, seems to have been due to faulty fitting up and possibly also carelessness in handling. The boiler was used with a hot water system of heating in a garage. It was not provided with a pressure — or altitude gage and the installation was also possessed

Exploded Heating Boiler.

of the all too common fault of not having a relief valve attached directly to the boiler. Our inspectors have occasion to belabor this latter detail very frequently in inspection reports, and to our sorrow we find in not a few instances that an unduly large amount of argument is required to convince owners that a relief valve attached directly to a hot water boiler is a paramount necessity for safety, irrespective of the fact that such boilers may have free communication with an open expansion tank.

In the case of the boiler shown in the illustration, there appears to have been good reason for believing that the absence of such a relief valve was responsible for the accident. When, as is supposed, during the very cold night preceding the accident, the connections to the expansion tank froze up, it became possible for an enormous pressure to build up in the boiler when it was fired up in the morning. One man, who stood directly in front of it at the time, was killed, and another man was seriously injured.

It may not be out of place to remind owners of heating boilers that a periodical inspection of such apparatus by experts, whose whole time is devoted to such work, is of immense importance.

Summary of Inspectors' Work for 1919.

Number of visits of inspection made	203,671
Total number of boilers examined	371,285
Number inspected internally	160,847
Number inspected by hydrostatic pressure	9,043
Number of boilers found to be uninsurable	1,042
Number of shop boilers inspected	10,548
Number of fly wheels inspected	26,980
Number of premises where pipe lines were inspected	8,046

Summary of Defects Discovered.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	31,599	1,783
Cases of adhering scale	47,284	1,907
Cases of grooving	2,393	271
Cases of internal corrosion	21,201	817
Cases of external corrosion	11,260	955
Cases of defective bracing	1,173	230
Cases of defective staybolting	2,428	493
Settings defective	9,423	836
Fractured plates and heads	3,473	487
Burned plates	4,836	518
Laminated plates	338	27
Cases of defective riveting	1,443	324
Cases of leakage around tubes	13,318	1,226
Cases of defective tubes or flues	19,700	6,353
Cases of leakage at seams	5,738	413
Water gauges defective	4,158	789
Blow-offs defective	5,325	1,488
Cases of low water	421	149
Safety-valves overloaded	1,134	289
Safety-valves defective	2,077	374
Pressure gauges defective	7,332	628
Boilers without pressure gauges	634	82
Miscellaneous defects	5,588	664
Total	202,276	20,603

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1920.

Visits of inspection made	4,733,353
Whole number of inspections (both internal and external)	9,389,203
Complete internal inspections	3,695,635
Boilers tested by hydrostatic pressure	367,113
Total number of boilers condemned	27,839
Total number of defects discovered	5,284,821
Total number of dangerous defects discovered	580,620

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

Devoted to Power Plant Protection

Published Quarterly

HARTFORD, APRIL, 1920.

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.
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Reprinting matter from this paper is permitted if credited to
The Locomotive of the Hartford Steam Boiler I. & I. Co.

THE truth of the old adage, that one is never too old to learn, we occasionally have brought home to us through our efforts of teaching firemen by mail the basic facts of combustion, so that they may recognize the difference between wasteful and economical furnace conditions. Among the recent graduates of our Correspondence Course on combustion and boiler handling was a man well past the days of prime youth. When he applied for enrollment he wrote: "I am 65 years young but willing to learn."

He did very well indeed. As regularly as clockwork came in his well-nigh perfect answers to the review questions and in just about four months he had mastered all the lessons. At the end of his studies we were pleased to extend to him a certificate which was marked "with honor grade."

Personal.

Mr. James G. Reid was appointed Chief Inspector of the Baltimore Department of this Company to fill the vacancy caused by the death of Mr. R. E. Munro.

Mr. Reid first became associated with The Hartford Steam Boiler Inspection and Insurance Company in 1909 as inspector at the Chicago Department, in which he served as an active and directing inspector. In 1917 he assumed charge of the inspection work of the local office at Detroit, and with such success that his promotion to the position of Chief Inspector was a natural step. We heartily commend him to the favorable consideration of our assured.

After forty years and one month of continuous service, Mr. A. W. Getchell, an inspector at the Cleveland Office retired on January 31st, 1920 from active duties and has taken up his residence at Santa Anna, Cal. Mr. Getchell has not severed his connection with the Company though he carries no responsibilities.

He came to Cleveland with his parents in 1853 at the age of three years. From the very beginning of his business career he was linked up with steam boilers and machinery and at the age of 26 he was Chief Engineer on the passenger steamer "Concord" plying between Chicago and Ogdensburg. In 1880 he became connected with The Hartford Steam Boiler Inspection and Insurance Company and has served it faithfully ever since. On the day of his leaving the surroundings of so many years of useful activity, one of those delightful informal meetings, at which good will and esteem come plainly to the fore, was held at the Cleveland office and Mr. Getchell was presented by his office associates with a gold chain, diamond-set charm, gold knife and stickpin. We wish him many happy years to enjoy his well earned retirement.

OBITUARY.

Robert E. Munro.

Mr. R. E. Munro, Chief Inspector of the Baltimore Department, died on March 29th, 1920, after a prolonged illness. He was born June 14th, 1862, and educated in Liverpool, England, being graduated from the Liverpool Institute. After serving his apprenticeship with Rollinson's Engineering Works, Liverpool, his early career was as engineer for various steamship lines, his last engagement being with the Red Star Line, on board the "Pennland," one of the largest ocean liners of her time. In 1888 Mr. Munro settled in this country and accepted the position of Chief Engineer for a large oilcloth manufacturing establishment, at Astoria, L. I., New York, remaining there until September 1891, when he became an inspector in the Baltimore office. He soon attracted the attention of the officers of the Company and in 1893 was appointed Chief Inspector of that Department, which position he held at the time of his death.

During the many years of Mr. Munro's connection with the Hartford Steam Boiler Inspection and Insurance Company, he was very highly regarded by its clients in his department and his aid and advice on engineering matters were frequently sought.

In addition to his professional attainments Mr. Munro was the happy possessor of a genial and sympathetic disposition. He made many friends and was much beloved by his associates in his office and a large circle of personal friends. Besides his widow, Mr Munro leaves three sons, two daughters and five grandchildren. To the members of his family we express our condolence in their great loss.

Mr. John McGinley, an inspector of this Company in the Philadelphia Department since 1903, died on February 19th, 1920, at his home at Chester, Pa., after a long illness. He had been practically an invalid for about two years before his death. Mr. McGinley was born in Ireland in 1866 and for a long time followed the trade of boilermaking. His occupation at the time of entering the Company's employ was that of foreman boilermaker. He leaves a widow and three small children to whom we extend our deep sympathy in their bereavement.

The title page and index for Vol. XXXII of THE LOCOMOTIVE is now available for distribution to those of our readers who wish to bind their copies of the years 1918 and 1919. Upon application to the Home Office of the Company these title pages and indices will be furnished.

Horizontal Tubular Boiler Settings.

(Continued from page 48)

features connected with the construction of brick settings for horizontal tubular boilers and the installation of such boilers in accordance with good practice but without any unnecessary frills. As stated before, many of our new setting plans are now completed and available for distribution to our friends upon request. Any inquiries regarding special features in connection with this general subject will receive the best attention of our Engineering Department at any time.

Boiler Explosions.

June, 1919.

(199) — A drum of a water tube boiler ruptured due to bulging out of the top of drum shell on June 1st, at the plant of the Nebraska Cement Company, Superior, Neb.

(200) — A boiler exploded on June 3rd in the Hopkins Creamery, Hopkins, Mich., killing two men and seriously injuring two others. A number of others were buried in the debris but escaped with slight injuries. The building was wrecked.

(201) — A tube exploded in a boiler on June 3rd at the plant of R. & H. Simon Silk Mill, Easton, Pa. Four men were injured, one fatally.

(202) — Two tubes burst in a water tube boiler on June 4th at the plant of the Delta Light and Traction Company, Greenville, Miss.

(203) — A crown sheet collapsed in a locomotive boiler belonging to the Kirby Lumber Co., Houston, Tex., on June 4th.

(204) — A boiler blew up on June 4th in the Belcher Saw Mill, 28 miles S. E. of Tuscaloosa, Ala., killing one man and injuring two others.

(205) — A blow-off failed on June 5th at the Home Ice Factory, San Antonio, Tex.

(206) — A boiler accident took place on June 5th on board the steamer "Kingston," Toronto, Ont., Canada. Two were injured.

(207) — A tee connection failed on a boiler mud drum on June 10th at the plant of the Davies Box and Lumber Company, Blairsden, Plumas County, Cal.

(208) — The head blew out of a drum of a water tube boiler on June 12th at Cane's pencil factory, New Market, Ont., Canada, injuring 11 persons and doing great damage to buildings and machinery.

(209) — On June 13th, while 18 miles north of Fort Worth, Tex., the boiler of a train locomotive of the Fort Worth and Denver City Railway exploded killing the engineer and fireman.

(210) — A boiler blew up on June 13th in the Deep River, Ia., electric light plant, injuring one man.

(211) — A rupture of a boiler shell took place on June 13th at the plant of the City Ice Company, Jeffersonville, Ind.

(212) — On June 13th a tube pulled out of the tube sheet in a water tube boiler of the North Star Egg Case Company, Quincy, Ill.

(213) — A tank containing carbonic acid gas exploded on June 14th in the drug store of Dr. Jessup, Diagonal, Ia., killing one and severely injuring two other persons. The interior of the store was wrecked.

(214) — The mud drum of a water tube boiler exploded on June 15th at the plant of the Pittsburg Plate Glass Co., at Kokomo, Ind.

(215) — The shell of a boiler ruptured on June 16th at the plant of Max Hahn Packing Company, Dallas, Tex.

(216) — On June 17th the shell of a boiler ruptured at the plant of the Port Blakely Mill Co., Pork Blakely, Wash.

(217) — A boiler used in drilling a well at Burkburnet, Tex., exploded on June 17th, killing one and fatally injuring two other persons.

(218) — A boiler ruptured on June 18th at the plant of the Texas Pressed Brick Company, Ferris, Tex.

(219) — A boiler accident occurred on June 19th on board the whale back steamer "Atikokan" while at the wharf, Montreal, P. Q., Canada. Three men were scalded to death.

(220) — On June 19th a boiler exploded at the saw mill belonging to John Reeves, one mile east of Brooklyn, Ill. Two men were injured, one of whom died the following day.

(221) — A boiler exploded on June 20th at the plant of the Hudson Valley Ice Co., Albany, N. Y. It shot up through the engine room roof and when returning demolished the building.

(222) — A small cast iron boiler used for heating water exploded on June 20th, in the basement of the Elk Hotel, Denver, Colo. Two persons were seriously injured.

(223) — A crown sheet collapsed in a logging-locomotive boiler belonging to Larkin Green Logging Co., Blind Slough, Ore., on June 21st.

(224) — A boiler exploded on June 21st on board the naval tender "Melville" while in tow of the Collier Orion off Colon. Six men were killed.

(225) — A 5" stop valve exploded on June 21st at the plant of the Lyon Lumber Co., Garyville, La.

(226) — A large air tank exploded on June 23rd at the Redmon Motor Car Co. garage, Paris, Ky.

(227) — Five tubes pulled out of the tube sheet of a water tube boiler on June 24th at the plant of the By-Products Coke Corporation, South Chicago, Ill.

(228) — Two sections cracked in a C. I. heating boiler on June 24th at Clark University, Worcester, Mass.

(229) — The boiler of a locomotive pulling a troop train near Omaha, Neb., exploded on June 25th. One man was seriously injured.

(230) — On June 26th a tube in a water tube boiler ruptured at the plant of Stevens and Thompson and Walloomsac Paper Company, Walloomsac, N. Y. Two men received burns, one of them died shortly after.

(231) — Two corrugated furnace flues collapsed on June 27th in a marine type boiler at the boiler house of the West Philadelphia Stock Yards, due to low water which was caused by the choking up of lower water column connection.

(232) — On June 30th a blow-off pipe failed on a boiler belonging to Woodward Creamery Company, Woodward, Okla.

(233) — Waterhammer action in a steam pipe caused the fracture of a 4" tee on June 30th at the plant of McCleary, Wallin and Crouse, Amsterdam, N. Y. This was caused by feed water entering the steam pipe through a leaky diaphragm of a feed water regulating device.

(234) — A boiler exploded on June 30th at the oil fields of the P. Welch Oil Company, Maricopa, Cal.

July, 1919.

(235) — The boiler of a passenger train locomotive exploded on the N. Y. Central railroad at Dunkirk, N. Y., when a rear-end collision took place on July 1st. The engineer and fireman were fatally scalded.

(236) — A tube ruptured in a water tube boiler on July 4th at the plant of Armour and Company, Chicago, Ill. Two men were seriously scalded.

(237) — A boiler exploded on July 5th at the saw mill of G. W. Henry, three miles S. E. of Whitwell, Tenn. One man was killed and another seriously injured.

(238) — A boiler exploded on board the yacht "Flyer" on July 10th at Southampton, N. Y. Two men were killed and one seriously injured. The deck and upper portion of the ship were wrecked.

(239) — A steam heater exploded on July 11th at Treber's warehouse, Deadwood, S. D., resulting in serious injuries to two boys and considerable property damage.

(240) — A mud drum pulled off the nipples by which it was attached to the boiler at the plant of the Pittsburgh Plate Glass Company, Pittsburgh, Pa., on July 14th.

(241) — On July 14th, the top of a drum of a water tube boiler bulged and ruptured at the Farrell Works of the Carnegie Steel Company, Sharon, Pa.

(242) — The boiler of a locomotive pulling a heavy West Shore freight train blew up while traveling at 30 miles an hour near Kingston, N. Y., on July 15th, killing three men.

(243) — A tube burst in a water boiler on July 15th at the plant of the Lorain Steel Company, Johnstown, Pa., fatally scalding one man.

(244) — A crown sheet came down on July 16th in a track locomotive belonging to the Birdsboro Stone Co.

(245) — A header in a water tube boiler cracked on July 17th at the plant of the Industrial Works, Bay City, Mich.

(246) — On July 19th, the boiler of a threshing machine blew up at Maysville, Ky. Two men were seriously scalded.

(247) — A rupture of a boiler shell took place on July 19th at the plant of the General Ice Co., Amityville, L. I., N. Y.

(248) — On July 21st, the boiler of the locomotive pulling Union Pacific train No. 5008 blew up near Castle Rock, Utah, instantly killing three men.

(249) — A boiler exploded on July 22nd at the Banner Laundry, St. Paul, Minn., killing one and injuring ten others.

(250) — A header in a water tube boiler fractured on July 22nd at the plant of the Westinghouse Airbrake Company, Wilmerding, Penna.

(251) — On July 25th, the boiler of a threshing outfit exploded on the E. and C. Bell farm, 15 miles S. E. of Charleston, Ill., seriously injuring two men.

(252) — A boiler exploded on July 26th at the cheese factory of Thos. Anglin, Kingston, Ont., Canada, killing one and seriously injuring four.

(253) — A rupture of a boiler shell took place at the plant of the Ashland Ice and Cold Storage Company, Ashland, Neb., on July 27th.

(254) — A boiler explosion took place on July 28th at the plant of the Model Laundry, East St. Louis, Mo.

(255) — A boiler blew up on July 29th at the plant of the Heldenfels Shipbuilding Co., and landed about a quarter of a mile away. Four men were instantly killed and the property damage was estimated at over $10,000.

(256) — A gas tank exploded as it was being removed from a wagon on July 30th in front of 92 Boerum Street, Brooklyn, N. Y. One man was instantly killled.

(257) — A tube ruptured in a water tube boiler on July 30th at the plant of the Michigan Alkali Company, Wyandotte, Mich.

AUGUST, 1919.

(258) — A tube ruptured in a water tube boiler on August 1st at the plant of the Public Service Corp. of N. J., Perth Amboy, N. J.

(259) — A blow-off pipe failed on August 1st at the plant of the Wm. S. Merrill Company, Cincinnati, Ohio, One man was injured.

(260) — A tube ruptured in a water tube boiler on August 1st at the plant of Mitchell Brothers Company, Cadillac, Mich. Two men were fatally burned and one other seriously burned.

(261) — A tube ruptured in a water tube boiler on August 2d at the power house of B. F. Goodrich Company, Akron, Ohio. Four men were slightly burned.

(262) — A header of a water tube boiler cracked on August 2d at the power house of the Pascagoula Ry. & Power Company, Pascagoula, Miss.

(263) — A tube in a water tube boiler ruptured on August 3d, fatally scalding one and seriously scalding another man at the plant of the Carthage Board & Paper Company, Carthage, Ind.

(264) — On August 4th a boiler exploded at the Standard Oil Works, Richmond, Cal. Three men were seriously scalded.

(265) — A tube ruptured in a water tube boiler at the Tuberculosis Sanitarium near Cresson, Penna. on August 4th.

(266) — On August 4th a boiler belonging to a threshing outfit exploded on the farm of Mr. Owen Meyers, Paris, Ill., killing one and injuring three others severely.

(267) — On August 6th an ammonia tank exploded at the plant of the Houston Ice Cream Company, Houston, Texas. Eight men were injured.

(268) — Waterhammer in a main steam line caused the disruption of a blank flange on August 7 at the plant of the Camden Forge Company, Camden, N. J.

(269) — On August 8th a boiler exploded on the dredgeboat "John Callup" of the Missouri Portland Cement Company near Nonconnah Creek. One man was killed and four others injured.

(270) — Four sections in a cast iron boiler failed on August 9th at the Apartment House, 124 West 72d Street, New York City, N. Y.

(271) — A tube in a water tube boiler burst on August 10th at the plant of the Prudential Oil Company, Baltimore, Md.

(272) — On August 11th a tube burst in a water tube boiler on board the wooden steamer "Fort Wright," while off the coast of lower California.

(273) — An explosion occurred on August 11th with a boiler used for threshing near Weatherford, Okla., painfully injuring one man.

(274) — A boiler exploded on August 11th at the camp of the Sutter Basin Company near Knights landing, Cal. One man was severely injured and the resulting fire did many thousands of dollars' worth of damage.

(275) — On August 13th the boiler of a threshing machine at the farm of John P. Wallace, Agency, Mo., exploded. One man was fatally injured.

(276) — On August 14th a boiler exploded in the lumber mill of Coulbourne Brothers near Eure Station, N. C., killing four and seriously injuring six others. The mill was totally demolished.

(277) — On August 16th a boiler used on a tire vulcanizing machine exploded at the plant of the Bellevue Tire Company, Fremont, Ohio.

(278) — On August 17th a boiler which furnished steam for a mine pump exploded on the farm of Norman Mayberry, five miles N. E. of Greenfield, Ill., killing three children and injuring fourteen.

(279) — The head of a kier blew off on August 21st at the Chester Lace Mills, Chester, Penna., causing a damage of $5,000.

(280) — A tube ruptured in a water tube boiler on August 24th at the plant of the Dubuque Electric Company, Dubuque, Iowa.

(281) — On August 25th a boiler exploded in the Toledo Canning Company's factory, Toledo, Ohio. Two men were severely scalded.

(282) — A blow-off pipe failed on August 26th at the plant of the Moody Bible Institute, Chicago, Ill.

(283) — On August 26th a boiler exploded in the sawmill of LeRoy Marbelle near Marlo, Wash. Two men were killed and two others were injured.

(284) — On August 27th a boiler used with a gas rigging outfit exploded on the farm of Fred McMannus three miles east of Carthage, Indiana. Two men were injured.

(285) — On August 28th a battery of three boilers exploded at the sawmill of W. J. Swann, at Stonewall, N. C. Three men were killed and several others more or less severely injured. The mill was demolished.

(286) — On August 29th a boiler belonging to the Shelby Oil Company near Fairmont, W. Va., exploded killing one man.

(287) — On August 29th the plant of the Green River Electric Light, Water & Ice Company, at Calhoun, Ky., was destroyed by a boiler explosion. The only man that was in the plant at the time was severely injured.

(288) — A tube in a water tube boiler burst on August 30th at the plant of the Aetna Portland Cement Corp'n, Fenton, Mich. One man was severely scalded.

September, 1919.

(289) —A tube of a superheater failed on September 1st at the plant of the Texas Power & Light Company, McKinney, Tex.

(290) —A tube in a water heater boiler ruptured on September 1st at the plant of the Hooker Electric Chemical Company, Niagara Falls, N. Y.

(291) — Three sections cracked in a cast iron boiler on September 1st at the apartment house, 50 West 67th St., New York City, N. Y.

(292) — On September 2d a hot water tank exploded at the home of Paul H Cromelin,, Hackensack, N. J.

(293) — Five headers cracked in a water tube boiler on September 2d, at the plant of the Consolidated Safety Pin Company, Bloomfield, N. J.

(294) — A tube sheet collapsed in a boiler on September 2d, at the plant of the Beacon Tire Company, Beacon, Dutchess County, N. Y.

(295) — An elbow on a blowoff pipe failed on September 3d at the plant of the Bailey Wall Paper Company, Cleveland, Ohio.

(296) — On September 4th a boiler exploded at the plant of the Polar Wave Ice Plant, St. Louis, Mo. Two men were severely injured, and the property damage was estimated at $5,000.

(297) — A tube of a water grate under a boiler failed on September 6th

at the plant of the Central Cotton Oil Company, Jackson, Miss. One man was seriously scalded.

(298) — A logging locomotive boiler of the Kirby Lumber Company. exploded on September 6th, at Silsbee, Tex., killing one man and injuring two others.

(299) — On September 9th a rupture of a boiler shell took place at the plant of the Rockwood Brewing Company, Rockwood, Pa.

(300) — On September 10th a boiler exploded at the sawmill plant of John Fleming, Fairhope, Ala., killing three men.

(301) — A tube pulled out of a tube sheet of a water tube boiler on September 10th at the plant of the American Strawboard Company.

(302) — A 10" steam pipe failed under 150 lbs. pressure on September 10 at the plant of the Winchester Repeating Arms Company, New Haven, Conn. The pipe opened up over a length of about 10 feet and the resulting damage was over 3,000 dollars.

(303) — A blowoff pipe failed on September 10th at the plant of the Autauga Oil & Fertilizer Co., Prattville, Ala.

(304) — On September 12th a boiler of a threshing outfit blew up at Holder's farm near Neosho, Mo., killing one and injuring one other man so seriously that he died the next day.

(305) — A boiler exploded on September 12th at the Shaw-Batcher shipyard, South San Francisco, Cal. One man was killed.

(306) — A tube of a water tube boiler burst on September 13th at the plant of the Martinsville Gas and Electric Company, Martinsville, Ind. One man was injured.

(307) — On September 13th a tube in a water tube boiler burst at the Corpus Christi Ice and Electric plant, Corpus Christi, Texas. Two men were scalded, one of whom fatally.

(308) — On September 15th a boiler exploded at the Curtis mine, twelve miles from Steamboat Springs, Colo., fatally injuring one and slightly injuring two other men. The damage was estimated at 4,000 dollars.

(309) — The crown sheets came down, on September 15th, in three locomotive type boilers used for well drilling at the oil lease of the Cohan Estate near Whittier, Cal.

(310) — On September 17th the boiler of a freight locomotive exploded on the L. and N. Railroad, at Hygeia, Tenn., killing one instantly and fatally scalding one other man.

(311) — A heating boiler exploded on September 16th in the basement of the home of R. G. Soule, Syracuse, N. Y. The damage was estimated at 2,000 dollars.

(312) — Six headers in a water tube boiler failed on September 17th at the plant of the Pittsburgh Plate Glass Company, Ford City, Pa.

(313) — On September 17th a boiler blew up at an oil well at Murphysboro, Ill.

(314) — A steam line failed on September 17th at the plant of the W and H. Walker Company, Pittsburgh, Pa., scalding two men.

(315) — The boiler of a locomotive exploded after falling from a 45 feet high trestle, on September 18th, at St. Louis, Mo. Two men were killed.

(316) — A tube in a water tube boiler ruptured on September 18th at the plant of the Winona Copper Co., Winona, Mich. One man was scalded.

(317) — A number of tubes pulled loose from the tube sheet of a water tube boiler on September 19th at the plant of the National Forge and Tool Company, Irvine, Pa.

(318.) — Two sections failed in a C. I. sectional boiler on September 22d at the apartment building of the Layman Land Company, Des Moines, Iowa.

(319) — A cap blew off from a sectional (power) boiler on September 22d at the plant of the Bradlee and Company, Philadelphia, Pa. One man was injured.

(320) — A tube pulled out of a drum of water tube boiler on September 22d at the plant of the Arizona Copper Company, Clifton, Ariz.

(321) — The shell of a boiler ruptured on September 23d at the plant of the Nazareth Brick Company, Inc., Nazareth, Pa.

(322) — On September 24th a boiler exploded at an oil well near Irvine's Mills, Bradford, Pa., fatally scalding one man.

(323) — A heating boiler exploded on September 24th at the Jewish Synagogue, Cheyenne, Wyo., fatally scalding the janitor and wrecking the building.

(324) — A header failed in a water tube boiler on September 24th at the plant of W. M. Bransford, Salt Lake City, Utah.

(325) — On September 25th a boiler exploded in a sawmill belonging to Stanford Lecates at Ross Point near Laurel, Del., resulting in the death of 4 persons and serious injury to 4 others. The mill was completely demolished.

(326) — A section in a cast iron boiler ruptured on September 25th at the building of the Wildwood Apartment Company, Jackson, Mich.

(327) — The boiler of a locomotive belonging to the Northwestern Railway Co. blew up on September 26th at the roundhouse at Norfolk, Neb., killing one man and slightly injuring three.

(328) — An acetylene tank exploded on September 26th at the Vickers Shipbuilding plant, Montreal, Que., killing one man and injuring sixteen.

(329) — A blowoff pipe failed on September 26th at the plant of the J. H. Smith Grape Juice Company, Lawton, Mich.

(330) — A boiler exploded on September 26th, at the National Tank Manufacturing Company, Los Angeles, Cal. One man was seriously injured by a flying fragment of the boiler.

(331) One section cracked in a cast iron sectional boiler on September 26th at the Windsor Avenue Congregational Church, Hartford, Conn.

(332) — A tube in a water tube boiler burst on September 26th at the plant of The Central Illinois Public Service Company, Mounds, Ill.

(333) — A blowoff pipe failed on September 26th at the plant of Spies Milling Company, Preston, Mich.

(334) — A furnace collapsed in a boiler on September 27th on board the dredge "Omega" at Calexico, Cal.

(335) — A tube in a water tube boiler burst on September 27th at the plant of the Hammermill Paper Company, Erie, Pa.

(336) — A hot water tank burst in the kitchen of the home of M. A. Frazar, Brookline, Mass., on September 28th, tearing a large hole in the side of the house. The damage was estimated at 2,000 dollars.

The Hartford Steam Boiler Inspection and Insurance Company.

ABSTRACT OF STATEMENT, JANUARY 1, 1920.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$390,221.07
Real Estate		90,000.00
Mortgage and collateral loans		1,426,250.00
Bonds and stocks		5,702,983.62
Premiums in course of collection		597,171.35
Interest accrued		107,590.44
Total assets		$8,314,216.48

LIABILITIES.

Reserve for unearned premiums		$3,715,903.48
Reserve for losses		175,539.16
Reserve for taxes and other contingencies		401,420.50
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,021,353.34	
Surplus to Policy-holders		**$4,021,353.34**
Total liabilities		$8,314,216.48

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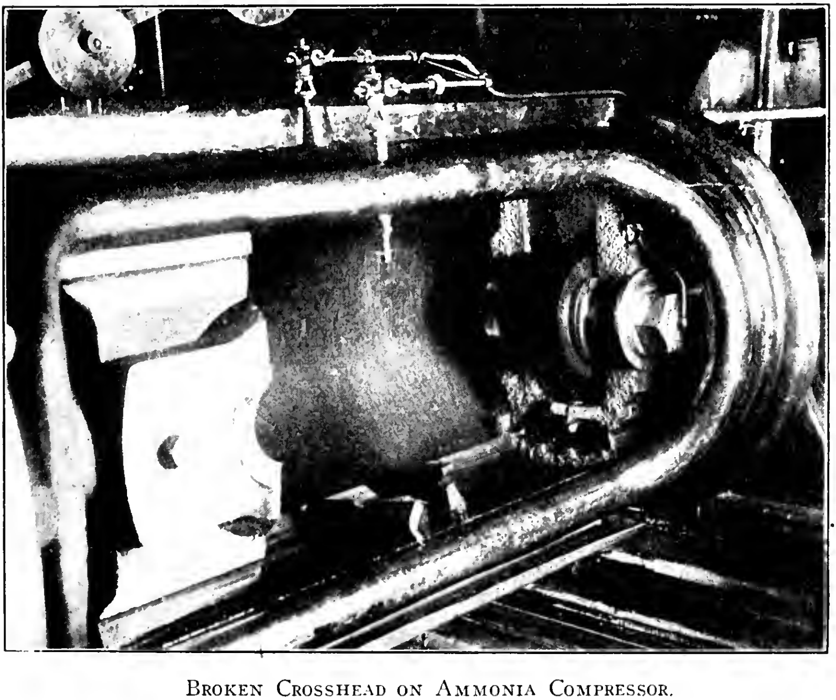
The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIII. HARTFORD, CONN., JULY, 1920. No. 3



BROKEN CROSSHEAD ON AMMONIA COMPRESSOR.

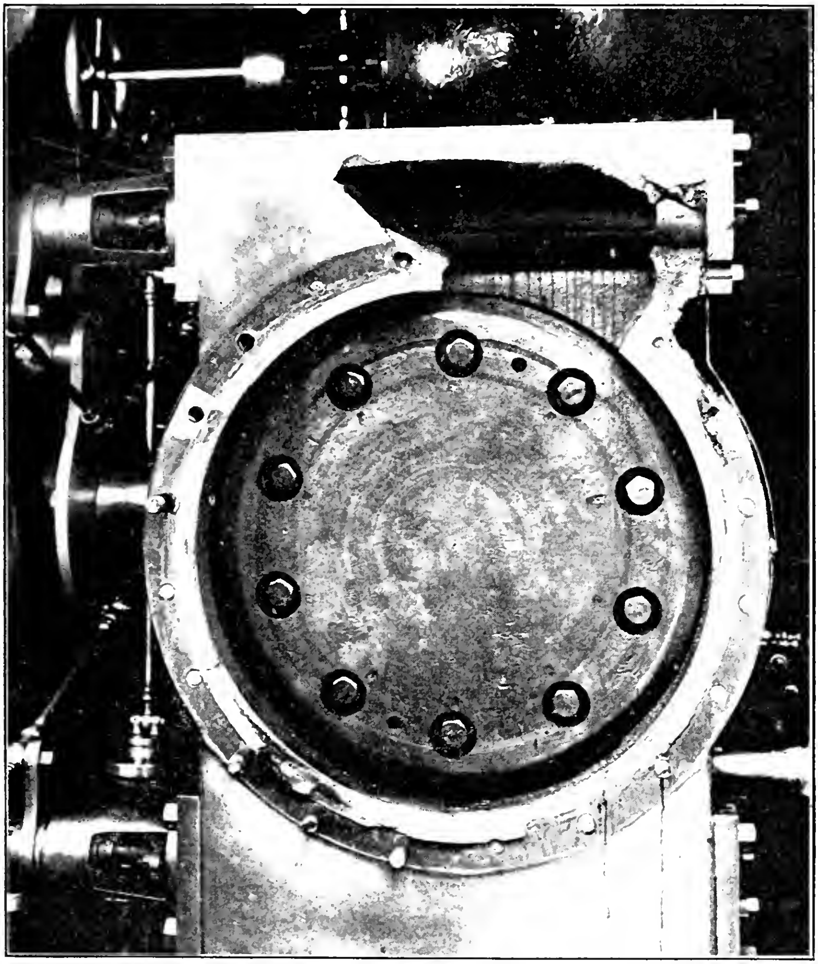
A Mysterious Engine Accident.

ON the front cover and on the following page of this issue we are presenting two views of an accident which occurred not long ago to the steam cylinder of an Ammonia Compressor. Fortunately no one was injured.

The machine in question consisted of a single horizontal steam cylinder with two vertical compressor cylinders. The engineer had started this engine up shortly before noon of the day of the accident and, in conjunction with two other ice machines, it had been running smoothly and quietly up to the very instant of the accident. At 4:50 P. M., the engineer passed through the engine room and found everything to be operating to his satisfaction. Five minutes after he left the room the oiler, who was giving his attention to one of the other machines, heard just one crash without the slightest noise or forewarning of any trouble. He immediately ran to the throttle of the machine and shut off the steam. The engineer arrived soon after and closed the throttle valves on the other two machines.

It was found that the machine had stopped on or very close to the crank end dead center. The cross-head was broken through the wrist pin hole, and apparently it was at this point that failure first took place. A piece of the cross head shoe was found lying on the bottom guide between the two broken parts of the cross-head, which fact might be taken to indicate that the crank-pin had passed dead center and was moving toward the head end when the accident occurred.

When the cross-head failed the steam pressure carried the piston, piston rod and the half of the cross head with a high velocity toward the head end of the cylinder. The piston struck the cylinder head, drove it off and the latter was found lying on the floor immediately back of and to the right of the cylinder. The follower plate was cracked circumferentially through the bolt holes for a distance of about thirty inches and the cylinder casting, as is shown in the illustration, was fractured through the steam valve chest. Upon further examination the piston was found to be drawn off the rod, leaving a space of 3/16", and on the rod a collar of metal had been rolled up as though the piston had been driven onto the rod. This condition was probably caused by the following series of events: When the cross head failed the steam pressure carried the piston up against the cylinder head which caused it to let go and the cylinder casting to fail as shown. Before the head let go, however, the inertia of the rod and the half of the cross-head attached to it had carried the rod into the piston which caused the collar of metal to be rolled up. The force of these two actions, however, was not sufficient to bring the moving mass to rest so that, after the cylinder head blew out, the parts continued their



View of Head End of Cylinder.

motion until the nut on the cross-head end of the piston rod brought up against the stuffing box on the crank end of the cylinder. While this brought the rod and cross-head to rest the remaining inertia of the piston caused it to be carried off the rod as mentioned above.

No satisfactory explanation has been given of the cause of this accident. The steam pipes were well drained and the traps found to be in good working order. The firemen reported that the water line in the boilers at the time of the accident was what they were accustomed to call a low one. There does not seem to have been any possibility therefore, for water to have gotten into the steam cylinder.

The case serves to show that any engine may be subjected at some time to forces of unknown origin which may lead to a more or less severe accident and it furthermore emphasizes the need for engine insurance.

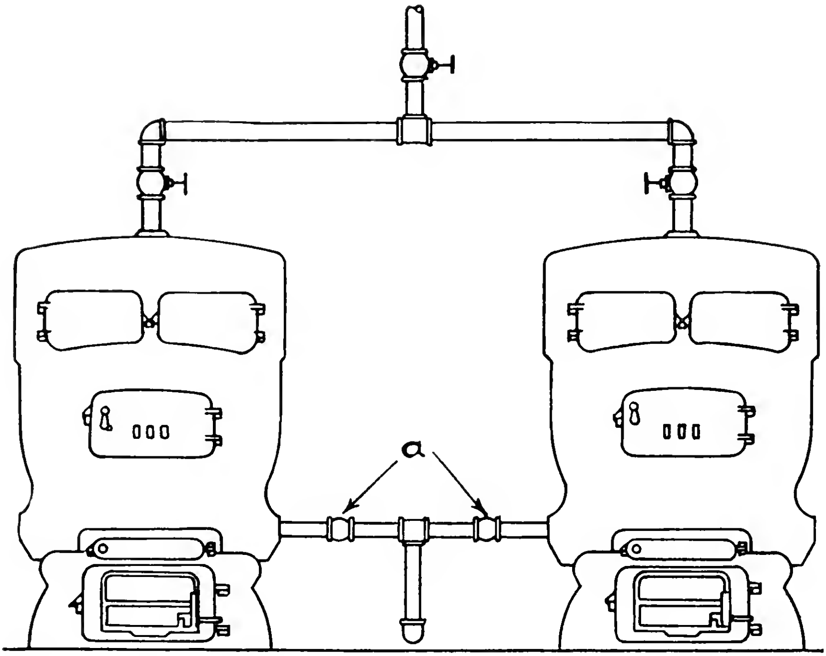
New Method of Connecting Return Pipes to Cast Iron Heating Boilers.

TO maintain a safe water level in heating boilers in which the condensation flows back by gravity would appear to be a simple matter. The steam in such boilers is raised slightly above atmospheric pressure and rushes to the radiators where the heat is abstracted, and consequently the steam becomes water which then flows back to the boiler. No water is lost in the process except a very small percentage that may leak out of the valves and fittings but, barring that negligible amount, the water level should not change appreciably since the same amount of water enters the boiler through the return pipe as is evaporated off into the heating system through the steam pipe.

In actual practice, however, there are a number of features present in the average steam heating installation which may cause the water level to temporarily become dangerously low resulting in over-heating of the highest parts of the heating surface and, in the case of cast iron boilers, when the water subsequently rises to the proper level again and covers these over-heated parts they usually crack.

As an illustration we will take an installation of two boilers connected to one heating system and receiving their return water through a single return pipe. With such an installation the use of check-valves on the return connections to each boiler is necessary to prevent the exchange of water between the boilers. Referring to fig. 1 it will be seen that if the check valves "a" were not present, the slightest difference in pressure on the water surfaces of the boilers Nos. 1 and 2 will cause the water to flow from one boiler into the other with the possibility of low water in one of them. It may seem a little paradoxical to some of the readers of this article that even a slight difference in pressure can exist in two boilers connected to a common steam main, but experience with low pressure boilers has shown this to be a fact, and the cause of this difference in pressure may be partly explained as follows:—

Within a low pressure steam system the balance of temperatures and pressures is a very delicate one due to several causes, such as local excessive friction of the fluid passing through the pipes and local



Boiler No. 1. Boiler No. 2.

Fig. 1.

condensation, so that it is indeed hard to foretell what the actual pressure will be at any given point. When boiler No. 1 is fired harder than No. 2 a greater amount of steam will flow from the No. 1 boiler than from the other. This increased flow of steam will result in increased friction in the steam pipe leading from boiler No. 1 and consequently the pressure in this boiler will rise somewhat above that in boiler No. 2.

The pressure difference need not be very much to cause a considerable variation in water level. With the water in the boiler at a

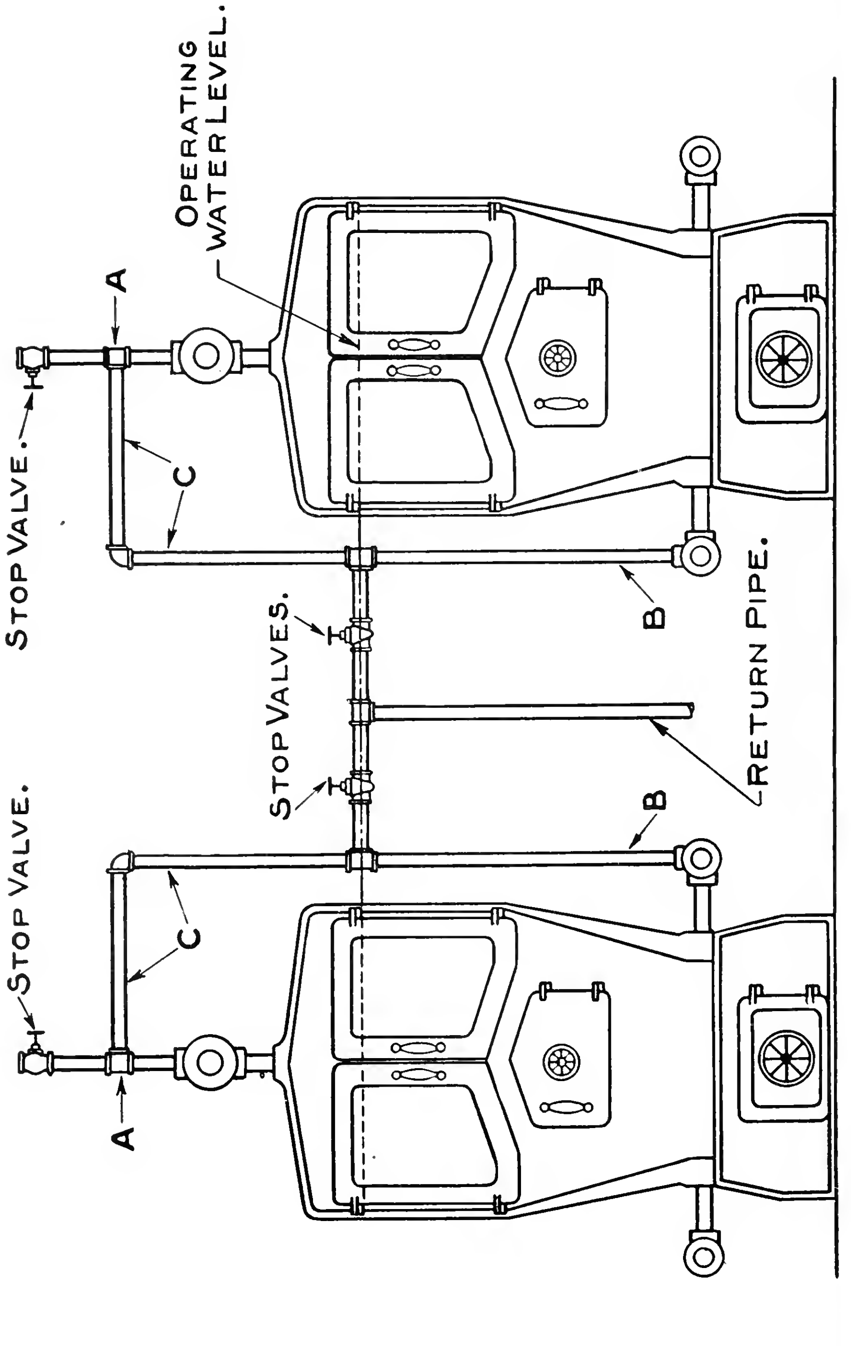

OPERATING WATERLEVEL.
A
STOP VALVE.
C
C
B
STOP VALVES.
RETURN PIPE.
B
STOP VALVE.
C
C
A

Fig. 2.

temperature of 220 degrees Fahrenheit a pressure difference of $\frac{1}{4}$ of a pound will cause the water level to differ approximately $7\frac{1}{4}$ inches, so that with the water only a few inches above the highest part of the heating surface it will be seen how a slight unbalance of pressure between two boilers may cause dangerously low water in one of them.

With the return water entering the lowest part of the boilers, as is customary, the use of check valves is also necessary to prevent the water from backing out of the boilers into the heating system through the return pipe when, for instance, the stop valve on the boilers (if present) or else the steam-valve on every radiator of the system might be closed. The use of check-valves on the return pipes, however, is far from being an ideal means to guard against these irregularities for the reason that to lift a check-valve a certain amount of head is necessary so that the operation of the check-valve itself involves a certain amount of unbalance in the system and, since it is a practical impossibility to get two check-valves that will act on exactly the same pressure, the chances for a variation in water level in two boilers getting their water through check-valves from a single return pipe are very great. Moreover, the effect of lifting the check-valve requiring the least pressure will tend to prevent the other check-valve from lifting.

This problem is as old as the art of low pressure steam heating itself and the lack of a proper solution of it thus far has undoubtedly been the direct cause of many a cracked section in cast iron heating boilers.

We now come to the main point of this article, the foregoing being all by way of introduction to a new scheme of attaching the return pipes to heating boilers as announced in the title. This new method of piping the returns is shown in fig. 2. It will be noted that no check-valves are used. The returning water from the heating system is carried to a point at about the water level of the boiler although it actually enters the boiler at the usual location at the bottom. It would, of course, be possible to carry the water into the boiler directly at about the water level, but this is not desirable with the average cast iron heating boiler, for the reason that it may cause too great a temperature difference at this level in view of the fact that the returning water can be quite cold.

However, with the arrangement as shown, it becomes necessary to install a steam equalizing pipe (marked " c " in fig. 2.) to the highest part of the return pipe, and this equalizing pipe must be of ample size

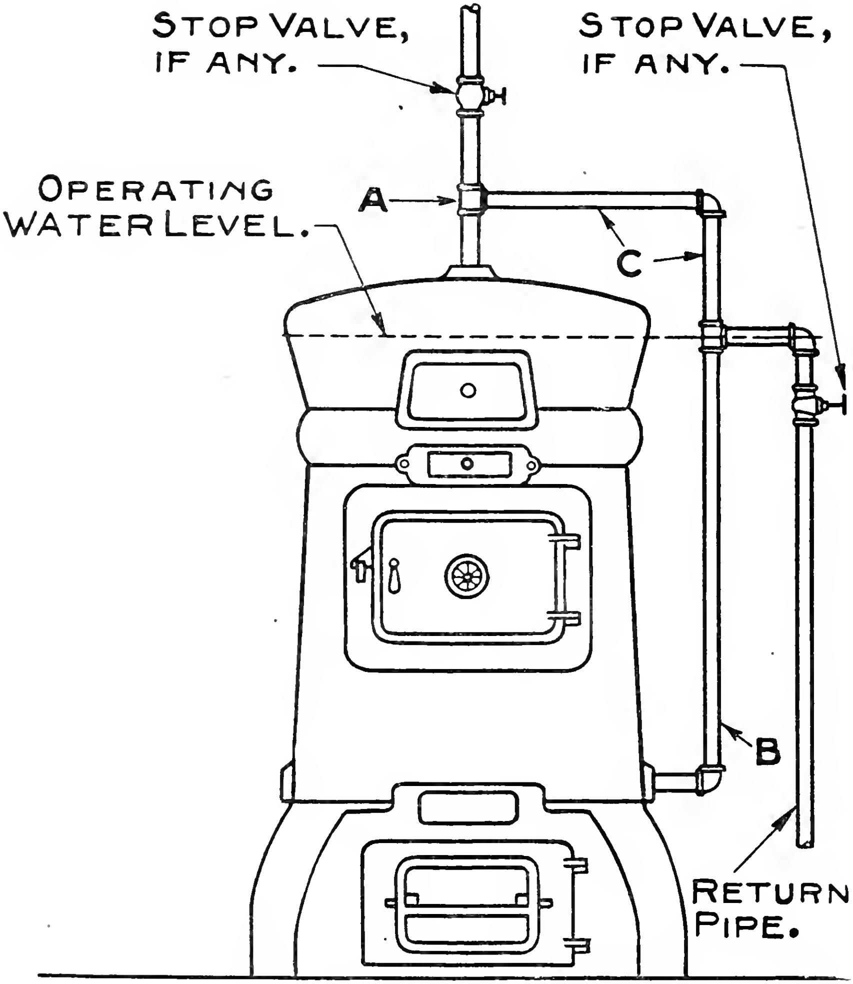


FIG. 3.

and with as few turns as possible in order to eliminate friction, but with such a pipe installed as shown water cannot be backed out of the boiler below the normal water level and the baneful effect of the installation of check-valves is thus done away with.

For the guidance of our readers, who desire to make this change in existing installations, we would state that the minimum size of pipe for equalizing pipes "C" should be as follows:—

Grate Area			Size of Pipe
4 square feet or less	-	-	1-½″
4 square feet to 15 sq. ft.	-	-	2-½″
15 square feet or more	-	-	4″

These figures apply to equalizing pipes " C " only. The return pipes and pipes " B " which are normally filled with water may be of any size which modern practice prescribes as proper for feeding boilers.

Also with a single boiler installation this method of attaching the return pipe can be used to advantage and the check-valve omitted. (see fig. 3.) It will be seen that even though there is no check-valve, water cannot be forced out of the boiler lower than the proper level, if, for instance, the stop valve on the boiler should be closed inadvertently or in case the valves on all radiators in the system should be closed. Under such conditions in a single boiler installation all the steam generated would need to escape through the equalizing pipe and the return pipe, which, of course, would produce a rattling noise, but this noise would be a real safety alarm since the operator of the boiler would be warned thereby that something is wrong and that the boiler needs attention. Under such conditions the evaporation in the boiler should be stopped by properly checking the fire so as to stop the flow of heat.

The correctness of principle of this method of piping the returns has been well demonstrated by test, so that we have no hesitation in recommending it to any owner of cast iron boilers with separate returns who desires a better safeguard against cracking of sections.

The Advantages of Co-operation Between the Boiler Manufacturer and Insurance Company.*

S. F. Jeter, Chief Engineer.

CO-OPERATION as a slogan has been overworked during recent years. It has been advocated in many instances by those who apparently had no conception of its meaning, or if they did have, it was not their intention to really co-operate. The derivation of the word indicates that it means to " work with others." Many have used it apparently with the idea that it meant to " work for others." It should be understood that co-operation necessarily involves the viewing of the subject from the other fellow's standpoint, as well as your own. There are many ways in which the boiler manufacturer and the insur-

* Paper read at the annual meeting of the American Boiler Manufacturers Association at French Lick Springs, Ind., May 31, 1920.

ance company can work with each other, or co-operate, and the interest of both be served.

Insurance companies are frequently confronted with claims due to minor accidents. If in making repairs in cases where an insurance company is involved, the boiler maker would keep the cost of the repairs that were actually necessitated by the accident, separate from any general repairs that might be made at the same time, it would be very advantageous to the insurance company as well as the assured who is the boiler maker's patron. With a proper division of the items the possibility of controversy between the insurance company and its patron is avoided. Such co-operation should not cause the slightest friction between the boiler maker and his customer. All that is needed is that he so keep track of the items of repair that he will be in a position to make a correct division of the cost if called upon to do so. There have been many instances where co-operation of the boiler maker in such cases has been of the greatest aid to both the insurance company and its customer. However, there have been many such cases, more especially in connection with the small boiler maker, where lack of co-operation, if not actual antagonism, has been extremely detrimental.

The furnishing in case of explosions of prompt and proper bids or estimates by the boiler manufacturer covering replacements or repairs required is a class of co-operation that is welcomed by the insurance company.

The boiler manufacturer can of course aid the insurance company in informing his patrons or prospective patrons of the service that may be secured through the insurance company. Boiler insurance has been so widely advertised in one way or another that it would seem there could be no user of steam who was unacquainted with the facts. However, there appear to be many boiler purchasers who do not yet realize the service they can secure from boiler specialists to look after their boilers from the cradle to the grave, or rather, from the plate mill to the scrap heap, even though the termination of the existence of their boilers is not of a more serious or spectacular nature. A suggestion from the manufacturer for inspection during construction, with its accompanying policy of insurance or certificate of inspection by an organization with which the manufacturer is not allied, cannot help but impress the purchaser with the manufacturer's good faith in meeting his contract obligations. I feel sure that the advantages of the service and co-operation rendered by the insurance company in this respect are fully appreciated by the members of the American Boiler Manufacturers Association.

The insurance company can be a distinct aid to the manufacturer in seeing that the workmanship in his shop is kept up to the standard he desires to maintain. A manufacturer can, and does, of course, instruct his own employes as to the grade of work he desires to turn out and may institute a form of inspection service through his own employes for the purpose of maintaining this standard. However, an employee, particularly if he is faithful, cannot refrain from keeping in mind what he considers to be his employer's best interest. Notwithstanding the fact that some features of workmanship may not come up to the mark set, the faithful employee will always consider the cost involved before rectifying the trouble. The shop employee, as a rule, is not in a position to make a decision in such cases for the best interest of his employer. Often he will decide that the rectification of a mistake is unwarranted, owing to the cost involved, when the officials of his company would have decided that the cost should not be considered. The inspector of the insurance company, of course, is not directly concerned with the cost of rectifying a mistake. If a mistake is judged of importance enough he will condemn the work outright or, if of more minor importance, the inspector may call it to the attention of the proper shop or company official who can decide with the inspector whether a change should be made or not.

Another feature that is a detriment in securing adequate inspection by a representative who is paid by and under the direct control of the manufacturer is this: mistakes are often made, which, if brought to the attention of the shop or company officials, are liable to cause a reprimand. It is natural, under such conditions, that an employee dislikes to be the cause of the reprimand of a fellow employee. For the same reason it is desirable that an insurance inspector, while enjoying the good will and respect of shop employes, should not be on too intimate terms with them. This is a feature that the insurance company attempts to guard against in all cases.

The insurance company can co-operate with the manufacturer and his employes in determining if the standards for workmanship which have been established are in accord with those maintained by the better shops doing a similar class of work. Co-operation of this kind is very advantageous and tends to spur the employes to their best efforts to see that others do not exceed the grade of work which they turn out.

Another feature in which the insurance company has become extremely valuable to the manufacturer is in co-operating with him in meeting the legal requirements for construction where boilers must be built to come under boiler laws. This is becoming more important each day, since the states having boiler laws governing construction are constantly increasing in number. It was this tendency for boiler laws to become more common that caused the manufacturers and insurance companies to co-operate in an effort to secure uniform rules governing boiler construction. The organization of the Uniform Boiler Law Society, which is sponsored by your Association, and the introduction of the A. S. M. E. Code, the success of which is mainly due to the hearty support and unceasing labors of some of your members, are two tangible evidences of co-operation between the boiler manufacturer and the insurance company. Along this same line the insurance company can be of the greatest aid to the manufacturer in checking his designs before commencement of work to see that the requirements of the law are met. Our Company is constantly called on by the manufacturer to furnish this class of service.

Another way in which the insurance company can co-operate with the manufacturer is in securing modifications of rules or regulations that may tend to work a hardship on either party without compensating advantages to the steam user or public. I feel sure that those of your members who are directly concerned with the Code work of the A. S. M. E. can vouch for the thorough co-operation which exists between the two interests in connection with such features.

Inflammability and Explosion of Ammonia.

FROM time to time one hears of explosions of ammonia compressors where the compressor heads have been blown out, and in some cases fire has resulted. These accidents have been referred to as "mysterious," as pure anhydrous ammonia will not burn or explode.

A refrigerating plant does not have to be run many years for the system to become impregnated with gases other than pure anhydrous ammonia, especially if from lack of knowledge and experience the plant is not properly handled. Regardless of knowledge or experience it is impossible to keep the system at all times clear of gases other than pure ammonia.

A new installation of a refrigerating or ice-making system that has never been in operation for a minute is never started with strictly pure ammonia, for in the first place the ammonia itself is not always absolutely pure, and in the second place it is impossible to pump a perfect vacuum in the coils before the ammonia is charged into them. After the plant is in operation and it becomes necessary to pump out a coil or set of coils for repairs, there is always a small amount of air left behind, as there never was a compressor made perfect enough to entirely expel the air or pump a perfect vacuum.

The air left behind in this way is of no practical consequence in the operation of the plant, but if an accumulation of air and other impurities such as oil vapor, decomposed ammonia (nitrogen and hydrogen) and many other gaseous impurities is allowed, there is no knowing what composition these mixtures will form, or at what temperature they are likely to explode; and as such explosions have occurred at various places throughout the country, causing serious damage to life and property, it behooves the operating engineer to think before allowing the plant under his supervision to accumulate too great a charge of impurities or to allow the discharge line and compressor to run at too high a temperature.

New York City has passed an ordinance allowing the fire department to open up connections from a refrigerating system and blow the entire charge of ammonia into the sewer in case of fire, the valves being located in a locker outside the building, the ammonia pipe lines discharging into water and then into the sewer.

The question of inflammability and explosion of ammonia has been definitely determined by Arthur Lowenstein and his associates, R. J. Quinn and S. Drucker, who conducted research and experimental work along these lines extending over a period of several years, the chief results of which are quoted herewith from a paper written by Mr. Lowenstein and read before the Chicago branch of the American Society of the Brewing Technology, March 29, 1916:

"Briefly, however, it may be stated from these experiments that ammonia gas, mixed with air in certain proportions, when ignited, will propagate a flame. Special apparatus has been designed which enables us to determine the conditions under which ammonia will burn, when all known mixtures with air are brought together under suitable conditions; also known mixtures of oxygen and ammonia.

These tests were made in steps of 0.5 per cent., using mixtures varying from 1 to 100 per cent. of ammonia in air, both dry and saturated with water vapor. The results under these conditions were that no visible form of burning was evident until the region of 11 to 13 per cent. of ammonia was reached. It was found that a small yellow flame was produced at 11 per cent. ammonia in air, which increased in size with increase of ammonia content until at the proportion of 13.25 per cent. of NH_3 the burning was complete. At this concentration a yellow flame completely enveloped the glass containing vessel and the combustion was sufficiently violent to shatter the vessel."

Another set of experiments was made by using an electrically heated incandescent platinum wire in place of the spark. "The percentages of ammonia in air were increased up to 19.58 per cent., at which point the mixture violently exploded upon ignition. . . . . Under these conditions mixtures of between 19.58 per cent. and 26 per cent. of ammonia in air were exploded. The explosions were very violent, sufficient pressure being generated to shatter the glass container."

There is no danger of an explosion unless heat is applied at some part in the system to cause one. The place where this can occur is at the compressor. If the compressor is kept in good condition there is little danger, but if there are a set of leaky rings, which may be broken or otherwise, causing the piston to churn the gas back and forth until the temperature reaches a point where the solder will melt and run out of the discharge connections, there is a possibility of one more "mysterious explosion" and if the engineer is lucky, he will be called upon to explain why.

There are many other reasons for the compressors running hot, and the engineer will find that there will be less explaining if he will see to it that the compressor is run cool at all times; there will be a better lubricating effect, less wear to the compressor cylinder, less expense of upkeep, longer life of the machine and a longer life to the engineer.

There was one experience that the writer is always rather timid and backward about mentioning. It happened at the Cudahy Packing Company's plant at Kansas City. On passing through the engine room, he noticed a cherry-red spot on the side of a compressor piston rod about the size of a silver dollar. This spot was passing through the packing and into the cylinder, and when the machine was shut down and the rod allowed to cool, the metal was pulled away and roughed up so that the rod had to be filed off before starting the machine.

This condition was caused by the packing being allowed to remain in service until too hard, and the red spot was probably caused by a soft spot in the metal; anyway, it was rather a freak condition and one that would not have been "healthy" if an explosive mixture of impurities had been in the system.

As a final precaution against fire in case of a possible explosion, the engineer should insist on the elimination of arc lights, open gas jets or any other form of inflammable light in the room where the refrigerating or ice machines are located. *B. E. Hill in "Power."*

A Hair-Breadth Escape.

IT has been very appropriately said that the number of boiler explosions that are prevented through the advice of inspectors can never be known. This fact, while fortunate for the community at large, detracts a great deal from the credit that properly belongs to the inspector if appearances are taken as the only criterion in judging the results of his labors. Every now and then however we meet with a situation where surely an explosion would have occurred involving heavy death toll and enormous property damage were it not for the inspector's timely advice based on his intimate familiarity with steam boilers and their appendages.

A short time ago the manager of a news-printing establishment in a Middle-Western city telephoned our local representative stating that the safety valve on their boiler was blowing continually but that they were unable to raise the pressure high enough to operate the engine. He further said that their engineer had attempted to adjust the safety valve until he had screwed it down to a point where the spring broke. The boiler had then been cooled down and a new safety valve set at the desired pressure was installed but this gave no better results as regards pressure. The new valve continued to blow and still not enough pressure to run the engine.

As the printing of the first edition of the newspaper was being considerably delayed for lack of motive power, they desired to know whether it would not be all right to plug the safety-valve opening and station a man at the steam gauge to guard against over pressure until the day's work was finished. Our representative, sensing the danger and instinctively, as it were, feeling what was wrong with the installation, requested that they immediately bank the fire and await the arrival of an inspector.

Upon looking over the installation the inspector found the steam gauge on the boiler registering 15 lbs. pressure and the engineer called his particular attention to the fact that the gauge in the engine room also showed 15 lbs. Two steam gauges registering the same. Was not that proof that the trouble must be elsewhere than with the gauges?

Our inspector found however that the two steam gauges were connected to a single pipe which led to the upper water column connection and that this connection was choked which prevented the steam gauges from indicating the actual boiler pressure. It is quite probable that the amount of over-pressure, at the time that the safety valve had been screwed down until the spring broke, was very great and in fact it may have been very close to the bursting pressure of the boiler. At any rate we feel that the persons that were near the boiler at the time the engineer was experimenting with the safety valve are to be congratulated with their escape from a violent death. As the boiler was located in the basement of a four story building filled with people, the loss of life would undoubtedly have been very heavy.

It is really strange that any one, with even a slight knowledge of the make-up of a spring-safety-valve can imagine that such a valve will all of a sudden begin to relieve the boiler at a much lower pressure than that at which it is set, but somehow there appears to be a tendency in the human mind to regard the indications of the hand on the steam gauge dial as absolute. When a marked difference shows up between the pressure indicated by the steam gauge and the relieving pressure of the safety valve, the first inclination seems to have been, in a number of unfortunate accident cases, to go for the safety valve.

We cannot bear down with too much emphasis on the warning to **let the safety-valve adjustment alone** after it has once been set to relieve at the desired pressure, unless of course, a small change in the working pressure is expressly wanted under normal circumstances. One of the principal functions of the safety valve is to take care of just such conditions as the derangement of the steam gauge. Blind confidence in the steam gauge has been the direct cause of a number of boiler explosions on record and these explosions have been particularly violent. This, no doubt, is due to the fact that a very high pressure may be reached when the safety valve is overloaded and consequently an enormous amount of energy is stored up within the boiler.

One of these unfortunate cases was the explosion that took place on the U. S. gunboat "Bennington" on July 21st, 1905, while at anchor in the harbor of San Diego, Cal. In this instance a boiler was fired up from a cold condition. After the water in it had been brought to boiling temperature and the air had been blown out by the first formation of steam, one of the fire-room crew was ordered to go on top of the boiler and close the air cock. This he did, but it appears that he also closed the cock on the outlet leading to the steam gauge so that it failed to register the rapidly forming steam pressure.

(Continued on page 87)

Summary of Boiler Explosions.
1918-1919.

IN accordance with our usual custom we present herewith a table showing the total explosions, persons killed, injured, and the total of killed and injured for the past calendar year of 1919. In addi-

SUMMARY OF BOILER EXPLOSIONS FOR 1919

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	54	15	16	31
February	44	20	39	59
March	46	9	13	22
April	34	9	13	22
May	20	8	9	17
June	36	21	28	49
July	23	19	24	43
August . . .	31	18	59	77
September . . .	57	26	47	73
October	46	24	30	54
November . . .	58	13	28	41
December . .	77	4	36	40
Totals . . .	526	186	342	528

SUMMARY OF BOILER EXPLOSIONS FOR 1918

Month.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	84	18	63	81
February	45	12	48	60
March	37	8	29	37
April	25	11	19	30
May	17	7	15	22
June	19	13	19	32
July	21	11	29	40
August	36	16	17	33
September . . .	30	19	29	48
October	43	8	34	42
November . . .	46	4	9	13
December . . .	46	3	29	32
Totals . . .	449	130	340	470

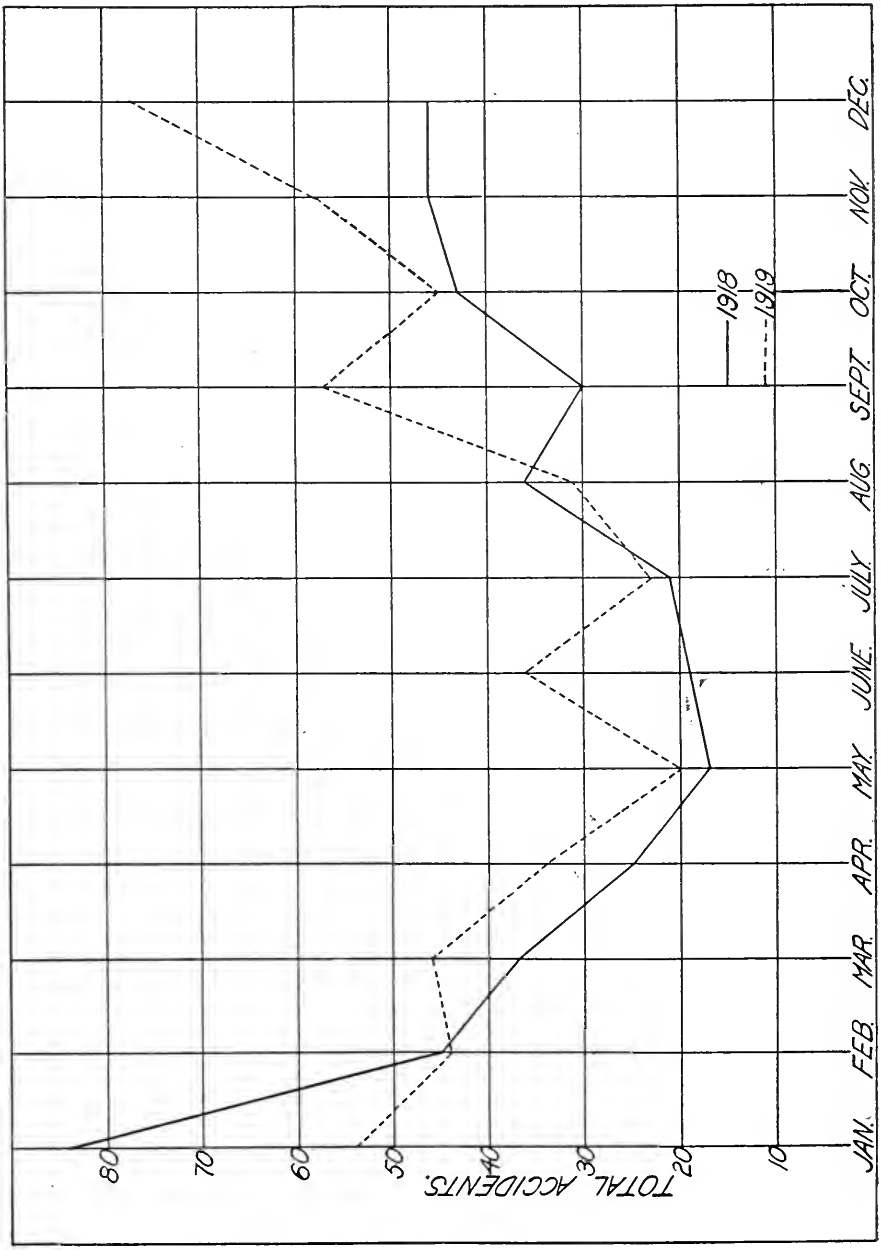


CHART OF BOILER ACCIDENTS.

tion we give the same data for the year of 1918 which was inadvertently omitted last year.

It should be understood that this company makes no claim of completeness for these lists. The information contained in them has been obtained from our own files and from such information as could be gleaned from the newspapers. There is little doubt that the papers have not reported all the accidents that have occurred and there is further certainty that a complete survey of all press reports of explosions has not been available for our use.

As a matter of additional interest we have charted the total accidents on the opposite page. The solid line on this chart represents the calendar year of 1918 and the broken line is for 1919.

Probably the most striking feature of these charts is the fact that both lines show a very marked depression during the summer months and a rise in the winter. As would very readily be supposed this decrease is effected to a considerable extent by the large number of heating boilers in use during the winter months.

We have made a further study of the data given above but for lack of space we are unable to present the results in this issue. We hope to do this in the very near future however. One of the purposes of this study has been to see what effect the heating load has upon this increase in accidents during the winter months. It is of course very difficult to say just how many of these troubles have come from the boilers which have been added to care for the heating load except in those cases where the boiler is clearly defined in that class.

Separating these clearly defined cases from the others we find that approximately one half of the rise of the chart during the Winter months is due to such cases. There are many instances, however, where additional boilers have been used in isolated plants during the winter because of the greater demand for steam and our source of information usually classifies these as being on a power load rather than a heating load. The rise in the number of accidents during this period is then in all probability due almost entirely to the heating load.

The sudden irregularities of the chart are only what we would naturally expect to find in any statistics of this nature. It is the general trend of the curve which is of the greatest interest, however, as it indicates the condition we may expect to find.

The Locomotive

Devoted to Power Plant Protection

Published Quarterly

HARTFORD, JULY, 1920.

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The Locomotive of the Hartford Steam Boiler I. & I. Co.

SAFETY against accidents and personal injury in the power plant can best be regarded as a commodity with a more or less definite purchase value. The post-war period with its tremendous increase in the cost of all labor and material has put a severe crimp in the purchasing power of the dollar, so that, while the industries are still quite rushed, a good many projects of much needed expansion and improvement of the plant are being held up until the tide of costs recedes somewhat.

The prevailing disposition, however, so far as we are able to observe, is to place in the same category investments in additional plant facilities and safety-improvement and we desire to caution most urgently against this tendency. There is, of course, a distinct difference between these two classes of investment. While the returns on plant-expansion may be quite obvious, the returns on a safety-improvement, though very real, are rarely apparent. Those who do invest wisely in safety-improvement can usually only realize its true worth when accidents occur in plants of others who lacked their foresight and prudence.

The insurance specialist is occasionally privileged to have a grandstand view of these matters. Not long ago a case of false economy came to our notice which may well serve as an example that safety-improvement is a good investment at almost any price. At a certain plant the insurance on boilers and digesters had been carried by the

"HARTFORD" until a short time ago, when, because our recommendations for necessary improvement went unheeded, we felt obliged to cancel the insurance. Some time later one of the vessels we had criticized exploded, seriously wrecking the plant. As it happened, the owners had at the time about completed negotiations for the sale of the property for a half million dollars. The sale fell through because the owners could not deliver a going concern and so instead of a half million dollars they have on their hands today only a badly wrecked plant.

A comparatively small amount of money, invested at the right time, might have prevented this serious accident and the subsequent embarrassment of the owners.

Personal.

Mr. Frederic H. Kenyon, Special Agent at the Home Office for the past ten years, has been promoted to the position of general agent in charge of the Home Office Department, which position recently became vacant by the resignation of Mr. F. H. Williams.

Mr. Kenyon has been connected with the underwriting department of this Company for the past ten years during which time he has formed very favorable acquaintances with the Company's agents and assured. He is well acquainted with this territory so that his success as General Agent is assured.

Mr. H. J. Vander Eb has been appointed Superintendent of the Engine Department of this Company, and will devote his attention in the future to the mechanical details connected with the insurance of engines and fly-wheels.

Mr. Vander Eb came to this Company in January 1912 and has been employed in the mechanical department at the Home Office continuously since that date. His thorough engineering education and long experience as a practical engineer as well as in machine design make him well qualified for the work he is now undertaking. His previous duties with the company have been directly in line with this work and thus he is fortified with a fund of valuable experience and information.

Mr. George H. Stickney has been appointed Superintendent of the Boiler Department of this Company and will devote his attention to the mechanical details connected with the insurance of boilers.

Mr. Stickney came to the company in 1914 and served in the capacity of an inspector in the Boston Department for a period of three years. In 1917 he entered the United States Navy as Lieutenant and acted as Chief Engineer of the transport U. S. S. Pensacola. Since his release from active duty in June 1919, Mr. Stickney has been connected with the Mechanical Department of the company at the Home Office.

Announcement.

THE Hartford Steam Boiler Inspection & Insurance Company takes pleasure in announcing that it has appointed Mr. William D. Halsey editor of this publication. Mr. Halsey is a graduate in mechanical engineering of Swarthmore College, 1912. Following his course in that institution he had practical experience as maintenance and designing engineer with the Sharples Separator Company and as assistant maintenance engineer of the Baldwin Locomotive Works at their Eddystone Plant. For the past five years he has been professor of mechanical engineering at the George Washington University, from which institution he comes to our company. During the war Mr. Halsey was with the National Advisory Committee for Aeronautics, giving his attention especially to the design of Diesel engines for aircraft.

We believe Mr. Halsey is thus by his education and training particularly qualified to have charge of this periodical of ours. He brings to the work both a theoretical and practical knowledge of mechanics and an experience in teaching which fits him to give clear and interesting expression in his technical writings. Mr. Halsey's editorial duties will commence with our next number, and we are confident that under his administration THE LOCOMOTIVE will increase in interest and usefulness, maintaining the prestige it has had for over fifty years as the prominent exponent of power plant protection.

Since the resignation of its former editor, last Fall, the responsibility of issuing and editing THE LOCOMOTIVE has fallen on the shoulders of Mr. Henry J. Vander Eb, a member of our Engineering Department. Our company gratefully appreciates the cheerful manner in which Mr. Vander Eb has borne this additional burden and duty, and the care and intelligence he has displayed in the preparation of the several issues which have appeared under his charge. Others of our force have willingly aided, but his has been the responsibility for writing and editing material while continuing his other important work.

CHARLES S. BLAKE,
President.

Hartford, Conn., July 1st, 1920.

Obituary.

Mr. Olaf Granberg, Vice-President of the Boiler Inspection and Insurance Company of Canada, died on April 17th, 1920. Mr. Granberg had been in poor health for a year or more prior to his death and the death of Mrs. Granberg last January no doubt hastened his own end.

Mr. Granberg was born in 1850 in Norway. He came to Canada in 1857 when his parents settled at Coaticooke, Province of Quebec, where he received his education. Later on he worked in the local blacksmith shop where his principal work was dressing the drills for a nearby quarry. Subsequently he entered a machine shop and served his apprenticeship as a machinist. From there he went to the plant of the Dominion Cotton Mills, Coaticooke, and rose to the position of Master Mechanic and later to Manager.

In 1890 he became affiliated with the Boiler Inspection and Insurance Company as an Inspector. In 1900 he became Chief Inspector for the Province of Quebec, and in 1905 he was appointed Manager of that district.

His earnestness and loyalty won for him the position of Vice-President of the Canadian Company to which office he was elected in 1917 and which office he held until he died. His death brings a deep sense of loss to all who knew him.

A Hair-Breadth Escape.

(Continued from page 80)

No one suspected that anything was wrong with the gauge and the boiler was fired heavily in order to hasten the steam pressure which according to the gauge remained at zero. To complete the chain of unfortunate circumstances the safety valves were stuck on their seats with the result that a dangerous pressure was permitted to build up and finally the boiler gave way in its weakest part.

The total number of persons killed was 62 and besides this there were 40 more or less severely injured. This unusually large number of casualties for a boiler explosion was, of course, due to the cramped conditions usually prevailing in a ship's power plant and the fact that on naval vessels men are likely to congregate in great numbers at any given point, but no doubt the very high pressure at the time was a contributing factor to this large loss of life.

Boiler Explosions.

September, 1919, continued.

(337.) — Two tubes pulled out and several other tubes were damaged at the Power House of the Arizona Copper Co., Clifton, Arizona, on September 22nd.

(338.) — On September 28th, a boiler exploded at the plant of the Crawford Mills, Pearl River, La. One man who was working in the mill 200 feet away was killed by a flying fragment. Six others were injured. The damage was estimated at $6,000.

(339.) — On September 29th, a boiler explosion on board the U. S. destroyer Greene, off Key West, killed one man and severely scalded two.

(340.) — On September 30th, a boiler exploded at the cotton gin of Shackleford Brothers, Attica, Ga., instantly killing one man and fatally injuring another.

(341.) — A three-inch stop valve in a steam line burst on September 30th, at the plant of the Bath Iron Works, Ltd., Bath, Me.

(342.) — A section cracked in a cast iron boiler on September 30th, at the Alcott Schoolhouse, Hastings, Neb.

(343.) — Two sections cracked in a cast iron boiler on September 30th, at the Woodfords Congregational Church, Portland, Me.

(344.) — On September 29th, a tank exploded at the rendering plant of Bell Bros., near Oakland, Ill. One man was killed.

(345.) — A blowoff tank exploded on September 30th, at the Cupples Station Light, Heat & Power Co., at St. Louis, Mo. Two men were injured.

October, 1919.

(346.) — An inner flue on a drier collapsed, October 2nd, at the South Omaha, Neb., plant of Swift and Company.

(347.) — A door frame section cracked October 2nd, on a heating boiler in the plumbing shop of J. F. Morgan, Lynn, Mass.

(348.) — On October 2nd, a hot water boiler exploded in the Westminster Hotel, Los Angeles, Calif. The engine room and hotel lobby were very badly damaged.

(349.) — On October 2nd, a steam boiler exploded on the farm of James Stewart, near Howard, N. Y. Edward Stewart and his son were instantly killed and several men were injured, two seriously.

(350.) — On October 4th, a boiler exploded at the Johnson Ginnery, Baxley, Ga. Three men were killed and five badly injured.

(351.) — A crown sheet collapsed on a locomotive belonging to the California Barrell Company, Portland, Oregon, October 6th.

(352.) — On October 6th, an air tank exploded at the Midvale Steel Works, Philadelphia, Pa. One man was killed.

(353.) — A cast iron fitting ruptured at the Laurel Lake Mills, Fall River, Mass., October 6th.

(354.) — Eight sections cracked October 7th, in a boiler in the Baxter Hotel, Ida Grove, Iowa.

(355.) — An accident occurred October 7th, to a water column pipe on a boiler belonging to The Normanna Gin Company, Normanna, Texas.

(356.) — A blowoff pipe ruptured October 8th, at the Blue-Island, Ill., plant of Libby, McNeill & Libby. Two men were injured.

(357.) — On October 8th, an ammonia drum exploded at the plant of The Commonwealth Public Service Corporation, Mena, Ark. One man was killed and another seriously injured.

(358.) — On October 8th, two men were injured, one seriously, by an accident to a boiler in the Hotel Royal, New Haven, Conn.

(359.) — A section of a boiler cracked October 8th, at a public school in Rochester, Beaver County, Penn.

(360.) — A rupture occurred October 9th to a boiler belonging to the City of Wellsburg, West Va.

(361.) — On October 9th, an acetylene tank exploded at the repair shop of F. Franzwa, Carroll, Ia.

(362.) — On October 10th, a boiler on the steamer Chestnut Hill exploded at Philadelphia, Pa. Several men were killed.

(363.) — On October 10th, a boiler exploded at the sawmill of E. Johnson, St. Landry, La. Five men were killed and six injured.

(364.) — An accident occurred October 11th, to a boiler in a steam laundry of the Home Service Corporation, Los Angeles, Calif.

(365.) — On October 12th, a heating boiler exploded in the basement of the Freehafer Building, Reading, Pa.

(366.) — An accident occurred October 13th, to a boiler at the Oriental Laundry, Dallas, Texas. One man was injured.

(367.) — A manifold on a boiler was ruptured October 14th, in a building belonging to Ahlvins & Shreeve at Jackson & Collins Streets, Joliet, Ill.

(368.) — On October 15th, an explosion of a steam pipe at the Henry Clay colliery, Shamokin, Pa., was the cause of the death of one man.

(369.) — Two sections cracked October 15th, in a boiler of the Windsor Ave. Congregational Church, Hartford, Conn.

(370.) — On October 15th, a blowoff pipe was damaged at the plant of the Knoxville Furniture Company, Knoxville, Tenn. Two men were injured, one seriously.

(371.) — A tube ruptured in the main plant of the Milwaukee Coke and Gas Company, Milwaukee, Wis., on October 15th.

(372.) — On October 18th, a boiler exploded at the sawmill of E. C. Lañtte & Sons, Carmel, La. Four men were killed and several injured.

(373.) — A tube was ruptured October 16th, at Plant No. 1 of the Michigan Alkali Company, Wyandotte, Mich.

(374.) — On October 19th, accidents to ammonia tanks in the Iowa Falls, Iowa, plant of Swift and Company caused the death of two men.

(375.) — Four sections of a boiler cracked October 16th, in the restaurant of J. W. Welch, Omaha, Nebr.

(376.) — Two sections of a cast iron boiler were ruptured October 20th, at the Hotel Shirley, Jackson, Mich.

(377.) — A tube ruptured October 21st, in the Morrison, Ill., plant of Libby, McNeill & Libby.

(378.) — A section of a boiler cracked October 22nd, in a theater belonging to the Armstrong Real Estate & Improvement Co., Johnsonburg, Pa.

(379.) — A section was ruptured October 23rd, in a boiler in the furniture plant of the Lauzon Furniture Company, Grand Rapids, Mich.

(380.) — Twelve headers were ruptured October 24th, in the power house of the Galveston Electric Company, Galveston, Texas.

(381.) — Tubes pulled out of a drum on a boiler at Station "B" of the Detroit City Gas Company, Detroit, Mich., on October 24th.

(382.) — An accident occurred October 24th to a boiler on a steam shovel belonging to the White-Barger-White Coal Mining Co., Grape Creek, Ill.

(383.) — An accident occurred October 27th, to a boiler in the New Marion Power Station of the Public Service Corporation of New Jersey.

(384.) — A tube ruptured at the Grasselli Powder Company, Wyside, Pa., on October 27th.

(385.) — A section cracked October 28th, on a boiler in the office building of Joseph G. Ryan, Maple and Cherry Sts., Danvers, Mass.

(386.) — On October 29th, a locomotive on the Southern Pacific Railroad, after jumping the track, exploded. Six persons were reported killed and one hundred and forty-two injured. although just how many of these casualties were due to the boiler explosion is not known.

(387.) — On October 29th, a valve ruptured at Plant No. 2 of Cosden & Co., West Tulsa, Okla. One man was killed and one injured.

(388.) — Four sections cracked October 30th, in a boiler in a garage belonging to the Stoddard Motor Car Co., Springfield, Mass.

(389.) — Rupture of a plate on a boiler in the sugar house of O. Richard, Sunshine, La., occurred on October 31st.

(390.) — On October 31st, a boiler exploded in the Jones Meat Market, East Second St., Chillicothe, Ohio. One man was slightly injured.

(391.) — An accident occurred October 31st, to a blowoff pipe in the Light Plant & Water Works of the City of Wynnewood, Wynnewood, Okla.

NOVEMBER, 1919.

(392.) — An accident to a tallow tank occurred November 1st, at the abattoirs of the Retail Butchers Protective Assoc. Company, Cleveland, Ohio.

(393.) — An accident to a boiler on a sand boat of the Schwartz Lumber & Coal Co., Wichita, Kansas, occurred November 1st.

(394.) — On November 2nd, a boiler exploded at the Convent of the Sisters of St. Francis of Assisi, St. Francis, Wis.

(395.) — Three sections of a heating boiler cracked November 3rd, in School No. 8, Sherman Ave., Jersey City, N. J.

(396.) — A tube pulled loose November 3rd, on a boiler on the dredge "Natonia" owned by the port of Astoria, Astoria, Ore. One man was killed and another injured.

(397.) — A tube ruptured in the barrel factory of the Tide Water Oil Company, Bayonne, N. J., November 3rd. Four men were injured.

(398) — A section of a heating boiler cracked November 3rd, in a building used by the Army & Navy Y. M. C. A., City Square, Charleston, Mass.

(399.) — A section cracked November 4th, in a boiler in the Williamstown Opera House, Williamstown, Mass.

(400.) — A section cracked November 4th, in a boiler in the garage at 20 Bowdoin St., Springfield, Mass., owned by H. G. Webster.

(401.) — Three headers in a steam boiler cracked November 4th, at the L. D. S. Hospital, Salt Lake City, Utah.

(402.) — On November 5th, a heating boiler exploded at the Home Garage, Arma, Kansas. The owner, Mr. E. J. May, was killed and another man was injured.

(403.) — An accident occurred, November 5th, to a blowoff fitting at a plant of the Southern Cotton Oil Co., 456 West 37th St., Chicago, Ill.

(404.) — On November 6th, three men were killed by an explosion of a locomotive boiler at Hewitt's Station, on the Bessemer & Lake Erie Railroad.

(405.) — Five sections cracked, November 11th, in a boiler at the garage of the United Garage & Sales Company, 1766 Stratford Ave., Bridgeport, Conn.

(406.) — A section cracked in a boiler at the plant of H. B. Raffel, 36 East 9th St., New York, on November 11th.

(407.) — On November 13th, an accident to a boiler at Pier C, Port Richmond, Pa., severely injured one man.

(408.) — An accident to a boiler on November 14th, occurred at the Church of the Covenant, Williamsport, Pa.

(409.) — On November 14th, a boiler exploded at the River Falls Normal School, River Falls, Wis.

(410.) — An accident occurred, November 14th, to the main steam pipe in the fibre mill of the Nekoosa Edwards Paper Co., Port Edwards, Wis.

(411.) — One tube blew out and others were damaged at the Sabraton Works of the American Sheet and Tin Plate Company, Morgantown, West Va., on November 15th.

(412.) — Two sections of a boiler were found cracked, November 11th, in a building at 57-66 Public Square, Watertown, N. Y., belonging to the Northern N. Y. Utilities, Inc.

(413.) — On November 17th, at the Botany Worsted Mills, Passaic, N. J., an accident to a boiler caused three men to be injured.

(414.) — On November 17th, a boiler exploded in the basement of the White River Junction House.

(415.) — A section cracked, November 17th, in a boiler at the garage of R. M. Sparks, Nicholasville, Ky.

(416.) — On November 17th, a boiler exploded at the People's Cleaning & Dye Works, 2416 Erskine St., Omaha, Neb.

(417.) — A boiler ruptured, November 17th, at the National Biscuit Company's plant, 7th and Cass Streets, St. Louis, Mo.

(418.) — A section cracked, November 17th, on a boiler in the greenhouse of the Schluaraff Floral Company, Erie, Pa.

(419.) — On November 17th, a tube burst in the boiler room of Henry Sonneborn & Company, Baltimore, Md. Two men were injured.

(420.) — Three men were injured when a tube ruptured in Boiler House No. 1 of the Botany Worsted Mills, Passaic, N. J., on November 17th.

(421.) — A tube blew out, November 18th, in the Finance Building, South Penn. Square, Philadelphia, Pa. Three men were injured.

(422.) — On November 19th, an accident occurred to a steam pipe at Mine No. 2 of the Parra Coal Company, Parra, Ill. Two men were injured.

(423) — A section cracked, November 19th, in a boiler in the office of the Elyria Telephone Company, Elyria, Ohio.

(424) — A tube ruptured, November 19th, in the power station of the Public Service Corporation of New Jersey at Paterson, N. J.

(425.) — An accident to a boiler of the National Veneer Company, West Michigan St., Indianapolis, Ind., occurred on November 20th.

(426.) — On November 21st, a boiler exploded at the mill of G. S. Parmille and Son, Taft, Oregon. Three persons were killed and two injured.

(427.) — On November 21st, a boiler exploded at the Farmer's Gin Plant, Roanoke, Texas. Three men were killed and three injured.

(428.) — An accident occurred, November 21st, to a boiler in the basement of The Harris Garage Corp., 341 Troy Ave., Brooklyn, N. Y.

(429.) — Seven sections of a heating boiler cracked, November 22nd, in the synagogue of the Congregation Ados Israel, Market St., Hartford, Conn.

(430.) — On November 22nd, a heating boiler exploded at the Fawkes Apartment House, 832 Colfax Ave., Denver, Colo.

(431.) — A section cracked in the basement of the Methodist Episcopal Church South, Conway, Ark., on November 22nd.

(432.) — A tube burst, November 22nd, at the plant of the New York Butcher's Dressed Beef Company, 39th St. and 11th Ave., New York City.

(433.) — On November 24th, a locomotive exploded at Macon, Ga., on the Macon & Birmingham Railroad. One man was killed and another injured.

(434.) — A fitting on a blowoff pipe ruptured, November 25th, at the plant of the Southern Cotton Oil Company, 1456 West 37th St., Chicago, Ill.

(435.) — A tube failed, November 26th, at Mine No. 9 of the Old Ben Coal Corporation, West Frankfort, Ill.

(436.) — Two tubes ruptured, November 26th, at the Buckingham Ave. Power House of the Public Service Corporation of N. J., Perth Amboy, N. J.

(437.) — Two sections of a heating boiler in the basement of a theatre at 214 East 14th St., New York, cracked on November 27th.

(438.) — Two sections were found ruptured, November 27th, in the heating plant of the property of The World Realty Company at 15th and Douglas Sts., Omaha, Neb.

(439.) — Two sections cracked, November 27th, in the hardware store of N. E. Blood, Beloit, Kansas.

(440.) — On November 28th, a boiler accident occurred on the steamer President Grant while the vessel was at sea.

(441.) — On November 28th, a boiler exploded at the factory of B. Zelenko and Company, 14 William St., White Plains, N. Y.

(442.) — An accident to a boiler on November 28th, at the bakery of William Seibt, 3155 Cherokee St., St. Louis, Mo., injured one man.

(443.) — A tube pulled out November 28th, in a boiler at the plant of the Lederle Antitoxin Laboratories, Pearl River, N. Y.

(444.) — A section cracked, November 28th, in a boiler belonging to the F. W. Woolworth Company at 461-69 Fifth Avenue, New York City.

(445.) — A header ruptured, November 28th, in a boiler at the Ferguson Building at 319 Third Avenue, Pittsburgh, Pa.

(446.) — A tube ruptured, November 29th, at the plant of The Winchester Repeating Arms Company, New Haven, Conn. One man was injured.

(447.) — On November 29th, a boiler exploded at the sawmill of Hooker & Campen, Alliance, N. C. One man was killed.

(448.) — Three sections cracked, November 29th, at the rope works of the Lambeth Rope Corporation, New Bedford, Mass.

(449.) — Two sections of a heating boiler in the residence of E. B. Chandler, No. 127 West French Place, San Antonio, Texas, cracked on November 30th.

December, 1919.

(450.) — Two sections cracked, December 1st, in a boiler at the packing house of Kingan & Company, Jacksonville, Fla.

(451.) — A tube ruptured at the Stimson Lumber Mill, Seattle, Wash., on December 3rd.

(452.) — Two sections cracked, December 4th, at the Whittier School, Bridgeport, Conn.

(453.) — A fire sheet ruptured, December 4th, at the light and pumping plant of the City of Atlantic, Iowa.

(454.) — A section cracked at the lumber mill of Parker & Page Company, East Cambridge, Mass., on December 4th.

(455.) — Three sections cracked, December 4th, at the Ansonia Amusement Company's theater, No. 385 Third Avenue, New York City.

(456.) — A fitting in a blowoff pipe failed, December 4th, at the Waltham Laundry Company, Gifford Ave., Waltham, Mass. One man was injured.

(457.) — A stop valve failed, December 5th, at the Water and Electric Light Plant of North Vernon, Ind.

(458.) — A section cracked, December 5th, at the prevocational school at New Britain, Conn.

(459.) — On December 6th, a boiler exploded in the store of George F. Reid, Grand Rapids, Mich. Five persons, two of them children, were injured.

(460.) — On December 8th, a tube ruptured at the New Marion Power Station of the Public Service Corporation of New Jersey, injuring two men.

(461.) — A tube failed at the factory of the Rhode Island Card Board Company, No. 163 Exchange Street, Pawtucket, R. I. on December 8th.

(462.) — On December 9th, a boiler exploded at the Great Western roundhouse, Des Moines, Iowa. One man was injured.

(463.) — Three sections cracked at the Jewish Hospital, No. 216 East Kentucky Street, Louisville, Ky., on December 9th.

(464.) — Two sections cracked, December 9th, in a boiler belonging to the Thistle Investment Company, No. 501 Highland Avenue, Kansas City, Mo.

(465.) — A furnace on the Tug "David Gibb," belonging to the North State Lumber Company, Charleston, S. C., collapsed on December 9th.

(466.) — One man was injured on December 10th, when a tube failed at the Fayetteville Gas & Electric Plant, Fayetteville, Ark.

(467.) — On December 11th, a boiler exploded on the Collins Brothers farm on the Georgetown Pike, near Cleveland, Tenn. Two men were injured.

(468.) — A tube ruptured in the power plant of the Louisville Street Railway Company, Louisville, Ky., on December 11th.

(469.) — On December 11th, a boiler exploded in the power plant of the C. and E. I. Railway at Danville, Ill. Two men were injured.

(470.) — An acetylene container exploded at the Wisconsin Foundry Company's plant at Madison, Wis., on December 11th. One man was injured.

(471.) — The bottom plate on a boiler blew out, December 11th, at the manufacturing plant of L. R. and Vilas Harsha Manufacturing Company, 401 Lincoln Street, Chicago, Ill.

(472.) — A tube ruptured, December 11th, at the Buckingham Avenue plant of the Public Service Corporation of New Jersey at Perth Amboy, N. J.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1920.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$390,221.07
Real Estate		90,000.00
Mortgage and collateral loans		1,426,250.00
Bonds and stocks		5,702,983.62
Premiums in course of collection		597,171.35
Interest accrued		107,590.44
Total assets		$8,314,216.48

LIABILITIES.

Reserve for unearned premiums		$3,715,903.48
Reserve for losses		175,539.16
Reserve for taxes and other contingencies		401,420.50
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,021,353.34	
Surplus to Policy-holders		**$4,021,353.34**
Total liabilities		$8,314,216.48

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FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
E. SIDNEY BERRY, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
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Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

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CHICAGO, Ill., . . . 209 West Jackson B'l'v'd .	J. F. CRISWELL, Manager. P. M. MURRAY, Ass't Manager. J. P. MORRISON, Chief Inspector. J. T. COLEMAN, Ass't Chief Inspector.
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NEW YORK, N. Y., . . 100 William St. . . .	C. C. GARDINER, Manager. JOSEPH H. McNEILL, Chief Inspector. A. E. BONNET, Ass't Chief Inspector.
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The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

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BOILER EXPLOSION AT OWOSSO, MICHIGAN.

Boiler Explosion at Owosso, Michigan.

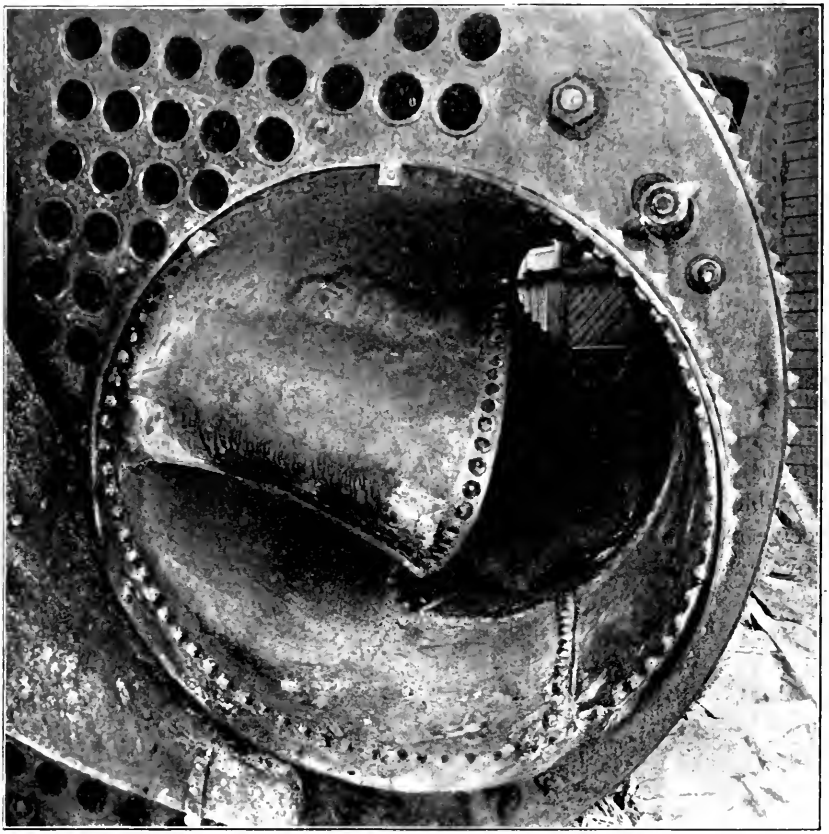
MANY of the farmers who live in Shiawassee County, Michigan, find an excellent market for their supply of milk at the creamery at Owosso near the center of the county. In addition to the usual creamery business a condensed milk plant is operated there by the Detroit Creamery Company of Detroit, Mich. Some idea of the amount of milk handled at the Owosso creamery may be gained from the statement that about $2000 is paid out per day to the farmers for their product.

An accident to a plant such as this obviously would be of serious consequence to the farmers and to the owners. It was not expected that any accident would happen yet on the 17th of June the business of this creamery was halted — sharply and abruptly. At 5.40 P. M. on the day mentioned a boiler at the plant exploded and the owners were unable to operate or to receive milk from the farmers until provision could be made for the necessary supply of steam to carry on the work.

If the interruption to the work of the creamery had been the only result of the accident there would be little more to tell. But the damage went further than that. The force of the explosion lifted the boiler up in the air and hurled it a distance of 100 feet where it landed, as shown in the illustration on the front cover of this issue of The Locomotive, on the rear of a dwelling house which was moved on its foundation about ten inches. Two other houses on the same side of the street and one on the opposite side were also damaged. A piece of a grate bar was hurled through the window of the house next door and landed on a bed where a child had been sleeping only five minutes before the accident.

The news of the accident spread rapidly and it was not long before a large number of people were on the scene. It was believed that the fireman had been killed and an immediate search of the wrecked boiler room was made but it was not until a half hour after the explosion that his body was found 600 feet away from the creamery. His legs, arms and skull were fractured and death had undoubtedly been instantaneous.

The boiler equipment at this plant consisted of two boilers of the internally-fired, dry-back, Scotch marine type, the one which exploded being known as No. 2. They were 90 inches in diameter and 12 feet, 10 inches long and were built in 1913. The rupture occurred in the furnace which failed as illustrated on the opposite page. Investigation showed that the furnace had collapsed over its entire length from head to head. The rupture, which started from the center on top and continued to a point about four inches below the horizontal center line on each side, was partly by tearing of the plate and partly by shearing of the rivets. Only one joint of the furnace was affected



View of Collapsed Furnace.

and, strange to say, the shell of the boiler was not so much as dented. As will be noted by reference to the illustration, the upper half of the front course of the furnace was bent until it stood at an angle of about ninety degrees. At the rear the upper half of the furnace was pushed down until it lay almost flat against the lower half.

Statements by persons who had been in the boiler room a short time before the accident and who were otherwise acquainted with the plant gave evidence that the safety valves had been blown several times each day and the assistant fireman stated that they had blown at about 5 P. M. on the day of the explosion. One man made the statement that he had seen about two gauges of water in each boiler just a few minutes before the explosion occurred. Examination of the exploded boiler, however, gave very plain evidence of overheating, although there were no signs of the presence of scale or oil to bring about this condition. It is probable that the water gauge connections became obstructed in some way and a false indication of the water level was given. The cause of the explosion was evidently overheating of the crown-sheet of the furnace which caused it to collapse and then to rupture.

The employees of the creamery were so wrought up by the occurrence that no one thought of the other or No. 1 boiler which still stood in place with a fire in it. The explosion, of course, left this boiler with a free opening for the steam to escape and by the time some one thought to give it attention the water level had fallen so as to cause overheating of the furnace in this boiler also. Its center ring was buckled and its seams so opened that it was unfit for further immediate service.

It was thought at first that it would be some time before the Creamery Company would be able to operate again but fortunately it was able to secure the use of a traction engine which enabled it to receive milk after a day's idleness. This makeshift, however, did not provide for the entire demand for steam and only the separating of the milk and cream could be accomplished. The creamery was forced to await the completion of the new boiler plant before resuming full operation.

In this disaster the Creamery Company found much consolation in its policy with The Hartford Steam Boiler Inspection and Insurance Company under which it was promptly indemnified for the property loss it had sustained and which amounted to approximately $7000.

Forty Years of Boiler Explosions.

A SUMMARY of the records of the past forty years (1880 to 1919 inclusive) shows that there have been in that period a total of 14,281 explosions, 10,638 lives lost and 17,085 persons injured. These figures have been obtained from the explosion lists of THE LOCOMOTIVE and, while we do not claim completeness for these lists, they are fairly representative of conditions from year to year.

On page 102 we have tabulated the data obtained from the above lists under the column headings of the Year, Explosions per Year, Persons Killed, Persons Killed per Explosion, Persons Injured, Persons Injured per Explosion, Total Casualties, Casualties per Explosion and the Ratio of Injured to Killed.

A study of statistics and the changes which have occurred from year to year is always of considerable interest. A tabulation of the figures, however, does not always bring out the salient features at a glance and in order that a better study may be made of the data we are presenting it in the form of charts.

Chart No. 1 below gives the Total Explosions per Year from

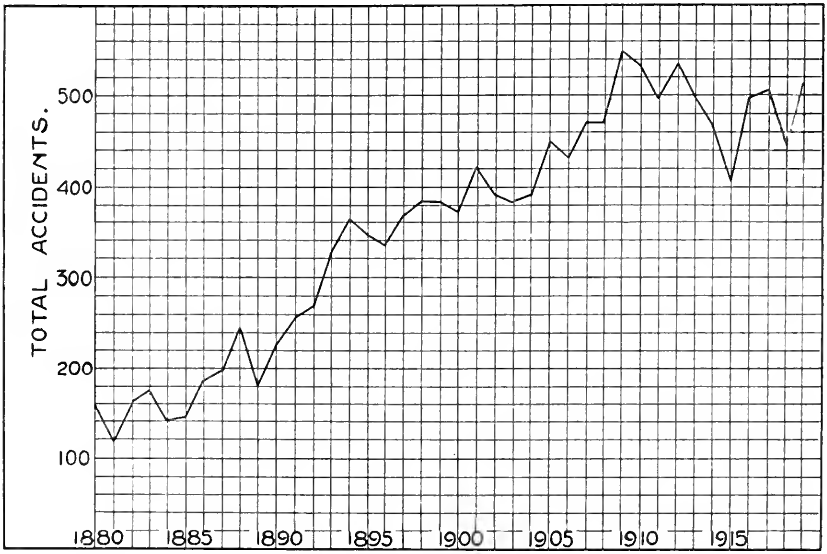


CHART NO. 1.—TOTAL EXPLOSIONS PER YEAR.

the year 1880 to 1919 inclusive. Of course the "saw-teeth" are only natural in a chart of this kind. It is interesting to note, however, that

Summary of Boiler Explosions from 1880 to 1919 Inclusive.

Year	Number of Explosions	Persons Killed		Persons Injured		Persons Killed and Injured		Ratio
		Total for Year	Per Explosion	Total for Year	Per Explosion	Total for Year	Per Explosion	Injured / Killed
1880	170	259	1.58	555	3.26	814	5.84	.467
1881	119	251	2.11	313	2.63	564	4.74	.801
1882	172	271	1.63	369	2.14	640	3.77	.735
1883	184	263	1.43	412	2.24	675	3.67	.640
1884	152	254	1.67	261	1.72	515	3.39	.972
1885	155	220	1.42	288	1.86	508	3.28	.764
1886	185	254	1.37	314	1.70	568	3.07	.808
1887	198	264	1.33	388	1.96	652	3.29	.688
1888	246	331	1.34	505	2.05	836	3.39	.658
1889	180	304	1.69	433	2.40	737	4.09	.702
1890	226	244	1.08	351	1.55	595	2.63	.695
1891	257	263	1.02	371	1.44	634	2.46	.709
1892	269	298	1.11	442	1.64	740	2.75	.674
1893	316	327	1.03	385	1 22	712	2.25	.850
1894	362	331	.89	472	1.30	803	2.19	.702
1895	355	374	1.05	519	1.46	893	2.51	.720
1896	346	382	1.11	529	1.53	911	2.64	.721
1897	369	398	1.15	528	1.43	926	2.58	.753
1898	383	324	.84	577	1.50	901	2.34	.562
1899	383	298	.78	456	1.19	754	1.97	.654
1900	373	268	.72	520	1.39	788	2.11	.516
1901	423	312	.74	646	1.53	958	2.27	.483
1902	391	304	.78	529	1.35	833	2.13	.575
1903	383	293	.76	522	1.36	815	2.12	.562
1904	391	220	.56	394	1.01	614	1.57	.558
1905	450	383	.85	585	1.30	968	2.15	.654
1906	431	235	.55	467	1.08	702	1.63	.503
1907	471	300	.64	420	.89	720	1.53	.713
1908	470	281	.60	531	1.13	812	1.73	.528
1909	550	227	.41	422	.77	649	1.18	.538
1910	533	280	.53	506	.95	786	1.48	.553
1911	499	222	.44	416	.83	638	1.28	.533
1912	537	278	.52	392	.73	670	1.25	.708
1913	499	180	.36	369	.74	549	1.10	.488
1914	467	148	.37	315	.67	463	1.04	.470
1915	404	132	.33	236	.58	368	.91	.559
1916	499	199	.40	375	.75	574	1.15	.531
1917	506	149	.29	289	.57	438	.86	.513
1918	449	130	.29	340	.76	470	1.05	.382
1919	528	187	.37	343	.68	530	1.05	.543
Total	14,281	10,638		17,085		27,723		
Average			.877		1.38		2.31	2.31

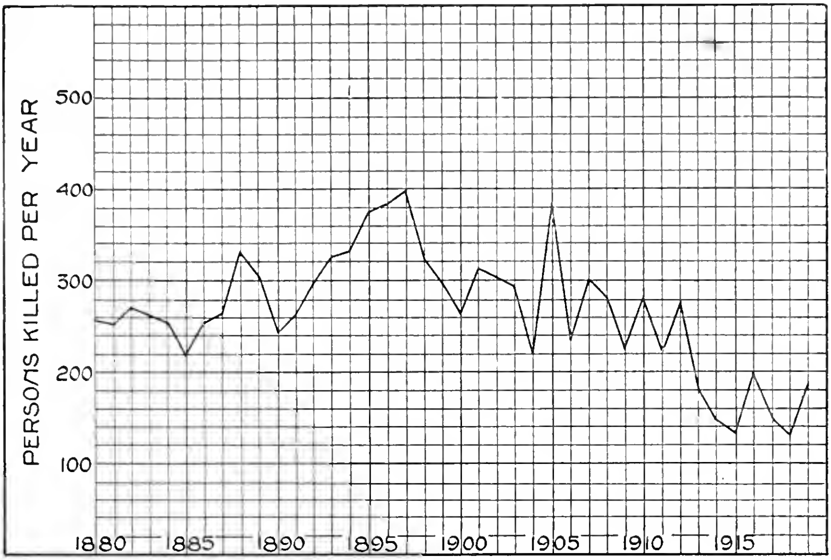


CHART No. 2.—PERSONS KILLED PER YEAR.

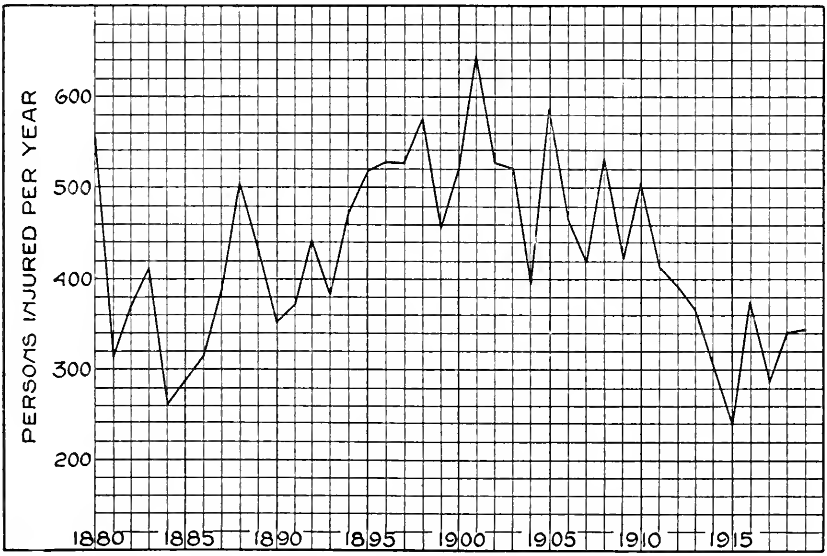


CHART No. 3.—PERSONS INJURED PER YEAR.

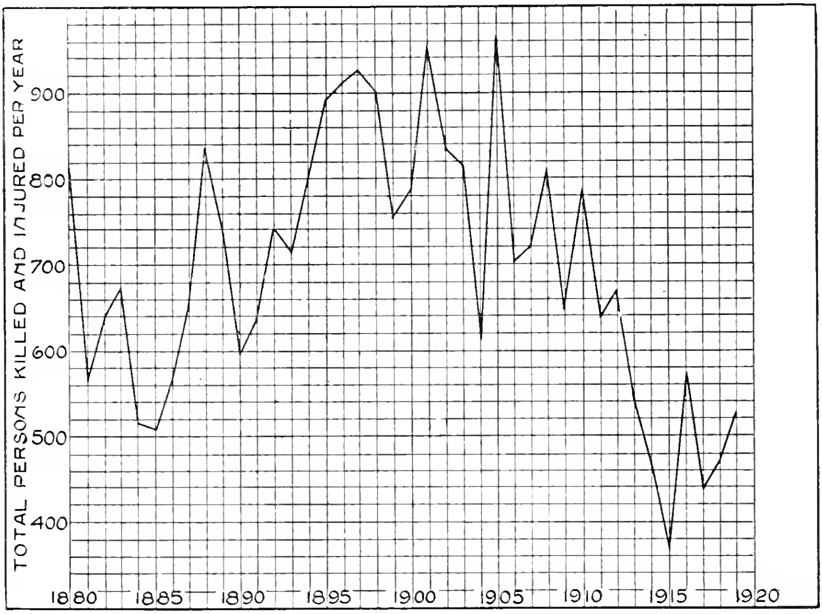


CHART No. 4. — TOTAL PERSONS KILLED AND INJURED PER YEAR.

the average curve rises rapidly until the year 1910 or 1912 is reached, after which time it is apparently on the decline. It is very probable that the rise is due to the rapid increase in the number of boilers in use and on that account the rise should continue to 1919. If accurate information in regard to the number of boilers in use during each of these years were available it would be of considerable help but certainly the number of boilers in use in the past ten years has increased at least as rapidly as in the previous period. The drop in the curve is undoubtedly due to better construction, better care and more heed to the advice of the boiler inspector.

Considering next the variation in Persons Killed, as shown in Chart No. 2, on page 103, we find at first a very slight decrease followed by a general increase which is interrupted in two successive years by a decline but which rises again to the peak of 398 in 1897. A general decrease then begins which again is broken by a sharp upward "saw-tooth" in 1905.

In Chart No. 3 on page 103 we have the variation in Persons Injured. The irregularities are very marked but there is a general rise to 646 in 1901 and then a decided falling off in the later years. The

CHART No. 5. — PERSONS KILLED PER EXPLOSION.

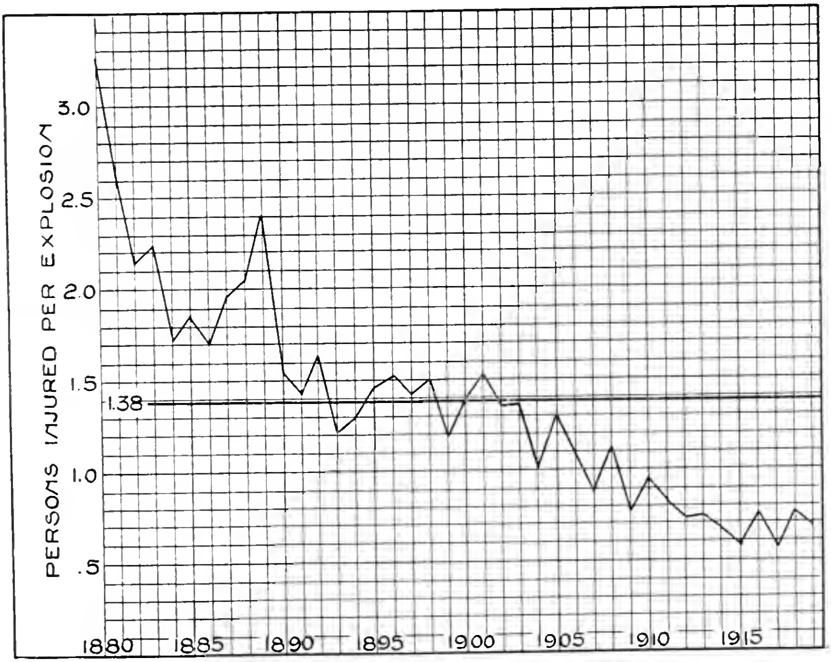


CHART No. 6. — PERSONS INJURED PER EXPLOSION.

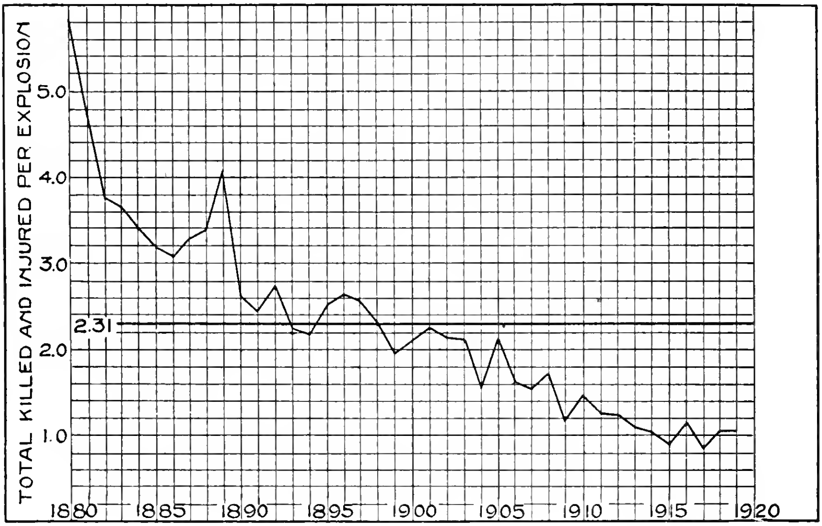


Chart No. 7.—Total Killed and Injured per Explosion.

average height in the past five years, in fact, is below that in the period from 1880 to 1885.

The variation in the Total of Killed and Injured as shown in Chart No. 4 on page 104 and which is, of course, the result of the addition of the figures of Charts Nos. 2 (Persons Killed) and 3 (Persons Injured), shows very markedly the effect of the "saw-teeth" of Chart No. 3. Here again, however, there is a general rise until the peak is reached, in this case in 1905, followed by a decline. Also, as in Charts Nos. 1 and 3, we find the average in the latter years to be lower than in the earliest years.

While all of the above charts show the facts they do not indicate the essential points as regards the casualties. To get a better conception of what has happened we must consider not the Persons Killed, Persons Injured and Total of Killed and Injured but rather the rate of each of these per explosion. These figures are given in Columns No. 4, 6, and 8 respectively. In each of these columns the figures have been obtained by dividing the respective casualties by the explosions for the year in question. The graphic analyses of these last three sets of figures are given in Charts No. 5 (Persons Killed per Explosion), No. 6 (Persons Injured per Explosion) and No. 7 (Total of Killed and Injured per Explosion) on pages 105 and 106. In every case we find a most marked falling off in the

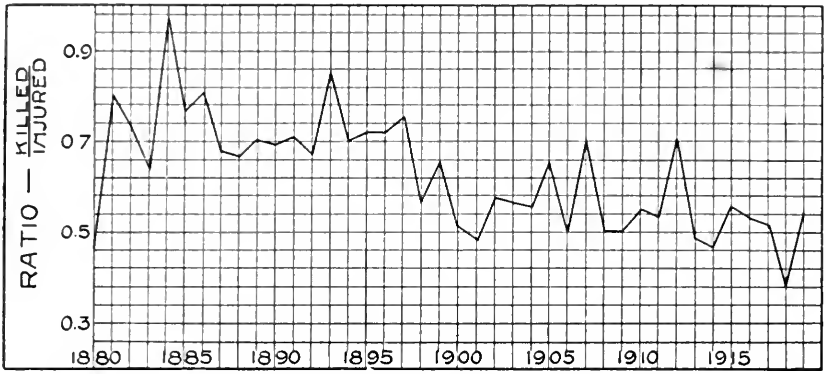


Chart No. 8. — Ratio $\frac{\text{Killed}}{\text{Injured}}$

rate. All are broken by "saw-teeth" yet at the same time they are remarkably smooth for charts of data of this nature.

Referring to Chart No. 5, that of the Persons Killed per Explosion, we find a horizontal line drawn at the height marked .877. This value is the average yearly rate of persons killed per explosion and is the result of dividing the sum of all the yearly rates by the number of years (40). This is not the same figure that we would obtain by dividing the total killed during the forty years by the total number of explosions during that period. The former figure is the average yearly rate whereas the latter figure is the rate over a period of forty years. For the forty year rate, in the case of persons killed per accident, we would have 10,637 divided by 14,259 or .747. If the variation followed a straight line of uniform slope or inclination these two rates would be identical.

Figures for average rates similar to that just described on the rate of Persons Killed per Explosion are given on the charts for Persons Injured per Explosion (Chart No. 6) and Total of Killed and Injured per Explosion (Chart No. 7) and are plotted as 1.38 and 2.31 respectively.

Chart No. 8 above represents the variation in the Ratio of Killed to Injured. It shows a slight though definite and rather regular decline. Reference to this chart will show that in the earlier years there were almost as many killed as there were injured whereas at the present time only about one half as many persons are killed as there are injured.

Charts No. 1 (Total Explosions per Year), No. 5 (Persons Killed per Explosion), No. 6 (Persons Injured per Explosion), No. 7 (Total of Killed and Injured per Explosion and No. 8 (Ratio of Killed to Injured) are important and interesting in their indications. The statistics of the last ten years furnish ample evidence that more attention is being given to safe construction and careful operation than in former years. Fewer explosions per number of boilers installed, lower rates of casualties per explosion and a lower ratio between killed and injured are all movements in a fortunate direction. But only untiring vigilance will keep them moving in that way.

Vulcanizers and De-Vulcanizers.

H. E. Dart, Superintendent of Engineering Department.

SINCE the process of vulcanization was patented by Charles Goodyear in 1844 pure india-rubber or caoutchouc has been very rarely used, the vulcanized rubber being far preferable for almost every use. In general, the process of vulcanization consists in mechanically mixing rubber at moderate heat with sulphur and then "curing" it in steam at from 250 to 300 degrees, Fahrenheit. The substance thus formed acquires extraordinary powers of resisting compression together with a great increase of strength and elasticity; it remains elastic at all temperatures, it cannot be dissolved by ordinary solvents, and it is not affected by heat within a considerable range of temperature. Various modifications of the process are employed as, for example, the mixture with the rubber and sulphur of other ingredients such as litharge, white lead, zinc-white, whiting, etc., giving color, softness and other qualities to the product. By using a greater proportion of sulphur and a higher temperature, hard rubber, known as vulcanite or ebonite, can be produced.

Since the process of vulcanization was perfected the uses of rubber have multiplied so that it is now employed in almost every department of industry. Some of the things for which it is used include tires, boots, shoes, mats, toys, belting, buffers, water-proof cloth, washers, valves, fire-hose, medical and surgical appliances, life preservers, steam and water packing, tubing, artificial sponges, etc.

Vulcanizing on a large scale is usually done in a long horizontal cylinder having one head hinged so that it can swing outward and thus provide access to the interior of the vessel by means of an opening of the full shell diameter. Rails are placed along the bottom of the cylinder and the articles to be vulcanized are placed on small cars running on these rails, provision thereby being made for ease in handling. For some special work jacketed vulcanizers are used. These vessels are of the same general form as the ordinary vulcanizer except that they have two concentric shells, the steam being admitted to the space between the shells so that the work is not exposed to moisture. Of course the inner shell is subject to collapse due to external pressure and it is therefore supported from the outer shell by means of staybolts in the same manner as some types of boilers. In some cases a vacuum is used in the inside shell, thus increasing the tendency to collapse, but there is no difficulty in designing the vessel so as to provide against this contingency. Small vulcanizers are sometimes placed in a vertical position with the lower head fixed and the entire shell removable by a chain-block or other similar means.

Devulcanizers are similar to vulcanizers in construction but the temperature (and consequently, the pressure) employed is higher than for vulcanizing.

Vessels of this general type are subject to a hazard not found in other kinds of pressure vessels, due to the necessity of providing such a large cover which must be amply strong and at the same time capable of quick opening and closing, and the failure of such a vessel is liable to be very destructive and is frequently accompanied by loss of life. The cover is generally attached to the shell by means of two flanged rings, one of which is riveted to the open end of the vulcanizer and the other to the cover. The two rings are hinged together at one side and a wheel roller, traveling on the floor, is provided at the bottom of the covering to take the weight off the hinge. Eye-bolts are attached to the vulcanizer ring by means of brackets cast on the back side of the ring and these bolts are designed to swing into slots in the cover ring when the cover is closed; the cover is then secured in position by tightening up nuts on the ends of the eye-bolts. Of course packing is necessary to make a steam-tight joint and this is placed in a groove turned in the vulcanizer ring. On account of their size and shape the rings are cast, thus introducing the usual uncertainty as to the quality of the metal. Cast steel should always be used for the purpose instead of cast iron. There is no simple formula for calculating the dimensions of these rings; in fact, the problem is considerably complicated and the article which appeared in The Locomotive for July, 1905, is probably as good as anything that has been published upon the subject. Several patented styles of quick-closing vulcanizer doors are on the market but not all of these are acceptable for insurance.

As regards the proportions of vulcanizers, a diameter of 60 inches is not uncommon; our Engineering Department has designed some with a length of over 50 feet but 16 to 20 feet is more usual. For a pressure of 125 pounds the head of a 60-inch vulcanizer would carry a load in excess of 175 tons and would require twenty-four 2¼-inch cover-bolts. Instead of tightening the bolts up gradually all around the circumference so that they will just hold the pressure, ignorant or careless workmen will often strain the bolts by using a long wrench with a pipe over the end. In this way it is possible to strip the threads after awhile, especially since the nuts must fit loosely as a matter of convenience in the repeated handling to which they are subjected. An added hazard sometimes is introduced when the workmen do not tighten up all of the bolts — either from laziness on the part of the men or because some of the bolts may be out of order.

The inherent hazard that exists in this class of apparatus will be illustrated by the following partial list of vulcanizer failures taken from the reports given in The Locomotive: —

May 6, 1912. Vulcanizer exploded at the Plymouth (Mass.) plant of the Boston Woven Hose and Rubber Co. Property loss said to have been about $10,000.

May 16, 1912. Vulcanizer exploded at plant of Empire Rubber Co., Trenton, N. J. One man killed and one fatally injured (Illustrated in The Locomotive of October, 1912.)

Jan. 21, 1914. Vulcanizer exploded in garage at Nashua, N. H. Large property damage.

June 9, 1916. Door of vulcanizer blew off at plant of Electric Hose and Rubber Co., Wilmington, Del. One killed and three injured.

Feb. 10, 1917. Vulcanizer exploded at plant of Luzerne Rubber Co., Trenton, N. J.

Jan. 17, 1919. Vulcanizer exploded at the tire shop of Samuel Bros., Philadelphia, Pa. Two men were seriously injured.

Feb. 10, 1920. Vulcanizer exploded at Durham, N. C. One killed and one injured. See explosion list in this issue, page 125, No. 106.

Supersaturated Steam.

THE terms "wet steam," "dry or saturated steam" and "superheated steam" are so familiar to every one who has but a slight acquaintance with water and its vapor that it would seem unnecessary to say anything further in regard to them. But now that we are hearing a good deal of the term "supersaturated steam," indicating, as it does, a condition of vapor somewhat unique, it may be well, before we discuss this condition of steam, to hark back to some first principles.

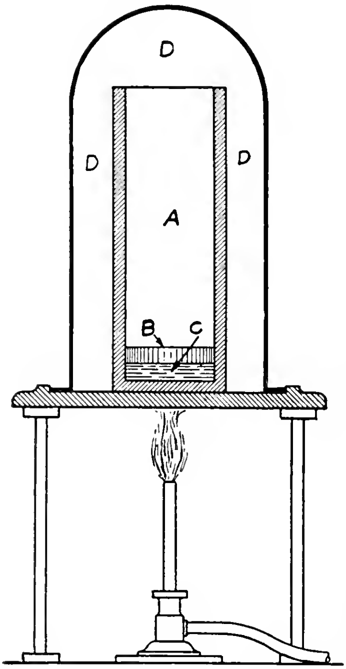


Fig. 1.

Let us suppose that we have an apparatus as shown in fig. 1 which consists of a cylinder A which has a piston B of an ideal nature such that it fits the cylinder perfectly and yet will move with absolutely no friction. Its weight is such that it will exert a pressure of 14.7 pounds on each square inch of the surface of the water C. We will suppose also that the water weighs exactly one pound. All the air has been exhausted from the surrounding space D so that the only pressure that can be exerted on the water will be 14.7 lbs. per square inch. By the nature of the arrangement the pressure will always be constant at 14.7 lbs. per square inch and cannot change as long as the piston is within the cylinder A. We will assume further that we have some means of supplying heat to the water as indicated in the sketch. If we start with the water at the temperature of 32° Fahrenheit and add heat to it the water will increase very slightly in volume but will still remain a liquid until the temperature of 212° is reached. At this point, if we continue to supply heat, the temperature will remain constant at 212° and the water will begin to change from a liquid to a vapor. It will continue to follow this change with a very rapid increase of volume at a constant temperature until the water is all vaporized. When and just when the vaporization is complete the volume occupied by the vapor will be 26.79 cubic feet. Of course, to do this, our apparatus would necessarily have to be of somewhat different proportions than indicated in the sketch. We will now have in our cylinder one pound of dry saturated vapor. We will have in that space occupied by the vapor a definite number of molecules or particles of extremely minute size although we shall not attempt to state the *exact* number.

If we continue to add heat to the vapor it will continue to increase in volume and it now also will undergo a temperature rise. It is no longer "dry saturated steam" but "superheated steam" and if we raise the temperature of it to 262° F. it will be 50° higher than when it was "dry saturated" and we would speak of it as being "steam at 14.7 lbs. and 50° superheat." Since the total number of molecules has not changed but the volume has increased it necessarily must be true that each cubic inch of the superheated vapor contains a smaller number of molecules than did a cubic inch of the saturated steam.

If now we cool the steam it will return to the dry saturated condition and if we cool it still further it will begin to condense and this condensation will continue until it returns to its initial condition of a liquid. In the condition in which it exists between dry saturated steam and a liquid it is known as wet steam or, more correctly, as wet saturated steam. This latter term, that of wet saturated, might appeal to us as incorrect. Actually, however, it is entirely proper. The steam in this condition consists of a mixture of a vapor and a liquid. The liquid may be present as a spray or mist or it may exist as one body of water. The vapor part, however, is still a dry saturated vapor. Each cubic inch of the *vapor* contains just as many molecules as it did when the entire pound was "dry saturated." This term, saturated, is a very good one. It means that we have put into a cubic inch of the vapor as many molecules as can conveniently be placed in that volume. In other words, we have *saturated* the cubic inch with water vapor molecules.

Using the same apparatus we might have had a piston that would have exerted a pressure of 100 pounds per square inch. We would have found, under this condition, that the water could not exist as dry saturated steam until the temperature was raised to 327.8° F. For this steam to be superheated 50° the temperature would have to be 377.8° F. And in the same way we would find that for every other pressure that we might impose there would be a corresponding temperature for the dry saturated steam.

It is important to note that the temperature of the dry saturated steam and of the wet saturated steam is the same. The vapor and the liquid are both at the same temperature and, provided no heat is removed from or added to the mixture, they will remain indefinitely in the proportions in which they are existing. If 75% of the pound is vapor and 25% is liquid then the mixture is known as 75 per cent. "quality" steam. This condition of both vapor and liquid being at the same temperature with no tendency to change in relative proportion is known as "thermal equilibrium." There is no more tendency for heat to leave the vapor and enter the liquid and thereby vaporize that liquid, than there is for heat to pass from the liquid to the vapor.

As a further illustration of what is meant by thermal equilibrium we may consider that we have a vessel filled with vapor at a given temperature and pressure. If we introduce some water, the temperature of which is lower than that of the vapor, into this vessel some of the vapor will condense until it has given up enough heat to raise the temperature of the liquid to that of the vapor. If the water is at a temperature higher than the vapor then some of the water will vaporize until the temperature of both becomes the same.

This idea of thermal equilibrium plays an important part in supersaturated steam. It might be said at this point that the condition of supersaturated steam is an unusual one in that it is a very unstable condition. While scientists long have known of the possibility of its existence it has not generally been supposed that it would be found in practice to any appreciable extent.

In order to appreciate this condition of supersaturation it must be fully realized that when we have thermal equilibrium the water vapor at any pressure must have a perfectly definite and easily determined temperature. Furthermore, if it is dry saturated, it will occupy a certain definite volume known as the *Specific Volume*. If it is 50% wet it will occupy very nearly 50% of the Specific Volume.

In investigating the conditions under which steam turbines operate it has been found repeatedly that if a pressure gauge and a thermometer are used to read the pressure and temperature of the steam in the exhaust passage the thermometer will read a temperature several degrees below the value corresponding to the pressure. If thermal equilibrium existed no such discrepancy in readings could exist. The condition has sometimes been spoken of as "undercooling" and this term is a very good one. As a matter of fact the vapor is lower in temperature than it would be under equilibrium conditions for the observed pressure. And yet it is a difficult matter to obtain the exact temperature of the vapor. The thermometer, if placed in a pocket where it will be protected from the rush of the steam, will soon be covered with a film of moisture due to condensation of the vapor. Condensation of the supersaturated vapor under these conditions will always occur because, as has been said before, this unique condition is a very unstable one. The vapor will always tend to return to a condition of thermal equilibrium with the condensate and the thermometer mentioned above will therefore read very nearly or exactly the temperature corresponding to the observed pressure. If, however, the thermometer bulb is exposed to the high velocity steam the film of moisture will be swept away and the molecules of vapor which are at the lower temperature will be given an opportunity to register their true value. Even this method of taking the temperature must give only approximate results

While the above discussion of "undercooling" serves to bring out some remarkable facts concerning supersaturated steam it does not give us a conception of just what is meant by the term "supersaturation." An attempt will now be made to explain this term.

The conditions under which steam flows through a nozzle and the theoretical laws which govern this flow have long been known. These laws had always been considered very exact and absolute. It was thought that the actual flow of steam through a nozzle would have to be less than the theoretical on account of friction impeding the flow. When, however, tests showed that the actual flow of the practically dry steam used in the tests was *greater* than the theoretical it was realized that something unusual had occurred. At first it was thought that moisture in the steam was the explanation of the greater weight discharged. But when calculation determined that from 10% to 20% of moisture would have to be present to give the results obtained it was realized that some other explanation must be secured. Since the weight discharged must be in direct relation to the number of molecules passing in a given time the only possible solution is that the vapor must carry more molecules per cubic inch under the actual conditions of flow than when the unit volume is "saturated" with molecules. In other words, the unit volume is "supersaturated." As an actual fact we do not know how many molecules it would be possible to crowd into a unit volume but we do know that only a certain definite number will stay there naturally and with this number in the unit volume the steam is saturated. Note that this is the only natural condition in which *vapor* will exist. While it may become supersaturated it will very readily and upon the slightest disturbance revert to the saturated state with consequent condensation of its excess molecules and when this change is effected thermal equilibrium will be established.

The subject of supersaturation is one that is demanding very close study by the steam turbine designer. The matter has been the more forcibly brought to the attention of engineers and scientists in this field by an article entitled "A New Theory of the Steam Turbine" by H. M. Martin in Engineering (London), Vol. CVI. Mr. Martin brings out the point that reciprocating engine design has been largely by cut and try methods with theoretical considerations giving aid only in a most general manner. The varying conditions in different engines such as temperature changes within each cycle of operation, valve leakage and clearance have been most difficult of correlation between any given engine and a new design. It is true that theory has been applied wherever and whenever possible but the gap between theory and practice has been a wide one. The steam turbine, however, has lent itself most favorably to theoretical design. Predictions of the performance of a given design have been possible to a remarkable exactness. Even here considerable experience has been necessary to determine certain correcting factors for discrepancies between theory and practice. Mr. Martin suggests that some of these apparent discrepancies may be explained by the fact that the steam is supersatured during all, or very nearly all, of its passage from the nozzle to the condenser.

The variable quantities encountered in an investigation of this nature are many. It would seem almost impossible to develop formulæ for use in design. Similar obstacles have arisen in the past, however, and sooner or later have been surmounted. It is therefore confidently expected that the investigators in this field will reach a complete and satisfactory solution of the whole problem.

The Locomotive

The Hartford Steam Boiler Inspection and Insurance Co.

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, OCTOBER, 1920.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. Co.

WE desire to call the attention of our readers to the leading article in this number of THE LOCOMOTIVE as indicating the trend of boiler accidents and the deaths and injuries which such accidents leave in their wake.

Possibly our treatment of the subject may seem cold blooded. Statistical study usually is of that nature. But we have no desire to leave that impression on our readers. Indeed our sympathies should be the more deeply touched when we think of the suffering a disastrous boiler explosion can bring. It is true that conditions are far better than they were in former years yet when we consider that during the past year there were 528 boiler explosions, 187 persons killed and 343 persons injured, we have cause to ask for the reason and the remedy.

The boiler manufacturer of today is extremely earnest in his efforts to produce not only an efficient boiler but one that is well constructed and safe in every detail. A very great degree of success has been obtained in this direction. But no boiler ever made was intended to be abused. It is also true that no one willfully would subject a pressure vessel, capable of doing such extreme damage, to carelessness and neglect. Unfortunately, however, mankind is not infallible. As long as there are boilers in operation; as long as these boilers must be subjected to the failings of the human race; just so long will we have boiler explosions and failures.

How many of the people of this country, other than boiler inspectors, would be willing after an inspection of a boiler to certify that it was safe to operate? Certainly only a small fraction of one per cent. Boiler inspection is not a thing to be learned in a day. It takes years of experience to learn the danger signals. The purpose of inspection is to warn of trouble and the purpose of insurance is to cover financial losses. Are YOU protecting your equipment, your employees, and your bank account?

We are always pleased to note in the pages of our contemporaries any reference to the value of boiler inspection and we therefore have read with considerable interest two recent articles of this nature.

In an article in the July issue of *Safety Engineering,* entitled "Value of Steam Boiler Inspections in Mining and Industrial Plants" by Mr. H. M. Motherwell of the United States Bureau of Mines, the imperative need for boiler inspection is brought out with exceeding clearness. Some interesting figures also are given on the economic losses attending the neglect of boilers.

Mr. W. E. Snyder of the American Steel and Wire Company in an article in *Power Notes,* published by the Diamond Power Specialty Co., lays great stress on the value of Safety First in the boiler room. Speaking of boiler inspection he says, "The benefits which result from periodic inspections by men whose sole time is taken up with such work, and who in consequence acquire an experience which makes them very keen detectors of defects, are so great that they cannot be over-emphasized."

Personal.

Mr. John T. Coleman, Assistant Chief Inspector of our Chicago Department, has been transferred from the main office of that department in Chicago to its branch in Detroit in order that he may have more direct supervision of the Company's inspection service in the territory adjacent to the latter city. The business prosperity of that automobile center is reflected in the increased demand there for our inspection and insurance protection, which service Mr. Coleman's transfer will enable us to afford more promptly and efficiently than heretofore. We are confident that our policy holders in that section will appreciate the advantage of this move.

Mr. Charles W. Zimmer, who has acquired proficiency in Hartford inspection methods and requirements by his service of over twenty years as an inspector of the Company has been promoted to the position of Assistant Chief Inspector and will fill the vacancy in Chicago created by Mr. Coleman's transfer. The ability and zeal for the Company's interests which Mr. Zimmer has shown in his work are thus rewarded in a manner which we believe will be gratifying to the many friends he has made among the patrons of our Company.

Boiler Explosions.

(Including Fractures and Ruptures of Pressure Vessels)
December, 1919, continued.

(473.) — On December 11th a heating boiler exploded at the Home Garage, Arma, Kansas, owned by Mr. Edw. J. May. Mr. May was killed and one other man was injured.

(474.) — A section of a heating boiler cracked at the factory of H. B. Raffel, 36 East Ninth Street, New York City, on December 11th.

(475.) — On December 12th, a boiler exploded at the Home for Aged Women, Cedar Rapids, Iowa.

(476.) — A pipe on the water column of a boiler in the Congregational Church at South Deerfield, Mass., failed on December 12th.

(477.) — One man was killed at the Sioux City, Iowa, Gas & Electric plant when a tube ruptured on December 12th.

(478.) —A tube ruptured, December 13th, at Plant No. 1, Huston Coal & Coke Company, Elkhom, West Va.

(479.) — A heating boiler accident occurred on December 13th, at the Brass Foundry Company, 711 South Adams Street, Chicago, Ill. One man was injured.

(480.) — On December 13th, a boiler exploded at the nursery of E. Enomoto, Redwood City, Calif. One man was injured.

(481.) — Six sections of a heating boiler cracked, December 13th, in the Jefferson School, Butte, Montana.

(482.) — Accidents to the heating boiler in the Simpson Memorial Church, Long Branch, N. J. on December 14th, necessitated the installation of a new boiler.

(483.) — A hot water tank exploded on December 14th, at the home of Mrs. Margaret Kelley, 664 St. Paul Street, Memphis, Tenn. Mrs. Kelley was severely injured.

(484.) — One tube was ruptured and nine others were damaged at the College of Wooster, Wooster, Ohio, on December 15th.

(485.) — An acetylene tank exploded, December 15th, at the Remmert Manufacturing Company's plant, Belleville, Ill. One man was injured.

(486.) — The head of a diffusion tank blew off on December 15th, at the factory of The Chesapeake Pulp & Paper Company, West Point, Va.

(487.) — A tube ruptured, December 15th, in the Union Stock Yards, Section 44, of Armour and Company, Chicago, Ill.

(488.) — A boiler sheet ruptured, December 15th, at the Sibley Electric Light Plant, Sibley, Iowa.

(489.) — Two sections of a heating boiler belonging to Asa C. Isham, Main and Maple Avenues, Norwood, Ohio, cracked on December 15th.

(490.) — On December 15th, a boiler exploded at the Blickham Ice House, Quincy, Ill.

(491.) — On December 16th, the boiler of a locomotive exploded on the B. & O. Railroad at Newcastle, Pa. One man was killed and two were injured.

(492.) — One man and six children were injured on December 16th, when a boiler in the High School at Mountain City, Tenn., exploded.

(493.) — On December 16th, a boiler exploded at the Municipal Golf Links, Seattle, Wash.

(494.) — A section of a heating boiler cracked December 16th, in the office building of W. A. Davis, 101 West Jefferson Street, Syracuse, N. Y.

(495.) — Three sections of a heating boiler in the hotel at 2139-45 Washington Street, Roxbury, Mass., owned by James E. Doherty & Company, cracked on December 17th.

(496.) — A steam separator ruptured, December 17th, at the Rogers-Brown Iron Company, Buffalo, N. Y.

(497.) — A section of a heating boiler cracked, December 17th, at a building at 16 East 18th Street, New York City, owned by Najeeh & Phillip Kaime.

(498.) — Two sections of a heating boiler in the Pittsburgh Plate Glass Company's building at 2406 Albion Street, Toledo, Ohio, were cracked on December 17th.

(499.) — On December 18th, an accident to a heating boiler in the basement at 1009 Arch Street, Philadelphia, Pa., badly damaged the heating plant.

(500.) — Two headers of a boiler cracked, December 18th, in the power plant of the Austin Street Railway Company, Austin, Texas.

(501.) — Five sections of a heating boiler cracked in the apartment house owned by Miss M. W. Knapp, at 96 Plymouth Avenue, Rochester, N. Y., on December 18th.

(502.) — On December 19th, an accident occurred to the heating plant of the Bay View Bottling Company, 11 Hamlin Street, South Boston, Mass.

(503.) — On December 19th, a boiler exploded in the basement of the Penn Beef Company's store, 2550 Germantown Avenue, Philadelphia, Pa.

(504.) — A cast steel fitting at the flour mill of the Marshall Milling Company, Marshall, Minn., ruptured on December 19th.

(505.) — A steam pipe fractured, December 19th, at the mill of the Buckeye Cotton Oil Company, Jackson, Miss.

(506.) — Two sections of a heating boiler cracked December 19th, in the apartment house at 1261-65 Main Street, Hartford, Conn., owned by Saul Berman and Benjamin B. Cion.

(507.) — The head on a boiler at the Valley Paper Company, Holyoke, Mass., cracked on December 19th.

(508.) — A tube ruptured, December 19th, at the plant of the MacSimbar Paper Company, Otsego, Mich.

(509.) — A section of a heating boiler cracked, December 19th, at the plant of the Gotham Can Company, 60 Eagle Street, Brooklyn, N. Y.

(510.) — A section of a heating boiler in the apartment house of Theodore and William D. Dellert, 44 Myrtle Street, Pittsfield, Mass., cracked on December 20th.

(511.) — The furnace of a logging boiler belonging to George Newell, Eureka, California, collapsed on December 20th.

(512.) — A tube ruptured, December 21, at Mill No. 1 of the Monroe Binder Board Company, Monroe, Mich.

(513.) — Two headers in a boiler at the chemical plant of the Diamond Alkali Company, Fairport, Ohio, cracked on December 21st.

(514.) — Two sections of a heating boiler cracked, December 22nd, at the Columbus Sanitarium, Columbus, Ohio.

(515.) — A tube was ruptured and a header fractured at Plant No. 2 of the Ford Motor Company, Highland Park, Mich., on December 22nd.

(516.) — A fire sheet ruptured, December 22nd, in the greenhouse of the E. G. Hill Company, Richmond, Ind.

(517.) — Two sections of a heating boiler cracked in the store and loft building at 73 Canal Street, New York City, owned by Ephriam Siff, on December 24th.

(518.) — A blowoff line failed, December 26th, at the plant of the Erie Dyeing Company, 1842 East 40th Street, Cleveland, Ohio.

(519.) — On December 26th, the boiler of a locomotive on the Canadian Northern R. R. exploded at Bartlett, Minn. Three men were injured.

(520.) — A section of a heating boiler ruptured, December 26th, at the garage of the Service Motor Truck Company, 2617-25 South Wabash Avenue, Chicago, Ill.

(521.) — A blowoff pipe failed at the Red Oak Electric Company's plant, Red Oak, Iowa, on December 26th.

(522.) — The drum of a boiler was ruptured, December 27th, at Washer No. 2 of the Southern Cotton Oil Company, Fort Meade, Fla.

(523.) — A tube ruptured on December 27th, at the No. 1 Works of the Jamison Coal & Coke Company, at Luxor, Pa. Three men were injured.

(524.) — On December 29th, a steam pipe ruptured at the mill of the Mardez Lumber Company, Benford, Texas. Two men were killed.

(525.) — On December 30th, an ammonia tank exploded at the plant of the Fulton Ice & Coal Company, Atlanta, Ga. Three men were injured.

(526.) — Four sections of a heating boiler cracked in the store building of Arthur N. Whittemore, 60 Arlington Street, Worcester, Mass., on December 30th.

(527.) — A tube ruptured, December 31st, at the Cadogan Mine of the Allegheny River Mining Company, at Nicholson Run, Pa.

(528.) — A tube ruptured at the Butler Street Power Plant of the Georgia Railway & Power Company, Atlanta, Ga., on December 31st.

January, 1920.

(1) — Three men were killed and three others seriously injured when a locomotive exploded, January 1st, on the Western Maryland Railroad at Clear Spring, Md.

(2.) — A boiler was damaged by an accident which occurred January 1st, on a log loader belonging to the Hill City Railway Company, at Hill City, Minn.

(3.) — A section of a heating boiler cracked, January 1st, in the Hartford School, Canton, Ohio.

(4.) — On January 2nd, a hot water heater exploded at the home of Leslie Miller, Cedarville, N. J.

(5.) — A flue ruptured, January 2nd, at the plant of the Jacob Dold Packing Company, Wichita, Kansas.

(6.) — One section of a heating boiler cracked, January 2nd, at the Pomfret School, Pomfret, Conn.

(7.) — One man was fatally injured when a tube burst, January 2nd, at the power plant of the Los Angeles Gas and Electric Company, Los Angeles, Calif.

(8.) — A tube failed, January 2nd, at the plant of the American Sheet and Tin Plate Company at New Castle, Penn.

(9.) — Two sections were cracked January 2nd, in the schoolhouse at 8th and Pine Streets, Traverse, Mich.

(10.) — A furnace sheet cracked in a girthwise direction in a boiler at the box factory of the McFerson & Foster Company, Evansville, Ind., on January 3rd.

(11.) — A heating boiler exploded January 4th, at the home of Dr. F. H. Lord of Plano, Ill. Mrs. Lord was fatally injured.

(12.) — Two sections cracked January 4th, in the basement of the United Supply Company store at Gary, W. Va.

(13.) — One man was injured when a tube ruptured January 4th, at the West End Gas Works of the Public Service Corporation, St. Pauls and Duffield Ave., Jersey City, N. J.

(14.) — Six men were injured when a crown sheet ruptured on January 4th at the plant of the Sinclair Gulf Oil Company, Hominy, Okla.

(15.) — A section cracked January 4th, in the apartment house at 1650 California St., San Francisco, Calif., belonging to L. Palmer and M. Stevens.

(16.) — Several tubes were damaged in an accident at the Carnegie Steel Company's plant at Upper Union Mills, Youngstown, Ohio, on January 4th.

(17.) — Accident to a heating boiler at the Graphic Theater, Bangor, Maine, on January 5th, necessitated closing the place until repairs could be made.

(18.) — A tube failed on January 5th, at the Gorge Power Plant of the Northern Ohio Traction and Light Company, Akron, Ohio.

(19.) — A hot water heater cracked January 5th, in the basement of the property of Charles Hirschhorn, 2541 Broadway, New York City.

(20.) — A tube ruptured January 6th, at Plant No. 2 of the Savage Arms Company, Sharon, Penn. Two men were injured.

(21.) — A section of a heating boiler was ruptured January 6th, at the East Ward School, Hastings, Neb.

(22.) — On January 6th, a heating boiler exploded in a garage near the Manhattan bridge on Madison St., New York City. Two men were injured.

(23.) — Two tubes failed January 6th, in the office building of A. R. Buell, Lorain, Ohio.

(24.) — A section of a heating boiler cracked January 6th, in the packing house of Kingan and Company at Jacksonville, Fla.

(25.) — Two tubes failed at the factory of the Wescott Motor Car Company, Springfield, Ohio, on January 6th.

(26.) — A collar brace failed January 6th, in the Ottawa Street Station of the City of Lansing, Lansing, Mich.

(27.) — Three sections of a heating boiler cracked at the Prevocational School, New Britain, Conn., on January 7th.

(28.) — On January 8th, a locomotive exploded at the Chesapeake and Ohio yards at Silver Grove, Ky. One man was injured.

(29.) — A rupture occurred in a boiler at the power plant of the Brush Light and Power Company, Brush, Colo., on January 8th.

(30.) — A blowoff pipe ruptured January 8th, in the factory of the F. J. Lewis Mfg. Company, 130 Second St., Moline, Ill.

(31.) — A tube ruptured January 8th, at the factory of the Kansas City Packing Box Factory, Adams and Wyoming Street, Kansas City, Kan.

(32.) — Four sections of a heating boiler at the New Grade School No. 2, Chassell, Mich., cracked on January 9th.

(33.) — Seven sections were found cracked on January 9th, at the cigar factory of Otto Eisenlohr and Brothers, Liberty and Ross Streets, Lancaster, Pa.

(34.) — Five sections of a heating boiler cracked January 10th, in the building at 1007-11 Market St., Philadelphia, Pa., owned by the estate of John Dobson.

(35.) — A tube ruptured January 10th at the National Metal Moulding Company's plant, Economy, Penn.

(36.) — A section ruptured January 11th, at the Children's Cottage of the Michigan State Sanitarium, Howell, Mich.

(37.) — Two sections of a heating boiler were found cracked January 12th, at the Franklin School, Creston, Ohio.

(38.) — A tube burst January 12th, at the cotton mill of the Arkwright Mills, Spartansburg, S. C.

(39.) — Two sections cracked January 12th, at the plant of W. D. Allen and Company, 5630-46 West 12th St., Chicago, Ill.

(40.) — A firebox section of a heating boiler cracked January 13th, at the garage of the U. S. Motor Sales Company, 621 First St., South Boston, Mass.

(41.) — A section of a heating boiler cracked on January 13th, in the apartment house of Peter and Andrew Bertelson, 1480 Larkin St., San Francisco, Calif.

(42.) — A section of a boiler cracked January 14th, at the bakery of the Consumers Baking Company, 76 Ferry St., Springfield, Mass.

(43.) — A section of a boiler cracked at the Old Burritt Public School, New Britain, Conn., on January 15th.

(44.) — On the 15th of January a hot water heating boiler exploded at the residence of Samuel Brownlie, near Hinsdale, Ill. The house was badly damaged, the property loss amounting to about $1,500.

(45.) — On January 16th a boiler exploded in a cooper mill at Fish, Mo., causing the death of Daniel E. Gunn.

(46.) — A heating boiler exploded on January 16th, at the residence of V. B. Huff, 72 North Main St., Geneva, N. Y.

(47.) — On January 16th, a locomotive exploded on the Galesburg and Ottumwa Division of the C., B. & Q. R. R. One man was killed.

(48.) — Two sections of a heating boiler were found to be cracked at the Franklin School, Creston, Iowa, on January 16th.

(49.) — On January 17th, a locomotive exploded near Horseheads, New York. The fireman was killed and the engineer was injured.

(50.) — A tube failed at the Gorge Power Plant of the Northern Ohio Traction and Light Company, Akron, Ohio, on January 17th.

(51.) — Two sections of a heating boiler cracked January 17th, at the main plant of the Western Printing and Lithographing Company, Racine, Wis.

(52.) — One tube was ruptured and two headers were cracked in an accident on January 17th, at the Nekoosa Edwards Paper Company, Nekoosa, Wis.

(53.) — One section of a heating boiler cracked January 17th, in a building at Broadway and Ferry Streets, Everett, Mass., owned by Sara A. Green.

(54.) — A tube in the power plant of the United Public Service Company, Rochester, Ind., ruptured on January 17th. One man was injured.

(55.) — Five sections of a heating boiler cracked January 18th, at the Buckland Building, Main Street, Woonsocket, R. I.

(56.) — A boiler in a greenhouse at Willow Grove, Pa., exploded on January 19th, and caused severe injury to one man.

(57.) — On January 19th, a locomotive exploded near Danville, Iowa. Three men were killed.

(58.) — On January 19th, a boiler exploded at the plant of the Interstate Iron and Steel Company at East Chicago, Indiana. Three men were killed and several others injured.

(59.) — Two men were injured when a fitting on a blowoff pipe failed January 9th, at the hat factory of the Hoyt Messinger Corporation, Danbury, Conn.

(60.) — A section cracked January 19th, at the property at 128 Southbridge St., Worcester, Mass., belonging to the R. C. Taylor Estate.

(61.) — A heating boiler exploded January 20th, in the garage of the Jewel Tea Company, Syracuse, N. Y.

(62.) — One man was injured when a tube failed January 20th, at the plant of the Nestle Food Company, South Dayton, N. Y.

(63.) — A blowoff pipe failed January 29th, in the office building of the Davidson Realty Company, 6th and Pierce Streets, Sioux City, Iowa.

(64.) — Two sections ruptured January 20th, in the office of the American Telephone and Telegraph Company, 21 Fifth St., Waterloo, Iowa.

(65.) — Two sections of a heating boiler cracked January 20th, at the apartment house of T. F. and A. K. Morrissey, 55 Imlay St., Hartford, Conn.

(66.) — On January 21st, a boiler exploded at the Alliance Dyeing Works, 80 East 13th Street, Paterson, N. J.

(67.) — One man was injured when a gauge glass broke January 21st, at the Fisk Street Station of the Commonwealth Edison Company, Chicago, Ill.

(68.) — Twenty-two sections were cracked at the garage of the Elton Motor Company, Youngstown, Ohio, on January 21st.

(69.) — A rupture occurred in the boiler at the plant of the Reliable Laundry & Dry Cleaning Company, 10th and Monroe Sts., Toledo, Ohio, on January 21st.

(70.) — A fire sheet ruptured in the power plant of the Home Lawn Mineral Spring Company, Martinsville, Ind., on January 21st.

(71.) — Five sections cracked January 23rd, at the Buckland Building, Main St., Woonsocket, R. I. This is a separate and distinct accident from No. 55 on January 18.

(72.) — Two sections were ruptured on January 24th, in the Public Library at Alliance, Neb.

(73.) — Nine headers cracked in the boiler room of the Philip Carey Mfg. Company, Lockland, Ohio, on January 24th.

(74.) — A tube ruptured in the hospital of the Sisters of Charity, Clifton and Dixmyth St., Cincinnati, Ohio, on January 24th.

(75.) — A water heater exploded, January 26th, at the home of M. L. Levitt, 1303 Northeast Boulevard, Philadelphia, Pa.

(76.) — On January 26th, a dye vat exploded at the plant of the General Processing Company, Collins & Willard Sts., Philadelphia, Pa. Two persons were injured.

(77.) — A section of a heating boiler cracked in the basement of the Manhattan Market Company, 594-600 Mass. Ave., Cambridge, Mass., on January 26th.

(78.) — One man was injured when a tube failed, January 26th, at the Alfred University, Alfred, N. Y.

(79.) — A tube burst January 26th, in the Augustine Mill of the Jessup and Moore Paper Company, Wilmington, Del.

(80.) — A fire sheet ruptured in the Adams Laundry, 1813 California Street, Omaha, Neb., on January 27th.

(81.) — Three sections were ruptured on January 28th, in the High School at Florence, Wis.

(82.) — On January 30th, a boiler exploded at Love's shingle mill, twelve miles south of Graceville, Fla. One man was killed and one injured.

(83.) — One man was killed when a tube burst, January 30th, at the plant of the New Albany Compress Company, New Albany, Miss.

(84.) — A tube burst at the power plant of the American Gas and Electric Company, Atlantic City, N. J., on January 31st.

(85.) — Six headers were cracked at the plant of the J. C. Ayer Company, Market Street, Lowell, Mass., on January 31st.

(86.) — On January 31st, a boiler exploded at the plant of the General Petroleum Company, Olinda, Calif. One man was killed.

February, 1920.

(87.) — A fire sheet bulged and ruptured at Fiske University, Nashville, Tenn., on February 1st.

(88.) — In an accident to a boiler at the Alfred University, Alfred, N. Y., on February 1st, one man was badly injured.

(89.) — On February 2nd, the water back in a kitchen range exploded at the home of Raymond Rich, Chester, Pa. Four persons were injured, one, a two year old child, seriously.

(90.) — One man was killed when a blowoff pipe failed, February 2nd, at the boiler house of the National Stove Co., Lorain, Ohio.

(91.) — Two sections of a heating boiler cracked, February 2nd, at the plant of the Fleischman Malting Co., Buffalo, N. Y.

(92.) — A section of a heating boiler belonging to Ralph Shulman, 312 South Warren St., Syracuse, N. Y., cracked on February 3rd.

(93.) — A fire sheet ruptured at the plant of the F. J. Lewis Mfg. Co., 2505 South Robey St., Chicago, Ill., on February 2nd.

(94.) — A section of a heating boiler cracked, February 3rd, at the office building of Jacob Horowitz, No. 9 Trumbull St., Worcester, Mass.

(95.) — Four sections of a heating boiler cracked, February 3rd, at the Rialto Theater, 404 E. Main St., East Rochester, N. Y.

(96.) — A tube failed at the Fritz Bros. Garage, Ripley, Ohio, on February 3rd.

(97.) — A fire sheet bulged and ruptured on February 3rd, at the power plant of the Williamstown Illuminating Co., Williamstown, Mich.

(98.) — On February 4th, a boiler exploded at the plant of the Albany Tanking Co., Albany, Ind. One man was injured.

(99.) — Three headers cracked, February 6th, at the plant of the American Steel & Wire Co., Waukegan, Ill.

(100.) — On February 6th, a boiler exploded at the plant of the Hayes Ionia Co., Grand Rapids, Mich. One man was killed and two others injured.

(101.) — On February 6th, a heating boiler exploded at the residence of E. McCormic, Ashley & Sigourney Sts., Hartford, Conn. The boiler was completely demolished and considerable damage done to the property.

(102.) — On February 7th, the boiler of a locomotive on the Western Maryland R. R. exploded at Clear Spring, Md. Three men were killed and three others injured.

(103.) — On February 8th a heating boiler exploded at the home of James Heinlein, Beach Cliff Road, Coraopolis Heights, Penna. Mrs. Heinlein was injured by a flying fragment of the boiler and died a few hours later.

(104.) — On February 8th, a compressed air tank exploded at the Midvale Steel Works, Philadelphia, Pa. One man was fatally injured.

(105.) — On February 9th, a boiler exploded at the Broad River sawmill near Black Mountain, N. C. Two men were killed and two others injured.

(106.) — On February 10th a vulcanizer exploded at the Five Points Automobile Co's garage, Durham, N. C. The explosion shattered the plate glass window in the front of the building and severely injured a school girl who was passing at the time. A man who was nearby also was injured.

(107.) — On February 10th, a boiler exploded at a sawmill near Chavies, Alabama. Two men were instantly killed. The mill was wrecked by the force of the explosion.

(108.) — Four sections of a heating boiler cracked, February 10th, at the nurseries of the Kemble Floral Co., Chariton, Iowa. The accident necessitated the installation of a new boiler.

(109.) — Four sections of a heating boiler belonging to the World Realty Co., 15th & Douglas Sts., Omaha, Neb., ruptured on February 11th.

(110.) — A valve body burst at the Nicetown (Phila.) Works of the Midvale Steel & Ordnance Works on February 11th. One man was killed.

(111.) — A tube ruptured, February 12th, at the plant of the Nichols Copper Co., Laurel Hill, Newton, Long Island, N. Y.

(112.) — A tube burst at the flour mill of the Schultz-Baujan Co., Beardstown, Ill., on February 12th. One man was injured and the property damage amounted to over $2,500.

(113.) — A section of a heating boiler belonging to L. Sinsheimer, 714 Broadway, New York City, cracked on February 13th.

(114.) — On February 13th, a boiler exploded at the plant of the Mason City Brick & Tile Co., Mason City, Iowa. One man was fatally injured.

(115.) — On February 13th, a locomotive exploded at Bend, Oregon, injuring four men. The locomotive was the property of the Brooks Scanlon Lumber Co. Damages exceeded $5,000.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1920.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks	$390,221.07
Real Estate	90,000.00
Mortgage and collateral loans	1,426,250.00
Bonds and stocks	5,702,983.62
Premiums in course of collection	597,171.35
Interest accrued	107,590.44
Total assets	$8,314,216.48

LIABILITIES.

Reserve for unearned premiums		$3,715,903.48
Reserve for losses		175,539.16
Reserve for taxes and other contingencies		401,420.50
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,021,353.34	
Surplus to Policy-holders		**$4,021,353 34**
Total liabilities		$8,314,216.48

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FRANCIS B. ALLEN, Vice-President. W. R. C. CORSON, Secretary.

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E. SIDNEY BERRY, Assistant Secretary.

S. F. JETER, Chief Engineer.

H. E. HART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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Incorporated 1866. Charter Perpetual.

INSURES AGAINST LOSS FROM DAMAGE TO PROPERTY AND PERSONS, DUE TO BOILER OR FLYWHEEL EXPLOSIONS AND ENGINE BREAKAGE

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BALTIMORE, Md., 13-14-15 Abell Bldg.	LAWFORD & MCKIM, General Agents. JAMES G. REID, Chief Inspector.
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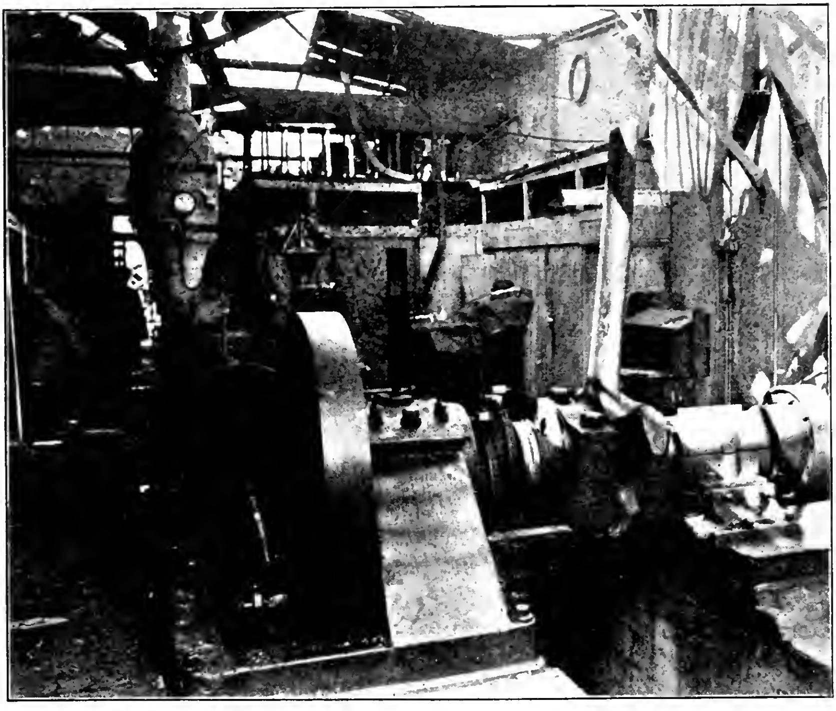
TORONTO, Canada. Continental Life Bldg.	H. N. ROBERTS, President Boiler Inspection and Insurance Company of Canada.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIII. HARTFORD, CONN., JANUARY, 1921. No. 5.



FLYWHEEL EXPLOSION AT STUTTGART, ARKANSAS.

Flywheel Explosion at Lancaster, South Carolina.

Two Recent Flywheel Accidents.

THO we give it little thought, the old, old story, "— a kingdom was lost, all for the want of a horseshoe nail," is illustrated time and again in our daily life. Rather striking demonstrations of the time worn allegory were given recently by two flywheel accidents — the one at Stuttgart, Arkansas, which is illustrated on the front cover of this issue, and the other at Lancaster, South Carolina, from which the view above is taken.

The accident at the Stuttgart plant occurred on November 8th, 1920. The engineer, who was standing near the boiler room door, said he thought he noticed the engine speeding up and he started for the throttle to close it but before he reached the valve the flywheel burst. The flying parts of the rim and spokes went through the roof, which was completely demolished, and most of them landed on the ground outside. One large piece of the wheel, however, dropped through the roof of the pump room, broke a large gear wheel on a feed pump, and ruptured several large pipes so that it was necessary to shut off the city water supply. This left the plant without any water for the boilers and it was nearly two days before the damage to the water line was repaired and the boilers were put back into service. A large amount of shafting and electric wiring was also damaged.

On November 25th, an engine at Lancaster, South Carolina, started to overspeed while no one was in the engine room. Two men made an effort to reach the throttle and stop the engine before any damage was done but they were not quick enough and the flywheel burst. Part of the wheel ripped through the roof of the plant and seriously damaged the roof and porch of a house nearby. Other sections of the wheel were thrown in various directions damaging much of the plant equipment.

Both of these engines were of the Corliss type and overspeeding resulted from breakage of parts of the valve gear. To clearly describe the causes of the accidents reference will be had to some sketches of the typical Corliss valve gear. Fig. 1 shows the parts of this gear that are intimately related to and operate the steam admission valve for the head end of the cylinder. A similar arrangement is used at the crank end of the cylinder. In this sketch A is the end of the valve-stem, which passes through the other parts of the gear and into the cylinder where it is attached to the cylindrical Corliss valve. The valve is actuated by the oscillation of this valve-stem. Part B is the steam-arm and, as will be seen, is secured to the valve-stem by a key. The rod C, attached to the steam-arm, is drawn down to the position shown in the sketch by a dash-pot on its lower end which is not illustrated here. In the position shown, the steam-valve is closed. The double-arm D is machined to a running fit on the valve-stem and has two arms — one extending to the left and carrying the steam-hook E and the other extending to the right and having attached to it the steam-valve-rod F. This steam-valve-rod is attached, through a series of levers, to the eccentric of the engine and is given a reciprocating motion which changes to an oscillating

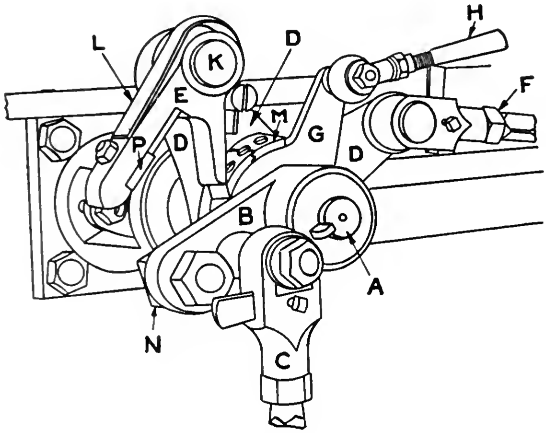


Fig. 1.

motion in the **double-arm**. The **knock-off-lever** G is also machined to a running fit on the **valve-stem** and is controlled by the **governor-rod** H. The governor shifts the position of this **knock-off-lever** by rotating it about the center of the **valve-stem** but for any given load the position of this lever will be stationary.

The **steam-hook** E is carried by the **double-arm** to which it is fastened by the **pin** K although motion is permitted between the pin and the hook. A **spring** L is fastened at one end to the **double-arm** and at the other end exerts a pressure which tends to rotate the **steam-hook** in a counter clockwise direction. The **steam-hook** is prevented from turning, however, in the position shown, because the end of its short leg is bearing against the **knock-off-cam** M which is fastened to the **knock-off-lever** G.

Starting from the position shown the operation of the engine would be as follows: The **double-arm** will rock counter-clockwise so that the **steam-hook** will be moved downward. This will remove the **steam-hook** from the control of the **knock-off-cam** and the **steam-hook** will make a slight counter-clockwise rotation until stopped by the end of the short leg coming in contact with the circular part or body of the **knock-off-arm**. At the outer end and on the far side of the **valve-arm** will be seen the end of a rectangular block N which is secured to the arm. As the **steam-hook** swings down it will pass over this rectangular block and when the **steam-hook** has moved far enough the upper edge of the block P will snap under the lower edge of the block N. Soon after this occurs, the **double-arm** will begin to move in the opposite or clockwise direction and by the interlocking of the two blocks N and P the **steam-arm** will be lifted and the **valve-stem** and the **valve** will, in turn, be rotated to admit steam to the cylinder. This rotation of the **valve-stem** by the **steam-hook** and **double-arm** will continue until the point is reached where the short leg of the **steam-hook** strikes the **knock-off-cam**. This will rotate the **steam-hook** about its pivot K, the **valve-arm** will be released and the **dash-pot** will pull the valve shut. The governor, by altering the position of the **knock-off-arm**, will change the time of cut-off and will thereby control the speed of the engine.

It should be noted that in order to have the valve **gear** under the control of the governor the **steam-hook** must be tripped by the **knock-off-cam** before the **double-arm** begins its return or counter-clockwise motion. If tripping does not occur by that time it will not occur at all and the **steam-valve** will not close until late in the stroke of the engine — in fact, it will be very nearly full stroke before cut-off occurs. For the reasons given above it is necessary, in an engine with a single eccentric, that cut-off occur no later than about half stroke of the engine. The valve gear is therefore provided with an additional safety-cam, not visible in this sketch, on the cam-arm, that prevents the steam-hook picking up the valve-arm should the governor shift the cam-arm to the position of an extremely late cut-off. It should be noted that this safety-cam comes into play only when the governor is running slowly, either from breaking of the governor belt or an overload on the engine.

In the accident at Lancaster, the knock-off-cam, which is a hardened block secured to the cam-arm, usually by three screws, cracked through the middle screw hole as indicated in Fig. 1 and the lower half dropped off. The effect was as though no knock-off-cam were present and the load at the time was such that the engine overspeeded even though the governor shifted the cam-lever to an early cut-off position and in fact effected an early cut-off in the crank end of the cylinder.

In the accident at Stuttgart the governor-rod broke near the end throwing the cam-arm out of the control of the governor. The cam-arm then rotated with the valve-stem so that the steam-hook, not being tripped by the knock-off-cam, held on to the steam-arm and caused the engine to take steam for practically full stroke on the head end. The load was such that any governing of cut-off on the crank end of the engine was of no avail and the flywheel overspeeded and burst.

It would be difficult to say where the blame, if there is any, for these accidents should be placed. Mechanisms will wear out and breakage will occur, even in the best designs and when given the best of care. The safety of an engine depends upon the correct operation of a number of relatively small and often rather inaccessible parts — but even so, they are highly important parts. And the loss of a relatively unimportant horseshoe nail brought disaster to a horse, his rider and the kingdom.

Excessive Water as the Cause of Engine Breakage.

OF all the causes of accidental injury to steam engines, the presence of an extraordinary amount of water in the cylinders is one of the most prevalent. After the exhaust valve closes, this water, forced by the piston into the space remaining in the cylinder, has no ready means of escape. If the clearance space is quite large and the engine is running very slowly, there is a possibility of no damage resulting. If the water is sufficient to more than fill the clearance space, however, an irresistible pressure will be produced and something must give way to relieve it.

All engines are, or should be, provided with cylinder drains or drips, one at the throttle valve and one in each end of the cylinder, for the purpose of removing the water of condensation when starting. Ordinarily these drips are closed by means of a plain globe or angle valve, though in many cases the cylinder drips are fitted with spring loaded relief valves which may be opened also by hand. The principal safeguard that such spring loaded valves may afford is in the relieving of unduly high steam pressure. Contrary to a somewhat prevalent belief, valves of this type are of little or no use for draining the cylinder should water in any appreciable amount enter through either the steam or exhaust pipe while the engine is running. Water, at rest or when set in motion, has considerable inertia. When the piston drives a volume of water before it in its stroke, the water is flowing in lines parallel to the axis of the cylinder and a considerable force is required to turn it from this direction of flow. To expect it to make a sudden, right-angled turn and to converge all its lines of flow into a relatively small drain pipe is not reasonable. Even a relief valve in the center of the cylinder head would be wholly inadequate in a case of this kind.

Probably the most frequent result of excessive water in the engine cylinder is that the cylinder head is blown off. The head itself may be broken, the thread on the cylinder head studs may strip, or the studs or bolts themselves may pull apart, and not unfrequently the wreck may involve failure of all of these parts. Sometimes the cylinder itself may be cracked or badly broken and there are numerous instances of the excessive pressure having driven the piston on or off the piston rod. The cylinder and piston construction may be strong enough to withstand the shock and to transmit the force developed to other parts of the engine so that a piston rod may be broken or bent, a crosshead may fail, the connecting rod may be damaged, or the force may be transmitted still further to the crank and shaft of the engine so that these parts may suffer serious injury. Sometimes the shock is so great that the engine is a complete wreck. Water in an engine cylinder is, in fact, so serious a matter that every precaution should be taken to remove the possibility of its presence.

When the boiler feed water contains foreign substances in sufficient amount to cause excessive foaming and priming, there is great danger of water being carried over to the engines in amounts sufficiently large to cause damage. If the engine is some distance from the boiler and the steam pipe is exposed, there is also the possibility of excessive condensation taking place so that the engine may sometime receive a "dose" of water sufficiently large to wreck it. It is best, under any condition, to provide a separator in the steam line, which should be connected close to the engine throttle, not only for the purpose of removing excessive amounts of water but also for the extraction of small amounts of moisture in the steam. It is always in the interest of economy to supply the engine with as dry steam as possible.

The function of the steam separator is to separate the liquid from the vapor in the steam pipe but after this has been accomplished some means must be provided to drain the separator of the water. To do this a drain pipe is provided to conduct the water to a steam trap which will discharge the water but not the steam to the atmosphere. It is best to have as short and as direct a drain pipe as possible from the separator to the trap and numerous fittings and valves are to be avoided. If a valve is installed in the drain between the separator and the trap, it should be locked or sealed open. Steam traps, at times, will become inoperative from some cause and if such a condition prevails the separator, of course, is deprived of a drain so that it will accumulate water and will thereby become valueless and even dangerous. The steam trap, therefore, should be carefully watched and inspected to make sure that it is, at all times, in perfect working order.

There have been many cases of engine wreckage from water taken into the cylinder from the exhaust piping. When a cold engine is started the throttle valve is opened, of course, only a slight amount and there is the possibility of a vacuum forming by rapid condensation of the steam in the engine cylinder so that if, by chance, any water be present in the exhaust line there is great likelihood of its being drawn into the engine cylinder. Then, when the engine turns over, the water is trapped in the cylinder and is the cause of damage. To guard against the possibility of wreckage from the cause just mentioned precautions should be taken to prevent the accumulation of water in the exhaust pipe. From the standpoint of ease of removal of the water the best way would be to have the exhaust pipe so installed that it will act as its own drain, the water running by gravity to the open end of the pipe. In the great majority of cases, however, the exhaust pipe, before reaching an open end, rises above the engine cylinder so that a pocket is formed in which water may very readily accumulate. Such lines should be equipped with ample size drain pipes located at the lowest points of the exhaust pipe and the installation of these lines should be carefully studied to see that they are drains in fact and not additional pockets in the system.

When a cold engine is to be put into operation it is necessary that certain precautions be observed before it is set in motion. If the steam be admitted to the engine too rapidly, severe expansion stresses will be set up in the engine parts which might lead to cracking of the cylinders. Furthermore, when steam is first admitted to a cold engine, and until the machine becomes warmed, rapid condensation will take place with consequent formation of a sufficient amount of water to give rise, should the engine turn over before this condensation ceases or the water is removed, to a greater or less degree of shock. It is therefore quite essential that any steam engine, before it is started, be brought up to temperature slowly and gradually. The length of time required for this is naturally a factor depending entirely on the size of the engine.

With Corliss engines, or with any other type in which the valve gear can be operated by hand, the cylinder is readily warmed by "cracking" the throttle a little and turning, alternately, the steam valves at the head and at the crank end to the open position. The valves of some engines cannot be operated independently by hand and with these it is necessary to bar the engine over from time to time during the process of warming so that both ends of the cylinder may be heated at as nearly a uniform rate as is possible. It is hardly necessary to call attention to the necessity of closing the throttle before attempting to turn the engine over. These methods of warming the engine cylinder preparatory to starting are, of course, the necessary steps for a simple engine or the high pressure cylinder of a multiple expansion engine. In the case of a compound engine it is well to warm the receiver and low pressure cylinder by means of the high pressure steam bypass to these parts, when such bypass exists, or by turning the engine over several times by hand to permit the steam from the high pressure cylinder to flow on through the engine. By thus thoroughly warming the engine before starting the danger of producing a vacuum in the engine cylinder and thereby drawing any water from the exhaust pipe into the cylinder will be greatly reduced.

When shutting down an engine, there is a condition produced which makes the entrance of water into the engine cylinder from the exhaust pipe, should it be present there at such time in sufficient quantity, an almost absolute certainty. In order to understand how this condition is produced, reference will be had to some indicator diagrams. Fig. 1 shows a typical card or diagram for an average engine under load. The steam valve opens

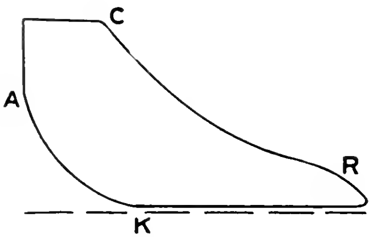


Fig. 1.

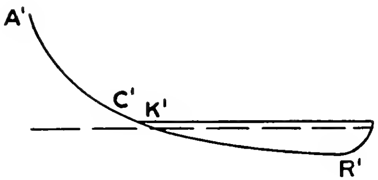


Fig. 2.

for the admission of steam at A and closes or cuts-off at C. The exhaust valve opens or releases at R and closes for compression of the steam remaining in the cylinder at K. Suppose now that the throttle of the engine is closed to stop the engine. On the next revolution, when the piston arrives at the point in its stroke indicated by K, there still will be some steam left in the cylinder and this steam will be compressed along the line K′ A′ of Fig. 2. When the piston starts in the opposite direction this steam will re-expand. At the point A′ the steam valve opens and the indicator diagram is therefore dealing with a greater volume of steam (the volume in the cylinder plus the volume in the steam chest made available by the opening of the admission valve) so that it is difficult to say just what line this re-expansion will follow. However, since the volume is increasing by the forward motion of the piston and since the steam is condensing somewhat, it is certain that the pressure will fall and it will be fairly accurate for the purpose of this discussion to say that it follows back along the line A′ K′. After the piston reaches the point in its stroke where the steam valve closes, or about at C′, the steam in the cylinder will continue to expand so that the pressure will drop considerably below atmospheric. We thus have a rather low cylinder pressure when the piston reaches the point where the exhaust valve opens. If a considerable quantity of water has accumulated in the exhaust pipe from any such cause as, for instance, the premature stopping of the pump of a jet condenser, this water may readily be drawn up with a rush into the engine cylinder. This rising of water into the cylinder in an attempt to equalize the cylinder pressure with that of the atmosphere results in the upward curve of the indicator card at the point R′.

When the engine makes the return stroke with the exhaust valve open, the water is carried ahead of the piston into the end of the cylinder. Some of it, of course, will return to the exhaust pipe, but some of it is sure to remain in the cylinder. When the water was drawn into the cylinder there were forces acting in a very positive direction to move it. After it enters the cylinder these forces are not so definite in their direction and the inevitable result will be that considerable water will be trapped in the cylinder after the exhaust-valve closes. With the engine still turning over at close to its normal speed and with no escape for the water, the result is obvious.

With condenser operation, it is rather common practice to install an automatic device on the condenser for the purpose of "breaking" the vacuum should the condensing water rise into the exhaust pipe. These vacuum breakers consist, quite frequently, of a float inside the condenser which, when the water rises, opens a valve to admit air to the condenser above the water level so that the further influx of injection water is prevented. This principle of breaking the vacuum is entirely correct but accidents have occurred from the float becoming water logged or from sticking of the valve. If the air is not admitted in sufficient quantity to break the vacuum before the water reaches the level where the air is admitted, the danger is accentuated, for if the water passes the point of air admission the air, when it does enter, will mix with the rising column of water, which will thereby have its specific volume greatly decreased, and it will be possible for the mixture to rise to a higher level than could the liquid alone. In order to avoid the condition just mentioned, it is well to admit the air as close as possible to the engine itself and to use a vacuum breaker that is reasonably positive in its action.

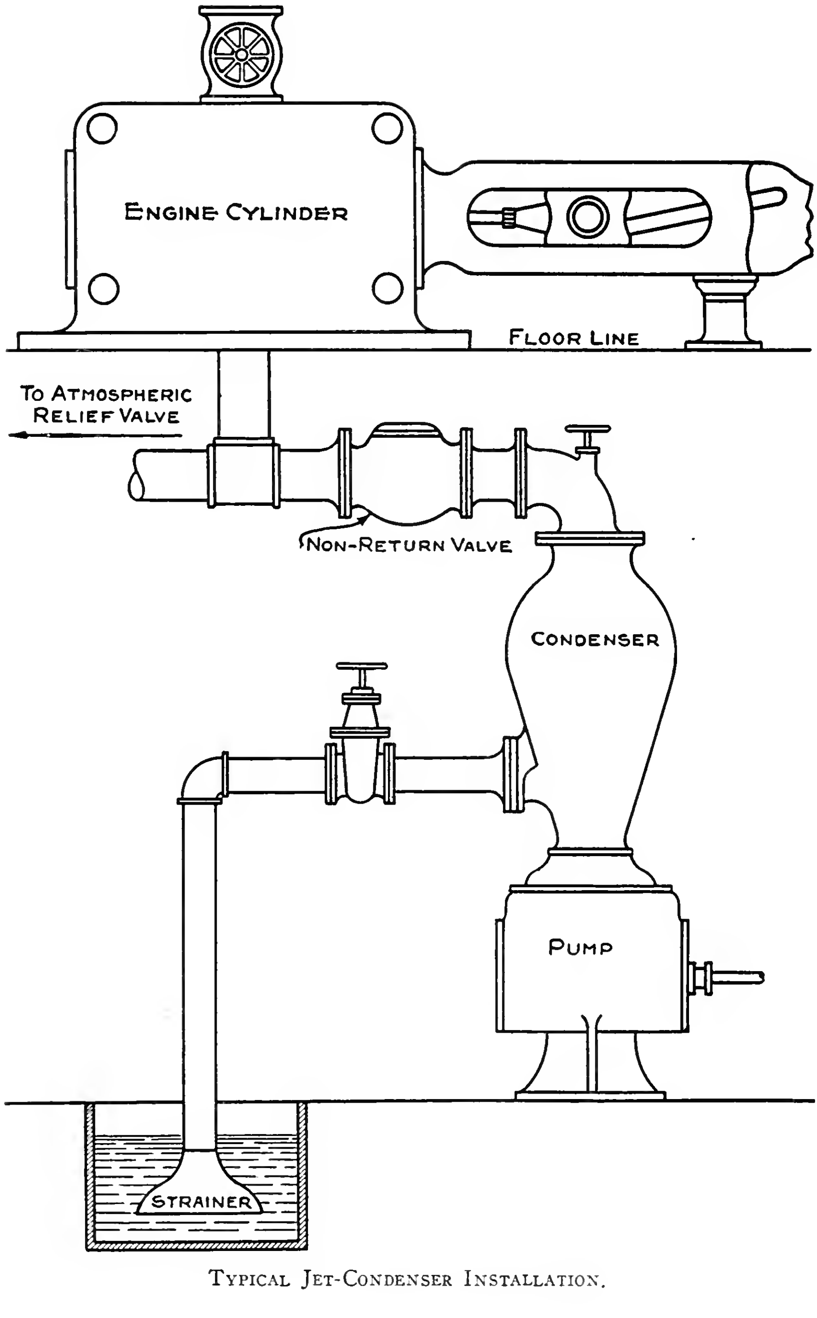
A condition that is sometimes encountered and one that is extremely dangerous is that in which the injection water to the condenser is supplied under a pressure head. With this condition it is possible for the water to flow into the engine cylinder while the engine is at rest so that the machine may be wrecked upon starting up. The water should always be drawn up to the condenser by the vacuum or else the head under which it flows to the condenser should be so small that, with the vacuum removed, the water would not rise to a point dangerously near the engine.

There may be cases in which the water is supplied the condenser from a pond, the level of which at the time of observation or inspection may not be dangerous but which may at times be subject to a large fluctuation from causes such as a heavy rainfall or rising tides and an unsafe condition may thereby be produced.

A very good preventive against the entry of water from the exhaust side of the engine is some form of non-return valve which will close when the water flows toward the cylinder. Such an installation is illustrated on page 140. It is always best, of course, to have an atmospheric relief valve in the exhaust line to prevent excessive pressures building up in the low pressure cylinder of a multiple expansion engine and also, of course, to prevent immediate shut-down should the condenser equipment cease to operate. The connection for this relief valve should be between the engine and the non-return valve as indicated in the illustration.

Not only jet but also surface condensers may give trouble if the latter type is so connected that the steam enters the condenser shell at the bottom. This method of piping is sometimes used when there is no basement under the engine and the condenser is placed on a level with the engine cylinder. If the condensate pump stops accidentally, the exhaust pipe will accumulate water from the condensing steam and at the time that the engine is being shut down this water may return to the cylinder to cause damage as explained in the foregoing.

Still another source from which water may enter an engine cylinder is the receiver on a compound engine. Engines of this type are sometimes constructed with a valve gear giving a fixed



TYPICAL JET-CONDENSER INSTALLATION.

cut-off to the low-pressure cylinder and are governed by a variable cut-off in the high-pressure cylinder. With a very early cut-off in the high-pressure cylinder the low-pressure cylinder acts as a pump, drawing the steam from the receiver, and this action may continue to the point where the pressure in the receiver will be lower than atmospheric. This is particularly true of an engine operating condensing. The receivers of compound engines are, of course, or at least should be, fitted with drain traps but as these are sometimes operative only when there is a pressure in the receiver greater than atmospheric the condition outlined above will cause such a trap to cease its functioning. Inasmuch as continued operation under these conditions must result in the accumulation of condensation in the receiver, it is not long before the low pressure cylinder receives a harmful " dose " of water. Of course, the proper apparatus to use for the draining of engine receivers is a special form of trap which will operate under vacuum or pressure so that some means of removing the water in provided under all conditions.

From what has been said above it is evident that there are a number of ways and reasons for the entry of water into an engine cylinder. All of these hazards may be mitigated by the use of the proper apparatus but it must never be forgotten that such safeguards as are installed must be subjected to the most rigid inspection as to the construction and method of installation and that careful watching is needed at all times to obtain dependable service.

With Reference to the Changing of Old Lap Seam Boilers to a Butt Seam Construction.

NOT long after the steam boiler came into general use in America, considerable discussion was aroused with respect to the question of limiting the life of a boiler. Numerous instances of serious accident, which it seemed impossible to account for, had impressed many with the idea that a boiler, like any other piece of apparatus, was subject to deterioration from constant use and that therefore it would be best to take a boiler out of service after a certain period. In fact, a number of concerns followed this practice. The majority of boiler users and engineers, however, felt then as they do now that rigid inspection would safeguard their boiler plants and would furthermore be of greater service in the interest of economy, for it was admitted that many boilers had served for twice the life that, by some, had been allowed for safety.

The plan of relying on inspection for a forewarning was adopted and served well but there were a number of unaccountable explosions in boilers of relatively short life. At the time, the majority of boilers in use were constructed with a longitudinal lap joint. A series of investigations was conducted to study the stress conditions in this type of joint and it was found that the construction, both from its fundamental shape and the conditions of manufacture, presented a most dangerous condition.

In The Locomotive for April 1905 there appeared an account of the disastrous boiler explosion at Brockton, Mass., on March 20, 1905, and also an article on the "Lap-joint Crack" to which type of defect the explosion was said to be due. For the sake of clearness we shall present here some of the more important points which were brought out in the last named article.

When a boiler plate is rolled to a cylindrical form, the edges of the plate, in passing through the rolls, are not gripped as effectively as is the middle of the plate so that the ends are left somewhat flat. The condition produced is illustrated in Fig. 1. This necessitates the plates being forced together at the edges and this produces an added stress that persists unless relieved

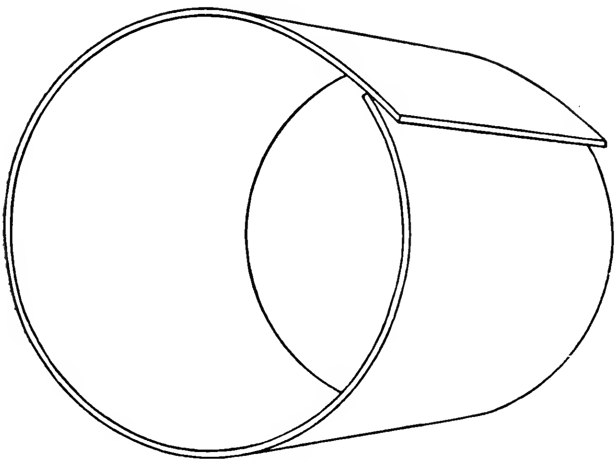


Fig. 1.

by annealing. In addition to this the plates, if bent after punching, will bend along a line of rivet holes as shown in Fig 2 in somewhat exaggerated form.

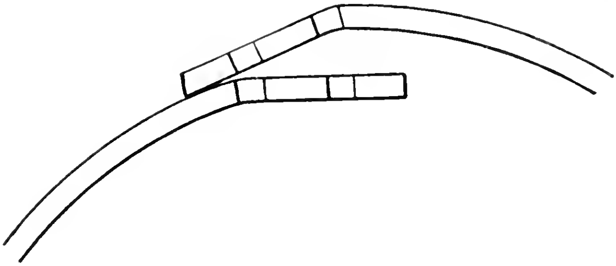


FIG. 2.

The elementary lap joint is illustrated in Fig. 3. If tension is applied as indicated in Fig. 4, the plates, in an attempt to align themselves with the load, will bend along a line running under the outer edge of the rivet heads.

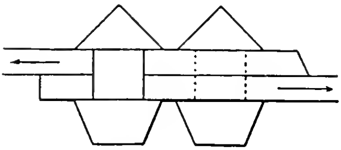


FIG. 3.

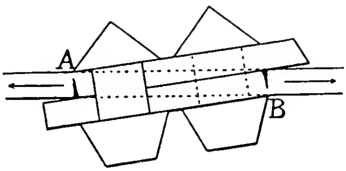


FIG. 4.

The combined effect of all these conditions, together with the constant bending of these joints by changes of pressure when in use, is to impose excessive stresses in the surface of the boiler plate along the line just mentioned. This has produced, in many boilers, a crack which starts always from the inside or covered surface of the inside or the outside plate of the joint as indicated at A and B in Fig. 4. This crack may eventually work its way through the plate until it shows itself by leakage. But in many cases it may develop for some distance along the joint and yet remain absolutely invisible. Eventually the weakness may develop to the point of complete failure and a disastrous explosion.

Inspection is generally accepted as being safe for the determination of the fitness of a boiler for use. The lap seam crack, however, is invisible to all methods of inspection, except cutting out the rivets and separating the plates or the method described in The Locomotive for October 1914. Recognizing the insidious danger presented in the lap joint for longitudinal seams in boilers, the Boiler Code Committee of the American Society of Mechanical Engineers formulated the following regulation: (*Par.* 380, *A.S.M.E. Boiler Code, Edition* 1918.)

"*The age limit of a horizontal return-tubular boiler having a longitudinal lap joint and carrying over* 50 *lbs. pressure shall be* 20 *years, except that no lap joint boiler shall be discontinued from service solely on account of age until* 5 *years after these rules become effective.*"

Some boiler owners may be of the opinion that the longitudinal lap seams of boilers of this type can be changed to butt strap construction and the boilers kept in service after the time limit. This change of design and construction is not approved, however, by those thoroughly familiar with steam boilers for, although butt straps and more rivets may be added, the material along the line of the joint, which was abused and tortured by the forming of the lap joint and fatigued by the years of service which subjected it to the expansion and contraction brought about by the many changes of temperature and pressure, would be further abused on the portion of the original construction left after cutting off one side of the lap joint and forcing the edges of the plate into line to form a butt joint.

Assuming that a double riveted lap joint has been changed to a triple riveted butt construction, the joint, after placing the butt straps and riveting, would appear as shown in Fig. 5 on page 145 with the rivet holes of the original lap joint at B and the new holes at C. If a defect existed in the plate as shown at A the joint would be very faulty. Assuming the original joint as having the rivet holes spaced 3¼ inches and the additional holes spaced 6½ inches, if the plate material were defective or contained a lap crack as shown, the failure of the joint would require only the shearing of the rivets in long pitch, or 6½ inches, and the failure of the defective plate.

It might be argued that the exposure of the inside of the lap seam, when the change to a butt seam is made, would reveal the presence of a lap seam crack. A crack of this nature is, however, often present in a boiler of this construction after years of service although it may not be visible to the naked eye. But, even though no crack exists,

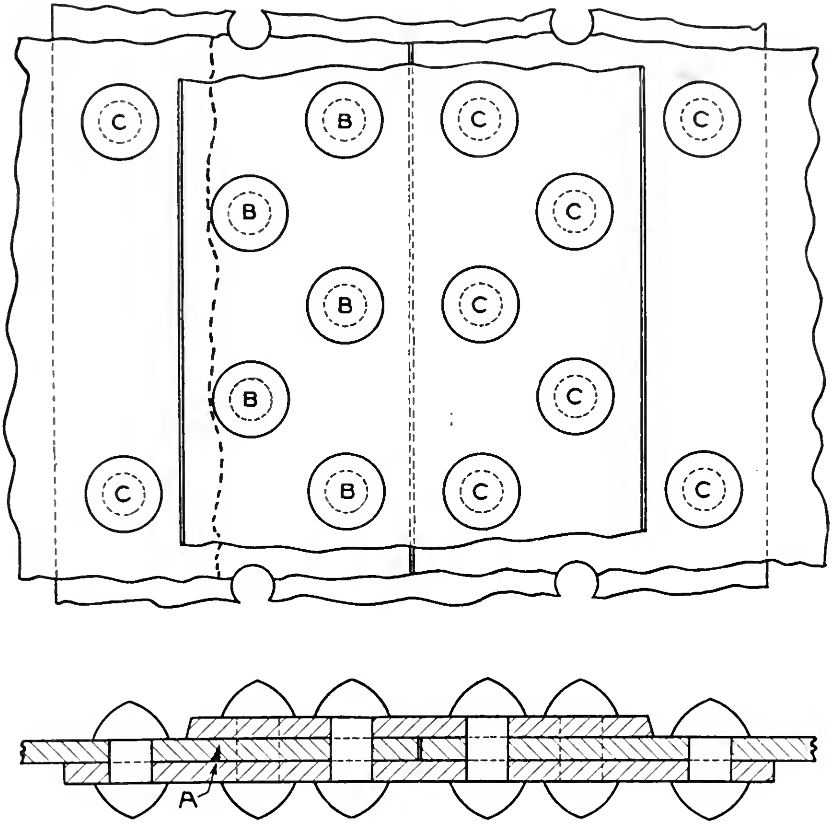


Fig. 5.

it must be remembered that boiler plate, like any other material, becomes fatigued after long years of service and for this reason, after it has been under stress for many years, it should not be subjected to a change of shape and torture of the material in an endeavor to keep the boiler in service, especially when there is evidence that the altered structure is defective.

The age limit of twenty years is none too exacting as will be evidenced by an explosion, resulting from a lap seam crack, of a boiler at the Tallahoma Lumber Co., at Mossville, Miss., on October 21st, 1920. This boiler was less than five years old. The explosion completely wrecked the plant, killed three men and injured four others. There was no negligence on the part of the operators and there was ample proof that the accident did not result from low water or overheating. On the other hand, the lap seam cracks could be clearly seen in the boiler plates after the disaster.

Regulations such as we have quoted are not intended to be arbitrary. Railroad companies determine the safe load capacity for each of their freight cars and if they discover an overloaded car they refuse to transport it. This is done not only to avoid the possibility of straining or breaking the overloaded car but also to prevent a possible wreck which might result in loss of life, property damage, and delay. In a like manner the Boiler Code Committee requests that steam boilers and pressure vessels be designed and constructed for a safe working pressure and that they be not subjected to overloads. The rule quoted above is sane and economic because it is intended for the protection of life, limb and property. So also should be regarded the action of the boiler inspector in condemning any construction regarded as unsafe.

Guarding the Coal Pile.

IT repeatedly has been said that no better opportunity exists for saving or for waste than in the coal pile. Modern improvements have brought the engine and the steam turbine to a high degree of perfection. If the exhaust steam is used to heat the feed water and for industrial purposes, there is practically no waste of the heat in the plant as a whole. But if we impose improper conditions on our boilers we might just as well store our coal on an open lot with a a sign reading, "Help Yourself."

Possibly both you and your chief engineer know what constitute proper conditions. But *you* are not operating the boiler plant. It is the fireman who holds the power to lock or unlock the back door to your coal pile. Experience is the usual school for firemen and while that school teaches its lessons well, when once they are grasped, its demonstrations are often, for the firemen, hidden and obscure. And, because of this, little of the fundamental facts is handed down from fireman to fireman and, in consequence, he does not progress in firing efficiency as rapidly as he might. And yet he is trying hard to grasp the facts and the reasons. It is not natural for the human mind, unless it be of the lowest order, to take no interest in its work, to solve no problems and to make no progress.

Is it not our duty, not only to ourselves but to our firemen, to see that they are given the proper knowledge to help them to fire efficiently? The Hartford Correspondence Course for Firemen was developed for just this purpose. Written in a clear and interesting style, it traces and solves the problem of combustion from the simplest illustrations to the more obscure facts. The burning of volatile matter and the change of carbon to carbon dioxide or to carbon monoxide are discussed in a manner easily understood and the methods for obtaining complete combustion are clearly explained. The use of the draft gauge and the care of the fire are given full treatment. Seventeen lessons of the course are devoted to this very important problem of efficient combustion. Seven lessons follow this, dealing with the proper care of the boiler to insure its being in condition to absorb the heat of the furnace and the precautions to be taken for its safety.

The lessons are issued one at a time. When a student has gone over a lesson and sent in his answers to the questions on that lesson the next installment is sent him, together with a friendly, helpful letter of encouragement and advice. When the twenty-four lessons of the course have been completed, a final examination is given and when that has been satisfactorily passed the student is given a certificate of completion of the work.

We believe it an advisable plan to have the student pay the expense of the course himself. The charge is small, being but five dollars. It has been the practice of many employers, when the student has secured his certificate, to refund the man his money as evidence of their interest in his endeavors. The principle involved is that the student, having made an outlay of his own money, has his interest the more thoroughly aroused and is the more eager to complete the work.

We have several hundred men enrolled in the course and find them to be eager for knowledge and very enthusiastic in their praise of the work. These men range from Superintendents and Chief Engineers down to the most inexperienced firemen.

Enrollment blanks for the course may be had on application to any of our offices and further information will be cheerfully given upon writing to the Hartford Office of the Company, attention of the Correspondence Course Department.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, JANUARY, 1921.

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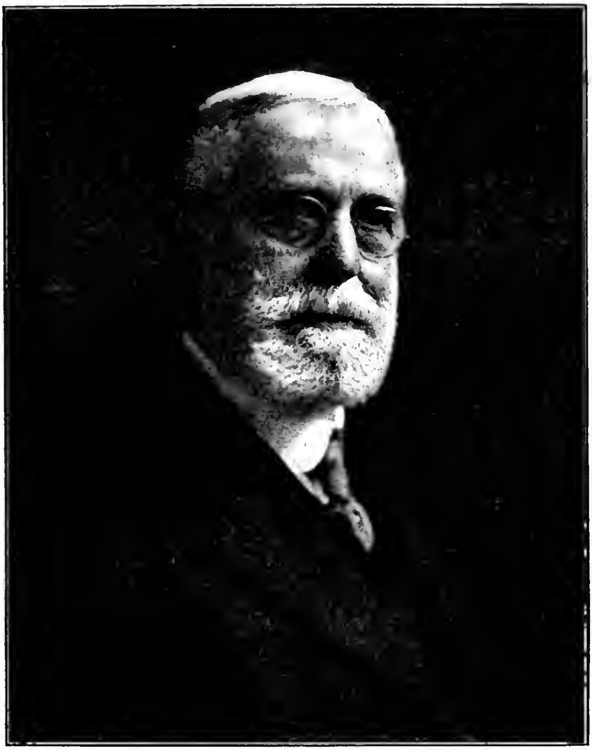
THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

THE reports of boiler explosions that appeared in the early issues of The Locomotive were comparatively lengthy articles and not infrequently extended through a dozen or more lines of type. At that time boiler explosions were far less numerous than at present so that a detailed description could be given of each one without encroaching too much on the other reading matter. As time went on, however, and the number of explosions increased, it became necessary to shorten the articles very materially and in the past few years little other than the date, nature of accident, owner, and location has been given. Even this cutting of detail, however, has been inadequate, of late, to reduce the space required to list all the accidents. To decrease the space required it has become necessary to go still further, and in this issue, as will be noted by reference to page 151, we are adopting a tabular method of presentation. It is believed that this method will give all the information of interest and will, at the same time, make these lists better adapted to a search for data under any particular heading.



President Blake Celebrates Sixtieth Birthday.

WHEN President Blake entered his office on October 25th, a vase containing sixty roses, and a stack of telegrams and letters reminded him that another birthday, his sixtieth, had rolled around.

Later in the day the Home Office force gathered in President Blake's office to express to him their best wishes for the day. At this time the officers, managers, and general agents of the company presented Mr. Blake with a silver service and announcement was made that the field force had made the day the culmination of a campaign for the greatest week of business ever done by the company, amounting to more than six times the weekly average for the past year.

In the evening a surprise reception in Mr. Blake's honor was given at his home and the employees of the company took advantage of the opportunity to offer him their felicitations and best wishes for many more years of a full and useful life.

Personal.

The Hartford Steam Boiler Inspection & Insurance Company naturally is happy to publish to its friends any fact or information which redounds to its credit, even that which touches it only as glory reflected from the achievements of a member of its organization. We therefore grasp this, our first opportunity to record with pride the distinguished honor that has been conferred on our resident agent in Minnesota, Mr. T. W. Hugo of Duluth. During the past summer the mayor of that city resigned his office to accept the nomination of Judge of the District Court. It then, it appears, was incumbent on the commissioners of Duluth to select a man to fill the vacancy. The Duluth Herald thus explains the result of their deliberations: —

> "The commissioners, in searching for a man who would meet the approval of the majority of the citizens, agree that T. W. Hugo would best fit the requirements. A number of other names were suggested but none received the approval of all the commissioners except Mr. Hugo."

We readily agree with the commissioners and commend their choice. We know Mr. Hugo from an association of over thirty-five years as a man of exceptional ability and tested integrity. Sincere and frank of character, he has given to our Company a loyal devotion which has not been displayed only by passive acquiescence in its policies and activities but has extended also to vigorous and constructive criticism at times when he felt its proposals were not to its best interest or those of its policyholders. We can readily appreciate, therefore, the kind of a citizen he has been been in Duluth and that the interest he has taken in public matters has been characterized by an aggressive activity for the good of the community that has won the respect and regard of his fellow townsmen. He has served his city as alderman, President of its Council, member and President of its Board of Education and Chairman of its Committee of Public Affairs. In 1900 he was elected mayor and administered the city government for a term of four years thereafter. That he was a good and faithful servant in all these capacities is now proved by this unanimous action of the commissioners. We congratulate the city of Duluth in the selection made and extend to the new mayor our felicitations and best wishes for a successful administration.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF FEBRUARY, 1920

Continued from October, 1920 Issue

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
116	14	Boiler exploded	6	3	Puget Sound Traction Light & Power Co.	Power Plant	Holyoke, Mass.
117	14	Top head of vertical boiler failed			Nansemond Brick Corp'n	Brick Plant	Norfolk, Va.
118	14	Stop valve ruptured			Houston Light & Power Co.	Power Plant	Houston, Texas.
119	15	Section of heating boiler cracked			Adolph Abbey	Apt. House	St. Louis, Mo.
120	15	Section of heating boiler cracked			J. F. Dolin	Residence	Hartford, Conn.
121	15	Section of heating boiler cracked			Staunton Ave. School	School	Piqua, Ohio.
122	16	Tube failed			Northern Ohio Traction & Lt. Co.	Power Plant	Cuyahoga Falls, O.
123	16	Boiler ruptured			Ohio River Sand Co.	Dredge	Louisville, Ky.
124	17	Three tubes pulled out			Grasselli Chemical Co.	Chemical Plant	Grasselli, Ind.
125	17	Stay brace failed			City of Lansing	Heat & Power	Lansing, Mich.
126	18	Boiler exploded			Michael Lambert	Residence	Philadelphia, Pa.
127	18	Tube ruptured			Consumers Power Co.	Power Plant	Flint, Mich.
128	18	Tube ruptured			Industrial Works	Industrial Mach.	Bay City, Mich.
129	18	Accident to a boiler			H. C. Frick Coke Co.	Coke Plant	Calumet, Pa.
130	19	Blow-off pipe fitting failed			Armour & Company	Meat Packers	New York, N. Y.
131	20	Section of heating boiler cracked			Louisville Industrial School	School	Louisville, Ky.
132	21	Boiler exploded			B. E. Sassman	Greenhouse	Elkhart, Ind.
133	21	Hot water heating boiler exploded			Sunset Building	Office Bldg.	Bellingham, Wash.
134	22	Accident to a boiler			Y. M. C. A.	Y. M. C. A.	Wichita, Kan.
135	22	Drum of boiler bulged, tubes warped and pulled out			Dodge Bros.	Mill Supplies	Hamtramck, Mich.
136	23	Flue blew out			American Coating Mills	Paper Mills	Elkhart, Ind.
137	23	Accident to a steam pipe	2	2	U. S. Government	Steamship "Kitty"	
138	23	Section of heating boiler cracked			Blakesville Forging Co.	Forgings	Plantsville, Conn.
139	24	Accident to a boiler			Charlestown Mining & Mfg. Co.	At Washer No. 2	Ft. Meade, Fla.
140	24	Header of boiler cracked			Lack. & Wyoming Valley R. R.	Power Plant	Scranton, Pa.
141	24	Section of heating boiler cracked			Henry Ford Public School	School	H'land Park, Mich.
142	26	Two sections heating boiler cracked			Adolph Abbey	Apt. House	St. Louis, Mo.

MONTH OF FEBRUARY, 1920 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
143	26	Section of heating boiler cracked			Harmony Cafeteria	Cafeteria	Omaha, Nebr.
144	26	Fire sheet of boiler cracked			Tekemah Electric Light Plant	Power Plant	Tekemah, Nebr.
145	27	Accident to a boiler			Columbia Chemical Co.	Chemical Plant	Barberton, Ohio.
146	27	Blow-off pipe failed			Alliance Cold Storage & Packing	Meat Packers	Alliance, Ohio.
147	27	Fire sheet bulged, crown sheet was distorted and large number of stays failed			Clinton Cotton Mills	Cotton Mill	Clinton, S. C.
148	28	Section of heating boiler cracked			Beaver Falls Public School	School	Beaver Falls, Pa.
149	28	Tube ruptured			Baton Rouge Elec. Co.	Power Plant	Baton Rouge, La.
150	29	Nine sections of heating boiler cracked			Auditorium Amusement Company	Theatre	Malden, Mass.
151	29	Tube and header failed			The Congoleum Co.	Floor coverings	Marcus Hook, Pa.
152	29	Tube sheets bulged and seams were sprung			Salmen Brick & Lumber Co.	Brick Plant	Slidell, La.

MONTH OF MARCH, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
153	1	Section of heating boiler cracked			Mass. Baking Co.	Bakery	Holyoke, Mass.
154	1	Four headers cracked			Acme Wet Wash Laundry	Laundry	Canton, Ohio.
155	2	Two sections heating boiler cracked			L. Sovrensky	Junk Dealer	E. C'bridge, Mass.
156	3	Two railroad locomotives exploded	3		C. R. R. of N. J.	Railroad	Elizabethport, N.J.
157	3	Header pulled out of fitting			Iowa Southern Utilities Co.	Power Station	Centerville, Iowa.
158	3	Four headers cracked			Amer. Steel & Wire Co.	Steel Plant	Waukegan, Ill.
159	4	Tube ruptured		2	Mac Sim Bar Paper Co.	Paper Mfgrs.	Otsego, Mich.
160	4	Pipe nipple pulled out of union			Amer. Distilling Co.	Distillery	Pekin, Ill.
161	4	Tube failed		2	Cleveland Builders Supply & Brick Co.	Brick Plant	Cleveland, Ohio.
162	5	Water arch ruptured			Baldwin Avenue Hospital	Hospital	Jersey City, N. J.
163	5	Section of heating boiler cracked			Vonhoff Hotel	Hotel	Mansfield, Ohio.
164	5	Section of heating boiler cracked			Jas. J. O'Meara	Residence	New York City.
165	5	Boiler exploded		12	Cross Keys Restaurant	Restaurant	Philadelphia, Pa.
166	5	Boiler sheet bulged			C. R. & J. B. Cline	Flour Mill	Cameron, Ohio.
167	6	Boiler of locomotive exploded	2	1	Birmingham Belt R. R.	Railroad	Birmingham, Ala.
168	6	Pipe fitting failed		1	N. Y. N. H. & H. R. R.	Railroad	Waterbury, Conn.

169	7	Tube ruptured			St. Paul & Tacoma Lumber Co.	Lumber	Tacoma, Wash.
170	8	Tube ruptured		2	Lackawanna Steel Company	Steel Plant	Lackawanna, N. Y.
171	8	Section heating boiler cracked			City Hall	Office Building	Laurel, Miss.
172	9	Steam header cracked			National Malleable Castings Co.	Mfg. of Mall. Cast.	Chicago, Ill.
173	9	Bank of tubes failed			Columbia Chemical Co.	Chemical Works	Barberton, Ohio
174	9	Tube ruptured			Simonds Mfg. Co.	Steel Works	Lockport, N. Y.
175	10	Tube ruptured		1	J. H. Ward & Sons Co.	Brick Plant	Pittsburgh, Pa.
176	10	Two sections of heating boiler cracked			Jacob Singer	Loft Building	New York City.
177	10	Elbow in pipe line failed			Theodore Schwamb Co.	Piano Case Mfgrs.	Arlington, Mass.
178	11	Two headers cracked			Amer. Steel & Wire Co.	Steel Plant	Waukegan, Ill.
179	12	Boiler bulged and cracked	1		Dalton Milling Co.	Flour Mill	Dalton, Mich.
180	14	Tube ruptured			Timken Detroit Axle Co.	Axle Works	Canton, Ohio.
181	15	Section of heating boiler cracked			Columbus Sanitarium	Sanitarium	Columbus, Ohio.
182	16	Boiler bagged and ruptured			Hocking Valley Brick Co.	Brick Plant	Nelsonville, Ohio.
183	16	Tube pulled out			Okmulgee Ice & Light Co.	Power Plant	Okmulgee, Okla.
184	16	Accident to blow-off pipe			Merrill Silk Company	Silk Mill	Hornell, N. Y.
185	16	Tube ruptured			Booth, Kelly Lumber Co.	Lumber	Eugene, Oregon.
186	19	Four sections of heating boiler cracked			Robert Findlay Mfg. Co.	Factory	Brooklyn, N. Y.
187	19	Fire sheet bulged and ruptured			Union Dairy Co.	Dairy	Rockford, Ill.
188	19	Section of heating boiler cracked			Ansonia Amusement Co.	Theatre	New York City
189	19	Fire sheet bulged and ruptured	1		Atlantic Ice & Coal Co.	Ice Plant	Nashville, Tenn.
190	19	Boiler exploded			Unknown	Hoisting Engine	Fairchance, Pa.
191	21	Three sections of heating boiler cracked			N. & P. Kiamie	Loft Building	New York City.
192	21	Crown sheet pulled from stays			Miller Brent Lumber Co.	Lumber	Poley, Ala.
193	23	Tube ruptured		1	Amer. Steel & Wire Co.	Steel Plant	Waukegan, Ill.
194	23	Flue sheet of boiler cracked			Moline Rock Island Mfg. Co.	Factory	Moline, Ill.
195	23	Boiler exploded			Mission Cleaning & Dye Works	Clean. & Dye Wks.	Los Angeles, Cal.
196	24	Boiler sheet bulged and ruptured			Pine Ice & Cold Storage Co.	Ice Plant	Dallas, Texas.
197	26	Two sections of heating boiler cracked			Jencks Paper Box Co.	Paper Boxes	Providence, R. I.
198	26	Tube ruptured			Bryant Paper Company	Paper Mill	Kalamazoo, Mich.
199	26	Tube ruptured			Fort Dodge Culvert & Iron Mills	Rolling Mill	Fort Dodge, Iowa.
200	26	Four headers fractured			Middle West Utilities Co.	Power Plant	Harrisburg, Ill.
201	27	Tube ruptured			Amer. Steel & Wire Co.	Steel Plant	Waukegan, Ill.
202	28	Boiler of locomotive exploded	2	1	C. M. & St P. R. R.	Railroad	Chicago, Ill.
203	29	Three headers cracked			Monsanto Chemical Works	Chemical Works	St. Louis, Mo.
204	30	Section of heating boiler cracked			Mrs. L. V. Turner	Apartment House	Louisville, Ky.
205	30	Pipe fitting on boiler failed			Pittsburgh Coal Company	Coal Dealers	Pittsburgh, Pa.

MONTH OF APRIL, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
206	2	Section of heating boiler cracked			Charlesbank Homes, Inc.	Real Estate	Boston, Mass.
207	2	Tube ruptured			Swift & Company	Meat Packers	Chicago, Ill.
208	6	Tube ruptured			Columbia Chemical Co.	Chemical Plant	Barberton, Ohio.
209	6	Fire sheet bulged and cracked			Village of Arcade	Municipality	Arcade, N. Y.
210	6	Tube ruptured			Consumers Power Co.	Power Plant	Flint, Mich.
211	6	Section of heating boiler cracked			Lewis Brothers	Apt. House	Tacoma, Wash.
212	6	Failure of blow-off pipe		1	National Gas & Heating Co.	Power Plant	Nashville, Tenn.
213	7	Boiler exploded			Keystone Woodw'k & Supply Co.	Mill Supplies	Philadelphia, Pa.
214	7	Tube burst	3	2	Philadelphia Elec. Co.	Power Plant	Philadelphia, Pa.
215	7	Boiler on hoisting engine exploded	1	1	Manhattan Construction Co.	Contractors	Okla. City, Okla.
216	8	Safety valve broke			J. Obenberger Forge Co.	Drop Forgings	West Allis, Wis.
217	9	Section of heating boiler cracked			Wendl & Rausch Company	Printers	Toledo, Ohio.
218	9	Two sections of heating boiler cracked			A. C. Johnson	Residence	Denver, Colorado.
219	11	Boiler exploded	1		D. R. Morrow	Drilling for Oil	Nevada, Mo.
220	12	Seven headers cracked in W. T. Boiler			Houston Gas & Fuel Co.	Gas Plant	Houston, Texas.
221	12	Pipe fitting failed			Cincinnati Frog & Switch Co.	R. R. Switches	Cincinnati, Ohio.
222	13	Boiler exploded		1	Harbison & Walker Refract. Co.	Fire Brick	Clearfield, Pa.
223	13	Boiler exploded		1	E. Reingpach	Bakery	Coalinga, Cal.
224	13	Section of heating boiler cracked			L. V. Niles	Apt. House	Boston, Mass.
225	13	Crown sheet bagged in locomotive			W. A. Bechtel	Contractor	San Fran., Cal.
226	14	Tube ruptured			Anderson & Middleton Lumber	Lumber	Aberdeen, Wash.
227	14	Boiler exploded				Apt. House	L. I. City, N. Y.
228	15	Three sections heating boiler cracked			Chevrolet Motor Co.	Auto Mfgrs.	New York, N. Y.
229	15	Sections of heating boiler cracked			Dr. M. Golland	Residence	St. Louis, Mo.
230	15	Two sections of heating boiler cracked			Board of Education	School	Travene City, Mo.
231	15	Boiler exploded			U. S. Shipbldg. Emer. Fleet Corp.	Shipbuilding	Mobile, Ala.
232	16	Two tubes in heating boiler cracked			Charlesbank Homes	Apt. House	Boston, Mass.
233	19	One tube burst, 95 tubes damaged			Michigan Alkali Co.	Chemical Works	Wyandotte. Mich.
234	20	Boiler exploded	1		L. Crossman	Oil Drilling	West Plains, Mo.
235	20	Boiler exploded, resulting fire did $20,-000 damage			A. Ribernio	Steam & Vul.	Riverhead, N. Y.
236	21	Shell plate damaged			Cresent Laundry Co.	Laundry	Webb City, Mo.
237	22	Section of heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
238	23	Boiler of locomotive exploded	3		Booth-Kelley Lumber Co.	Lumber Camp	Eugene, Ore.

239	23	Tube ruptured			American Steel & Wire Co.	Steel Plant	Waukegan, Ill.
240	25	Tube cracked			Hammermill Paper Co.	Paper Mfg.	Erie, Pa.
241	25	Section of heating boiler cracked			F. A. Poth	Residence	Philadelphia, Pa.
242	26	Tube ruptured	2		Terminal Freezing & Heating Co.	Heating Refrig.	Baltimore, Md.
243	26	Blow-off pipe .ails			Midland Chemical Co.	Chemical Works	Argo, Ill.
244	26	Boiler bulged and ruptured			Whitney Manufacturing Co.	Cotton Mfrs.	Whitney, S. C.
245	26	Boiler exploded			A. C. Shaner	Oil Drilling	Boliver, N. Y.
246	26	Boiler exploded		1		Oil Drilling	Ozark, Ark.
247	26	Five sections heating boiler cracked			Lauzon Furniture Co.	Furniture Mfg.	Gd. Rapids, Mich.
248	27	Boiler exploded		1	B. F. Freymark	Machine Shop	St. Louis, Mo.
249	28	Boiler bulged and ruptured			L. T. Bornwasser Co.	Meat Packers	Louisville, Ky.
250	29	Tube ruptured		1	Alex Smith & Sons	Carpet Mfgrs.	Yonkers, N. Y.
251	29	Boiler exploded	1			Flour Mill	Toledo, Ohio.
252	30	Air tank exploded			Central Garage	Garage	Porterville, Cal.

MONTH OF MAY, 1920

253	1	Two sections heating boiler cracked			Alfred Brown	Apt. House	Worcester, Mass.
254	2	Section heating boiler cracked			Irvington Construction Co.	Theatre	New York, N. Y.
255	3	Flue of boiler fractured			Sister of Poor Hand Maids	Hospital	Mishawauka, Ind.
256	3	Crown sheet ruptured, 7 tubes pulled [loose			Southwestern Oil Corp.	Oil Refinery	Enid, Okla.
257	4	Blow-off pipe ruptured			Dallas St'm Laundry & Dye Wks.	Laun. & Dye Wks.	Dallas, Texas.
258	5	Two sections heating boiler cracked			St. Margaret's Memorial Hospital	Hospital	Pittsburgh, Pa.
259	6	Corrugated boiler furnace collapse			Western Brewery & Ice Co.	Ice & Cold Storage	Albuquerque, N.M.
260	6	Hot water boiler exploded			Ballard & Johnson	Restaurant	Peoria, Ill.
261	7	Accident to a boiler		2	McCombs Producing & Refin. Co.	Office Bldg.	E. St. Louis, Ill.
262	7	Section of heating boiler cracked			Atlantic Chain Corp.	Chain Mfgrs.	Long I. City, N. Y.
263	11	Bulged fire sheet			Original Min. Spring & Hotel Co.	Hotel	Okawville, Ill.
264	11	Accident to a boiler	1		Swanson Packing Co.	Meat Packers	N. Sacra., Cal.
265	11	Pipe fitting burst			Lackawanna Steel Co.	Steel Plant	Lackawanna, N. Y.
266	12	Water heater exploded		1		Restaurant	Oakland, Cal.
267	12	Boiler exploded	1	2		Saw Mill	Clarksb'g, W. Va.
268	12	Pipe fitting burst			King Paper Co.	Paper Mill	Kalamazoo, Mich.
269	14	Tube burst — town was without car service or light			Jackson St. Railway & Light Co.	Power Plant	Jackson, Tenn.
270		Tube ruptured			American Steel & Wire Co.	Steel Plant	Waukegan, Ill.
271	17	Accident to an economizer		1	Commonwealth Edison Co.	Power Station	Chicago, Ill.
272	17	Cracked header in water tube boiler			Barrett Mfg. Co.	Roofing Material	Elizabeth, N. J.

MONTH OF MAY, 1920 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
273	20	Furnace sheet of boiler bulged			Henneberger Ice Co.	Ice Plant	Mt. Carmel, N. Y.
274	20	Tube ruptured			Eastern Mfg. Co.	Paper Mill	So. Brewer, Me.
275	21	Hot water heater exploded			Emma Apartments	Apt. House	Peoria, Ill.
276	24	Tube failed and two headers cracked			Nekoosa-Edwards Paper Co.	Paper Mill	Pt. Edwards, Wis.
277	24	Section of heating boiler cracked			Meals Printing Co.	Printers	Gardner, Mass.
278	24	Tube ruptured		1	Washington Steel & Ordnance Co.	Steel Plant	Gresb'ro M'r, D. C.
279	24	Fire sheet ruptured			Kingan & Co.	Meat Packers	Indianapolis, Ind.
280	25	Rendering tank exploded			Littlefield & Sons Co.	Rendering Works	Auburn, Me.
281	25	Tube burst		1	Standard Paper Co.	Paper Mill	Kalamazoo, Mich.
282	26	Accident to heating boiler			American Railway Express Co.	Express Co.	Worcester, Mass.
283	26	Boiler exploded; resulting fire did $75,000 damage		2	M. S. Richardson	Garage	Orchard, Col.
284	26	Boiler of locomotive exploded	2	1	Michigan Central R. R.	Railroad	Bay City, Mich.
285	26	Two tubes pulled out of drum			Grasselli Chemical Co.	Chemical Plant	Grasselli, Ind.
286	28	Boiler exploded	1		Jackson Blake	Saw Mill	Cameron, W. Va.
287	29	Tube burst			Standard Paper Co.	Paper Mill	Kalamazoo, Mich.
288	31	Tube burst			Alexander City Mills	Cotton Mills	Alexander City, Ala.

MONTH OF JUNE, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
289	1	Bagged firesheet			Marianna Ice & Cold Storage Co.	Cold Storage	Marianna, Ark.
290	2	Boiler bagged and cracked			Lowman Brothers	Cotton Ginners	Staples, Texas.
291	4	Header in water tube boiler ruptured			Industrial Works	Construct'n Mach.	Bay City, Mich.
292	5	Boiler of locomotive exploded	1	1	Norfolk & Western Railroad	Railroad	Roanoke, Va.
293	5	Boiler exploded	1		John Glassick	Feed Mill	Cross Roads, Pa.
294	7	Hot water heating boiler cracked			Dwight State Company	Hotel	Springfield, Mass.
295	8	Cap on steam header blew off			St. Paul Sanitarium	Sanitarium	Dallas, Texas.
296	9	Tube ruptured			Nebraska Power Co.	Power Station	Omaha, Nebr.
297	10	Boiler exploded		1	Home Laundry Co.	Laundry	Devils Lake, N. D.
298	10	Water leg of boiler ruptured			Jacob Dold Packing Co.	Meat Packers	Wichita, Kans.
299	11	Header in water tube boiler cracked			Amer. Steel & Wire Co.	Steel Plant	Waukegan, Ill.
300	11	Tube ruptured			Hodenpyl-Hardy & Co.	Power Station	Flint, Mich,

301	12	Boiler exploded			Gold Cheese Co.	Cheese Makers	Pound, Wis.
302	12	Four headers in one tube ruptured			H. P. Cannan & Sons	Canners	Bridgeville, Del.
303	13	Boiler of locomotive exploded		4	Baltimore & Ohio R. R.	Railroad	Washington, Pa.
304	13	Boiler of locomotive exploded	1	2	Chicago, Rock Island & Pacific	Railroad	Paxico, Kans.
305	18	Two tubes and three headers ruptured			Susquehanna Collieries Co.	Coal Mining	Shamokin, Pa.
306	19	Boiler stop valve cracked			Morris Ice Company	Ice Plant	Jackson, Miss.
307	19	Boiler exploded (See locomotive for October, 1920).	1		Detroit Creamery Company	Creamery	Owasso, Mich.
308	20	Boiler exploded			Alabama Packing Company	Cold Storage	Aciteo, Ala.
309	21	Header in water tube boiler ruptured			Mensanto Chemical Company	Chemical Plant	St. Louis, Mo.
310	21	Two tubes pulled out	1		Kentucky & W. Va. Power Co.	Power Station	Lothair, Ky.
311	23	Accident to steam valve		2	Bruce Hardwood Lumber Co.	Lumber Mill	Little Rock, Ark.
312	23	Boiler exploded		2	J. F. Scheberlie	Rock Drilling	Darlington, Wis.
313	23	Boiler exploded	1		Duquesne Steel Company	Steel Plant	Duquesne, Pa.
314	23	Boiler on st'mship exploded. Vessel sank	1	6	Steamer State of Washington	Steamship	Tongue Pt., Ore.
315	25	Boiler exploded		2	Steamtug Jerry	Steamtug	Staten Is., N. Y.
316	26	Tube ruptured		1	H. C. Lytton	Store Building	Chicago, Ill.
317	28	Boiler exploded	1			Oil Drilling	Eldorado, Kan.
318	29	Section of heating boiler cracked			Fifty West Sixty-Seventh Street	Apt. House	New York, N. Y.
319	29	Section of heating boiler cracked			W. A. Bradford	Office Bldg.	Quincy, Mass.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1920.

Capital Stock, . . . $2,000,000.00.

ASSETS.

Cash in offices and banks		$390,221.07
Real Estate		90,000.00
Mortgage and collateral loans		1,426,250.00
Bonds and stocks		5,702,983.62
Premiums in course of collection		597,171.35
Interest accrued		107,590.44
Total assets		$8,314,216.48

LIABILITIES.

Reserve for unearned premiums		$3,715,903.48
Reserve for losses		175,539.16
Reserve for taxes and other contingencies		401,420.50
Capital stock	$2,000,000.00	
Surplus over all liabilities	2,021,353.34	
Surplus to Policy-holders		**$4,021,353.34**
Total liabilities		$8,314,216.48

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FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.

L. F. MIDDLEBROOK, Assistant Secretary.

E. SIDNEY BERRY, Assistant Secretary.

S. F. JETER, Chief Engineer.

H. E. DART, Supt. Engineering Dept.

F. M. FITCH, Auditor.

J. J. GRAHAM, Supt. of Agencies.

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AUTOMATICS

In "Power"

By Rufus T. Strohm.

There are scads of strange devices in our power plants today,
Made to put an end to trouble and to keep the jinx away,
While a lot of them are fashioned with the pleasing end in view
Of avoiding heavy labor that would fall to me and you;
But although they're almost human in the way they do their share,
They require close inspection and they need continued care;
So some accidents will happen and some trials will remain,
For we haven't found the fellow with an automatic brain.

You can use a warning whistle of the kind that starts to blow
When the water in the boiler gets too high or falls too low,
But your hair will turn to silver while you wait to hear it wail,
If the water-column piping isn't free from sludge and scale;
And unless the water tender is alive and on the jump,
It will never halt disaster though it blare like Gabriel's trump;
For a boiler can't forevermore withstand an overstrain,
And we haven't found the fellow with an automatic brain.

You may furnish every engine with a form of safety stop,
With the object of protecting all the workers in the shop,
But you've got to clean and oil it, or its joints will rust and grip,
And you'll find it out of order when you're praying it will trip.
So, you see the risks you're running and the chances that you take
If the chief and his assistants aren't keen and wide awake;
Troubles thrive where men are careless, foolish, ignorant or vain,
Since we haven't found the fellow with an automatic brain.

Thus with stokers, lubricators, non-return valves and the like —
They are mighty clever helpers, but they're sure to go on strike
If, when you have made them part of your equipment, you proceed
To forget you ever bought them and ignore the care they need.
You will find that they'll protect you, and your drudgery will shrink,
But they're only brass and iron, and they weren't made to think;
So you needn't look for absolute security to reign
Till the race brings forth the fellow with an automatic brain.

The following stanza is added with apologies to the Author.

But when the hand upon the pressure gauge swings 'round against the stop
And the safety valve relied upon gets stuck and will not pop.
If the safety stop won't function and the engine goes awry
So that pieces of the flywheel upward sail unto the sky,
Or if the boiler gets to foaming and the engine gets a shot
Of some water in the cylinder and things go all to pot,
Then's the time a Hartford Policy will save you from the pains
Of a bank-roll cut to pieces by non-automatic brains.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

Vol. XXXIII. HARTFORD, CONN., APRIL, 1921. No. 6.

BOILER EXPLOSION AT SAVANNAH, GEORGIA.

Boiler Explosion at Savannah, Georgia.

THE year 1920 closed in an unfortunate way for the firm of G. H. Tilton and Sons of Savannah, Georgia. About the middle of the afternoon of December 29th, while everything was running smoothly and the year's work was nearing its close, one of the boilers in the mill of this concern exploded with terrific violence and serious damage was done to the plant. A general view of the ruins appears on the front cover of this issue of The Locomotive and, as will be seen by reference to that picture, the wreckage was

View of Exploded Boiler.

spread over a large area. The boiler room was completely demolished as was also a brick warehouse nearby. The boiler, in exploding, ripped off one course or sheet which landed some distance away from the mill. The rest of the boiler was hurled through the picker room, adjoining the boiler room, and was brought to rest by the wall of the main mill building but only after it had torn a fair sized hole in that wall. In the picture above, the boiler is shown where it landed after its flight. A piece of pipe three inches in diameter and about eighteen feet long was thrown through the air and came down through the roof of a dwelling fifty yards away.

The property loss amounted to about $40,000. In addition to the property damage, however, and for which money cannot adequately pay, was the injury to the two firemen at the plant. One of these men was so seriously injured that he was not expected to live.

The cause of the explosion is not definitely known though it would appear, from the evidence we have at hand, to have been another case of a lap seam crack, reference to which was made in the last issue of The Locomotive.

Flywheel Accident at The Kentucky Utilities Company.

BUSINESS which required light or power was recently brought to a standstill in Richmond, Kentucky, when a flywheel on an engine at the plant of the Kentucky Utilities Company exploded and so damaged the building and equipment that the plant was forced to shut down. The illustration herewith gives a view of the wrecked engine and some of the damage that was done to the building.

FLYWHEEL EXPLOSION.
KENTUCKY UTILITIES CO.

Aside from the economic loss produced by the interference with business, the accident carries with it the sad story of the loss of a life. Driven by its tremendous momentum, part of the wheel ripped out through the roof of the plant and buried itself in the ground almost half a mile away. In its flight it crashed through a house.

which it entered through the roof, passing through the upper floor and coming out through the side wall. As it did so, it struck and instantly killed a child and injured a young woman who lay asleep directly in the path of the flying missle.

The accident came without warning. The engineer, but a few moments before, had been oiling the engine and had just stepped out to the boiler room when the crash came. So far as we have been able to learn, no explanation has been obtained as to the cause of the explosion.

Engine Foundations.

FOUNDATIONS for engines are necessary for several reasons. The engine must, first of all, be held in alignment — alignment of its own parts and with the external machinery that it drives. The foundation must distribute the weight of the engine and also its own weight to a ground area sufficiently great to avoid exceeding the bearing power of the soil. A third function that the foundation must perform is to absorb or dampen the vibrations of the machinery resting upon it so that these vibrations will not be exaggerated in the machine itself nor transmitted to the surrounding machinery and buildings.

Fifteen or twenty years ago it was common practice to build engine foundations of brick or stone. It is modern practice, however, to use concrete as this material is not only more convenient but also is better adapted to the requirements of a foundation. Practically all concrete foundations of ordinary size may be made monolithic — that is to say, in one solid block without joints. Even with foundations of great size the joints will be few and with proper precautions the bond at these joints may be made practically as strong as any other part of the structure.

It is somewhat difficult to state a rule, that will cover all cases, as to the proper size of a foundation. For the weight to be from four to five times that of the engine is in accordance with average practice. The factor of primary importance, however, is the ability to remain fixed in position. Settling or sinking of the foundation cannot be absolutely avoided but it can be reduced to a negligible amount and in most cases to an amount so small that it cannot be measured by any ordinary means. Whatever settling does occur should be uniform. To provide adequate bearing for the foundation, the structure should be proportioned in accordance with the bearing power of the soil as given in Table I. Knowing the weight of the engine and the approximate weight of the foundation, it is easy to calculate the area that the foundation should cover. In this calculation the weight of concrete should be taken as 150 lbs. per cubic foot.

TABLE I.[1]

BEARING POWER OF SOILS AND ROCK.

Ledge rock	36 tons per sq. foot
Hard pan	8 " " " "
Gravel	5 " " " "
Clean sand	4 " " " "
Dry clay	3 " " " "
Wet clay	2 " " " "
Loam	1 ton " " "

The foundation must, of course, be deep enough to be entirely free from disturbance by frost. If bed rock can be reached at not too great a depth, it would be well to excavate to that depth. A bearing on bed rock is not always desirable, however, as will be shown later. In some cases the nature of the soil may be such that the area necessary to support the weight will not be great enough to bring the bearing pressure on the soil within the safe limit without excavating to an extreme depth. In such cases it will be best to excavate to a moderate depth and then to construct a mat, or sub-foundation, as shown in Fig. 1,

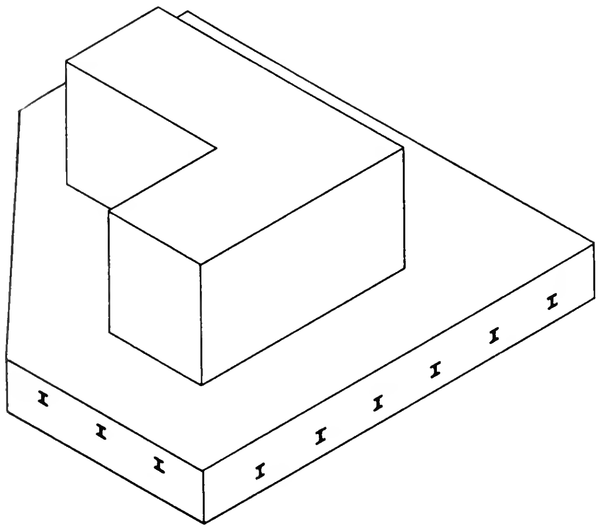


FIG. 1

[1] Taylor & Thompson "Concrete, Plain and Reinforced."

which will distribute the load over a greater area. In any ordinary case it would probably not be advisable to go deeper than twelve feet to reach a bearing soil, for if an adequate bearing stratum is not reached within this distance it would be better to construct a mat or to sink piling and then place the foundation upon a large mat or cap built upon this piling. This mat should be well reinforced with bar iron. The regular reinforcing steel is, of course, quite acceptable for this purpose although a few lengths of railroad iron laid at right angles to each other is an excellent reinforcement in a construction such as this. The rails should be cleaned of oil and grease before using.

There have been installations in which the foundations of the walls of the buildings have been placed on bed rock and vibration has developed in the building when the machinery also had its foundations resting on this rock. In such cases, when the rock lies so near the surface that it is difficult to avoid placing the machinery foundations upon it, it is well to blast an opening in the rock so that a sand cushion may be placed between the engine foundation and the rock as illustrated in Fig. 2. A box or retaining wall of concrete as shown in Fig. 3, may also be used to accomplish this purpose. The necessary spread or area of foundation is, of course, based on the allowable bearing pressure on the rock.

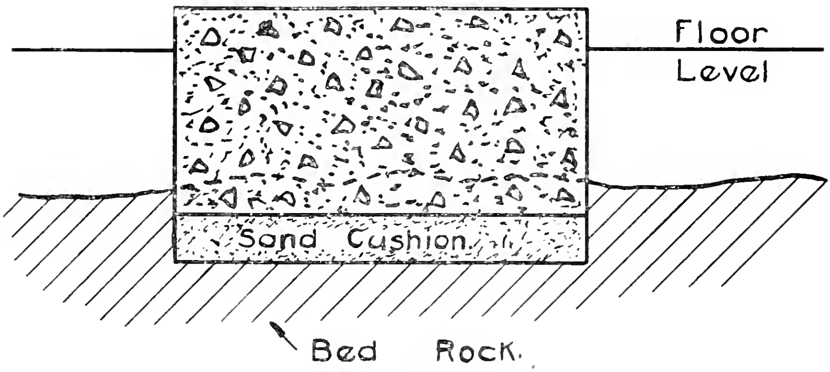


Fig. 2.

When the soil will permit it, the excavation itself may provide the form for pouring the concrete. If the ground is not firm enough for this, wooden forms must be built. Battered or sloping slides may be used when it is desired that the foundation have additional spread or bearing area. It is more convenient, however, and it is just as satisfactory to use vertical sides and secure additional bearing surface

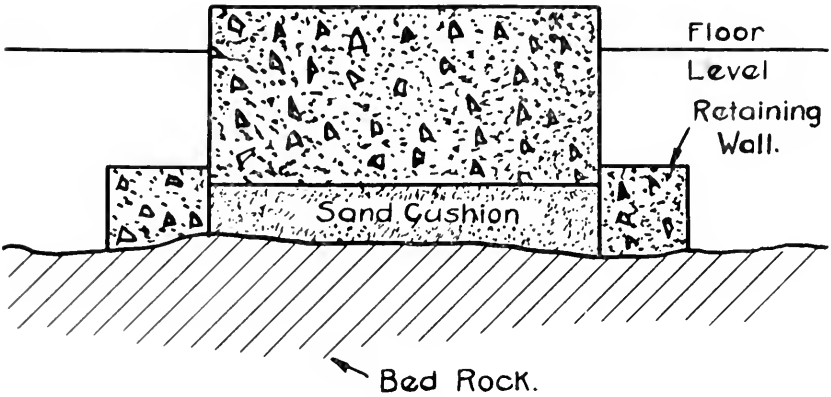


Fig. 3.

by the use of a mat or sub-foundation. The plan of the foundation follows, roughly, the outline of the base of the engine. When there is an outboard bearing the design should be somewhat as shown in Fig. 4 in which the foundation or pier under the outboard bearing is tied to the rest of the structure by a slab of concrete. With such a construction some thought should be given to the weight imposed upon the foundation by the outboard-bearing pedestal and the weight of the parts that such bearing carries. Even though the total area of the foundation may be sufficiently great to support the total weight without exceeding the safe bearing pressure, it is quite possible that the load may become highly concentrated at certain points such as that under the outboard bearing. In such a case it would be well to spread the base of the foundation under the pedestal by sloping the walls or by a sub-foundation to bring the pressure within the allowable limits.

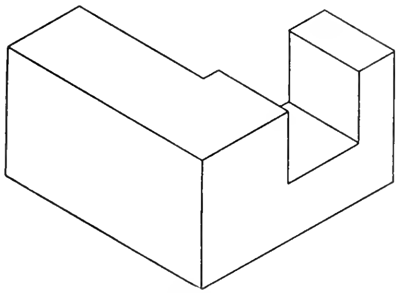


Fig. 4.

In constructing the form for the foundation it is well to use green or unseasoned lumber because such lumber does not have as great a tendency to warp out of shape in the presence of water as it would if it were seasoned. Spruce is an excellent wood to use and fir is also very satisfactory. The lumber for foundations below ground may be one-inch boards. It should be borne in mind that the water in concrete is necessary for the proper formation of the cement crystals, and that the forms should be as water tight as it is practicable to make them so that the water will be retained within the concrete until it hardens. For this reason the edges of the boards of the forms should be joined. Even better than the joining by square edges is the construction in which the edges are beveled as indicated in Fig. 5. When the wood becomes wet and swells, these edges are forced together into a water-tight joint. This construction is favored, by many, above that in which tongued and grooved boards are used.

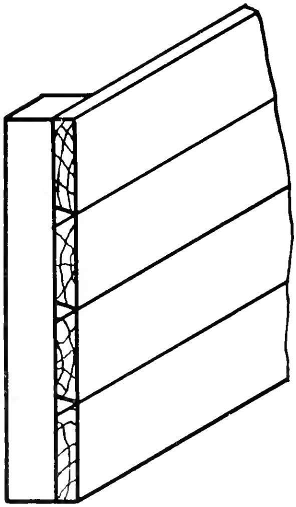


Fig. 5.

The battens or studs, to which the boards of the form are fastened, should never be less than 2″ x 4″ nor spaced more than two feet apart. The battens should be braced in position so that the form will hold its shape and position, and the braces should be securely fixed at their outer ends. When it is impossible to provide a sufficient number of braces outside of the form, bolts or wires may be run through the foundation itself to tie the opposite sides of the form together.

When foundations are entirely below ground there is no necessity for a smooth finish nor does it matter if the forms bulge slightly so that the sides of the foundation do not form a plane surface. With foundations that are visible, however, attention must be given to these details. In such cases care must be taken to see that the surfaces of the boards in contact with the concrete are planed and smooth unless, of course, a cement plaster finish is to be given later. It is well also to use 1½″ or 2″ planking and to pay some extra attention to the bracing so that true surfaces will be obtained. The obtaining of a good finish will be discussed a little later.

When the sides of the foundation form have been constructed they may be placed in position and fastened together as shown in Fig. 6. The sides should be made square with each other and then braced in that position with boards laid diagonally across and fastened to the top of the form. Lines should be run across the top of the form to indicate the center lines of the shaft and the cylinder, and the form should then be placed accurately in position by reference to these lines and securely held in this position. The engine, when it is set on the foundation, is not to rest upon the concrete itself but will have, between it and the concrete, a bed of cement grout (equal parts of sand and cement, about one-half inch thick. This method of setting in grout insures the accurate placing of the engine and at the same time provides a full and even bearing for the engine bed-plate. When placing the foundation forms, therefore, it is well to have the top edge of the sides straight and level and located one-half inch below the level that the bed plate of the engine is to assume. The form is then filled with the concrete to the point of overflowing.

The next step is to support the holding-down or foundation bolts in the proper position in the foundation opening. To do this a template, such as that shown in Fig. 7, on page 170, is necessary. The center lines of the engine shaft and of the cylinder are carefully laid out at right angles to each other on the template and the bolt holes are then located from these center lines. The location of the bolt holes in the bed plate of the engine is secured either by direct measurement or from the makers. The length of the foundation bolts should be, if possible, thirty or more times their diameter. That is to say, a one-inch bolt should be thirty inches or more in length. This is the length of the bolt that is within the foundation and to it should be added the necessary length to extend above the foundation to pass through the grouting, the bed plate of the machine, and the nut and washer above. There is considerable advantage in having the bolts extend an inch or two above the level theoretically required, for inaccuracies of setting or measurement may cause this extra length to be of considerable value. If, after the engine is finally set, the bolts

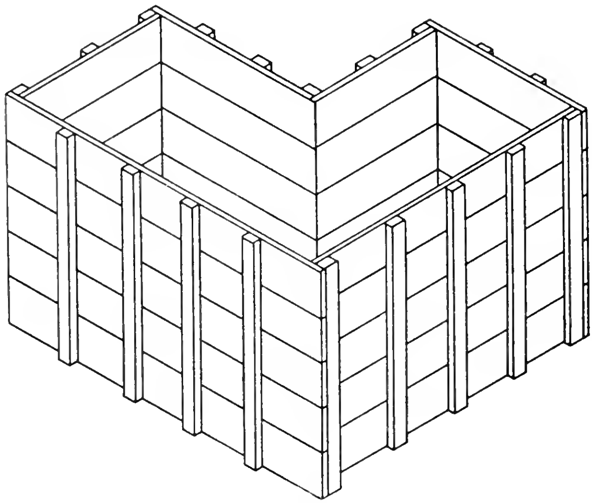


Fig. 6.

extend beyond the nuts, the protruding ends may readily be removed with a hack-saw.

The holding-down bolts should not be rigidly fastened in the foundation because, for one reason, the bolt holes in the bed-plate

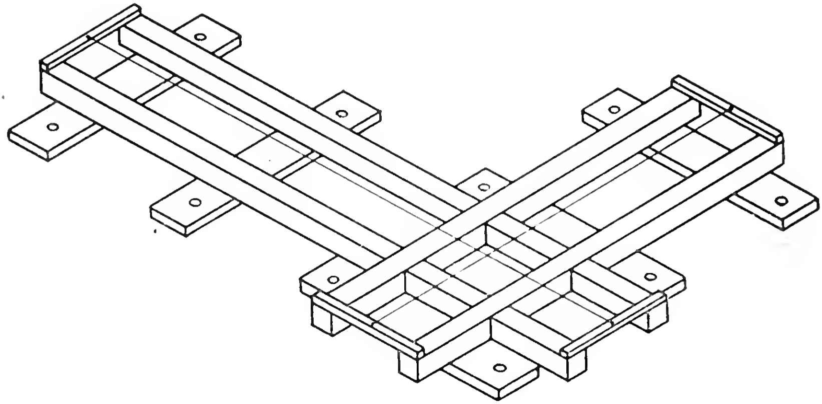


Fig. 7.

casting may not agree in position with the design. Then too, there is always the possibility of error in the layout of the template. The engine, after being placed on the foundation and located by fixed foundation bolts, may not line up with the machinery it is to drive, even though the foundation and template were carefully located. It is best, therefore, to use some method of holding the bolts in the foundation that will provide a fair degree of freedom so that they can be entered in the bed-plate holes and the engine shifted slightly to bring it into alignment. This can be accomplished by the method of Fig. 8 which shows a piece of pipe, whose internal diameter is from one to two inches greater than that of the bolt, suspended by the bolt from the template. This piece of pipe should be centered with the pipe at the top and bottom by means of centering-disks as shown. These disks may be made of wood or metal. It is very convenient to have the lower centering-disk cast upon the upper face of the foundation washer. Wooden wedges or even paper or waste may be used at the top of the pipe where the centering of the bolt in the pipe can readily be observed. Wooden boxes may be used, of course, instead of the pipe but when used they should be made wet before the concrete is poured. This will prevent the wood absorbing moisture from the concrete — which would prevent the formation of a hard concrete — and it is of value also in that the boxes will later dry out, shrink, and thus be easy to remove from the foundation.

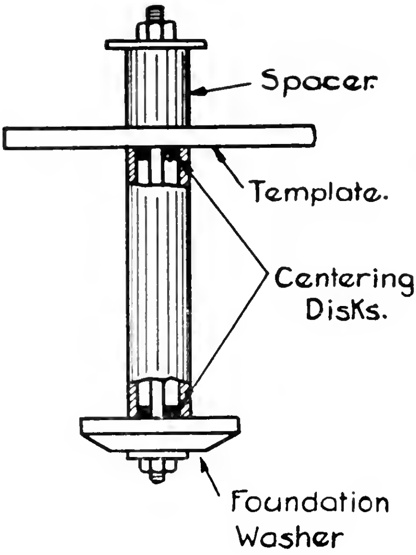


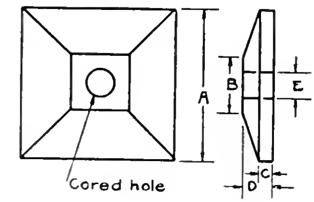
Fig. 8.

The washers for use on the lower end of the holding-down bolts may be made of cast iron and should be of good size. Proportions for these washers are given in Table II. The nut on the lower end of the bolt will be held from turning if the concrete, when poured, is puddled or rodded around the lower end of the bolt although it is advisable to have the bolt extend through the lower nut for about twelve inches and to have this extension bent out of line so as to act as a lever. Ridges may also be cast on the foundation washer to prevent turning of the nut.

In many cases, especially those in which the foundation bolts extend for some distance above the top of the foundation, it will be convenient to have the bolts so installed that they may be removed,

Table II.

Proportions of Cast Iron Foundation-Washers.



Dia of Bolt	A	B	C	D	E
1"	6½"	2½"	⅝"	1¼"	1¼"
1½"	9½"	3½"	15/16"	2⅞"	1¾"
2"	13"	4½"	1¼"	2½"	2¼"
2½"	16"	5"	2⅝"	3¼"	2¾"

and for this purpose the foundation should be constructed with pockets to hold the lower washer and nut. The details of such a construction are shown in Fig. 9. When this plan is followed, the bolt holes may best be formed by boxes which are held in place by cross braces or stays at the top and by the form for the pockets at the bottom. This construction for the bolt holes is of great advantage when placing heavy machinery. There are no bolts to interfere with the moving of the machine and it can easily be rolled into position and the bolts dropped in later on. When the bolts are not removable a great amount of time is often lost by the necessity of elevating the machine above them and, furthermore, damage to them may very readily occur.

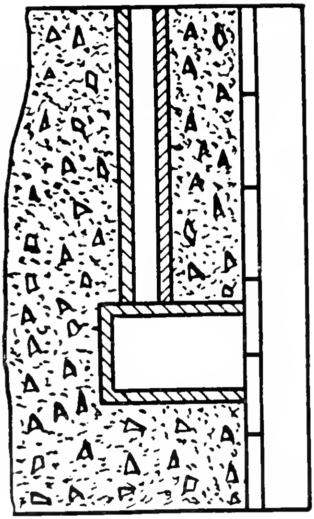


Fig. 9.

The best mixture for making concrete for foundations is what is known as the 1:2:4 mixture or, in other words, *one* part cement, *two* parts sand, and *four* parts crushed stone (all parts by volume. This mixture forms a dense, hard concrete. When a foundation is very large the lower part of it may be built of a 1:2½:5 or 1:3:6 mixture with a top of the 1:2:4 mixture about two feet thick.

The cement is the binder for the whole structure and care should be used to see that a good grade of Portland cement is obtained. The sand should be clean and sharp and it is better for it to be composed of a mixture of large and small grains than for it to be all of uniform size. The stone may be used as it comes from the crusher after the dust and screenings have been removed. The stone should all be of such a size, however, that it will readily pass through a 2½" ring.

A power driven concrete mixer is, of course, the most convenient means of mixing and in large foundations is practically an absolute necessity as all concrete foundations should be carried to completion without interruption when the pouring has started. The power mixer has also the advantage of giving a thoroughly mixed concrete. There is no serious objection, however, to the hand method of mixing if the pouring of the concrete can be completed within a reasonable time.

When hand mixing is employed, a mixing platform about fifteen feet square should be built. One inch boards supported on joists which are spaced three feet apart will, in most cases, be satisfactory. A 2″ x 3″ strip running around the edge of the platform is useful in preventing the waste of materials. For the purpose of measuring the materials, a bottomless box with a capacity of four cubic feet will be of advantage. It will be found convenient to have this box made approximately to the dimensions of 18″ wide x 32″ long x 12″ deep.

In making up a batch of concrete the measuring box is placed on the mixing board, filled to half its depth with sand and then removed. One standard size bag (approximately 1 cubic foot) of cement is added to the sand and the two are thoroughly mixed together while dry. The mixture is then leveled off, the measuring box placed on it and a full measure, or four cubic feet, of the broken stone added. The three ingredients are then thoroughly mixed while dry, by turning with shovels and by raking. When thoroughly mixed, the water is added gradually while the mixture is again turned and re-turned and raked and re-raked. Sufficient water is added to give a consistency of thick cream. Of course, double or triple the above quantity may be mixed at once if it is found convenient to do so.

When the concrete is well mixed, it may be placed in the form and evenly distributed. The surface should be kept approximately level at all times as the work progresses, and the concrete should be tamped and worked with rods or bars into all corners of the form. Care should be used about the foundation bolt casings so that they will not be thrown out of a vertical position. It is well, as an added precaution, to hold the lower end of these casings in position by tie wires running from casing to casing and from casing to foundation form.

At least one week — a longer time is advisable — should elapse between the pouring of the concrete and the placing of the engine upon it. During this time it is well to keep the concrete wet to assist the setting because cement develops its strength by the formation of crystals and water is essential for this action. Once the crystallization is started it should continue to completion, for if interrupted a weak concrete will result. If for any reason the pouring of the concrete is interrupted before completion of the work, the surface of the foundation should be kept wet by placing water-soaked bags upon it. On the other hand it should not be mixed too wet, for excessive water in the mixture will wash the sand-and-cement mortar away from the stones and weakness will result. It might be mentioned here that if the pouring is interrupted it may be continued later upon the old surface if that surface is not too smooth and has been kept wet and free from dust. Otherwise the old surface should be "picked" until rough and then thoroughly washed, and this procedure should also be followed just before the engine is to be placed on the foundation.

The engine, after being placed in an approximately correct position on the foundation, must be levelled and aligned with the machinery it is to drive. For the purpose of leveling, some iron wedges with a rather small taper must be provided. These are laid on the foundation so that when the engine is placed the wedges will be distributed around the edge of the plate. Enough wedges should be provided to enable them to be spaced not more than six feet apart and, in any case, a wedge should be placed close to each foundation bolt. The machine is to be made level with reference to the shaft and to the cylinder and cross head slide. This is easily determined by placing a machinist's level on a machined surface of the parts mentioned. The crosshead slide is convenient for the one direction. For leveling in the other direction the level must be carefully placed on the top of the shaft at a place where the shaft is perfectly cylindrical and does not taper. By driving on the wedges with a heavy hammer or sledge the engine may be brought to a perfectly level position in both directions. At the same time that the machine is made level it must, of course, also be brought into alignment with the line shaft or other machinery that it is to drive. When the engine has been made level and in alignment, the nuts on the foundation bolts should be tightened and each wedge should be struck a light blow to set it up firmly without disturbing the setting.

When the setting of the engine has been accomplished, it should be resting with a space of about one-half inch between the bottom of its bed-plate and the top of the foundation. A dam is then built about the base of the engine with timbers, about 4 x 4″ in size, laid two inches or more away from the sides of the base. Grout, composed of equal parts of Portland cement and clean sand mixed with water to about the consistency of cream, is poured within this dam so as to flow under the engine. Before pouring, however, the opening in the foundation around the bolts should be plugged at the top with waste or paper, so that the grout cannot run into and fill these holes. The mixture, when poured, should be stirred and worked in and under the engine base to remove all air bubbles and to insure complete contact of the grout with the foundation and engine bed-plate. Enough should be poured to fill the dam to the point of overflowing as this will insure its reaching all parts that are to be imbedded. After the grout has set a few hours the dam may be removed and the surface smoothed with a trowel. Do not, however, remove the wedges until about a week's time has elapsed. They should always be removed and the bolts made tight before the engine is put into service but care should be used in doing this so that the setting of the engine is not disturbed.

If a smooth finish is desired the foundation may be plastered with a mortar composed of equal parts of sand and cement although it is sometimes difficult to secure a good bond between the concrete and the cement plaster. A better plan is to use a little extra care in the construction of the forms so that the surfaces of the boards are clean, smooth, and free from knots. Then by plastering the inside of the form a few inches in height at a time and just before a batch of concrete is poured, the plaster, which should be about ¾″ thick, and the concrete will be bonded while still wet. As a final finish and to prevent any oil permeating the structure and thereby weakening it, a coat of paint may be given the foundation when it has become thoroughly dry.

The Petroleum Situation.

THE Drake Well, which "struck" oil on Watson's Flats near Titusville, Penn., on August 28, 1858, marks what may be called the beginning of our petroleum oil industry. "Rock oil" had been produced prior to this date by digging shallow wells wherein the oil floated to the surface of the water and was then dipped up with blankets. Coal-oil, distilled from bituminous coal, was also being produced and, while not in extensive use, had awakened the people to the advantages of the oil lamp over the old-fashioned candle. Kerosene, obtained by distillation from crude petroleum, found therefore, a ready market. In fact, in the early days the demand for kerosene was the spur to the development of the oil fields. Benzine and gasoline were at that time considered as waste and were often physically destroyed. Because of its dilution by the lighter products of distillation, kerosene used in oil lamps was often the cause of serious accidents. Nowadays we complain of too much kerosene in our gasoline.

It has been said that the units of mechanical power per capita are a measure of our progress in civilization. Certainly there is no comparison between the power produced today and that used before the Civil War. In the olden days we could successfully lubricate our machinery with animal and vegetable oils and what little mineral oils were available. Today we are practically totally dependent upon petroleum for our supply of lubricating oils. In those earlier days crude oil and fuel oil were little used in industrial furnaces either for the production of steam or for the numerous purposes to which they are now applied such as heat treating furnaces, retorts, and kilns. Approximately one-half of the petroleum recovered from the earth is now being consumed in the direct production of heat.

Though we little realize it, we are in almost daily contact with the products of petroleum. Dyes for our clothes, flavoring extracts for our foods, chemicals and drugs in formidable array, all are obtained from this mineral resource. It has been estimated that there are eight million automobiles in use in the United States and that the figure may soon reach twelve million. The motor truck industry is growing by leaps and bounds, the farm tractor is fast becoming indispensable to agriculture, and the airplane, developed to a remarkable degree during the World War, is also finding its place of service. As rapidly as the crude oil is removed from the ground, new uses are found for its products.

Some idea of the enormous size of the petroleum industry may be gained from the statement that during the year 1920 we removed from the oil fields of this country 531,186,000 barrels of oil. To visualize it, think of the picture that has been drawn that this is equal to the flow of Niagara for over three hours. The question should naturally arise in the mind of anyone who gives thought to the future — how long will our petroleum resources continue to supply us at this rate?

The United States Geological Survey has made careful and reliable estimates of the amount of oil that has been removed from and that still remains in the ground. Since the drilling of the Drake Well in 1858 over five billion barrels of oil have been consumed and we have remaining in the ground and recoverable by present methods of production approximately seven billion barrels more. At the present rate of consumption seven billions reserve supply will last us about seventeen and one-half years. *At our present rate of consumption* — and every year we are finding new uses for the products of petroleum. Of course the inexorable law of supply and demand will step in before the expiration of that period so that actually our use of petroleum must gradually taper off.

It is estimated that by present methods we are recovering less than one-quarter and in many cases as little as one-tenth of the oil in the strata pierced by the wells. By improved methods there is promise of a greatly increased flow so that our total recoverable oil may be doubled, leaving us nineteen billion barrels available. Using our present yearly rate of consumption, we would reach the end in about fifty years. But even that is within the lifetime of the next generation.

Looking abroad, estimates indicate that the world's supply of petroleum amounts to about forty-three billion barrels. Of this, the United States has about one-sixth (based on the seven billion known to be recoverable). The world in general is increasing its consumption of oil just as is this country, so we cannot look to foreign fields for a fully adequate supply. It might be stated, in this connection, that in 1920 we imported 106,175,000 barrels of oil which is more than double the imports of 1919 and almost five times greater than the imports in 1913. It is true that one enormous resource, the oil bearing shales of Utah, Colorado and Wyoming, is yet to be developed and may solve many of our difficulties but "counting your chickens before they are hatched" is a poor policy and, furthermore, it must be realized that the labor question involved in the development of these oil shales is a tremendous one.

Dr. George Otis Smith, Director of the U. S. Geological Survey, presents the problem of the future supply of energy in a most interesting way. In comparing the energy resource of water power, coal, and oil he says:

"If we take fifty million horsepower as an average figure for the potential water power of the United States, without storage, we find that, if fully developed and if used at the average load factor of today, our rivers and streams would just about meet the country's present needs and would supply that amount of power for all time; moreover, with storage and an improved load factor they could provide a considerably increased output of energy to meet the growing demand.

"If, however, we should put the whole burden on our coal mines, not using even the water power now used, we would find that by adopting the best steam practice of today the present power requirements of this country could be met with coal for 57,000 years, although we know that long before the end of that period the greater depth of the coal mines and their increased distance from market would alone create power demands for mining and transportation, that would considerably cut down the amount of power available for other uses.

"We measure the petroleum wealth of the United States by billions of barrels — about five billions already produced in the last sixty years, and about seven billions left for the future. Again adopting the best steam practice of today in public-utility stations of Texas and California — a little less than thirty-two barrels to the horsepower-year — and trying to carry the whole power load of the country with oil alone, we find that the oil reserves of the United States, although measured by billions of barrels, would last only nine years and three months. Without allowing for the fact that steam raising for power is only one of the many uses of coal, these two figures — 57,000 years and 9¼ years — are sufficiently impressive to make us fairly receptive to the general truth of Mr. Eckel's statement in his recent book "Coal, Iron and War!" "'We have just as much real chance of replacing coal by oil as we have of finding enough gold to use it in place of steel.'" These are only comparative estimates of the energy supplies which may be tapped for the use of our own citizens."

Petroleum, in the civilized world of today, is a commodity of far reaching importance. We find in isolated districts, where electricity is not available, that kerosene is the only adequate source of light. Our dependence on the automobile can no longer be looked upon as an extravagance but as a daily necessity. Lubricating oil must be had for the wheels of industry to turn and no adequate source other than petroleum is in sight. In many sections industries wholly dependent upon oil for fuel have been developed. Truly the petroleum situation is a serious one and demands our attention.

The enormous increase in demand for oil as fuel has arisen because of the ease of handling the oil and the difficulty, at times, of securing coal. Crude oil, with its content of benzine, gasolene, kerosene and the lighter lubricating oils, is hardly thought of for use in steam raising. The portion of the petroleum oil that is left after the lighter distillates have been removed, and which is commonly known as fuel oil, may be considered, in a broad way, as a solution of asphalts and waxes in lubricating oils. It would appear therefore that this fuel oil, like crude oil, may serve a higher purpose than that of steam raising.

Does it not seem that, since coal is what might be called a single purpose commodity in that it serves almost solely for the production of heat, and since petroleum is a multiple purpose commodity capable of filling wants which coal cannot fill, we therefore should look to the diverting of oil to its special uses? Oil may be abundant now but what of future generations? It is of course quite true that new oil fields may be opened up and also that methods of recovery far superior to any now in use may be developed. Some day, however, the supply must be exhausted. Should we hasten that time to the detriment to posterity?

Engine Wrecked by Excessive Water.

By Inspector R. Downie.

IN the last issue of The Locomotive mention was made, under the heading of "Excessive Water as the Cause of Engine Breakage," of the possibility of an engine being wrecked by water drawn into the cylinder from the exhaust pipe. An accident of this nature occurred recently at Utica, New York, and serious damage was done to the engine.

According to the engineer in charge, the engine was started up one Monday morning and, soon after it reached full speed, was wrecked. Several of the cylinder head bolts broke and allowed the cylinder head joint to leak enough to release some of the pressure although the cylinder head itself was not blown off. But before the pressure had been thus relieved, four of the six main-bearing-cap bolts were broken and the other two were elongated. The connecting-rod was bent at both ends although not so badly damaged but that it was possible to straighten and use it again. The crank-shaft, which was six inches in diameter, and the piston-rod were so badly bent that it was necessary to replace them with new parts.

We have been advised that the six-inch exhaust line on this engine was provided with but a ½″ drain pipe. When this small drain pipe became stopped up, as it very likely did, considerable condensation accumulated in the exhaust pipe between the time of shutting down on Saturday and of starting on Monday morning. As soon as the engine reached normal speed with no load the governor cut down the steam admission to the cylinder to a very small amount, the cold cylinder walls readily produced a vacuum in the engine, and the water was thereby drawn into the cylinder and caused the damage. It hardly seems probable that the water reached the engine from the boiler as the water was well below the normal level at the time of the accident. To guard against a repetition of the accident, however, the exhaust line has since been provided with a larger drain pipe.

Engines may very often be subjected to any one of a number of conditions that will cause a sudden breakdown. Protection against the financial loss that is so brought about may, however, be secured by having the engine covered by a Hartford Engine Breakage Policy.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, APRIL, 1921.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

TO be given a "square deal," machinery of every description should rest upon a firm foundation. In no case does this apply with greater force than in that of the steam engine. Although the inertia of the reciprocating parts is well balanced in a properly designed engine, yet there must inevitably be a varying load imposed upon the area on which the engine rests. A varying load is often more harmful than a steady pressure and inadequate support under such conditions must result in misalignment of the parts and, sooner or later, undue wear will develop even if actual breakage does not occur. This is particularly true in an engine covering a large area with the loads concentrated upon a relatively small number of bearing points.

We would therefore call particular attention to the article entitled, "Engine Foundations" which appears in this issue of The Locomotive. Not all the points involved in the design and construction of a foundation have been covered but we believe that the information given, together with some thought to local conditions, will be adequate for any ordinary installation. In any case, play safe. The added years of life that are given an engine by providing a well designed and well constructed foundation are well worth the extra cost.

OBITUARY.

Mr. Edward B. Hatch, a director of The Hartford Steam Boiler Inspection and Insurance Company, died on February 18th at his home in Hartford after a brief illness. This wholly unexpected termination of an exceptionally active life came as a great shock to a wide circle of friends and associates not only in the community in which he lived but also throughout the country generally. Mr. Hatch was well known throughout the business world and was highly regarded for the qualities which had made him successful in the industries under his care and also because he brought to every business relationship the qualities which distinguish a gentleman and the straightforward, honest dealing of a stern Christian character. After graduating from Trinity College, Mr. Hatch entered the employ of the Johns-Pratt Company of Hartford, which was then a young enterprise in a novel and untried line of business. He entered into his work there with the energy and devotion which characterized his business connections all his life and early was given the responsible direction of its affairs, to later become its President, a position which he held until his death. The Johns-Pratt Company is to-day one of Hartford's largest and most prosperous industries. Its present success stands as a monument to the ability and energy of Mr. Hatch's life.

Mr. Hatch was actively connected as officer or director with many other industrial and financial corporations both in Hartford and in other sections of the country. In his own city he took great interest in civic affairs. For several terms he served as a member of the Board of Water Commissioners of Hartford at a time when important enlargement of the water supply presented many serious problems for consideration, and it is recognized that their successful solution was in large part due to the constructive study and judgment which he gave in that service.

Mr. Hatch was elected a director of The Hartford Steam Boiler Inspection and Insurance Company in 1915 and served continuously from that date. He brought to the deliberations of the Board the viewpoint of a man of affairs and broad experience in the business world. As a manufacturer he knew the needs and requirements of that large class of business men whom our Company especially serves, and he was in position to advise how that class could best be served by us. Our Company has indeed sustained a great loss in his death. The Board of Directors of this Company, in a desire to express their sorrow and their sense of this loss, directed, at a meeting on February 23rd, that the following minute be entered on the records of the corporation:

> " It is with sad hearts that we record the death of Mr. Edward B. Hatch, who died on February 18th, 1921, following a very brief illness. As a director of this Company since February, 1915, he ever showed his devoted interest in its affairs. He was sound in Christian character, kindly in nature, practical in business, and was regarded as a friend by all who knew him.
>
> The members of the Board of Directors, with a deep sense of their loss, desire to express to his wife their sincerest sympathy, and to record this minute upon the books of the Company, and the Secretary is hereby instructed to send a copy of it to Mrs. Hatch."

OUR "BOILER BOOK."

FOR more than forty years the designs of the Engineering Department of this Company have been accepted as standards throughout the United States and have been copied into the most authoritative engineering handbooks and textbooks as well as the trade catalogs of the best known boiler makers and dealers in materials required for boiler construction.

Our designs and standards have been disseminated principally in the form of blue-prints, of which more than 83,000 have been sent out since the Engineering Department was established. As a rule, however, each blue-print covers but one single phase of some particular subject and we have often thought that it would be worth while to assemble some of the more commonly used data in the form of a pamphlet. This idea has been more forcibly brought to our attention since the promulgation of the Boiler Code of the American Society of Mechanical Engineers and its adoption by several states and cities. Upon its publication, we adopted this Code as a standard and all our drawings, tables, and other data in use today have been designed in accordance with its provisions. In view of the many inquiries that we receive regarding the A. S. M. E. rules for boiler design, it would seem that such data ought to be especially valuable to those who are trying to follow such requirements.

With these ideas in mind we have published, "The Boiler Book" of The Hartford Steam Boiler Inspection and Insurance Company. This book, which has been gotten out in loose-leaf form so that it may later readily be expanded, is not intended as a treatise on boiler design but merely as a collection, in convenient form, of data which we have found valuable in our Engineering Department and which we hope will prove of equal value to those who may have occasion to use it. Among the subjects covered the following may be mentioned: Design of Riveted Joints; Tube Layouts; Allowable Pressures on Spherical Heads and Unstayed Furnaces; Design of Horizontal Tubular Boiler Settings with table of dimensions and number of brick required; tables relating to Heating Surface, Horse Power and Weights of Horizontal Return Tubular Boilers; Safety Valves; and other miscellaneous tables of interest. Since the subject matter deals only with the design of boilers the book is not one which would be of interest to the operating man. It is intended rather for the use of boiler-makers and designers, consulting engineers, and college professors.

We have a limited number of copies of The Boiler Book for distribution, at the price of $1.50 per copy, to those interested in it.

Pat was Persistent.

PAT was never happier than when in a heated argument. He lived to argue, he fattened on it, thrived on it.

At one time Pat had a job with Jones Brothers and Company as a fireman. Now Pat had never taken the Hartford Correspondence Course for Firemen but he thought he knew how to burn coal. No one could tell him any better methods than he knew and used. The Engineer did his best to show him how to use his head to save his back but it was no use. Pat used more time in arguing than he did in firing. So the Engineer decided that Pat must go. He knew that there would be trouble if he told Pat he was discharged so in order to save time he wrote Pat a letter to that effect.

Pat left, but a few days later the Engineer walked in to find Pat at work in the boiler room.

"Pat," he said, "did you get a letter from me?"

"Oi did, sor," said Pat.

"Well, Pat, what did that letter say?"

"Indade and Oi read yor letter on the insoide and on the ootsoide. On the insoide it said Oi was foired, but bejabers, on the ootsoide it said 'Rayturn to Jones Brothers and Company in foive days.'"

Summary of Inspectors' Work for 1920.

Number of visits of inspection made	207,641
Total number of boilers examined	393,900
Number inspected internally	173,034
Number tested by hydrostatic pressure	9,376
Number of boilers found to be uninsurable	1,139
Number of shop boilers inspected	14,469
Number of fly wheels inspected	39,924
Number of premises where pipe lines were inspected	10,423

Summary of Defects Discovered.

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale	35,236	1,938
Cases of adhering scale	47,064	1,799
Cases of grooving	2,136	294
Cases of internal corrosion	22,382	1,133
Cases of external corrosion	11,999	983
Cases of defective bracing	964	288
Cases of defective staybolting	3,058	715
Settings defective	10,065	892
Fractured plates and heads	3,738	544
Burned plates	4,046	547
Laminated plates	459	37
Cases of defective riveting	1,216	268
Cases of leakage around tubes	14,884	1,586
Cases of defective tubes or flues	21,804	6,531
Cases of leakage at seams	5,650	533
Water gauges defective	5,126	877
Blow-offs defective	5,346	1,505
Cases of low water	454	168
Safety-valves overloaded	1,212	332
Safety-valves defective	2,119	435
Pressure gauges defective	7,540	733
Boilers without pressure gauges	715	152
Miscellaneous defects	5,526	773
Total	212,739	23,063

Grand Total of the Inspectors' Work from the Time the Company Began Business, to January 1, 1921.

Visits of inspection made	4,940,994
Whole number of inspections (both internal and external)	9,783,103
Complete internal inspections	3,832,669
Boilers tested by hyrostatic pressure	376,489
Total number of boilers condemned	28,978
Total number of defects discovered	5,492,424
Total number of dangerous defects discovered	603,683

FLYWHEEL EXPLOSIONS.

DURING 1920

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	Jan.	17	Flywheel exploded	4		Kasa William Colliery	Coal Mining	Pottsville, Pa.
2	Jan.	21	Flywheel exploded		2	Goodyear Metallic Rub. Shoe Co.	Rubber Shoes	Naugatuck, Conn.
3	Feb.	5	Flywheel exploded	1		George Hunt	Wood Saw	Sacramento, Calif.
4	Feb.	23	Flywheel exploded See Locomotive for April, 1920		3	Pacific Lumber Co.	Saw Mill	Scotia, Calif.
5	Feb.	29	Flywheel exploded on gasoline motor fire engine		1	City of Milwaukee	Fire Dept.	Milwaukee, Wis.
6	March	12	Centrifugal separator exploded	1	2	United Gas Improvement Co.	Gas Plants	Philadelphia, Pa.
7	March	23	Broken pulley			Grosvenor Dale Co.	Cotton Mills	North Grosvernor Dale, Conn.
8	May	5	Broken pulley			Hodge Boiler Works	Boiler Mfgs.	E. Boston, Mass.
9	June	1	Turbine overspeeded and burst	1		Phœnix Mills	Knitting Mill	Little Falls, N. Y.
10	June	23	Flywheel exploded			Arkansas Light & Power Co.	Power Station	Stuttgart, Ark.
11	July	11	Broken pulley			Ash Grove Lime & Portland Cement Co.	Lime & Cement	Chanute, Kans.
12	Aug.	4	Broken pulley			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
13	Aug.	6	Ensilage cutter exploded	1		Harry Klock	Farm	Harlowton, Mont.
14	Aug.	7	Flywheel explosion			C. B. & Q. R. R.	Railroad Shop	Centerville, Ia.
15	Aug.	12	Flywheel exploded		1	Scott Paper Co.	Paper Mill	Chester, Pa.
16	Aug.	25	Pulley exploded			MacAndrews & Forbes Co.	Licorice	Camden, N. J.
17	Aug.	26	Flywheel exploded		1	West Va. Pulp & Paper Co.	Paper Mill	Mech'n'ville, N.Y.
18	Sept.	1	Pulley exploded			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
19	Sept.	15	Flywheel explosion			Herman Schmidt	Cotton Gin	Kingsbury, Tex.
20	Sept.	20	Ensilage cutter exploded			Cleve Walker	Farm	Alexandria, Ind.
21	Sept.	28	Flywheel exploded See page 163 of this issue of The Locomotive	1	1	Kentucky Utilities Co.	Power Station	Richmond, Ky.
22	Oct.	19	Flywheel exploded	1	2	J. W. Wells Lumber Co.	Saw Mill	Menomonie, Wis.
23	Oct.	25	Flywheel exploded See Jan. 1921 issue of The Locomotive			Lancaster Cotton Oil Co.	Cotton Gin	Lancaster, S. C.
24	Oct.	28	Pulley exploded			Richard Borden Mfg. Co.	Cotton Mill	Fall River, Mass.

FLYWHEEL EXPLOSIONS.

(Continued)

No.	MONTH	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
25	Oct.	29	Flywheel exploded		1	Girardville Gas Works	Gas Plant	Shenandoah, Pa.
26	Nov.	8	Flywheel exploded See Jan. 1921 issue of The Locomotive			Stuttgart Rice Mills Co.	Rice Mill	Stuttgart, Ark.
27	Nov.	19	Flywheel exploded		1	Charles Curry	Gasoline engine	Manchester, O.
28	Nov.	20	Two flywheels exploded			Acme Road Machinery Co.	Road machinery	Frankfort, N. Y.
29	Nov.	21	Flywheel exploded			Federal Plate Glass Co.	Glass Works	Ottawa, Ill.
30	Dec.	16	Flywheel exploded	1		American Strawboard Co.	Paper Mill	Quincy, Ill.
31	Dec.	31	Flywheel exploded		1	Municipal Light Plant	Power Station	Hannibal, Mo.

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF JULY, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
320	2	Boiler accident	1		Pennsylvania R. R.	Railroad	Atlantic City, N. J.
321	2	Boiler explosion		1	Main St. Bakery	Bakery	Sandoval, Ill.
322	2	Boiler explosion		2	P. Riosette and P. Gubuotte		Springfield, Ill.
323	4	Boiler ruptured	1	1	Ford Colleries Co.	Coal Mining	Bairdford, Pa.
324	5	Accident to blow off pipe		1	City of Caldwell	Lgt. & Wat. Plant	Caldwell, Kan.
325	6	Broken header			Westinghouse Air Brake Co.	Air Brake Mfgs.	Wilmerding, Pa.
326	7	Boiler explosion		1	Eugene Sharp farm	Threshing mach.	Milford, Del.
327	7	Four tubes pulled out			Grant Leather Corp'n	Tanning extracts	Kingsport, Tenn.
328	7	Tube rupture			Philip Dietz Coal Co.	Coal & Ice Dealers	Brooklyn, N. Y.
329	12	Accident to blow off pipe			Interstate Water Co.	Water supply	Danville, Ill.
330	12	Section heating boiler cracked			City of Springfield	School	Springfield, Mass.
331	13	Ruptured fire sheet			Windsor Ice Co.	Ice & Cold Storage	Windsor, Mo.

332	13	Boiler explosion	1	2	Sharp farm	Threshing mach.	Houston, Del.
333	13	Nine headers cracked			Ehret Magnesia Mfg. Co.	Magnesia covering	Port Kennedy, Pa.
334	13	Furnace collapse			Orinoka Mills	Weaving & Dyeing	Philadelphia, Pa.
335	14	Valve burst	1		Belton Coal Mining Co.	Coal Mining	Drakesboro, Pa.
336	15	Section of heating boiler cracked			Georgia State Normal School	Normal School	Athens, Ga.
337	16	Boiler explosion	1		George Becker	Fertilizers	Wauseon, Ohio
338	16	Autogenously welded boiler exploded	2	3		Sawmill	McMin'ville, Tenn.
339	17	Boiler exploded	1		Keating farm	Threshing mach.	Ponca City, Okla.
340	17	Boiler of locomotive exploded	3			Railroad	Kellogg, Minn.
341	19	Tube and header ruptured			American Steel & Wire Co.	Steel Plant	Waukegan, Ill.
342	19	Steampipe accident	1	1	Steamship "Aquitania"	Steamship	At sea.
343	20	Failure of boiler stop valve			Clinton-Copeland Co.	Candy Mfgrs.	Burlington, Iowa.
344	21	Boiler exploded		3		Rice Mill	Bogaloosa, La.
345	21	Boiler of locomotive exploded		3	Pittsburgh & Lake Erie R. R.	Railroad	Brownsville Jct. Pa
346	22	Tube rupture	1		Hull & Dillon Packing Co.	Meat packers	Pittsburg, Kan.
347	22	Tube rupture			Drayton Mills	Cotton Mill	Spartansburg, S.C.
348	22	Boiler explosion		1	Charles Luft farm	Threshing mach.	Keokuk, Iowa.
349	22	Failure of pipe fitting	1		City of Benton	Municipality	Benton, Ark.
350	24	Boiler of locomotive exploded	2		Georgia & Alabama R. R.	Railroad	Richland, Ga.
351	24	Tube rupture		1	Armour & Co.	Meat packers	Chicago, Ill.
352	26	Tube rupture			S. A., Uvalde & Gulf R. R.	Railroad	Pleasanton, Tex.
353	28	Tube rupture			Newcomb Hotel Co.	Hotel	Duluth, Minn.
354	28	Tube rupture			Ætna Portland Cement Co.	Cement Mfgs.	Fenton, Mich.
355	29	Heating boiler exploded			John Lang	Residence	Sioux City, Ia.
356	29	Tube rupture			Thos. Potter Sons & Co.	Linoleum Mfgs.	Philadelphia, Pa.
357	30	Boiler of locomotive exploded		2		Railroad	Greenfield, Mass.
358	30	Ruptured fire sheet			Mayfield Coal & Ice Co.	Coal & Ice Co.	Mayfield, Ky.
359	31	Heating boiler exploded			H. P. Crane	Residence	St. Charles, Ill.
360	31	Tube rupture			American Steel & Wire Co.	Steel Plant	Joliet, Ill.

MONTH OF AUGUST, 1920

361	2	Boiler of locomotive exploded		2	Arabia Granite Co.	Granite Quary	Lithonia, Ga.
362	3	Tube rupture		5	Union Light & Power Co.	Power Station	Junc. City, Kan.
363	3	Section of heating boiler cracked			University of Pittsburgh	University	Pittsburgh, Pa.
364	3	Tube rupture		1	Ætna Portland Cement Co.	Cement Mfg.	Fenton, Mich.
365	4	Economizer explosion		4	Aluminum Ore Co.	Aluminum	E. St. Louis, Ill.
366	4	Tube rupture			Delaware River Steel Co.	Steel Plant	Chester, Pa.

MONTH OF AUGUST, 1920 — Continued.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
367	4	Ruptured fire sheet		3	Peterson Beverage Co.	Beverages	Grand Rds., Mich.
368	4	Furnace sheet cracked			McCleary, Wallin & Crouse	Carpet Mfgrs.	Amsterdam, N. Y.
369	5	Broken headers and ruptured tube			Crown Oil & Refining Co.	Oil refiners	Houston, Tex.
370	8	Boiler exploded		2	T. Carlous	Threshing mach.	Ponca City, Okla.
371	8	Two headers cracked			Bd. of Penitentiary Comm.	Power House	Santa Fe, N. M.
372	10	Two sections heating boiler cracked			D. G. Dery	Silk Mill	Allentown, Pa.
373	12	Boiler exploded			J. Channess	Threshing mach.	Marion, O.
374	13	Three tubes pulled from drum			West Penn Power Co.	Power Station	Wheeling, W. Va.
375	13	Boiler explosion			W. J. Parrish	Brick Mfg.	Richmond, Va.
376	14	Boiler explosion	1		Robt. Erdman	Threshing mach.	Aberdeen, S. Dak.
377	17	Boiler explosion		3	Golley & Finley	Machine Shop	Lima, Ohio.
378	18	Ruptured fire sheet			Eldon Ice & Fuel Co.	Ice Plant	Eldon, Mo.
379	18	Four headers broken			Glen Willow Ice Mfg. Co.	Ice Plant	Glen Willow, Pa.
380	19	Boiler of locomotive exploded	1	1	Canadian Western Lumber Co.	Lumber	Vancouver, B. C.
381	21	Tube failure		1	Middle West Utilities Co.	Power Station	Mounds, Ill.
382	21	Ruptured boiler			Harrison Electric Co.	Power Station	Harrison, Ark.
383	24	Fire sheet bulged and cracked			City of Fairmont	Lgt. & Wat. Wks.	Fairmont, Neb.
384	24	Superheater drum cracked			Public Service Corp. of N. J.	Power Station	Newark, N. J.
385	25	Boiler exploded	1		McAuliffe Farm	Threshing mach.	Woodstock, Ill.
386	25	Tube rupture			Consumers Power Co.	Power Station	Flint, Mich.
387	25	Boiler exploded		2	W. Harbold farm	Threshing mach.	Marshalltown, Ia.
388	26	Tube failure		3	Wells Building	Office Building	Milwaukee, Wis.
389	26	Ruptured fire sheet			Peoples Ice & Cold Storage	Ice & Cold Storage	Claremore, Okla.
390	26	Plate bulged and cracked			Susquehanna Collieries Co.	Coal Mining	Shamokin, Pa.
391	27	Tube failure	1		National Sewing Machine Co.	Sew. Mach. Mgrs.	Belvidere, Ill.
392	27	Tube pulled out of drum	1		Rosiclare Lead & Fluorspar Co.	Fluorspar	Rosiclare, Ill.
393	27	Cracked header			Cleveland & Erie Elec. Ry. Co.	Electric Railway	Elk Park, Pa.
394	29	Tube rupture			Providence Gas Co.	Gas Works	Providence, R. I.
395	30	Tube rupture			Woodward Iron Co.	Iron Works	Woodward, Ala.
396	31	Crown sheet failed		2	Whitney Engineering Co.	Eng. Supplies	Tacoma, Wash.

MONTH OF SEPTEMBER, 1920

397	1	Boiler exploded		2	Del-Tex Syndicate	Drilling for oil	Powell, Texas.
398	2	Tube rupture		1	Los Angeles Gas & Elec. Co.	Power Station	Los Angeles, Cal.
399	2	Head forced off			G. H. Prettyman	Canning	Milford, Del.
400	2	Boiler ruptured			Oscar Nelson	Gasoline plant	Brnchs Sdg W. Va.
401	3	Boiler of locomotive exploded	2	3	Baltimore & Ohio R. R.	Railroad	Proctor, W. Va.
402	3	Boiler exploded	1			Drilling for oil	Portsfalls, W. Va.
403	3	Tube ruptured			Public Service Corp. of N. J.	Power Station	Perth Amboy, N. J.
404	5	Boiler ruptured			Texas Ice & Cold Storage Co.	Ice Plant	Dallas, Texas.
405	7	Boiler of locomotive exploded	1		Detroit, Toledo & Ironton R. R.	Railroad	Springfield, O.
406	7	Boiler of locomotive exploded	2		Chicago & Alton R. R.	Railroad	Shirley, Ill.
407	7	Tube ruptured			Tennessee Paper Mills	Paper Mill	Chattanooga, Tenn.
408	8	Boiler explosion	3		Steamer "Empire City"	Steamship	On Lake Erie
409	9	Fire sheet bulged and cracked			City of Madison	Power Plant	Madison, Neb.
410	10	Ruptured patch			Vernon Parish Lumber Co.	Saw mill	Kurthwood, La.
411	10	Boiler of locomotive exploded		2	Delaware & Hudson R. R.	Railroad	Lake Placid, N. Y.
412	10	Boiler of locomotive exploded		2	C., R. I., & P. R. R.	Railroad	Falcon, Colo.
413	10	Tube failure			Island Creek Coal Co.	Coal Mining	Holden, W. Va.
414	12	Tube rupture		1	The Casey-Hedges Co.	Boiler Shop	Chattanooga, Tenn.
415	12	Accident to blow off pipe		1	Torsch Packing Co.	Canning	Norma, N. J.
416	13	Boiler explosion	2	2	Antlers Lumber Co.	Lumber Mills	Antlers, Okla.
417	15	Heating boiler exploded			L. Kontos	Tailor	David City, Nebr.
418	16	Crown sheet failure			Blackwell Lumber Co.	Lumber Mill	Fernwood, Idaho.
419	18	Accident to steam pipe		1	H. C. Frick Coke Co.	Coke Plant	Rices Landing, Pa.
420	21	Boiler of locomotive exploded	3		New York Central R. R.	Railroad	Matoon, N. Y.
421	21	Two sections of heating boiler cracked			Town of Danbury	School	Danbury, Conn.
422	22	Boiler explosion		3	D. P. Grinels	Meat packer	Urbanna, Va.
423	22	Boiler bagged and ruptured			Greenwell Brothers	Ice Plant	Morganfield, Ky.
424	23	Tube rupture			Jessup & Moore Paper Co.	Paper Mill	Wilmington, Del.
425	23	Boiler explosion		2		Saw mill	Cameron, O.
426	23	Boiler bagged and ruptured			Graff Bros. Co.	Coal Mining	Black Lick, Pa.
427	24	Tube failure			American Sheet & Tin Plate Co.	Tin Plate Mfgrs.	New Castle, Pa.
428	24	Boiler explosion		1		Threshing mach.	Stevens, Pa.
429	24	Tube failure			Diamond Alkali Co.		Fairport, O.
430	25	Boiler exploded		3	Isco Chemical Co.	Chemical Plant	Niagara Falls, N.Y.
431	26	Tube failure	1		Interm't'n Lgt. & Power Co.	Power Station	Scottsbluff, Nebr.
432	27	Tube failure			Robert Smith Ale Brewing Co.	Brewers	Philadelphia, Pa.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1921

Capital Stock, . . $2,000,000.00

ASSETS.

Cash in offices and banks		$366,891.88
Real Estate		90,000.00
Mortgage and collateral loans		1,543,250.00
Bonds and stocks		6,188,435.00
Premiums in course of collection		728,199.44
Interest accrued		116,654.78
Total assets		9,033,431.10

LIABILITIES.

Reserve for unearned premiums		$4,512,194.11
Reserve for losses		205,160.80
Reserve for taxes and other contingencies		388,958.85
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,927,117.34	
Surplus to Policy-holders		**$3,927,117.34**
Total liabilities		$9,033,431.10

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FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
E. SIDNEY BERRY, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.
J. J. GRAHAM, Supt. of Agencies.

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The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIII. HARTFORD, CONN., JULY, 1921. No. 7.

BOILER EXPLOSION AT LUMBER, SOUTH CAROLINA.

Showing How the Boiler Ripped Open.

Another Long Seam Boiler Explosion.

THE long seam boiler again demonstrated its ability to kill people and cause enormous property damage when a boiler of this construction exploded at the mill of The McKeithan Lumber Company, Lumber, South Carolina, on April 26th.

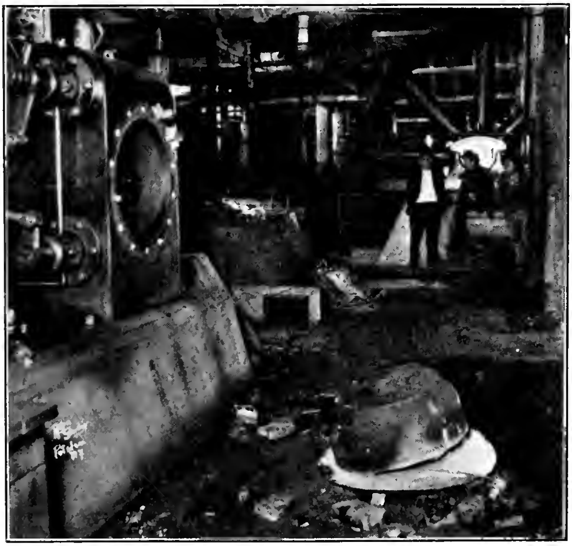
The mill had been idle for some time and was about to resume operations, the boiler plant having been fired up for this purpose. Shortly before a force of two hundred men were to report for work, the boiler exploded with terrific violence and if the accident had occurred a little later the casualty list would have been a long one. As it was, two men were killed and the mill almost entirely destroyed, the damage being estimated at about $30,000. A view of the wreckage appears on the front cover of this issue of The Locomotive.

The boiler was built with two sheets — one upper and one lower — with two horizontal lap seams running the length of the shell. The explosion, as is usual in this type of construction, was the result of a lap seam crack. Whereas a boiler subject to this type of defect is always treacherous, the long seam gives additional opportunity for an extremely violent explosion because the boiler may rip open from head to head. This is clearly shown on the opposite page in the illustration of the wrecked boiler at the McKeithan mill. Evidence of the fatal lap seam crack can also be clearly seen.

A Recent Engine Breakdown.

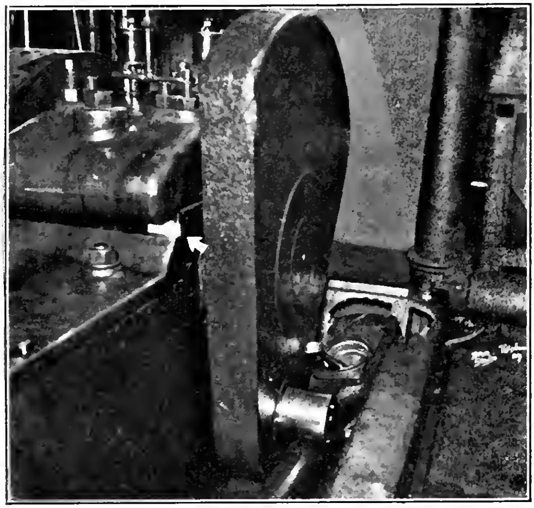
PRODUCTION at the Raymondville, N. Y., plant of the Remington Paper and Power Company was seriously interfered with a short time ago by reason of an engine breakdown. Had the engine been an old one, the accident might not have caused great surprise, but since it was a comparatively new machine — having been in operation less than a year — the break came when least expected and the case is a good illustration of the hazard that exists in operating any and every engine, whether it be new or old.

The initial failure occurred at the cross-head, which broke into several pieces. When this happened the piston and rod were free of restraint and when the valve, which was still in operation, admitted steam to the crank end of the cylinder, the piston was driven with terrific force against the cylinder head. The blow ruptured almost every cylinder-head stud and drove off the head itself, which landed, as shown in the illustration, on the floor nearby. The piston did not leave the cylinder but was damaged to such an extent that a new one had to be installed.



THE CYLINDER HEAD END OF THE WRECK.

An attendant, who was standing nearby, shut off the steam from the engine as soon as it was possible for him to do so but not before further damage had been done. The connecting-rod, driven by the crank and being somewhat free at the cross-head end, whipped about until it broke the crank-pin brasses and then fell into the crank pit. In this position it did not leave sufficient room for the crank-pin to pass by, with the result that the crank-shaft was lifted bodily from the inboard bearing when the crank-pin struck the connecting-rod. The parts came to rest at this point as illustrated herewith. It can be clearly seen how the bearing-cap was lifted from its place, the cap bolts having been elongated to permit this movement.



THE CRANK END OF THE WRECK.

To repair the engine, a new cross-head, cylinder-head, piston and crank-pin were required and the mill was, of course, without the services of the engine while these new parts were being obtained and installed. The assistance of our inspector at the mill and of our branch office nearest the engine manufacturer, however, served to expedite the repairs and, furthermore, the owners, being covered by both a Direct and a Use and Occupancy Engine Policy in The Hartford, were promptly indemnified.

The Value of Inspections.

NOT long ago one of our inspectors made a visit to a plant for an internal inspection of a horizontal return tubular boiler, and while in the furnace he noticed a brownish stain on the shell, well up on the side where the brick wall of the furnace and the shell join. To his trained eye this indicated a leak and he thereupon questioned the chief engineer as to whether any leakage had been noticed. The reply was in the negative but our inspector, nevertheless, was not satisfied. Climbing on top of the boiler he proceeded to learn, if possible, the source of the leak that had caused that stain on the boiler shell. The engineer called his attention to a water pipe running across and somewhat above the boiler, mentioning that considerable condensation collected on this pipe and that possibly there was some water reaching the boiler from this source. This did not seem an altogether satisfactory explanation, however, so the inspector ordered some of the asbestos covering of the boiler removed at a point where he believed a leak might be. The boiler was then filled with water under pressure and it was probably some-

Water Issuing from a Lap Seam Crack.

what of a surprise to all present but the inspector to see water spraying out through a crack in the boiler shell as shown in the photograph herewith. The leakage was through a lap seam crack and it is practically certain that this boiler would have caused a disastrous explosion if it had remained in service. The watchful eye of the inspector, however, prevented further use of the boiler and thereby safeguarded life and property.

The case just cited brings to our mind a somewhat similar one in which the owner had repairs made and only by good fortune was a serious accident averted. The engineer of the plant, a laundry, noticed some steam issuing through the covering of the boiler and upon investigation found that the steam came from a crack in the shell of the boiler. The crack was of the lap seam type but the owner did not know its dangerous character and neither did the self-styled "boiler-maker" he called in for advice. This "expert" said, "That's all right. Go ahead and use her till the end of the week and then shut her down. I'll be over Sunday and weld her up." He apparently did not know that autogenous welding in a case of this kind is a most dangerous practice, or else he had no regard for the safety of the fifty girls at work directly above the boiler.

One of our inspectors heard of the case and made a visit to the place. As soon as he saw the nature of the leak he advised an immediate shutdown of the boiler and also told the owner that the contemplated repairs would not make the boiler any less dangerous to operate.

A few days later a hydrostatic test was applied to the boiler and the results were practically identical with the first case mentioned. The demonstration and the inspector's explanation of the serious nature of the defect were sufficient for the owner, and not only the leaking boiler but also its mate, both of them of the same age, were removed and new ones installed. Had this precaution not been taken there might very easily have been a repetition of the accident which occurred at the American Palace Laundry, Buffalo, N. Y., on November 3rd, 1906. In this disaster, the boiler, which was of the long seam type, failed as the result of a lap seam crack and four persons were killed. The property loss amounted to $12,000.

ENGINE ALIGNMENT

THE alignment of the component parts of an engine is an extremely important factor in determining its serviceable life. Too great care and attention cannot be given to the erecting and assembling of an engine, for undue wear and breakage from repeated stress on the parts will surely result if misalignment exists. It is well, also, when the opportunity is presented, to check up the alignment of an engine that has been in use for any length of time. Settling of foundations, structural weakness within the engine, and wear resulting from long continued service will bring about conditions that only a complete overhauling and readjustment can remedy.

The majority of engines are built with a foundation or sole-plate extending under and supporting the several castings. In such a case, lines representing the center lines of the cylinder and the cross-head may readily be marked on the sole-plate which can then be set level and in its proper relation to the machinery it is to drive. After this has been accomplished the different parts of the engine can be placed and aligned with each other. In the case of a new engine of this type, the alignment is taken care of by the machined joints of the separate castings so that the only point requiring particular care is the setting of the outboard bearing. Some of the smaller types of engines are entirely self contained and are shipped as one assembled unit from the factory. Such engines, when new, require no attention other than setting in correct relation with the machinery to be driven and with the crank shaft and cylinder level. On the other hand, the wear that results from long continued service will frequently require that such an engine be readjusted and realigned.

There are some engines, however, that have been built without sole-plates, and, instead, have the different castings resting directly upon the concrete foundation. The alignment of such an engine requires exceptional care because there is no level, machined surface, such as the sole-plate, to insure alignment of the different parts. The cylinder casting, cross-head barrel, main frame and outboard bearing must be set individually and securely fixed in position as the work proceeds. In this work, flat iron wedges are used between the castings and the foundation so that a space of from ½″ to 1″ will exist for the bed of cement grout.

Possibly each type of engine might call for a special method of procedure as regards its alignment. We will assume, however, for the purpose of discussion, that we are dealing with the type of construction that has just been mentioned — that without a sole-plate — and that the engine is to be erected for belt drive to a line shaft. Such a case would cover practically all the points involved in the alignment of engines, and, from the discussion of the subject, particular steps may be selected or modified to suit particular cases or conditions.

The steps to be taken in this work will first be enumerated in the order in which they should be taken and a further discussion of them will then be given. The procedure which, in general, will apply to a new engine or an old one being re-erected is as follows:

(1) From the position of the line shaft obtain a reference line to which the center line of the cylinder is to be made parallel.

(2) Set the cylinder so that its center line is level and parallel to the reference line.

(3) Set the cross-head slide so that its center line will coincide with that of the cylinder.

(4) Set the casting which carries the inboard bearing so that the center line of this bearing will be at exact right angles to the center line of the cylinder.

(5) Set the outboard bearing to bring the center line of the shaft level and at right angles to the center line of the cylinder.

(6) Assemble the remaining parts of the engine, taking care to check the correct relationship or alignment of each part as the work proceeds.

In the case of a self contained engine it is a simple matter to place the crank shaft parallel to the line shaft by the usual procedure of aligning belt wheels and pulleys. In the case of the type of engine under consideration, however, whereas the crank shaft could easily be placed parallel to the line shaft, such procedure would involve difficulties when the cylinder and cross-head slide are to be adjusted to their proper relation with the crank shaft. It therefore becomes necessary to erect a reference line which shall be perpendicular to the line shafting and to which the center line of the cross-head slide will be made parallel.

To secure this reference line the line shafting must be placed in alignment from hanger to hanger. The next step is to drop a plumb line from two points of the line shaft to the floor, as shown in Fig. 1 at AA, and thus get the line BB which will necessarily be parallel to the shaft. From a point C (the selection of which will later be made apparent) measure off the distance CD equal to three feet. Then with a board or steel tape, swing an arc with center at C and radius

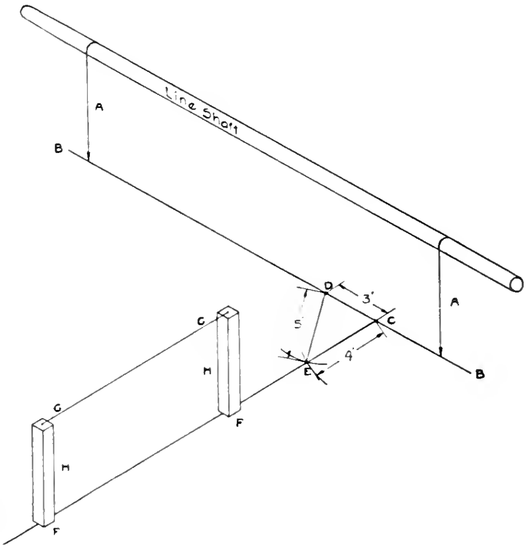


Fig. 1.

of four feet and another with center at D and radius of five feet. The intersection of these two arcs will give the point E and the line through CE will be perpendicular to the line BB because the sum of the squares of the two short sides of a right angled triangle is equal to the square of the hypotenuse or long side.

At the two points FF (the selection of which will also be evident later on) erect two posts HH, plumb them vertical, and brace them to remain fixed in that position. The tops of these posts should be at about the same level as that of the cylinder. Now stretch a line, GG, over the tops of the posts and, with the aid of a plumb bob or spirit plumb, bring this line exactly over the line on the floor and fasten it in this position. The line thus erected is, by construction, perpendicular to the line shafting, although not intersecting it, and is the reference line to which the axis of the cylinder is to be made parallel.

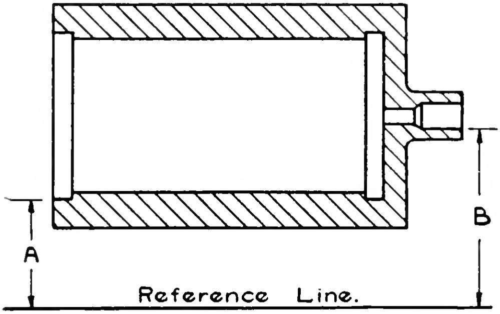


Fig. 2.

If the cylinder has not already been placed in its approximate position as determined by the foundation bolts, this part of the work should now be attended to and the cylinder should then be set level and parallel to the reference line. A spirit level of fairly good length placed inside and on the bottom of the bore will serve to show which way the cylinder must be shifted in a vertical plane. If the cylinder has been in service for some time and has become worn out of round it should be rebored. This work should be entrusted only to competent men experienced in such work.

The locating of the cylinder in a horizontal plane so that it will be parallel to the center line is a simple matter. Fig. 2 is a plan view showing how this may be accomplished. The lengths A and B are entirely arbitrary. What is of importance is the difference between A and B and this may readily be calculated from measurements of the cylinder.

The center line or axis of the cylinder is to be represented by a stout linen thread or annealed copper wire stretched through the cylinder, passing from the head end, through the piston rod stuffing box, and continuing to a point well beyond the center line of the crank shaft. This line must be located by careful measurement with reference to the bore of the cylinder at the head end and the bore of the stuffing box at the crank end of the cylinder.

To locate and securely fix the line at the head end, a fixture

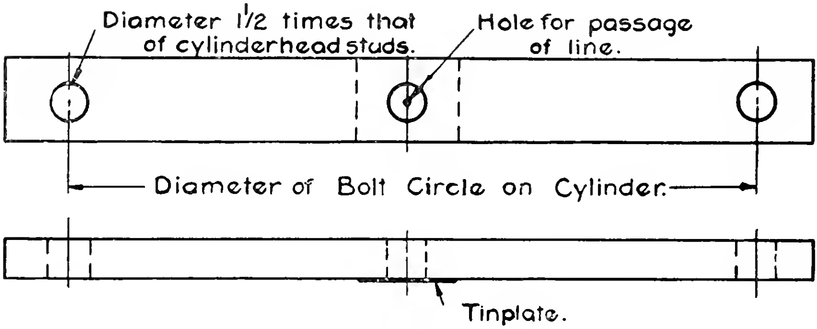


FIG. 3.

such as that shown in Fig. 3 may be used. For the crank end a wooden plug similar to that shown in Fig. 4 should be made. This plug should be turned and bored in the lathe so that the center of the small hole passing through it and the center of the plug itself will be identical. These two fixtures are installed on the cylinder as shown in Fig. 5. One end of the line is tied around a short stick or rod, as shown in Fig. 5, and is then passed from the head end of the cylinder through the hole in the tin plate, which should be no larger than to just permit passage of the line, through the hole in the plug at the stuffing box and continued several feet beyond the center of

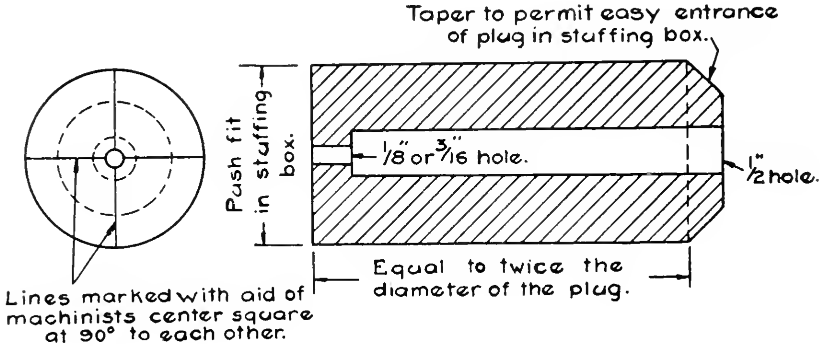


FIG. 4.

the crank shaft as indicated in Fig. 6, to a point on a standard or post that has been erected in a thoroughly secure position for this purpose. A convenient method for locating this end of the line — and the same scheme may also be used at the cylinder end — is as illustrated in Fig. 7 on page 204. The notched piece of sheet metal is clamped to the post until its correct position is accurately determined and it is then securely fastened to the post. The line is run through this notch and fastened on the post at some convenient point. This method of providing two fixed points through which the line may be run is adopted so that the line may be removed or replaced when it is found necessary to do so.

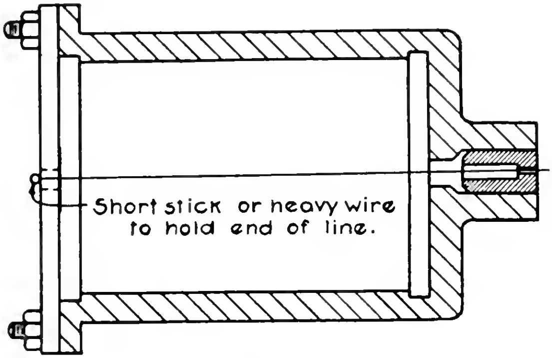


Fig. 5.

The line must now be centered in the cylinder at both ends. At the head end a centering rod or stick, with an ordinary pin driven in each end, is used. By placing one end of this rod on the surface of the cylinder bore at four points, 90° apart from each other, swinging the other end of the rod past or near the line and, at the same time, shifting, if necessary, the position of the board bolted on the cylinder, the line can be brought to the exact center of the cylinder bore. The length of the test rod should be adjusted from time to time until it will just touch the line when placed at the four equidistant points. This is a very particular and nice part of the work and must be carried out with extreme care. "About right" will not do — it must be *exactly* right.

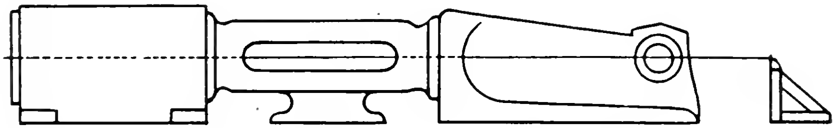


Fig. 6.

The method of centering the line by reference to the bore of the cylinder should be used only where the cylinder is new or has been rebored. In the case of an old engine which has not been moved from its foundation but which is to be checked for alignment the centering of the line should be with reference to the counterbore of the cylinder. This is because wear of the cylinder may have occurred and an incorrect setting might thereby be made. Furthermore, this procedure provides an easy means of detecting any such wear.

If reboring is found necessary it must be remembered that the strength of the cylinder walls will be deceased so that a reduction of pressure may be necessary to provide a proper factor of safety.

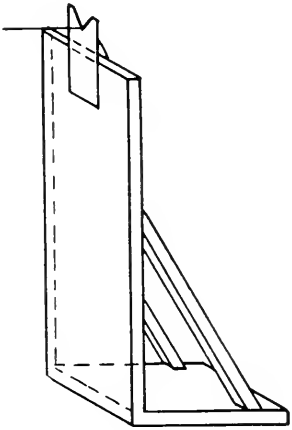


Fig. 7.

When the head end of the line has been adjusted we may go to the crank end of the cylinder. In this case the position of the far end of the line must be shifted sideways or up and down until, by sighting across the reference cross lines on the plug in the stuffing box, the line is made to pass through the *exact* center. It is possible that this procedure may have changed the proper location of the line at the head end of the cylinder so it is advisable to go back to that point and check up. Before leaving this part of the work the line must be adjusted so that it is central at both ends simultaneously.

The notched pieces of sheet metal that have been used to locate the ends of the line should now be fixed in a secure manner in the position that has thus been determined for them. The line may then be removed from and replaced on these metal center points, whenever it is found necessary to do so, without the necessity of relocating each time it is replaced.

The alignment of the cross-head guide of the barrel type is a comparatively easy matter. The joint between the cross-head guide casting and the cylinder casting is usually made with a shoulder and counterbore so that the two parts are automatically centered when bolted together. All that is necessary with a new engine, therefore, is to set the guide level and bolt it tight to the cylinder. In the case of an old engine the surfaces of the slide itself should be tested for parallelism. This may readily be done with a pair of inside calipers, preferably of the micrometer type. If they are found parallel the same procedure may be followed as in the case of a new engine. If not parallel, the surfaces should be machined to bring them into the proper relation with each other and with the faces of the flanges at the ends of the casting. As in the case of the reboring of a cylinder, only a competent person should be entrusted with this work.

After the cross-head guide has been firmly fastened in position the main frame, carrying the inboard bearing, may be moved into place. Since the joint between the cross-head guide casting and the main frame is similar to the joint at the cylinder end of the guide, the alignment of the two parts in question is readily attained. Do not, however, attempt to pull the main frame into place by tightening up on this joint as such procedure would strain the cross-head slide casting if the two parts were not in exact alignment. The main frame casting should first be brought into perfect contact with the flange on the cross-head slide, secured in that position by the wedges and foundation bolts, and the flange joint then made tight.

The center line should now be placed in position and checked to see that it is correct, preparatory to aligning the shaft bearings.

In the type of engine under consideration, the outboard bearing is sometimes of the independent pedestal type with a sole-plate and means to raise and lower or to shift sideways the pedestal casting itself. In erecting this outboard bearing the sole-plate should be placed in its approximately correct position, with wedges between it and the foundation, and the pedestal casting then placed upon it with the adjusting wedges and screws set in about their middle position. With the bearing boxes or brasses in place we are ready to proceed with the alignment.

In this work the bearing caps are first removed and a piece of board is forced into the lower box of each bearing, as shown in Fig. 8. On this board a line is laid out, by careful measurement, to represent the center line of the bearing. A level line is then erected to intersect and to be at right angles to the center line of the cylinder. The bearings are then shifted so that their center lines lie exactly under and just touching the line of the shaft center. In doing this, any shifting of the outboard bearing that is necessary should be done, as far as possible, by moving or wedging the sole-plate and not by adjustments between the pedestal casting and the sole-plate. The distance between the two bearings must also be given careful attention.

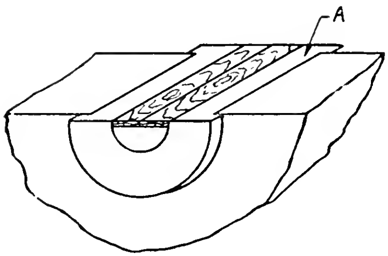


Fig. 8.

The erection of the shaft center line is probably the only point requiring further explanation at this point. Targets or posts, similar to the one used for the location of the crank end of the cylinder center line, should be used to carry the ends of the line in question. A large carpenter's square, known to be true, may be used to test the angle between the two lines. The 3-4-5 method, described earlier in this article, may also be applied in this case. A long spirit level may be used to level the line. In making these adjustments care should be taken to see that the lines are not touched so as to throw them out of position.

Instead of the board shown in Fig. 7 a circular piece, turned to the same diameter as the shaft with a small hole through the center and two cross lines marked upon it, may be used, one in each bearing. The idea is the same as that given in Fig. 4 for locating the cylinder center line through the stuffing box.

When all the foregoing steps in the alignment process have been carried out, the foundation bolts made tight and the alignment re-checked, the shaft center line may be removed and the engine grouted in place.

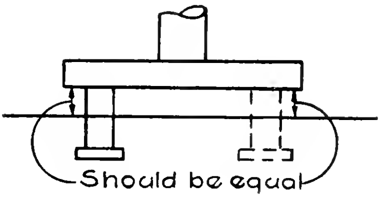


Fig. 9.

The shaft is then laid in its bearings and the boxes raised or lowered to bring it level, which condition may be indicated by a spirit level laid on the shaft. When the bearings have been correctly located in this respect they should be scraped to fit the shaft. This is a matter for the attention of an expert in such work.

Although every care may have been given to the work so far described, there may be some slight inaccuracies and it would be well to investigate a few points. The first of these may be the checking of the angle between the cylinder and the crank shaft center lines. This may easily be done by turning the shaft to the two positions shown in Fig. 9 and making the indicated measurements. If these distances are the same the shaft is correctly located. If not, the out-board bearing should be shifted in the proper direction to make them equal.

The cross-head, piston and piston rod should now be placed in position and adjustments made to align these parts. To do this the rod is connected to the cross-head while the parts are in the position shown in Fig. 9. The cross-head is then adjusted by means of the shoes at top and at bottom, until the rod is parallel to the slide. In the case of an old engine it is possible that the cross-head may need to be rebabbitted and refitted to the slide.

The condition produced by a crankpin that has been bent out of parallelism with the crank shaft is illustrated, in exaggerated form, in Fig. 11a. Such a condition will produce overheating and serious strains in the engine when it is running. The trueness of the crankpin in this respect may readily be observed by turning the crankpin with the rod to one of the positions shown, measuring the distance A, and then swinging the parts to the other position and repeating the measurement. If the two distances, A, A agree, the crankpin is in correct alignment but if they do not agree some adjustments must be made either by scraping or by suitable machine work. Conditions vary so greatly that no exact procedure for correcting this type of fault can be prescribed. Since the crankpin may be bent in the direction shown in Fig. 11b the test should also be carried out in the positions shown there.

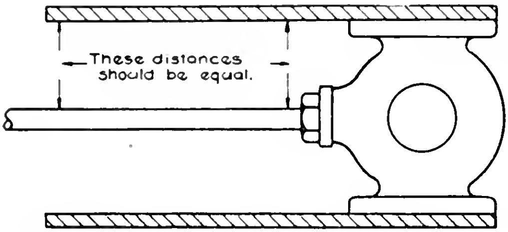


Fig. 10.

Another condition that may exist is that the center line of the crankpin brass may not be perpendicular to the center line of the connecting rod. To test for this, connect the rod to the crankpin, bring the bearing brass snugly against the inner shoulder of the crankpin, and note the distance A as in Fig. 11a. Then disconnect the rod from the pin, turn it over half way and repeat the measurement. If the relation between the cylinder center line and the line on the rod is the same as in the first case the crankpin brass is in correct alignment.

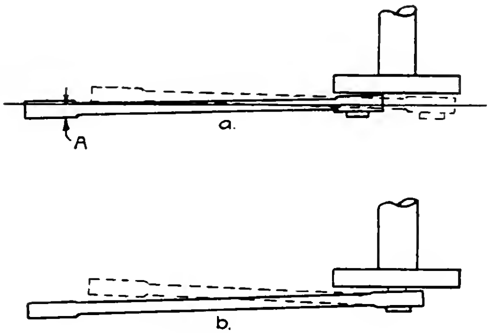


Fig. 11.

The same test can be made on the wristpin brass in a similar way, measurements being made from the side of the connecting rod to the face of the crank disc. If in either case the bearings are found out of alignment, they should be scraped or machined to bring them to the correct condition.

It is possible that the wristpin may not be in correct alignment. This can be tested by connecting the rod snugly to the wristpin and then noting if the crankpin brass lies midway between the inside and outside collars or shoulders on the crankpin so that no possibility for binding exists on either side. This test should be repeated with the crank in several positions.

One more point should be checked before the engine is fully and finally assembled. This is in regard to the parallelism of the center lines of the connecting rod brasses. While the connecting rod is still coupled to the wrist pin, the crankpin bearing should be taken apart, the pin smeared with Prussian blue, and the bearing adjusted rather snugly on this pin. The engine is then turned over once and the bearing taken apart. If the bearing surface of the brass does not show an even bearing, as would be indicated by a fairly even deposit of blue over the whole surface, it should be scraped and retested until a good bearing is secured. The fitting and adjusting of the bearings requires judgment and only men of experience should be entrusted to do such work.

Before any of the bearings are finally bolted up, the bearing surfaces should be well covered with oil to insure lubrication until the usual provisions for oiling can come into full operation. When the engine is started and for some time afterwards, the bearings must be carefully watched for signs of overheating and if such trouble occurs the cause should be determined and remedied without delay. The same attention should also be given to any bearing that has been taken up for wear.

You, Mr. Watertender.

THE following was recently sent out by W. E. Thomson, steam-plant engineer of the Southern California Edison Co., to all watertenders of the company as an appeal to "sell them their jobs." It is well worth the attention of all boiler-plant employers.

Do you, Mr. Watertender, realize that you occupy an important position? You are largely responsible for the lives and safety of others as well as yourself. You have almost as much to do with the efficiency made by your shift as has the fireman. You are the one to see that the water is heated as hot as possible before it leaves the heater so that you gain by using all of the exhaust steam. Heating the water hot before it enters the boiler helps the boiler. It does not have to put so much heat into each pound of water, hence you increase the amount of steam the boiler can make. This increased capacity, especially over the peak load, enables your station to carry more kilowatts. Every eleven degrees you can heat the feed water by using exhaust steam means a saving of one per cent. in the amount of fuel oil used on your shift, and almost one per cent. gain in boiler capacity.

WATCH THE WATER LEVEL.

By watching the water level in the boiler, you keep the boiler from going dry, perhaps exploding. At one of our plants someone did not watch the water level. The water in a boiler was allowed to get low — way out of sight in the glass. A tube burst. Luckily, no one was injured, as the force of the explosion happened to be sideways into the other tubes. But the whole front bank of tubes had to be renewed. The brickwork had to be repaired. The total cost was over eleven hundred dollars, besides the loss from having the boiler out of service.

It is you, Mr. Watertender, who must watch to see that the water does not get too high in the glass. If it does get too high, the water will go over into the steam main. The temperature of the steam is lowered. More steam is required to carry the same load. More oil has to be used to make the steam. Hence your shift efficiency suffers. But this is not all. If enough water goes over, it is likely to wreck some machine. An instance of this happened not long ago. An exciter was wrecked. Fortunately, no one was hurt, but the repairs cost over five hundred dollars, and for some time, until the parts were received from the factory, the other exciters were overloaded and the plant in danger of shutting down any minute. This water, going over into the turbines, corrodes and scales the parts, causing a loss not only to your shift efficiency, but to everybody else's until the machine can be taken out and overhauled.

FEED THE WATER GRADUALLY.

It is you, Mr. Watertender, who can help your fireman and your shift efficiency by feeding the water into the boilers gradually, not have a valve half open one minute and closed the next, but set the valves so that the water goes into the boiler just as fast as the steam-flow meter shows it is going out. It has been shown by tests that a swinging load will cause a loss of over 5 per cent., and that is just what you get when you feed the water into the boiler by spurts. You get the same action that a swinging load on the plant would cause. If you don't believe this, try it out. Take a reading on the flow meter, then open your feed valve wide and watch the flow meter — drops back, doesn't it? Now, close the feed valve and watch the flow meter — jumps right up, perhaps to a greater reading than you had at the start. Just the same action when you open the valve as if the station load would suddenly drop and the fireman had to cut back on his fires, only in this case the boiler stops steaming so fast, but you are using the same amount of fuel oil in the furnace. If the water is fed regularly, the flow-meter chart will not show any sudden swings and your shift efficiency will thus get the benefit.

CARRY WATER LEVEL AT HALF A GLASS.

Did you, Mr. Watertender, ever stop to thing that by carrying the water level constant at half a glass, your work is made easier and you are in a position to help the fireman out? A sudden demand comes for more steam. All right, you have a half-glass of water, a little extra, so you can shut the feed valve a minute — just long enough so that the boiler output increases because you are not putting cold water into it, but that minute gives the fireman a chance to get his steam pressure up. You can now open the feed a little — very gradually, remember, too fast will cause the steam to drop again — and slowly work your water levels up to half-glass again.

This little extra work on your part has kept the steam from getting away down so that both you and the fireman would have had to work for perhaps an hour to get it up. Now, suppose your water levels are back to half a glass again, and the fireman is carrying his steam high so as to get the best efficiency, a little load drops off, a boiler pops. All right, once more you can save. The boiler popping can stand a little more water; you open the feed valve. The popping stops almost immediately. The extra water you let in had to be heated. You have saved the steam that was going to waste through the pop valve. The fireman has now cut back on his fires a little so you can regulate the feed again until you have the half-glass of water showing in the gage.

BLOWING DOWN THE BOILERS.

It is you, Mr. Watertender, who is responsible for blowing down the boilers — for keeping the concentrate in the boilers below 200 so that the boilers will not prime. It is you who must keep the concentrate as near 200 as possible, so that heat will not be wasted by too much blowing down. Every time a boiler is blown down unnecessarily, it means a loss of approximately ten gallons of oil.

When a boiler is on stand-by, it is you, Mr. Watertender, who should report it in writing to the fireman if the boiler keeps filling up so you have to blow it down to keep the glass from getting full. It is you who should report it to the fireman if the stand-by boiler keeps losing water so you have to open the feed valve to keep the water in sight in the glass. In both these cases hot water is being wasted and you are in a position to catch these wastes before anybody else. A barrel of water wasted in either of these cases means a gallon of oil lost.

It is you, Mr. Watertender, who must blow down the water column and gage glass on each boiler at least once a shift so that you are sure the water level shown is correct. Otherwise, these lines may become clogged, the glass show water and still the boiler go dry, perhaps explode, kill someone and wreck the plant. —*from "Power."*

The class in French was reading an account of the war between France and Germany in 1870-71. The correct translation of a certain passage ran about as follows: "Thus the Germans had been able, without our having the slightest suspicion of it, to throw up gigantic works at a few thousand meters from our lines." Several students omitted the word "thousand" in translating which rendered the passage absurd enough, but one young lady improved on this by rendering: "a few millimeters from our lines." She knew, in a vague way, that "milli-" had *something* to do with thousands.

Similar mistakes may easily be avoided if one possesses a copy of The Metric System of Weights and Measures, published and for sale by The Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn., U. S. A. This publication is a valuable, indexed handbook of 196 pages of convenient size (3½" x 5¾") and substantially bound, containing a brief history of the Metric System, and *comparative tables* carefully calculated, giving the English or United States equivalents in all the units of measurement.

The price of the book, bound in sheepskin, is $1.25.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

WM. D. HALSEY, EDITOR.

HARTFORD, JULY, 1921.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

IN the last issue of THE LOCOMOTIVE we published an article on foundations for engines and called particular attention to the importance of providing a well designed and well constructed foundation. In addition to a solid foundation there are a number of other conditions necessary for satisfactory operation and not the least of these is the correct alignment of the component parts of the engine. Faults in design, in material, and in workmanship present hazards in the operation of an engine that are many times mitigated by accurate alignment. And without alignment the best materials must sooner or later give way. In addition, even before an actual breakdown occurs, an amount of power difficult to estimate is wasted by the additional friction load produced.

In an endeavor to point out some of the principles of engine alignment we print, on another page, an article which we believe will be helpful. It would be difficult to cover every situation and discussion has therefore been limited to a specific case. The principles, however, are general and with a little thought may readily be applied to a problem of this nature.

"A sweet running engine" is the term applied by operating engineers to an engine that runs smoothly and quietly. Perfect alignment of parts and adjustment of bearings is largely the secret of such operation.

The Flywheel is Still with Us.

One is prone to associate the flywheel with the old factory Corliss engine which drove by belt the machinery of a manufacturing establishment. The need of care in the operation of such a unit and the safety appliances necessary to safeguard the flywheel from disaster were generally appreciated. As the art has advanced in the last few years, the mind of the operator is turning to turbine units without flywheels, and the impression is gaining that the flywheel is not so important as it has been in the past. Occasionally, a flywheel is wrecked and we are brought face to face with the terrific amount of potential energy stored in one of these wheels and are forced to realize that the flywheel is still with us.

Where large turbine units are used with auxiliaries of the reciprocating type, there are a number of flywheels per unit, though of comparatively small size. It must be remembered that the energy stored in a wheel is not alone a function of the speed, but also depends upon the amount of metal that is in motion and the centrifugal force set up. Thus a machine with a comparatively small though heavy flywheel may have as much potential energy stored in it as a larger, lighter wheel.

Where, formerly, there was only the main flywheel to think of, with its accompanying safety device, there may be a number of flywheels serving one large generating unit, each one of them with its potentiality for disaster. Again, we must not neglect the flywheel effect of the rotor whether in the main unit or in the auxiliary machinery.

Failure of the flywheel on any one of the small units may cut a steam line or do damage that will cause a discontinuance of service to a much larger and more important load than formerly carried by one of the old-time factory engines. The introduction of centrifugal auxiliaries is reducing the number of flywheels in use, but at that there are few plants that do not contain a flywheel of some charactor. — *Editorial in "Power."*

The Veteran.

One of our contemporaries, *The Valve World,* published by The Crane Co., recently laid claim to the title of "the oldest corporation magazine in the United States that has been consistently and continuously a magazine (not a catalogue or a 'plant organ') from the beginning." The claim was made upon the entry of *The Valve World* into its seventeenth year. In a spirit of indulgence we wrote the editor and called his attention to the fact that The Locomotive also came within his classification but that it dated from November 1867 — more than thirty-seven years before the first issue of *The Valve World.*

In a more recent issue of *The Valve World* the editor has replied to our letter and, in closing, says, "The Locomotive seems to be entitled to the palm as the 'oldest house organ' — or corporation magazine — published in the United States, and we most heartily wish it continued success. It is an interesting publication and serves its own peculiar field as well and as faithfully as *The Valve World* endeavors to occupy its own chosen place."

The endeavors of *The Valve World* have been crowned with success and we hold it in high esteem. It is a most excellent publication, well written and well edited, and we feel honored by its expression of kind wishes. May it, too, continue to enjoy a life of service and success.

Luxurious Travel in the Olden Days.

The frequency with which boilers blew up on the early Hudson River boats led to the use of what were known as "safety barges," and these, in their day, were considered the utmost luxury in travel, comparable to the private cars of the magnates of today. The barges were boats with main and upper decks and were almost as large as the steamers which towed them. The rabble rode on the steamers, inhaled the smells of the kitchen and the freight holds, endured the noise of the engines, and took the chances of explosions, while on the barges behind the elite traveled in luxurious state. Food was brought from the boat kitchen to the barge saloon over a swaying bridge between the vessels and was served with great aplomb under the direction of the barge captain, who was a noble figure in the setting.

The upper decks of the barges were canopied and decked with flowers, with promenades and easy chairs from which to view the scenery. At night the interiors were transformed into sleeping accommodations, much the same as a modern Pullman, except that they were more commodious. Not the least attractive feature of these barges, according to a chronicler of their excellence, was "an elegant bar, most sumptuously supplied with all that can be desired by the most fastidious and thirsty." — *Buffalo Courier.*

Boiler Explosions during 1920.

THE year 1920 produced the largest number of boiler accidents so far recorded. The total of accidents amounted to 652 which is greater by 102 than the largest previous year, 1909, when the number was 550. The number of persons killed and persons injured has, on the other hand, fallen below the average figure of recent years, 1920 showing a total of 137 killed and 262 injured.

The monthly figures for number of accidents, persons killed, persons injured, and total of killed and injured are given in the table below.

SUMMARY OF BOILER EXLOSIONS FOR 1920.

MONTH.	Number of Explosions.	Persons Killed.	Persons Injured.	Total of Killed and Injured.
January	86	13	27	40
February. . . .	66	12	20	32
March. . . . ,	53	9	23	32
April	47	12	9	15
May	36	5	11	16
June	31	8	21	29
July	41	16	22	8
August	36	5	29	34
September . . .	42	15	25	40
October	53	17	15	32
November . . .	87	18	22	40
December . . .	74	7	38	45
Totals . . .	652	137	262	399

BOILER EXPLOSIONS.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF SEPTEMBER, 1920 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
433	27	Blow-off pipe failure			Boyle-Farrell Land Co.	Planing Mill	Farrell, Ark.
434	29	Collapse of crown sheet			Copeland-Inglis Shale Brick Co.	Brick Mfgrs.	Alton, Ala.
435	29	Boiler explosion				Threshing mach.	Marietta, Pa.
436	30	Section of heating boiler cracked			S. & H. A. Blumenthal	Apt. House	New York, N. Y.
437	30	Section of heating boiler cracked			University of Pittsburgh	University	Pittsburgh, Pa.
438	30	Section of heating boiler cracked			U. S. Government	Apt. House	New York, N. Y.

MONTH OF OCTOBER, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
439	1	Three headers ruptured			Clinton Woolen Mfg. Co.	Woolen Mill	Clinton, Mich.
440	2	Boiler of locomotive exploded			C. & N. W. R. R.	Railroad	Chadron, Nebr.
441	2	Five sections heating boiler cracked			T. H. Gaither & G. M. Balliere	Apt. House	Washington, D. C.
442	4	Rupture of hot water tank			R. S. Pollet	Residence	Worcester, Mass.
443	5	Ruptured boiler	2	4	Wellington Machine Co.	Mach. Mfgrs.	Wellington, O.
444	5	Steam pipe burst			Winchester Repeating Arms Co.	Arms & Am'nition	N. Haven, Conn.
445	6	Heating boiler exploded		3	People's Theatre Co.	Theatre	Greenville, Miss.
446	6	Section of heating boiler cracked			United Realty Co.	Apt. House	S. Francisco, Cal.
447	6	Section of heating boiler cracked			John Sheldon Estate	Office Building	Greenfield, Mass.
448	7	Mud drum ruptured			William Lea & Sons Co.	Flour Mill	Bloomington, Del.
449	10	Six headers cracked			Salmen Brick & Lumber Co.	Saw Mill	Slidell, La.
450	11	Section of heating boiler cracked			Wadsworth Village	School	Wadsworth, O.
451	12	Fifteen headers broke			Kingston Coal Co.	Colliery	Kingston, Pa.
452	14	Section of heating boiler cracked			The Citizen Co.	Publishers	Asheville, N. C.
453	15	Boiler exploded	5	1	Bacey Gin Co.	Cotton Gin	Rowland, N. C.
454	15	Blow-off pipe ruptured			Terrell Cotton Oil Co.	Cotton Gin	Grand Salins, Tex.
455	16	Boiler exploded	1		Wood-Bomar Gin Co.	Cotton Gin	Honey Grove, Tex.
456	16	Five sections heating boiler cracked			H. P. Dygert	Theatre	E. Rochester, N.Y.

457	17	Rupture of boiler shell			Paragon Plaster Co.	Plaster Works	Syracuse, N. Y.
458	17	Accident to steam pipe			Commonwealth Edison Co.	Public Utilities	Chicago, Ill.
459	19	Collapse of crown sheet			Maloney Paving Co.	Road Building	Ch'lottesville, Va.
460	19	Tubes pulled out of tube sheet			Pittsburgh Steel Products Co.	Tube Mill	Allenport, Pa.
461	20	Section of heating boiler cracked			J. R. Thompson	Restaurant	Buffalo, N. Y.
462	20	Blow-off pipe failure			Utah-Idaho Sugar Co.	Sugar Mfgrs.	Delta, Utah.
463	20	Boiler of locomotive exploded		3	Lehigh Valley R. R.	Railroad	Jersey City, N. J.
464	20	Tube failure			Kersler & Folse	Sugar Mfgrs.	Klotzville, La.
465	20	Section of heating boiler cracked			S. Liebovitz & Sons	Clothing Mfgrs.	Lawrence, N. Y.
466	21	Boiler of locomotive exploded	3		New York Central R. R.	Railroad	Batavia, N. Y.
467	21	Boiler exploded	3	1	Tallahoma Lumber Co.	Lumber Mill	Laurel, Miss.
468	21	Section of heating boiler exploded			George A. Fuller Co.	Hotel	Wilmington, N. C.
469	22	Valve body cracked			S. B. Wolf Shoe Co.	Shoe Mfg.	Cincinnati, O.
470	23	Heating boiler exploded			Morrow Hospital	Hospital	Seward, Nebr.
471	23	Boiler of locomotive exploded	3		C. R. I. & G. R. R.	Railroad	Fort Worth, Tex.
472	21	Three sections heating boiler cracked			L. & M. Libman	Hotel	Hartford, Conn.
473	24	Nine sections heating boiler cracked			Calvery Church	Church	New York, N. Y.
474	25	Tube failure			Brewster & Co.	Carriage Mfgrs.	L. I. City, N. Y.
475	25	Two sections heating boiler cracked			Univ. Club Bldg. Ass'n	Club Building	Columbia, Mo.
476	25	Main stop valve broken		1	Brown Phelps Hosiery Co.	Hosiery Mfgrs.	Philadelphia, Pa.
477	25	Tube failure			Retail Grocers Ice Co.	Ice Plant	Little Rock, Ark.
478	26	Tube pulled out		1	Phil-Fibre Box Board Mills	Box Bd. Mfgrs.	Philadelphia, Pa.
479	27	Failure of fitting on blow-off pipe			Utah Idaho Sugar Co.	Sugar Mfgrs.	Delta, Utah.
480	27	Section of heating boiler cracked			United Realty Co.	Apt. Hotel	S. Francisco, Cal.
481	28	Section of heating boiler cracked			Township No. 28, Range No. 5	School	Pontiac, Ill.
482	28	Three sections heating boiler cracked			F. Ruffelo		Kansas City, Mo.
483	28	Tube failure			Snoqualmie Falls Lumber Co.	Lumber Mill	Snoqualmie Falls,
484	29	Heating boiler exploded			Oxford Apartments	Apt. House	Rochester, N. Y.
485	29	Heating boiler exploded			Jones & Flobeck		Chicago, Ill.
486	29	Steam pipe failure			Mary Graham Hotel Co.	Hotel	Atlantic City, N. J.
487	30	Mud drum cracked			Muessell Brewing Co.	Brewery	South Bend, Ind.
488	30	Four sections heating boiler cracked			Standish Realty Corporation	Theatre	New York, N. Y.
489	30	Tube rupture			Public Service Corp. of N. J.	Power Station	Newark, N. J.
490	30	Blow-off pipe failure			Lampasas Ice & Refrig. Co.	Ice Plant	Lampasas, Tex.
491	31	Explosion of diffuser tank		1	New England Power Co.	Paper Mill	M'ntain Mills, Vt.

MONTH OF NOVEMBER, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
492	2	Boiler of locomotive exploded	2	1	B. & O. Railroad	Railroad	Akron, O.
493	2	Heating boiler exploded			New Capitol Hotel	Hotel	Little Rock, Ark.
494	2	Two sections heating boiler cracked			A. C. Johnson	Apt. House	Denver, Col.
495	3	Boiler exploded	1		Santa Fe Railroad	Hoisting Crane	Chicago, Ill.
496	3	Tube and six headers ruptured			Ford Motor Co.	Automobiles	H'land Pk., Mich
497	4	Section of heating boiler cracked			Kane Borough School Board	School	Kane, Pa.
498	4	Heating boiler exploded	2		Delmonte Hotel	Hotel	St. Louis, Mo.
499	5	Two sections heating boiler cracked			B. & R. Gross	Apt. House	Hartford, Conn.
500	5	Boiler of locomotive exploded		2	Chicago North Western R. R.	Railroad	Iron Mt., Mich.
501	5	Nine sections heating boiler cracked			S. W. S. Amusement Co.	Theatre	New York, N. Y.
502	5	Tube ruptured			West Penn Power Co.	Power Plant	Connellsville, Pa.
503	5	Section of heating boiler cracked			Emigrant Industrial Savings Bk.	Bank	New York, N. Y.
504	6	Heating boiler exploded		3	People's Theatre	Theatre	Greenville, Miss.
505	6	Vulcanizer exploded			Spies Bros.	Auto Rep'r Shop	Cleveland, O.
506	6	Blow-off pipe ruptured			Knoxville Lumber & Mfg. Co.	Planing Mill	Knoxville, Tenn.
507	6	Tube ruptured			Utah-Idaho Sugar Co.	Sugar Mfrs.	Delta, Utah
508	6	Accident to blow-off valve		1	LeFlore Co. Gas & Elec. Co.	Light Plant	Poteau, Okla.
509	8	Section of heating boiler cracked			Pinehurst Hotel Co.	Hotel	Laurel, Miss.
510	9	Section of heating boiler cracked			D. of I. Home for Aged	Home	Newark, N. J.
511	9	Steam pipe burst		1	Crucible Steel Co.	Steel Mill	Pittsburgh, Pa.
512	9	Tube ruptured			Dubuque Elec. Co.	Power Plant	Dubuque, Ia.
513	9	Three sections heating boiler cracked			H. F. Bailey	Garage	Westfield, Mass.
514	10	Boiler of locomotive exploded				Railroad	Susquehanna, Pa.
515	10	Four sections heating boiler cracked			E. J. & H. W. Orr	Garage	Boston, Mass.
516	10	Section of heating boiler cracked			Twenty Morningside Ave. Corp.	Apt. House	New York, N. Y.
517	10	Accident to blow-off pipe		1	Blue Grass Laundry	Laundry	Dayton, Ky.
518	10	Five sections heating boiler cracked			Liberty Screw Co.	Factory	Worcester, Mass.
519	10	Section of heating boiler cracked			American Can Co.	Warehouse	New York, N. Y.
520	11	Section of heating boiler cracked			John Mayer	Apt. House	Kansas City, Mo.
521	11	Two sections heating boiler cracked			Pittsburg Machine Tool Co.	Machine Shop	Braddock, Pa.
522	11	Boiler exploded		2	G. P. Avery & Son	Drilling for Oil	Bingham, Pa.
523	11	Boiler shell ruptured			Alvah Nelson Lumber Co.	Planing Mill	Thomaston, Ga.
524	11	Three sections heating boiler cracked			Sam Harris	Apt. House	San Francisco,Cal.

525	12	Drier collapsed			Swift & Co.	Stock Yards	Chicago, Ill.
526	12	Section of heating boiler cracked			West Texas Nat'l Bank	Bank	Big Springs, Tex.
527	13	Tube ruptured			Barge "Pierce McLouth"	Steam Barge	Alpena, Mich.
528	13	Seven sections heating boiler cracked			The Stanley Co. of America	Theatre	Philadelphia, Pa.
529	13	Accident to blow-off pipe			W. W. Carre Co.	Planing Mill	New Orleans, La.
530	14	Section of heating boiler cracked			Village of Atkinson	School	Atkinson, Ill.
531	14	Section of heating boiler cracked			I. T. S. Rubber Co.	Rubber Works	Elyria, O.
532	15	Boiler bulged and ruptured			Shoreham Hotel Bldg. Corp'n	Somerset Hotel	Chicago, Ill.
533	15	Section of heating boiler cracked			L. Kaiser	Apt. House	Houston, Tex.
534	15	Section of heating boiler cracked			Borough of Naugatuck	School	Union City, Conn.
535	15	Accident to blow-off pipe			St. Mary's Hospital	Hospital	Evansville, Ind.
536	15	Two sections heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
537	15	Three sections heating boiler cracked			Louis Herrup	Furniture Store	Hartford, Conn.
538	15	Tube ruptured			Warner-Klipstein Chemical Co.	Chemical Works	Charleston, W. Va.
539	16	Two sections heating boiler cracked			Mobile Y. M. C. A.	Y. M. C. A.	Mobile, Ala.
540	16	Section of heating boiler cracked			Magaziner Baking Corp'n	Bakery	Springfield, Mass.
541	16	Two sections heating boiler cracked			J. R. Thompson	Restaurant	Chicago, Ill.
542	16	Nine tubes pulled out of drum			Delta Light & Traction Co.	Power Plant	Greenville, Miss.
543	16	Section of heating boiler cracked			Highland Hospital	Hospital	Ashville, N. C.
544	17	Accident to steam pipe			Hatfield & Penfield Steel Co.	Steel Foundry	Willoughby, O.
545	17	Four sections heating boiler cracked			Beaumont Floral Co.	Greenhouse	Beaumont, Tex.
546	18	Boiler exploded			Grant & Mays	Drilling for oil	No. Baltimore, O
547	18	Tube ruptured			Taylor Wharton Iron & Steel Co.	Steel Mill	High Bridge, N. J.
548	19	Tube ruptured			Solvay Process Co.	Chemical Plant	Detroit, Mich.
549	19	Heating boiler exploded		1	Chilton Apartments	Apt. House	Richmond, Va.
550	19	Range boiler exploded	2		Augustus Stern	Residence	New York, N. Y.
551	19	Seven sections heating boiler cracked			L. & M. Libman	Hotel	Hartford, Conn.
552	20	Section of heating boiler cracked			Wm. H. Trowbridge	Office Bldg.	S.Fr'm'gh'm.Mass.
553	21	Heating boiler exploded			Fred Wood	Residence	Grafton, Mass.
554	21	Heating boiler exploded			Nelson Johnson	Apt. House	Kansas City, Mo.
555	21	Header of heating boiler cracked			Kyle Building Co.	Hotel	Houston, Tex.
556	23	Heating boiler exploded		2	Welles Ave. Garage	Garage	Dorchester, Mass.
557	23	Three sections heating boiler cracked			J. F. Rolfe	Office Bldg.	Salem, Mass.
558	24	Boiler exploded	5		Stoughton Marketing Co.	Market	Stoughton, Wis.
559	24	Two tubes ruptured			The National Tube Co.	Tube Mill	Lorraine, O.
560	24	Section of heating boiler cracked			Ashland Realty Co.	Apt. House	Buffalo, N. Y.
561	25	Boiler exploded			Ohio Oil Co.	Drilling for oil	Bluffton, O.
562	25	Tube ruptured			Michigan Alkali Co.	Chemical Plant	Wyandotte, Mich.
563	25	Section of heating boiler cracked			James F. Dolin	Apartment House	Hartford, Conn.

MONTH OF NOVEMBER, 1920 — Continued.

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
564	26	Hot-water boiler exploded	1	2	Ida Weissbrott	Residence	New York, N. Y.
565	26	Boiler exploded	3	1	Dunwoody Milling Co.	Flour Mill	Dunwoody, Ga.
566	26	Tube ruptured			Pittsburgh Plate-Glass Co.	Glass Works	Ford City, Pa.
567	27	Boiler of locomotive exploded	1	3	Seaboard Air Line Railroad	Railroad	W. Jacks'ville, Fla.
568	27	Tube ruptured			Barnsdall Zinc Co.	Zinc Mill	Waco, Mo.
569	27	Section heating boiler cracked			St. Andrews Church	Church	Buffalo, N. Y.
570	27	Accident to steam pipe			Peet Bros. Mfg. Co.	Soap Works	Kansas City, Mo.
571	27	Two sections heating boiler cracked			Sol Bettin	Apt. House	Houston, Tex.
572	28	Manifold and three sections of heating boiler cracked			City of Greenville	Hospital	Greenville, S. C.
573	29	Two sections heating boiler cracked			Kingsley School	School	W. Waterloo, Ia.
574	29	Boiler exploded	1	2		Donkey Engine	Galveston, Tex.
575	29	Mud drum rupture			N. S. Coal & Coke Co.	Coal Mining	Gary, W. Va.
576	29	Section of heating boiler cracked			Fifteenth St. Amusement Co.	Theatre	Brooklyn, N. Y.
577	30	Autogenous weld failed			Holt Hotel Co.	Hotel	Lafayette, Ind.
578	30	Section of heating boiler cracked			School District of Pittsburgh	School	Pittsburgh, Pa.

MONTH OF DECEMBER, 1920

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
579	1	Boiler exploded	1	1	Gustave Liljeroot Farm	Threshing Mach.	Galva, Ill.
580	1	Rupture to fitting on boiler feed line			Utah-Idaho Sugar Co.	Sugar Mfrs.	Delta, Utah
581	1	Rupture to fitting on blow-off pipe			Lawrence Hotel Co.	Hotel	Erie, Pa.
582	1	Accident to steam pipe			City of Monroe	Power Station	Monroe, La.
583	2	Tube ruptured		2	Standard Steel Works	Steel Plant	Lewistown, Pa.
584	2	Boiler plate bulged and ruptured			Aberdeen Gas Co.	Gas Plant	Aberdeen, S. D.
585	3	Tube ruptured			American Steel Wire Co.	Steel Plant	Anderson, Ind.
586	3	Boiler plate bulged and ruptured			Iowa Methodist Hospital	Hospital	Des Moines, Ia.
587	3	Section of heating boiler cracked			E. B. Jennings	Store Building	Fall River, Mass.
588	4	Section of heating boiler cracked			Rhinelander Garage	Garage	New York, N. Y.
589	4	Tube ruptured			Los Angeles Gas & Elec. Corp'n	Power Plant	Los Angeles, Cal.
590	6	Tube ruptured		2	Consumers Power Co.	Power Plant	Gd. Rapids, Mich.

591	6	Two sections heating boiler cracked			Sonken-Galamba Iron & Metal Co.	Iron & Metal Co.	Kansas City, Kan.
592	6	Stop-valve ruptured			Southport Mill, Ltd.	Oil Refining	New Orleans, La.
593	6	Accident to steam-pipe fitting		1	C. H. Guenther & Son	Flour Mill	San Antonio, Tex.
594	7	Tube ruptured			J. B. Ward School	School	DuQuoin, Ill.
595	7	Accident to steam pipe		2	F. D., D. M. & S. Interurban Co.	Power Plant	Boone, Ia.
596	7	Boiler ruptured			Vernon Parish Lumber Co.	Lumber	Kurthwood, La.
597	7	Two sections heating boiler cracked			J. H. Levy & Sons, Inc.	Apt. House	New York, N. Y.
598	7	Tube ruptured and headers cracked			Warren Manufacturing Co.	Paper	W'ren Mills, N.Y.
599	8	Header ruptured			Pittsburgh Plate Glass Co.	Glass Mfrs.	Ford City, Pa.
600	10	Boiler exploded			C. N. Lindley	Laundry	Menasha, Wis.
601	10	Stop-valve ruptured			Utah-Idaho Sugar Co.	Sugar Mfrs.	Payson, Utah
602	11	Section of heating boiler cracked			G. F. Heublein	Garage	Hartford, Conn.
603	11	Eight sections heating boiler cracked			J. W. Welch	Restaurant	Omaha, Nebr.
604	12	Heating boiler exploded			Louis Fortner	Residence	Jenkintown, Pa.
605	12	Five headers cracked			Freeport & Mexican Fuel Oil O'p'n	Oil Refining	Arabi, La.
606	12	Stop-valve ruptured		1	Rand Avery Supply Co.	Printers	Boston, Mass.
607	13	Three hot-water tanks exploded				Apt. House	Portland, Me.
608	13	Section of heating boiler cracked			City of Lincoln	School	Lincoln, Nebr.
609	14	Boiler exploded	2		Weldon Oil Co.	Drilling for oil	Beaumont, Tex.
610	14	Boiler exploded		4	Lang Farm	Saw Mill	Cox's Mills, W.Va.
611	14	Section of heating boiler cracked			Lemon Thomson Realty Corp'n	Office Bldg.	Glens Falls, N. Y.
612	14	Two sections heating boiler cracked			E. J. & H. W. Orr	Garage	Newtonville, Mass.
613	15	Section of heating boiler cracked			Stanley Co. of America	Theatre	Philadelphia, Pa.
614	15	Section of heating boiler cracked			Colonial Courts	Apt. House	Bridgeport, Conn.
615	15	Section of heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
616	15	Tube ruptured		1			Gd. Rapids, Mich.
617	15	Two sections heating boiler cracked			L. Sarbinski	Apt. House	Akron, O.
618	15	Section of heating boiler cracked			The Bland Hotel	Hotel	Raleigh, N. C.
619	17	Fire sheet ruptured			Breese Trenton Coal Co.	Coal Mining	Beckemeyer, Ill.
620	17	Tube ruptured		2	Sumter Lumber Co.	Lumber	Elec. Mills, Miss.
621	18	Rupture of fitting on blow-off pipe			Utah-Idaho Sugar Co.	Sugar Mfrs.	Delta, Utah
622	19	Boiler exploded				Apt. House	Elizabeth City, N.C.
623	19	Accident to steam pipe			Bellman Brook Bleachery Co.	Bleaching Plant	Fairview, N. H.
624	20	Two sections heating boiler cracked			Hughes Realty & Investment Co.	Office Bldg.	Richmond, Mo.
625	21	Tube blew out			Los Angeles Gas & Elec. Corp'n	Power Plant	Los Angeles, Cal.
626	22	Section of heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
627	22	Boiler exploded. Resulting fire destroyed building			Feitschan's Junior High School	School	Springfield, Ill.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1921

Capital Stock, . . $2,000,000.00

ASSETS.

Cash in offices and banks		$366,891.88
Real Estate		90,000.00
Mortgage and collateral loans		1,543,250.00
Bonds and stocks		6,188,435.00
Premiums in course of collection		728,199.44
Interest accrued		116,654.78
Total assets		9,033,431.10

LIABILITIES.

Reserve for unearned premiums		$4,512,194.11
Reserve for losses		205,160.80
Reserve for taxes and other contingencies		388,958.85
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,927,117.34	
Surplus to Policy-holders		**$3,927,117.34**
Total liabilities		$9,033,431.10

CHARLES S. BLAKE, President.
FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
E. SIDNEY BERRY, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.
J. J. GRAHAM, Supt. of Agencies.

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NEW YORK, N. Y., . . . 100 William St. . . .	C. C. GARDINER, Manager. JOSEPH H. MCNEILL, Chief Inspector. A. E. BONNETT, Ass't Chief Inspector.
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ST. LOUIS, Mo., ... 319 North Fourth St.	C. D. ASHCROFT, Manager. EUGENE WEBB, Chief Inspector.
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The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

VOL. XXXIII. HARTFORD, CONN., OCTOBER, 1921. No. 8

HEAD OF EXPLODED LAUNDRY MANGLE.

Explosion of a Laundry Mangle.

The guests of the Hotel Pemberton and the residents of Hull, Mass., had an element of terror injected into their peaceful summer life on August 11th by the explosion of a mangle in the laundry of the hotel. A newspaper account in *The Boston Post* for August 12th stated that the explosion wrecked the laundry, tore an eight foot hole in the hotel wall as great pieces of the mangle, weighing hundreds of pounds, were hurled through it, and scattered debris all about the New Haven Railroad station and the Nantasket Beach Steamboat pier. Ten persons were injured in the accident, eight of them being

Showing Flight of the Mangle Head.

hotel employees and the other two being guests who were sitting on the porch just above the laundry at the time of the accident. The property damage amounted to about $4000.

It was said that a few days prior to the explosion steam was seen escaping through a crack in the cast iron shell close to one of the heads of the mangle. To stop this leak, autogenous welding was resorted to and while this method of repair temporarily stopped the escape of steam it would appear that it materially weakened the shell. Examination of the broken parts showed that the casting had been cracked for some time at the base of the flange, as shown in Fig. 1, this defect extending around the circumference meeting the welded portion at both ends, and varying in depth from one eighth to three eighths of an inch from the inside surface of the shell. The extent of this crack at the point where the leak developed could not be determined because the welding had destroyed all traces other than those mentioned above. The welded portion extended for about twenty-five inches around the circumference and was about five inches wide but its holding power was probably slight since a large portion of it appeared defective. At the break, the larger part of the weld had the appearance of slag which indicated that the metal had not fused at all, excepting on the outside surface. While no doubt the crack which already existed in the mangle cylinder would, in time, have caused a failure, it is, on the other hand, very likely that the welding hastened the end.

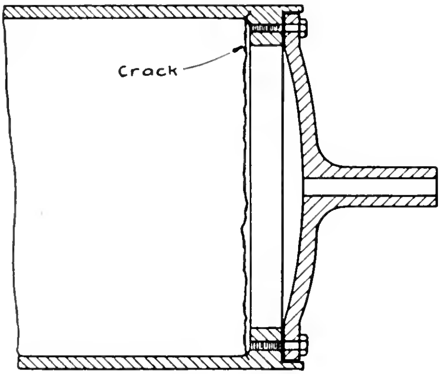


Fig. 1.

The head which broke away weighed approximately 750 pounds and was blown through the brick wall of the laundry and across the street, a distance of about sixty feet, coming to rest near the ticket office in the railroad station. The flight which it took is illustrated in the picture on the opposite page, the head lying at the spot marked 2 and the hole in the hotel wall, boarded up when the photograph was taken, at the spot marked 1. The head itself is shown on the front cover of this issue of The Locomotive. The cylinder and the other head were driven in the opposite direction through the basement for a distance of about fifty feet.

It is evident from this that a laundry mangle may become a rather powerful engine of destruction and therefore should be subjected to rigid inspection and given the greatest care in its operation.

More About the Value of Inspections.

TWO instances of the finding of a lap seam crack in time to prevent a disastrous explosion were described in the last issue of THE LOCOMOTIVE and well illustrate the really necessary service of the boiler inspector. The lap seam crack is a common cause of failure and many other illustrations can be cited of the very common misunderstanding that exists as regards the use of a boiler in which this weakness exists. Since the publication of the previously mentioned article on this type of defect we have been reminded of several cases which may well be described.

Some years ago a representative of this Company called upon a mill owner in an endeavor to interest him in boiler inspection and insurance, but the owner could see no value in such service. About a month later a crack developed in the longitudinal seam of one of the boilers in this mill and a supposedly experienced mechanic was called in. The crack was drilled at intervals, the holes tapped out, and soft iron plugs inserted to stop the leakage. About a week later the boiler exploded, fatally injuring the fireman and seriously injuring his wife who happened to be there at that time. Had this boiler received the attention of a qualified inspector the dangerous condition could have been pointed out in time to prevent the disaster which occurred.

Mention was made, in the July issue, of repairs to a lap seam crack by autogenous welding. It has been reported to us that a boiler belonging to the Wishkah Shingle Co., State of Washington, was repaired (?) at a lap seam crack by this method and soon afterwards exploded, killing three people. It was said that the boiler was not regularly inspected by a competent person and that the owners had no knowledge of the danger in such a repair.

Many similar instances are recalled of the inevitable sad results which follow improper treatment of a lap seam crack. This type of failure frequently shows itself by a leak extending over a comparatively short distance. The boiler plate may very likely be cracked over a considerable distance but, not being apparent by casual inspection, this is not realized and repairs are confined to the vicinity of the leak. A soft patch is frequently placed over the leak, sometimes temporarily alleviating the leaky condition and at other times accentuating it. Sooner or later, however, the crack extends through the plate at other points and an explosion frequently results.

But the lap seam crack, although a frequent offender, is not the only cause of trouble. Many conditions, dangerous to life and property, are found on the trips of the boiler inspector. Cracks in other parts of a boiler, such as to make it unsafe to use, have often been found. In one such case, cracks twelve and fourteen inches long were found at the bend of the flange on each side of the fire door sheet of a locomotive type boiler and in addition, some smaller cracks in the side sheets, making it necessary to condemn the boiler as unfit for service. A second hand dealer purchased the boiler and sold it to a saw-mill in Virginia. A few days after it was put into service it exploded and two persons were killed. In this case the inspector gave protection to the original owner and also did all he could to safeguard the public by warning the second hand dealer not to sell

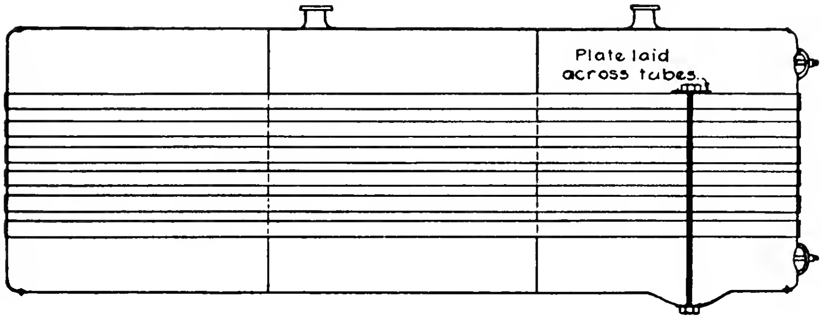


FIG. 1.

the boiler but to cut it up for scrap. The unscrupulous dealer, however, was not so mindful of the safety of others. A similar case was that of a boiler which exploded, some years ago, near Clifton Heights, Pa.

Repairs, that to the inexperienced appear safe, but to the boiler inspector are immediately recognized as dangerous, are frequently found. In one such case a bag had developed in a boiler from overheating which resulted probably from an accumulation of scale. The "repair" made in this case is illustrated in Fig. 1, above. The center of the bag or bulge was tapped and a 7/8" threaded rod screwed in with the end upset or riveted over. The upper end was supported by a flat iron bar resting on the top row of tubes. The idea apparently was to prevent a complete failure at the bag. However, an excellent place for scale to accumulate was provided by permitting the bulge to remain and the condition presented was rather dangerous. Our inspector had the rod removed. The plate was then heated and the bag driven back, the small hole being plugged with a rivet.

The corrugated furnace in one of two Scotch-marine boilers collapsed and necessitated repairs to that boiler. Thinking it advisable to investigate conditions in the other boiler, a hydrostatic test was applied by our inspector and the furnace showed a decided tendency to collapse, indicating that the structure was weak for the pressure desired. It was recommended that a new furnace be installed and assurance was given that this would be done. A few weeks later the owners requested that we make an examination and this we proceeded to do. The results were rather remarkable. It was found that the repair man who was called in to do the work, after looking over the boiler, and announcing that he could "fix her as good as new," apparently concluded that a cylindrical furnace, lying in a horizontal position, could only collapse from the upper side although subjected to pressure from all sides. He therefore placed four 1½" rods extending from the upper surface of the furnace, where the furnace had first shown a tendency to collapse, to the top of the boiler shell and then remarked to the engineer, "There she is, she's all yours." Unfortunately for the owner, this repair could not be approved.

Improper attachment or use of boiler appliances often results in damage to the boiler even if an explosion does not occur. Such conditions are often found and corrected by the boiler inspector. As an example we cite the following: —

One of our inspectors, when calling at the office of a certain plant, was advised that considerable trouble had been experienced from leakage at the girth seams of the horizontal water tube boilers in use in the plant. The superintendent stated that they had recaulked the seams a number of times but to no avail and the boiler maker who had done this work had expressed the opinion that they had received a "bum bunch of boilers." On walking into the boiler room the first thing that struck the inspector's eye was that the water glasses were considerably below the drums of the boiler. A comparison of the water level in the gauge glass with the height of the drums showed that the water columns were set 12" too low so that when the normal water level was carried in the water column there was absolutely no water in the drums. This resulted in rapid overheating as soon as the boiler was fired up. When the water column was correctly placed and the seams again caulked no further trouble was experienced.

Improper pipe connections are often found. As an example of this condition, the following experience, related by one of our inspectors, will be illustrative.

"As I was going about my regular work I stopped at a small mine and became engaged in conversation with the engineer who claimed he was a licensed man and said that he had installed the boiler plant. He took great pride in showing me the installation but after looking it over I was unable to work up the same degree of enthusiasm that he had and the reason may easily be explained.

"The faulty connection that first struck my eye was that a ½" pipe had been run from the dome of the boiler to supply an injector and a feed pump, both of which required a 1" line, and to this pipe the steam pressure gauge had also been attached. The steam pressure, when first noted, was 100 pounds. Soon, however, the injector was started and, because of the pressure drop which then took place in the ½" pipe, the gauge reading fell back to 60 pounds. The engineer noticed this and immediately forced his fire a little harder which soon resulted in the safety valve blowing off although the gauge reading did not rise any great amount. Seeing this, the engineer remarked, 'Sometimes that safety valve doesn't work just right. I don't know what gets the matter with it. I've had it off several times and examined it but I can't find anything the matter with it.'

"I stepped outside to look up at the valve which was about twelve feet above the boiler and while looking at it the blowing stopped. A few minutes later I walked in and looked at the pressure gauge. It showed 140 pounds. I immediately started an investigation to determine the reason for the safety valve remaining closed with this pressure behind it and, when I climbed up on the boiler, I soon discovered the cause. There I found a gate valve, closed tight, in the line leading to the safety valve. Apparently the engineer had closed it when I stepped outside for just then I saw him come around to the front of the boiler, glance at the pressure gauge, and then rush up the ladder to open the gate valve. This I cautioned him to do slowly as a sudden release of the pressure on the boiler might have caused an explosion. As soon as a few turns had been given the gate valve to open it the safety valve began to blow and continued to do so until the pressure was reduced to 100 pounds.

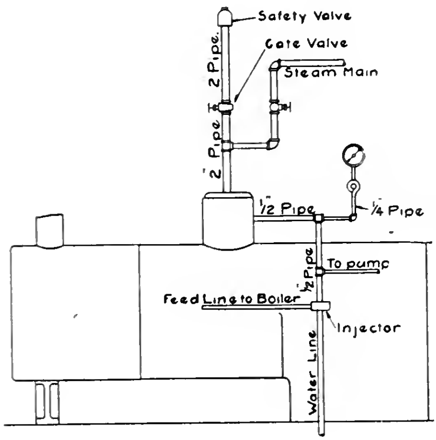


FIG. 2.

"A sketch of the boiler with its improper pipe connections is given in Fig. 2. In addition to what is shown there I might mention that the blow off line had been piped outside the building where a trap had been formed so that any water accumulating in it would freeze very readily. A man, in blowing down the boiler, would have been placed in a very dangerous position.

"A short time later I had to make an internal inspection of this same boiler and, although the engineer said that he had just had the boiler open the day before and that I could take his word as to its good condition, I found it to be in very poor shape. Although no great amount of scale was present, a considerable amount of corrosion and a number of cracks in different parts of the boiler were found. When this information was given the superintendent he ordered the boiler out of service."

Inspections are of value not only in the detection of dangerous conditions but also in preventing unnecessary expenditures for repairs. In one case a tube ruptured in a vertical water tube boiler and there was also some slight overheating of several other tubes. The coal mining company who owned the boiler engaged a repairman to put the boiler in serviceable condition. This repairman had them place an order for new tubes which were to cost $1200. He expected to almost take apart the entire boiler, the total cost to be about $2,500, and had actually started work. Someone, however, suggested to the coal company that they obtain the services of a boiler inspector and at their request we rushed a man over to the plant. As a result of his inspection the repairs necessary were limited to ten new tubes and some other minor repairs, amounting in all to about $250, or a saving to the owner of over $2000. This was at pre-war prices and the figures would be considerably greater at the present time.

In another somewhat similar instance the expenditure for repairs was reduced from $1100 to about $20. In still another case a boiler had been condemned, by a steam fitter, as unfit for further use but upon examination by a boiler inspector was found to be good for many years more of service.

The boiler inspector also finds a field of service in the help that can often be given a manufacturer in the arrangement of his steam generating equipment and piping. In a certain plant where rendering tanks were used, considerable difficulty had been experienced in obtaining a lard of uniform quality. Changes that were recommended by the inspector resulted in safer working conditions and a more uniform product.

In another striking instance, which seems almost incredible but which, nevertheless, is true, a furniture factory complained of the wastefulness of their boiler equipment from the standpoint of fuel consumption. After an inspection we recommended the installation of a boiler of a different type. Before the change the plant used a car of coal a month in addition to the refuse from the mill. After the change the coal consumption was reduced to a maximum of two cars of coal per year. It does not require much figuring to compute the saving that would be made in a case like this.

Many accounts might be given of the savings resulting from the suggestions of the boiler inspector, such as the covering of steam pipes, use of pumps and exhaust steam heaters in place of injectors, use of a lesser number of boilers to carry the load, and so forth. We shall content ourselves, however, with the relation of one instance which is interesting from more than one point of view.

One of our inspectors, upon visiting a plant, noticed that the exhaust steam drips were being discharged to the sewer. He made the recommendation that this practice be discontinued and, with the proper piping arrangements, the condensate be returned to the boiler so that whatever heat was contained therein might be saved. The next visit of inspection was made by a different man and the engineer of the plant, in speaking to him of the recommendations made by the previous inspector, said, "Now wasn't he a numskull? Why we had already cooked all the steam out of that water."

It would be practically impossible for the owner of a plant to give the time for a personal inspection of his boilers even though he were so inclined and sufficiently experienced in this line of work. No matter how efficient operating engineers may be in running their plant, but few of them have had the specialized training to qualify them as inspectors of boilers. On the other hand the expert boiler inspector examines the boilers for all known causes of trouble and then the owner is handed an unbiased statement of the condition of the equipment. If everything is in good shape the owner has a sense of security from accident, or, if there is trouble in sight, ample time is given to make repairs before the danger point is reached.

A Comparison of the Reciprocating Engine and the Steam Turbine.

MANY persons have had difficulty in understanding the action of the steam in the cylinder of a steam engine and still greater difficulty in obtaining a grasp of the principle of operation of the steam turbine. Many who are well informed as to the pressure and volume changes that take place in the reciprocating engine do not fully comprehend the changes that take place in the steam turbine; and still others, though fully aware of the changes that take place, have had difficulty in appreciating the fact that there is a striking similarity in certain fundamental principles underlying the operation of the reciprocating engine and the turbine. It is the purpose of this discussion to clear up, if possible, some of these obscure points.

We have intimated, only a few lines above, that a certain fundamental similarity exists between two principal types of steam prime movers. In making this statement, we refer to the similarity that exists in the heat changes that take place and which we shall discuss more fully later on. Before proceeding with this discussion, however, it may be well, for our readers who lack the information, to describe the principle of operation of the engine and the turbine. We trust that we will be pardoned if to some, this description seems elementary.

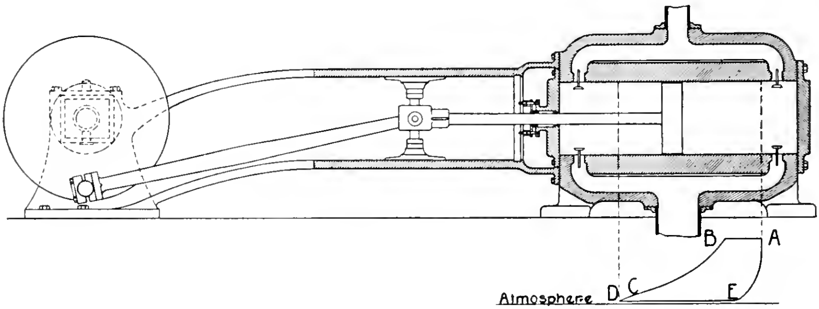


Fig. 1.

The reciprocating steam engine may be illustrated diagrammatically as in Fig. 1. At each end of the cylinder are shown two valves, those at the top being for admission of steam and those at the bottom being for the exit or the exhaust of the used steam. Considering the head end (the right hand end in this sketch) of the cylinder, we have first that the admission valve, operated by the valve gear which is driven by the engine, is opened and steam practically at boiler pressure is admitted. The pressure thus created in the cylinder drives the piston forward, thereby turning the crank shaft. When the piston has moved about one-quarter of its stroke the admission valve closes. The steam that is thereby entrapped in the cylinder is at high pressure and the piston, therefore, continues its motion, but as soon as it does so the volume occupied by the steam increases and the pressure begins to fall. Nevertheless, the pressure continues for some time to be sufficient to drive the piston forward. Under normal operating conditions the engine is so designed that as soon as the pressure of this steam falls to a point such that it can no longer be effective in driving the piston the exhaust valve at the head end is opened and the steam permitted to escape. This action, known as "release," may be considered to take place when the piston has completed about nine-tenths of its forward stroke. The exhaust valve remains open and the steam escapes from the cylinder during the remaining one-tenth of the forward stroke, and through the greater part of the return stroke when the piston goes from the crank end to the head end of the cylinder. The exhaust valve closes when the piston has completed about eight-tenths of the return stroke, and the steam remaining in the cylinder is then compressed thereby reducing the volume and at the same time increasing the pressure. This action of compressing the steam assists in giving smooth operation over the end or dead points when the reciprocating parts change their direction of motion. For this reason, the term "cushioning" is often applied to this action of using some of the exhaust steam as a buffer to take the shock out of the end of the stroke. At or near the end of the stroke the steam admission valve opens again and the whole cycle of events is repeated. With a double acting engine there is also a similar action taking place in the crank end of the cylinder.

The changes in pressure and volume taking place within the cylinder may be represented on a chart in which horizontal distance represents volume or length of stroke and vertical distance represents pressure. Such a chart is shown directly below the cylinder in Fig. 1. Its length has been taken the same as that of the cylinder. The line AB shows the pressure that exists while the piston is passing from the end of the stroke (directly over A) to the point of cut off (directly over B). The curved line BC shows that expansion is taking place or, in other words, that the pressure is falling gradually with the forward motion of the piston. At the point C the exhaust valve opens and the pressure within the cylinder then falls from C to D very rapidly, but not instantaneously, to the pressure in the exhaust pipe because the steam, most obviously, cannot all get out at once. From D to E the steam is pushed out of the cylinder by the returning piston. The line marked "Atmosphere" is drawn to represent the zero *gauge* pressure of the external air and the line DE is slightly above it because some pressure difference is necessary between the inside and the outside of the cylinder to make the steam flow out. The line EA represents the compression or cushioning effect that takes place at the end of the stroke.

The steam engine indicator is an instrument for securing such a chart in reduced size from an engine. The diagram or chart illustrated in the sketch is, in a way, ideal. Actually the events of cut off, release, compression and admission do not take place with such marked sharpness as is indicated and the actual diagram is somewhat rounded and otherwise changed from the ideal. It also varies greatly in different engines and with the power developed in any one engine.

We have said that there is a striking similarity in the fundamentals of the reciprocating engine and the turbine. This is true from a certain viewpoint and yet, on the other hand, there is a most striking dissimilarity between the two machines. In the turbine, the steam from the boiler is passed through a nozzle or a passage and in so doing is reduced in pressure or expanded. This means that an increase in volume takes place and it also results in giving a high velocity to the steam as it leaves the nozzle. This jet of rapidly moving steam is directed against a number of specially designed vanes, paddles, or buckets fastened on the periphery of a wheel or a drum and by this means rotary motion is obtained. Thus the turbine is essentially a machine that uses the *velocity* of the steam whereas the reciprocating engine depends on the *pressure* of the steam to develop its power. In this respect, therefore, the two machines are widely different. The similarity in fundamental principles is based on other considerations and is a matter we shall now discuss.

Let us suppose that we have a specially constructed boiler, engine and connecting steam pipe, all built with the same cross section as shown in Fig. 2 on the opposite page. Suppose further that steam has been generated at some given pressure, until all the space is filled between the surface of the water in the boiler and piston in the cylinder. We might consider that the space mentioned is filled with several unit volumes of steam in contact with each other, as indicated by the dotted lines in the boiler and steam pipe, and of such a size that each weighs one pound. Now we can cause the piston to move and to increase the volume between it and the position shown in the sketch by pro-

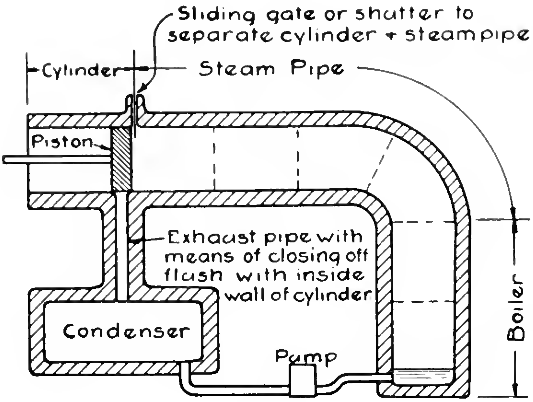


FIG. 2.

ducing or generating another unit volume of steam at the surface of the water in the boiler. To do this, heat, of course, is required.

The changes in volume and pressure that take place in this imaginary engine cylinder can be charted on a diagram similar to that in Fig. 1. This diagram is given in Fig. 3, and the line AB which represents the increase in volume at constant pressure within the cylinder is exactly similar to the line AB of Fig. 1.

Suppose next that the sliding gate or shutter at the head end of the cylinder is closed, thereby preventing the entry of any more steam into the cylinder. The entrapped steam will then expand, driving the piston further along in the cylinder and the pressure-volume change may be represented by the line BC of Fig. 3 which is similar to the line BC of Fig. 1.

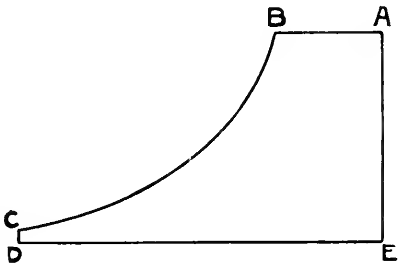


FIG. 3.

In Fig. 1 we had the engine exhausting to the atmosphere which is a space of constant pressure. In the present arrangement we shall substitute a condenser which, being constantly cooled by water at a uniform temperature, reduces the exhaust steam to water and provides a space of constant pressure. The temperature of the cooling water will determine what this pressure will be. Furthermore, in Fig. 1 we had release taking place slightly before the end of the stroke of the piston. In this case, as will be noticed, we do not open the exhaust valve until the completion of the forward piston stroke. The pressure in the cylinder then drops approximately to that in the condenser and, with the return stroke of the piston, we get the line CDE. This line also differs from the corresponding line of Fig. 1 in that we have continued it back to the end of the return stroke.

In this we have differed a little from the actual engine of Fig. 1 in which some of the steam was retained in the cylinder for the cushioning effect. The *weight* of steam so retained, however, is comparatively small and the difference between the real and this imaginary engine is without relative importance.

We now have the piston back to the starting point in contact with the sliding gate and, with the exhaust valve closed, this gate may be opened when the pressure against the piston (we could also say the pressure in the cylinder) is raised. This change can be represented by the line EA.

By means of the pump shown in Fig. 3 the condensed steam may be taken from the condenser and returned to the boiler. In so doing it should be noted that the volume changes but very little, while its pressure is raised from that in the condenser to that in the boiler.

In the above discussion we have been considering one pound of water or steam. During the change from A to B on the chart, we said that to increase the volume we caused one pound of water in the boiler to change to one pound of steam. This involved an increase of volume at constant pressure and theoretically we may say that the line AB is just as representative of the generation of this unit volume of steam in the boiler as it is of the increase of volume in the cylinder. In other words, the pound of steam in the cylinder at one time was a pound of water in the boiler and underwent an increase in volume just as did all the other units of steam between the cylinder and the boiler. Therefore, we may say that the chart in this imaginary engine represents the changes in volume and pressure to which one pound of water is subjected in making the cycle from the boiler through the engine, condenser, pumps and back to the boiler. The line AB represents the increase in volume during the change from water to steam. The line BC represents the expansion of this or a similar pound of steam in the cylinder. The line CDE represents the exhausting of the pound of steam to the condenser and its reduction to one pound of water. Finally, the line EA represents the increase in pressure at practically constant volume, to which the pound of water is subjected in being forced back to the boiler.

Since a steam engine indicator can be applied to a reciprocating engine and can graphically record the changes taking place within the cylinder, it is not so difficult to see the relation between the actual pressure-volume changes in the cylinder and the action of a unit volume of steam or water in passing out from and back to the boiler. It is not possible, however, to take a similar chart from a steam turbine, yet the volume and pressure changes which a pound of water or steam undergoes in the turbine are exactly the same as in the engine. This we will attempt to explain and in doing so, we will use an imaginary arrangement similar to that of Fig. 3 but adapted for a steam turbine.

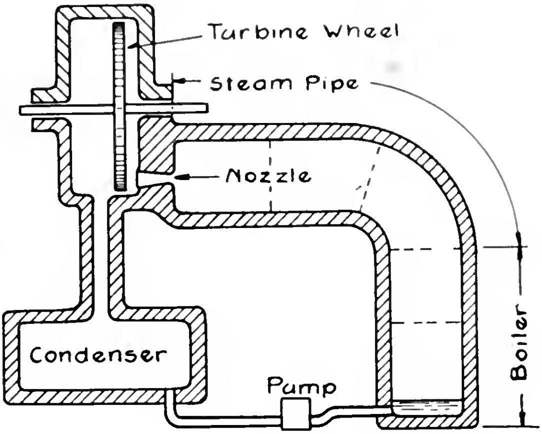


Fig. 4.

This sketch, Fig. 4, shows, diagrammatically, a boiler with a steam pipe of the same cross section leading to the nozzle of the turbine. If we are to maintain constant pressure in the boiler while a pound of steam flows from the pipe into the nozzle of the turbine, we must change one pound of the water in the boiler into one pound of steam, thereby pushing along the successive unit volumes of steam and in turn causing the flow of one unit into the nozzle. Considering the chart shown in Fig. 5 as representing the pressure and volume changes taking place in one pound of steam or water the line AB will indicate this first action of changing from water into steam at constant pressure.

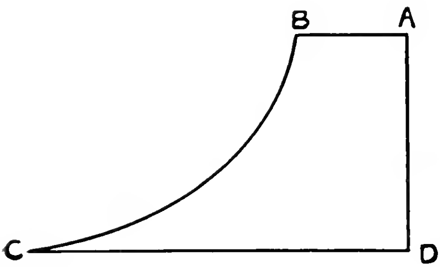


Fig. 5.

The turbine differs from the reciprocating engine in that the flow is continuous in the turbine and is intermittent in the engine. In the imaginary engine of Fig. 2 it was proper for us to isolate a unit volume of steam in the cylinder by the closing of the sliding gate because such action is exactly similar to the operation of the real engine. With the turbine, however, we cannot isolate a unit volume. Nevertheless, we can confine our consideration of the pressure and volume changes to one unit, bearing in mind that every unit that has preceded and everyone that follows after is acting in the same way.

The pound of steam expands in its flow through the nozzle, the volume increasing and the pressure falling, so that at the mouth of the nozzle the pressure has fallen to its lowest value. Such a change can be represented on our chart by the line BC. It will be noted in this chart for a turbine that this expansion line continues until it meets the exhaust line CD in a point and is not chopped off by a vertical line, such as CD in Fig. 3. It will be remembered that in the steam engine the expansion was stopped when the *pressure* had fallen so low that it would no longer be effective in driving the piston. In the turbine the continuation of the expansion beyond the point D of Fig. 3 results in increased *velocity* to the steam and thereby enables the turbine to make use of this "tail end" of the diagram.

The expansion of the steam in the nozzle increases its velocity to a high degree and it is this rapidly moving steam impinging on the blades of the turbine that gives motion to the turbine shaft. In the type of turbine under consideration, there are no further changes in pressure or volume while the steam is passing "through the turbine blades." Power is produced at the turbine shaft by reason of the reduction in the velocity of the steam and, ideally at least, the steam leaves the rotating blades at zero velocity. In some types of turbines the steam passes through several successive sets of nozzles and blades, the expansion taking place in steps, sometimes wholly in the nozzles and sometimes partly in the nozzles and partly in the moving blades. From our present viewpoint, however, the action of expansion is fundamentally the same as though it took place in one nozzle.

Since there is no further change in pressure and volume while the steam is acting on the blades of the turbine, it is impossible to chart this part of the steam flow. After the expansion in the nozzle and when the steam has been brought to the pressure and volume conditions represented by the point C in Fig. 5, the next change to take place, from our viewpoint, is the condensation of the steam in the condenser. This action is exactly the same as in the case of the steam engine and can be represented by the line CD in Fig. 5. So also, the return of the condensed steam to the boiler by the feed pump can be indicated by the vertical line DA.

The two charts shown in Figs. 3 and 5 thus represent the pressure and volume changes through which a pound of water or steam passes in its working cycle. In both types of prime mover the increase in volume represented by the line AB may be thought of as taking place in the cylinder or nozzle or in the boiler. The expansion of the steam represented by BC takes place in the cylinder of the engine or in the nozzle of the turbine. In both machines the reduction of the steam to water and the return of this water to the boiler is accomplished by external means, namely the condenser and the feed pump. Thus we may say that, while the steam engine is a pressure machine and the turbine a velocity machine, the cycle of events through which the steam goes in its passage through either is practically identical.

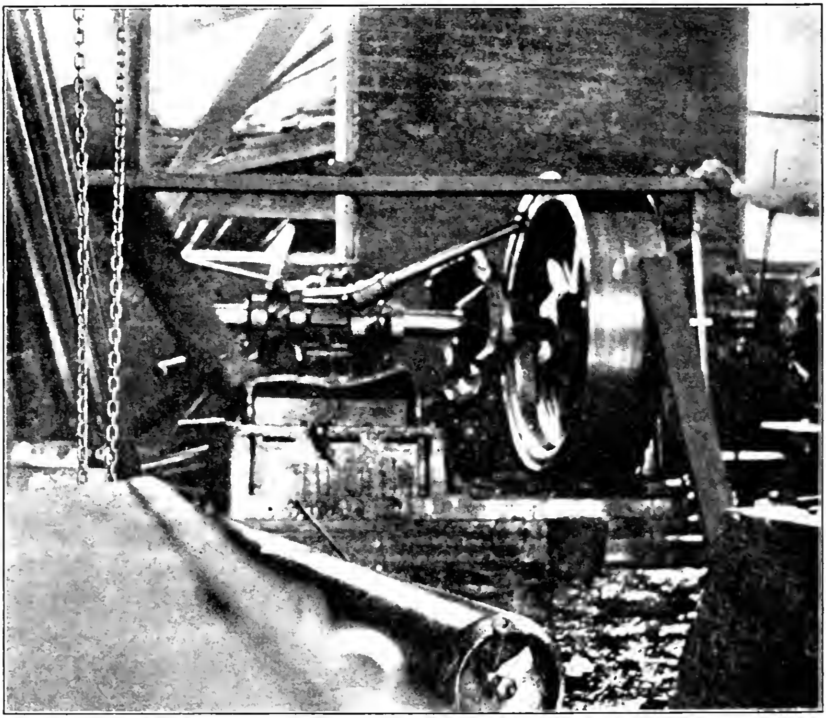
Explosion of an Ammonia Compressor.

AN accident which is of considerable interest and which should serve as a warning to many owners and engineers of ice and cold storage plants using ammonia compressors is one that occurred a short time ago in one of the southern states.

The machine which figured in the accident was a two cylinder single acting compressor, belt driven from a motor. It had been running with apparent ease and smoothness when suddenly the closed crank case was shattered from internal pressure, as illustrated on page 242, the damage being so great that it was necessary to install another complete machine. Fortunately the machine was covered by a Hartford Engine Policy and the owners were promptly indemnified for the property loss they sustained from the accident.

While the breaking of the crank case was clearly the result of over pressure, what gave rise to this condition is not definitely known. The theory has been advanced that ammonia vapor leaking by the pistons had an opportunity to build up to such a degree as to burst the walls of the crank case. It is possible, although not very probable in this incident, that the ammonia fumes became ignited within the crank case thereby causing the explosion. It is known that when ammonia vapor is mixed with a certain proportion of air and raised to a sufficiently high temperature that it will ignite and burn with explosive violence if the mixture is confined. (See THE LOCOMOTIVE, July, 1920, pg. 76.) With the circumstances of this particular case, however, it is difficult to see how the temperature necessary for ignition was produced. On the other hand it may be that the necessary conditions were produced and that this accident did result from the explosive property of ammonia gas. It is also possible that the explosion resulted from the ignition of oil vapor in the crank case although this would also require the presence of a high enough temperature to produce combustion.

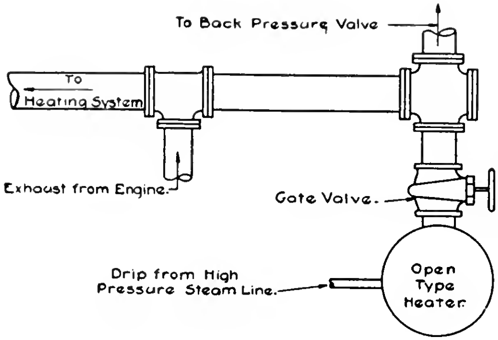
In connection with this accident and as further evidence of the inflammability of ammonia we desire to call attention to a disastrous fire which took place at the Syracuse Cold Storage Company of Syracuse, N. Y. on July 13th, 1921. This, it was said, resulted from an ammonia pipe that burst, filling the room with the gas which became ignited by the spark produced when the switch was opened to stop the electric motor driving the machinery. It was reported that five men were injured in fighting the fire and that the property damage amounted to over $50,000.



Wrecked Ammonia Compressor.

Explosion of an Open Feed Water Heater.

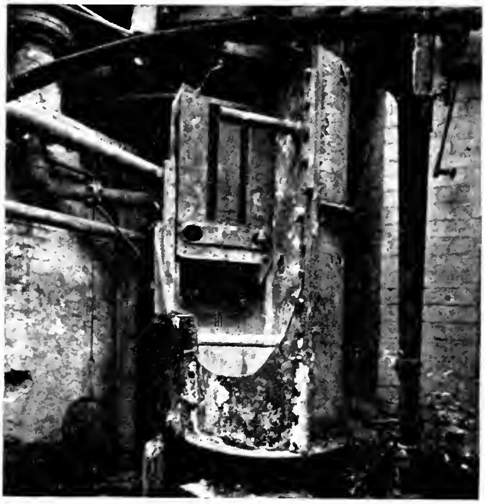
WHEN is an "open heater" not an "open heater"? The recent explosion of a feed water heater of this type will serve to show that there is a possibility, through faulty pipe connections, for such equipment to become "closed" and capable of doing severe damage.



Pipe Connections to Heater.

A plan of the arrangement of the heater and its piping is given in the accompanying sketch. The engine exhausted into a line which led, in the one direction, to the heating system and, in the other direction, to a back pressure valve and also to the heater, which could be cut off from the exhaust steam supply by a gate valve. The drips from a high pressure steam line were also led into the heater so that some of this heat could be returned to the boiler.

As the heater was in need of cleaning, the gate valve connecting it to the exhaust steam line was closed. The heater was not immediately opened, however, and as it apparently had no vent and leakage existed in the steam traps on the drips of the high pressure steam line, it was not long before a pressure was produced in the heater sufficient to burst it. A view of the wreck is given in the illustration herewith.



Wreck of an Open Feed Water Heater.

Is your "open" heater so installed that it is always *open?* It might be well to have it inspected. Go a step further — have it insured in The Hartford.

The Locomotive

DEVOTED TO POWER PLANT PROTECTION

PUBLISHED QUARTERLY

W. D. HALSEY, Editor.

HARTFORD, OCTOBER, 1921.

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THE LOCOMOTIVE OF THE HARTFORD STEAM BOILER I. & I. CO.

Obituary.

Francis Burke Allen.

IT is with a sense of deep sorrow that we record the death of Francis Burke Allen, vice-president of this Company, at his home in Hartford, Conn., on July 27th, 1921.

Mr. Allen had been in the service of the Company for forty-nine years, having joined the New York Department in 1872 as special agent. In 1882 he was appointed supervising general agent at the Home Office, in 1888 was elected second vice-president, and on February 9th, 1904 became vice-president of the Company. For many years he directed the affairs of the Inspection Department beside adjusting many claims and to his ability and continued efforts are due largely the development of the inspection service and methods along the lines that have gained so excellent a reputation for The Hartford Steam Boiler Inspection and Insurance Company. During the past few years his failing health confined him to his home and forced him to give up the very active part he had taken in many affairs.

Francis B. Allen.

Mr. Allen was born in Baltimore, Md. on June 1st, 1841. He was the son of William Cathers Allen and Louisa Williams Allen. He received a public school education in Baltimore, Philadelphia and Portland, Me. and later served an apprenticeship of four years in the machinist trade. Born of fighting stock — a great grandfather, Edward D. Burke, having served in the Revolutionary War, and one of his grandfathers, Dr. Francis Burke of Washington, D. C., having fought in the War of 1812 — Francis Burke Allen early felt the call of his country and in 1862 entered the United States Navy as assistant engineer with the rank of ensign. In this capacity he saw service during the Civil War on the gunboat Port Royal, which took a prominent part in operations on the James, Appomattox, Chickahominy and Mississippi Rivers and in the battle of Mobile Bay. He was then promoted to the grade of master and was ordered to the ironclad ram Dictator. After a year's assignment to this vessel, service upon which Mr. Allen was able to withstand only by reason of his robust health, he was ordered to the Novelty Iron Works, of New York City, to take part in experiments on the expansion of steam. He later served on the DeSoto, flagship of the West Indies Squadron. In 1868 he resigned from the navy and entered civil life as an engineer in the employ of The Novelty Iron Works remaining with this concern until he entered the service of the Hartford Steam Boiler Inspection and Insurance Company.

Mr. Allen was an intense patriot and this found expression in the active part he took in many patriotic organizations. He was a member of the Grand Army of The Republic, The National Association of Naval Veterans, The Army and Navy Club of Connecticut, and The Military Order of the Loyal Legion and also took an active part in the formation of the Admiral Bunce Section, Navy League of The United States.

In addition to these societies, Mr. Allen was a member of The American Society of Mechanical Engineers and of The American Society of Naval Engineers.

To all who knew him, Mr. Allen endeared himself by his kind and generous spirit. His cheerful personality won him many friends to whom, as to this Company, he was ever loyal. His death has brought to all a feeling of great loss.

Failure of Autogenously Welded Boiler.

THE Hartford Steam Boiler Inspection & Insurance Company has long taken the stand that, except in a few special cases, it could not approve any boiler construction or repair by autogenous welding. That this decision is justified is well illustrated by a recent failure resulting from a repair of this nature in the firebox of a locomotive type boiler.

In this particular case, which was described in *Power,* the boiler was not in service and at the time of the failure was being examined by an inspector who had gone into the firebox. While he was there, he heard a sudden, deafening report and thought at first that a stick of dynamite had exploded nearby. He discovered, however, that one of the side sheets of the firebox had ripped open for a length of about 36 inches, directly through an autogenous weld that had been made in the sheet, the rupture extending about an equal distance on either side of the repair.

The explanation given of the failure was that the sheet was thought to have been overheated when the welding was done so that it became crystallized and was, therefore, under a severe shrinkage strain. It is believed that many other disastrous accidents which have involved welding may have resulted from a similar cause.

The case, while unique, strongly supports our contention that, in cases where the safety of the structure is dependent on the strength of the weld, autogenous welding on pressure vessels is a dangerous practice.

Madman Burglar Steals Steam Boiler.

Orleans, France.— A few nights ago burglars broke into an ironmonger's warehouse and the next morning the only object missing was a large boiler. The police at first believed the theft to be the work of a madman. Later they arrested Mr. Boltier, a wealthy wholesale wine merchant and owner of a chateau and extensive grounds at Cerdon-sur-Loire.

Boltier admitted the theft saying that he had committed it in a moment of weakness, as he had ample means to buy such a boiler had he wished. A number of similar boilers, some of them weighing over a ton, were found in the cellars of his country home.

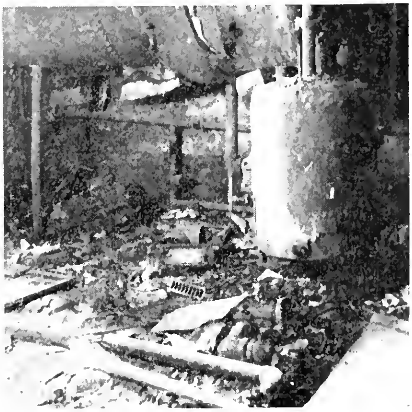
Boltier's lawyer says he will plead kleptomania.— *Meriden Record.*

[*Editor's Note.— We wouldn't insure these boilers. If M. Boltier had his cellar in the U. S. we wouldn't insure anything in it.*]

During the evening of November 21st, 1920 a heating boiler exploded at the home of Fred Wood, at Grafton, Mass., injuring four persons and causing considerable damage to the building. Mr. Wood had gone to the cellar of his home to remove the drafts from the fire and just as he opened the door of the steam heating boiler the explosion took place, completely wrecking the boiler and literally bombarding Mr. Wood with a volley of iron and hot coals. It was said that the explosion was caused by too great a steam pressure which the safety valve, remaining closed, failed to relieve.

A "low pressure" heating boiler exploded at the Rose Tree Hunt Club near Media, Pa. on March 29, 1921, injuring one person and damaging the club rooms to the extent of about $4,000. The boiler was not provided with a safety valve and the conditions surrounding the accident indicated that the boiler had been fired up while the inlet and outlet valves were closed. The boiler was a small one and a club member remarked after the accident, "If a little thing like that could do this damage I would hate to be near a big one when it goes off on a tear."

A boiler used for hot water supply exploded on March 18th, 1921 at the Hillcrest Apartments, 430 West 116th St., New York, N. Y. The boiler itself was demolished and considerable damage was done to the building. The boiler was one of a battery of two, both of which could be cut off from the water heating system by valves on the inlet and outlet pipes. It is thought that these two valves on the wrecked boiler had not been opened before placing the heater in service and that the safety valve had become inoperative, thus permitting an excessive pressure to build up and cause an explosion.



Boiler Explosions.

(Including Fractures and Ruptures of Pressure Vessels)

MONTH OF DECEMBER, 1920 (Continued)

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
628	22	Heating boiler exploded			Snowden Smith	Residence	Syracuse, N. Y.
629	22	Boiler of locomotive exploded	1	2	Santa Fe Railroad	Railroad	Monument, Col.
630	22	Boiler exploded		2	W. F. Hutchins	Saw Mill	Bardstown, Ky.
631	22	Tube ruptured		2	The Texas Co.	Oil Refinery	Norfolk, Va.
632	23	Gauge-glass burst		2	U. S. S. Kennedy	U. S. Navy	Point Loma, Cal.
633	23	Three sections heating boiler cracked			Edwards Hotel	Hotel	Birmingham, Ala.
634	23	Two sections heating boiler cracked			St. Lawrence County, N. Y.	Almshouse	Canton, N. Y.
635	23	Two sections heating boiler cracked			S. Lacchetti & J. Beathy	Hotel	Pleasant Unity, Pa.
636	23	Two sections heating boiler cracked			Borg & Beck Co.	Machine Shop	Moline, Ill.
637	24	Five sections heating boiler cracked			Allen School	School	Canton, O.
638	26	Boiler exploded			Carey Salt Works	Salt Plant	Hutchinson, Kan.
639	26	Eight headers cracked			Lexington Laundry Co.	Laundry	Lexington, Ky.
640	26	Section of heating boiler cracked			Mazer Cigar Mfg. Co.	Cigar Factory	Detroit, Mich.
641	26	Accident to boiler	3		Yellow Cab Co.	Garage	Chicago, Ill.
642	26	Two sections heating boiler cracked			Morris Raphael	Apt. House	N. Britain, Conn.
643	27	Boiler exploded		9	Star Laundry	Laundry	Ottawa, Kans.
644	28	Heating boiler exploded			Traders State Bank	Bank	Glen Elder, Kans.
645	28	Fitting on steam pipe ruptured			Michigan Alkali Co.	Chemical Plant	Wyandotte, Mich.
646	28	Heating boiler exploded		2	F. J. Fisher	Residence	Detroit, Mich.
647	28	Reducing valve ruptured			Illinois Maintenance Co.	Maintenance Co.	Chicago, Ill.
648	29	Boiler exploded. See Locomotive for April, 1921			G. H. Tilton & Sons	Hosiery Mfrs.	Savannah, Ga.
649	29	Section of heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
650	29	Tube ruptured			Morton Salt Co	Salt Plant	Hutchinson, Kans.
651	31	Six sections heating boiler cracked			G. O. F. Williams	Residence	Hartford, Conn.
652	31	Boiler exploded		3	F. Thorn		Gl'cester City N.J.

MONTH OF JANUARY, 1921

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
1	1	Section of heating boiler cracked			F. W. Woolworth Co.	Store	Watertown, N. Y.
2	2	Accident to steam pipe	1		Milford Elec. & Water Co.	Lt. & Water Plant	Milford, Del.
3	2	Water heating boiler exploded			B. Lebovitz	Residence	Pittsburgh, Pa.
4	3	Heating boiler exploded			Traders State Bank	Bank	Glen Elder, Kan.
5	3	Two sections of heating boiler cracked			Fleischman Co.	Grain Malting	Cincinnati, Ohio
6	3	Twenty-five tubes failed			Charlesbank Homes, Inc.	Apt. House	Boston, Mass.
7	3	Section of heating boiler cracked			Borough of Indiana	School	Indiana, Pa.
8	3	Section of heating boiler cracked			University of Pittsburg	University	Pittsburgh, Pa.
9	4	Hot water heater exploded			T. H. Robinson	Barber Shop	Washburn, Wis.
10	4	Section of heating boiler cracked			J. L. MacIntyre	Garage	Pittsfield, Mass.
11	5	Boiler exploded	1		Sun Oil Company	Drilling for Oil	Saratoga, Tex.
12	5	Two sections of heating boiler cracked			Harmony Cafeteria	Cafeteria	Omaha, Neb.
13	5	Tube ruptured			Montreal Mining Co.	Mining	Montreal, Wis.
14	6	Rendering tank exploded			Baker Slaughter House	Slaughter House	Horton, Kan.
15	6	Throttle valve burst			Shetucket Company	Cotton Mill	Norwich, Conn.
16	7	Vulcanizer exploded		2	Allen Tire & Rubber Co.	Rubber Works	Allentown, Pa.
17	8	Section of heating boiler cracked			County Comm. Hiawatha, Kan.	Court House	Hiawatha, Kan.
18	10	One section of heating boiler cracked			Fleischman Co.	Grain Malting	Cincinnati, Ohio
19	10	Six sections of heating boiler cracked			Fifty Associates	Office Bldg.	Boston, Mass.
20	11	Boiler exploded	1	1		Threshing Mach.	Hooker, Okla.
21	11	Six sections of heating boiler cracked			Town of Uxbridge	High School	Uxbridge, Mass.
22	12	Tube failure		1	Cape Girardeau Elec. Co.	Light Plant	Cape G'rdeau, Mo.
23	12	Two sections of heating boiler cracked			Children's Aid Society	Children's Home	New York, N. Y.
24	12	Two sections of heating boiler cracked			Lipman Schurmacher	Garage	New York, N. Y.
25	12	Boiler exploded			Lange Brothers	Cement Works	Champaigne, Ill.
26	13	Heating boiler exploded	1	1	Kroger Grocery & Baking Co.	Grocery Co.	Detroit, Mich.
27	14	Two sections of heating boiler cracked			E. Gottschalk & Co.	Dry Goods	Fresno, Cal.
28	14	Section of heating boiler cracked			Penn. School No. 6	School	Pittsburgh, Pa.
29	15	Accident to heating boiler		1	Stoeckle Green House	Green House	Watertown, N. Y.
30	16	Tube ruptured			Atlantic City Elec. Co.	Power Station	Atlantic City, N .J.
31	16	Tube ruptured			Leitelt Iron Works	Structural Iron	Gr. Rapids, Mich.
32	17	Section of heating boiler cracked			L. Sinsheimer Est.	Estate	New York, N. Y.
33	17	Six sections of heating boiler cracked			E. M. Glidden	Apt. House	Denver, Col.

34	17	Crown sheet pulled down		1	Massillon Coal Mining Co.	Coal Mining	Hurford, Ohio
35	17	Two sections of heating boiler cracked			Gotham Can. Co.	Can. Mfgs.	Brooklyn, N. Y.
36	19	Three sections of heating boiler cracked			John R. Thompson	Restaurant	Philadelphia, Pa.
37	20	Heating boiler exploded		1	Henry Grover	Residence	Two Rivers, Wis.
38	20	Compressed air tank exploded		1	Deming Filling Station		Deming, N. Mex.
39	20	Section of heating boiler cracked			Stanley Co. of Amer.	Theatre	Philadelphia, Pa.
40	22	Boiler exploded			Bent Wood Farm	Drilling for Oil	Brocton, Ill.
41	22	Tube ruptured			Los Angeles Gas & Elec. Corp'n	Power Station	Los Angeles, Cal.
42	22	Two sections of heating boiler cracked			The Garwood Company		Brooklyn, N. Y.
43	23	Heating boiler cracked			Superior Garage	Garage	Garwood, N. J.
44	25	Boiler exploded			Jeremiah Sweezy	Wood Saw	Aquebogue, N. Y.
45	25	Two sections of heating boiler cracked			A. B. Wilson & Co.	Garage	Hartford, Conn.
46	25	Four sections of heating boiler cracked			St. Andrews Church	Church	Buffalo, N. Y.
47	25	All sections of heating boiler cracked			Molton Hotel Co.	Hotel	Birmingham, Ala.
48	26	Boiler ruptured			Texas & New Orleans R. R. Co.	Creosoting Plant	Houston, Texas
49	26	Plate bulged and ruptured			City of Ada	Light Plant	Ada, Minn.
50	26	Section of heating boiler cracked			New Albany Amuse. Co.	Theatre	Brooklyn, N. Y.
51	26	Section of heating boiler cracked			Fleischman Co.	Grain Malting	Cincinnati, Ohio
52	27	Tube ruptured			Providence Gas Co.	Gas Plant	Providence, R. I.
53	27	Tube ruptured			Nekoosa Edwards Co.	Paper Mfgrs.	Pt. Edwards, Wis.
54	27	Tube ruptured			Amer. Tel. & Tel. Co.	Telephone Co.	Omaha, Neb.
55	27	Heating boiler exploded			Union Mer. & Cooperative Assn.	Mercantile Estab.	Marysville, Kan.
56	27	Boiler exploded			J. E. Williamson	Slaughter House	Clendennni, W. V.
57	28	Boiler bagged and fractured			United Fuel Gas Co.	Gasoline Plant	Clinton, Ill.
58	28	Boiler exploded	1	2	National Drug Co.	Drug Mfgrs.	Montreal, Canada
59	28	Heating boiler exploded			Poulter Apartments	Apt. House	Ardmore, Okla.
60	28	Vulcanizer exploded		5	Allen Tire & Rubber Co.	Rubber Works	Allentown, Pa.
61	29	Two boilers bagged and fractured			United Fuel Gas Co.	Gasoline Plant	Clendennni, W. V.
62	29	Boiler of locomotive exploded	4		B. & O. R. R.	Railroad	Littleton, W. Va.
63	31	Heating boiler exploded			C. A. Allen	Residence	Hoopeston, Ill.

MONTH OF FEBRUARY, 1921

64	1	Rupture of valve and fittings			Galveston Ice & Cold Storage Co.	Ice & Cold Storage	Galveston, Tex.
65	1	Accident to blow-off pipe			Manchester Laundry Co.	Laundry	Philadelphia, Pa.
66	1	Boiler exploded	1	1		Threshing Mach.	Liberal, Kan.
67	2	Section of heating boiler cracked			G. L. Morganthau	Taft Bldg.	New York, N. Y.
68	2	Six sections of heating boiler cracked			C. M. Wortman	Hotel	Indiana, Pa.
69	2	Boiler exploded	1	1		Sawmill	Lake Odessa, Mich.

MONTH OF FEBRUARY, 1921 (Continued

No.	DAY	NATURE OF ACCIDENT	Killed	Injured	CONCERN	BUSINESS	LOCATION
70	3	Six sections of heating boiler cracked			A. Kohn & D. Baird	Commercial Bldg.	Louisville, Ky.
71	3	Tube ruptured	1	1	Texas Power & Light Co.	Power Station	Palestine, Tex.
72	4	Section of heating boiler cracked			Fleischman Malting Co.	Grain Malting	Buffalo, N. Y.
73	4	Section of heating boiler cracked			J. M. & L. Keller	Club Rooms	Brazil, Ind.
74	4	Eleven headers cracked			Congoleum Co.	Floor Coverings	Marcus Hook, Pa.
75	5	Two sections of heating boiler and water front cracked			The Carroll Thomson Co.	Garage	Columbus, Ohio
76	5	Boiler exploded	1			Drilling for Oil	Breckenridge, Kan.
77	6	Header cracked			National Malleable Castings Co.	Wagon Mfg.	Cleveland, Ohio
78	7	Crack in fire sheet			Abingdon Wagon Co.	Malleable	Abingdon, Ill.
79	7	Tube failure		3	International Paper Co.	Paper Mill	Glen Park, N. Y.
80	9	Crown Sheet collapsed			Pagosa Lumber Co.	Planing Mill	Dulce, New Mex.
81	9	Vulcanizer exploded		1	Standard Tire & Rubber Co.	Rubber Works	Boston, Mass.
82	9	Vulcanizer exploded			Herman Weddige	Tire Repair Shop	Philadelphia, Pa.
83	10	Tube ruptured			S. H. Greene & Sons	Print Works and	Riverpoint, R. I.
84	13	Section of heating boiler cracked			H. H. Knoblock	Hotel	Fresno, Cal.
85	14	Mud drum fractured			Belton Cotton Mills	Cotton Mill	Belton, S. C.
86	14	Section of heating boiler cracked			S. J. Cordner & Co.	Oil Depot	W. Sp'gf'ld, Mass.
87	14	Section of heating boiler cracked			Fleischman Malting Co.	Grain Malting Co.	Buffalo, N. Y.
88	14	Section of heating boiler cracked			Consol. Amusement Enterprise	Theatre	New York, N. Y.
89	15	Section of heating boiler cracked			Central Auto & Supply Co.	Auto Supplies	Jackson, Mich.
90	16	Failure of main steam pipe			Western Compress & Storage Co.	Cotton Compress	Abilene, Texas
91	16	Three sections of heating boiler cracked			Bd. of Ed., Norman, Okla.	School	Norman, Okla.
92	17	Section of heating boiler cracked			Hartford Realty Co.	Apt. House	Hartford, Conn.
93	19	Section of heating boiler cracked			Harney Realty Co.	Hotel	Omaha, Neb.
94	19	Two tubes cracked in heating boiler			The Green Realty Co.	Hotel	Danbury, Conn.
95	19	Section of heating boiler cracked			George Schleicher	Residence	New York, N. Y.
96	20	Failure of mud drum			Lit Brothers	Dept. Store	Philadelphia, Pa.
97	20	Rupture of shell			Gloucester Ice Mfg. Co.	Ice Mfg.	Gloucester, N. Y.
98	20	Three sections of heating boiler cracked			Mayer & Schneider Enterprise	Theatre	New York, N. Y.
99	21	Two sections of heating boiler cracked			Children's Aid Society	Children's Home	New York, N. Y.
100	21	Section of heating boiler cracked			City of Altoona	City Hall	Altoona, Pa.
101	24	Boiler of locomotive exploded	4	2	Lehigh Valley R. R.	Railroad	Jersey City, N. J

102	25	Section of heating boiler cracked			J. M. Keller	Mercantile	Brazil, Ind.
103	25	Heating boiler exploded			Smithwood Grammar School	School	Knoxville, Tenn.
104	27	Boiler exploded			St. John's Orphanage	Orphanage	Philadelphia, Pa.
105	27	Three sections of heating boiler cracked			M. C. Barrett	Garage	Springfield, Mass.
106	28	Two sections of heating boiler cracked			B. & R. Gross	Apt. House	Newark, Del.
107	28	Tube collapsed			Curtis & Brother	Paper Mfg.	Hartford, Conn.
108	28	Shut-off valve broke			United Laundries Co.	Laundry	Cambridge, Mass.
109	28	Section of heating boiler cracked			Fall River Daily Herald Pub. Co.	Publishing Co.	Fall River, Mass.
110	28	Boiler exploded	1	3	Missouri Pacific R. R.	Railroad	Van Buren, Ark.

MONTH OF MARCH, 1921

111	1	Section of heating boiler cracked			Samuel Marbis	Apt. House	Boston, Mass.
112	2	Section of heating boiler cracked			Consol. Realty & Theatre Corn.	Theatre	Evansville, Ind.
113	2	Tube ruptured		2	American Stove Co.	Stove Works	Cleveland, Ohio
114	3	Boiler exploded	1	1	James Shoemaker Farm	Sawmill	Benton, Ill.
115	4	Failure of blow-off fitting			Whittle Trunk & Bag Co.	Trunk Mfg.	Knoxville, Tenn.
116	4	Boiler bulged and ruptured			Germaine Bros. Co.	Piano Mfg.	Saginaw, Mich.
117	5	Heating boiler exploded			St. Paul's Lutheran Church	Church	Platteville, Wis.
118	5	Heating boiler exploded			Belvedere Apts.	Apt. House	Louisville, Ky.
119	7	Section of heating boiler cracked			T. E. Beaniff	Apt. House	Okla. City, Okla.
120	10	Section of heating boiler cracked			North Congregational Society	Church	Haverill, Mass.
121	10	Boiler of locomotive exploded		2	B. & O. R. R.	Railroad	Barksdale, Md.
122	11	Bulged and cracked fire sheets			Mutual Ice & Cold Storage Co.	Ice Plant	Topeka, Kan.
123	11	Two headers fractured			Nat. Soldiers Home	Soldiers Home	Hampton, Va.
124	12	Pipe failure			A. L. Aiken	Rubber Goods	New Haven, Conn.
125	12	Failure of three headers			City of Baltimore	Hospital	Baltimore, Md.
126	13	Accident to blow-off pipe Boiler No. 2		2	Northern Pipe Line Co.	Pumping Sta.	Leesburg, Pa.
127	13	Accident to blow-off pipe Boiler No. 1		1	Northern Pipe Line Co.	Pumping Sta.	Leesburg, Pa.
128	15	Three sections of heating boiler cracked			Pittsburg Bd. of Ed.	School	Pittsburgh, Pa.
129	15	Section of heating boiler cracked			Ironwood Amusement Co.	Theatre	Ironwood, Mich.
130	15	Three sections of heating boiler cracked			Underwriter Bldg. Co.	Office Bldg.	New York, N. Y.
131	15	Section of heating boiler cracked			U. M. Ryan & Co.	Stores & Sales Rms.	Boston, Mass.
132	16	Failure of fitting on blow-off pipe			Nestles Food Co.	Creameries	Menominee, Wis.
133	17	Failure of pipe fitting			The Frost Mfg. Co.	Machine Works	Galesburg, Ill.
134	17	Header cracked			Pittsburg Plate Glass Co.	Mfgs. Plate Glass	Ford City, Pa.
135	18	Tube failure			South Acton Woolen Co.	Woolen Mills	So. Acton, Mass.
136	18	Heating boiler exploded		1	Hillcrest Apts.	Apt. House	New York, N. Y.

The Hartford Steam Boiler Inspection and Insurance Company

ABSTRACT OF STATEMENT, JANUARY 1, 1921

Capital Stock, . . $2,000,000.00

ASSETS.

Cash in offices and banks		$366,891.88
Real Estate		90,000.00
Mortgage and collateral loans		1,543,250.00
Bonds and stocks		6,188,435.00
Premiums in course of collection		728,199.44
Interest accrued		116,654.78
Total assets		9,033,431.10

LIABILITIES.

Reserve for unearned premiums		$4,512,194.11
Reserve for losses		205,160.80
Reserve for taxes and other contingencies		388,958.85
Capital stock	$2,000,000.00	
Surplus over all liabilities	1,927,117.34	
Surplus to Policy-holders		**$3,927,117.34**
Total liabilities		$9,033,431.10

CHARLES S. BLAKE, President.
FRANCIS B. ALLEN, Vice-President, W. R. C. CORSON, Secretary.
L. F. MIDDLEBROOK, Assistant Secretary.
E. SIDNEY BERRY, Assistant Secretary.
S. F. JETER, Chief Engineer.
H. E. DART, Supt. Engineering Dept.
F. M. FITCH, Auditor.
J. J. GRAHAM, Supt. of Agencies.

Board of Directors

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LUCIUS F. ROBINSON, Attorney, Hartford, Conn.

JOHN O. ENDERS, President, United States Bank, Hartford, Conn.

MORGAN B. BRAINARD, Vice-Pres. and Treasurer, Ætna Life Insurance Co., Hartford, Conn.

CHARLES P. COOLEY, President, Society for Savings, Hartford, Conn.

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MORGAN G. BULKELEY, JR., Ass't Treas., Ætna Life Ins. Co., Hartford, Conn.

CHARLES S. BLAKE, President, The Hartford Steam Boiler Inspection and Insurance Co.

WM. R. C. CORSON, Secretary, The Hartford Steam Boiler Inspection and Insurance Company.