The Locomotive

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THE LOCOMOTIVE

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THE LOCOMOTIVE—INDEX.

Vol. XXXVIII No. 1 January 1930

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

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Inspection and Insurance
Company

Please show to your Engineer

"Too Safe *to* Warrant Inspection," Hot Water Supply Tank Explodes *and* Kills 5, Injures 40

FIVE persons were killed and forty others were injured in Washington, D. C. when, on November 22, an exploding hot water supply tank ripped its way up through a sidewalk and into a dense crowd of Christmas shoppers. The blast was so severe that it

Figure 1

shook buildings in the business district for several blocks around. According to Washington newspapers, it was the worst catastrophe the Capitol has experienced since the memorable collapse of the Knickerbocker Theatre in which almost a hundred lives were lost several years ago.

The tank was a part of the hot water supply system of the McCrory five-and-ten-cent store and was located in a part of the basement that extended out under the sidewalk. As a consequence dozens of persons were above it when it let go. Many of the victims fell into the hole in the sidewalk where they were scalded and crushed as the tank, its upward flight arrested by a heavy I-beam supporting the overhanging store-front, fell back through the opening on top of them. Emergency squads of firemen and police turned to the work of rescuing the injured and freeing the bodies of the dead, while ambulances and doctors from all hospitals in the city waited to carry the victims away. A large motor derrick was pressed into service to aid in shifting the heavier pieces of wreckage. Much of the wreckage had been cleared away by the time the photograph shown in Figure 1 was taken.

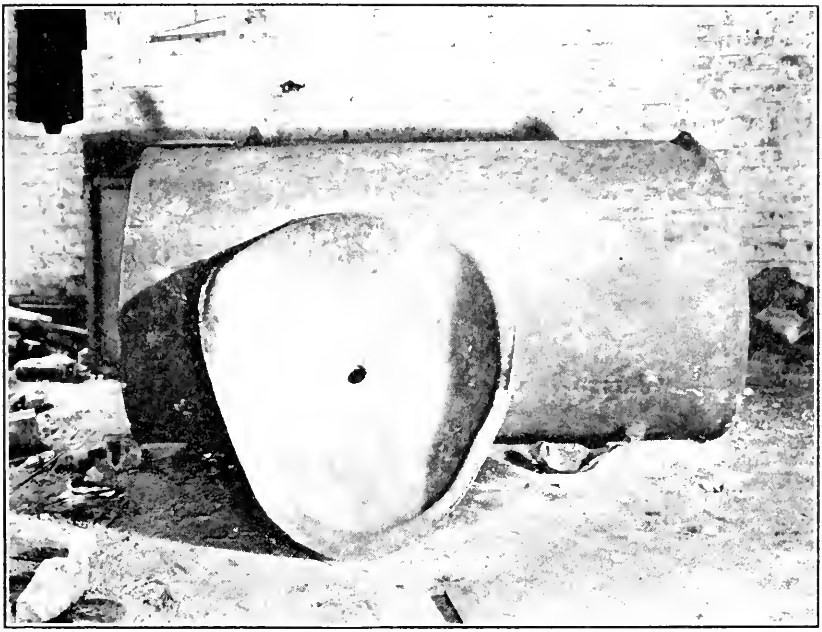


Figure 2

Those who were near enough to witness the tragedy without themselves being injured said that simultaneously with the terrific blast the sidewalk shot skyward, the store-front collapsed, and scores of persons were mowed down by pieces of masonry and other debris that swept the street like a burst of shrapnel. One large chunk of concrete struck and killed instantly a woman who was on the side of the street farthest from the explosion. Hospital attendants expressed the opinion that many of the more seriously injured were hurt in this manner. In several instances the explosion ripped the clothing from its victims.

Inside the crowded store persons were terrified. Those who were in the front of the bargain basement near the tank probably owe their escape from serious injury to the fact that the force of the explosion was directed upward. Firemen prevented one frantic woman from leaping from a second-story window.

According to an official report by one of the city's assistant engineering commissioners, the tank was equipped with a safety valve set to relieve at 65 pounds. This valve was found to be in good condition when tested after the accident, the commissioner venturing the surmise that its failure to prevent over-pressure may have been caused by an obstruction of some sort in the pipe between the valve and boiler.

The exploded vessel was a vertical tank six feet long, 37″ in diameter, and welded throughout. Its shell was of 3/16″ steel plate and both heads were of quarter-inch material. It appears that the bottom head had a flange or skirt and was fitted inside the shell so that it had a "minus" dish and that excessive pressure turned this head inside out (see Figure 2) and tore it loose from the shell at the welded joint. The top head was of somewhat different construction. It was without a flange and was installed so that it bumped outwardly, resembling a large, shallow saucer with its rim welded to the end of the shell plate.

Aside from the deaths and injuries, the loss caused by the Washington explosion ran well up into the thousands of dollars. The front of the McCrory store was demolished and an adjacent store building as well as those on the opposite side of the street were badly damaged.

It is interesting to note that the Washington Evening Star, in reporting the accident, referred to the exploded tank as "a low-pressure boiler regarded as too safe to warrant inspection". The owners carried no boiler insurance, it is understood.

The title page and index for Vol. XXXVII of THE LOCOMOTIVE, covering the years 1928 and 1929, is now available and may be obtained by applying to the Hartford Office of the Company.

Prior to the issue of July, 1928, one of the regular features of THE LOCOMOTIVE was a list of boiler accidents (including explosions, fractures and ruptures of pressure vessels) taken from our records and from other available sources. In order that the five or six pages devoted to that feature might be given over to other material of more general interest to our readers, the list was discontinued after the completion of 1926 accidents. However, since then the list has been kept up to date in this office. Accidents for 1927-1928 have been published in pamphlet form as a supplement to Vol. XXXVII of THE LOCOMOTIVE and a limited number of these pamphlets are available for distribution at the present time.

Engine Accident Due to Progressive Crack

By H. J. Vander Eb, *Sup't Engine Dept.*

CLOSE inspection of engine parts frequently makes it possible to find surface cracks which, if undetected, might lead to complete failure of the cracked parts and cause serious damage to the engine. Such cracks or flaws are not always in the most accessible places.

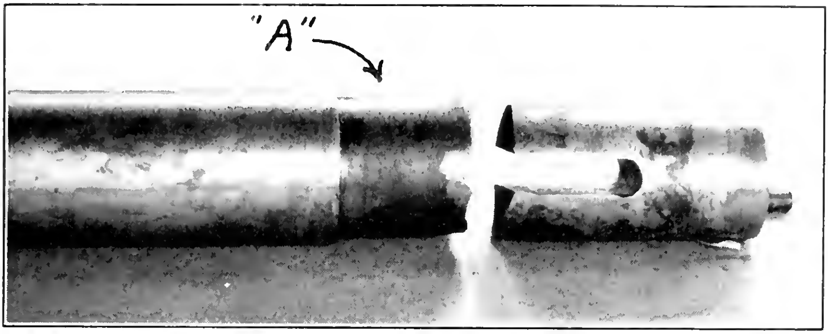


Figure 1

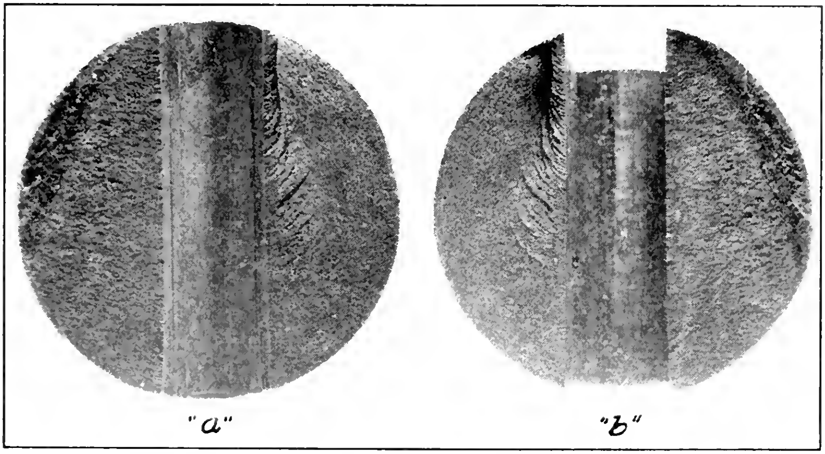


Figure 2

More often than not they are in parts of the engine that normally are hidden from view, so that some dismantling is necessary before the parts can be inspected.

It may seem a hardship if a proposal is made to have an engine taken apart for close inspection of vital parts, and consequently such a request is sometimes stro[illegible] [illegible]osed by engine owners. However, in the light of long expe[illegible] with breakdowns of reciprocating engines it is entirely justifiable to make this very necessary preparation for searching out hidden cracks, especially after an engine has been in use for several years. As a result of a slow, painstaking educational campaign among engine owners most of our machinery inspectors have

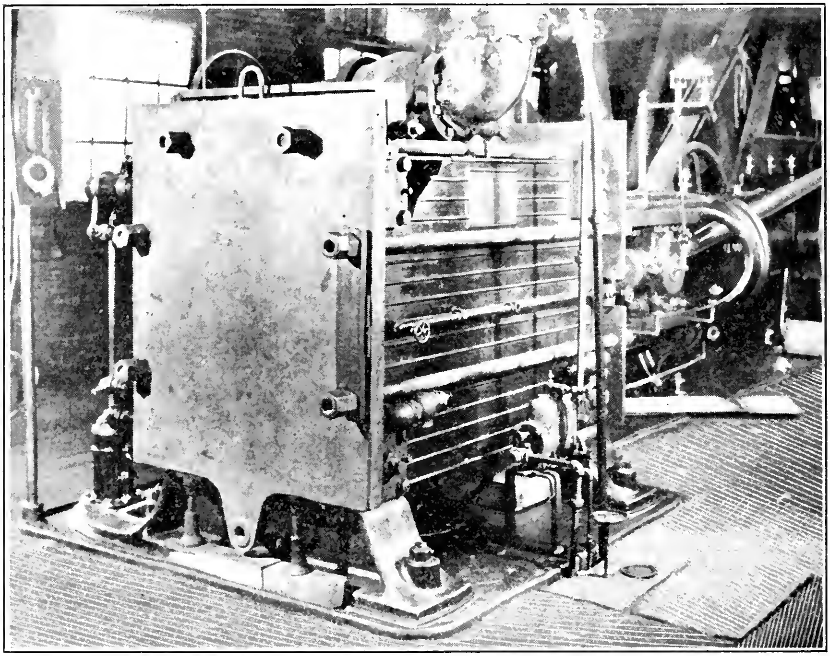


Figure 3

to their credit a considerable list of dangerous defects found in hidden parts, such as cracked crossheads, cracked connecting rod straps, partly broken piston rods, cracked crankpins, shafts and other vital engine members.

A case in point, where a dismantled inspection would have been very useful, is illustrated by the accompanying photographs showing the result of and the apparent reason for a progressive failure in a piston rod. Figures 1 and 2 show respectively the broken piston rod and the endwise views of the fracture. The latter show clearly the characteristics of a crack which progressed slowly until only the small, dark area at the left of Figure 2-a and the corresponding dark area at the right of Figure 2-b remained unbroken.

It is evident that the rod had been flexing a small amount, and that this first caused a slight surface overstress. In time the surface crack penetrated the rod, thus reducing the area of sound metal to a point where there was not enough left to withstand the normal load stress. From an examination after the accident it was apparent that the fit of the rod in the crosshead left much to be desired, the rod being tight only at its extreme end. This condition can be seen in Figure 1, the bright area near the end showing where the rod fitted tightly, and the dark area "A" near the shoulder giving evidence that there had not been a proper fit at that point. Of course, this was what allowed the flexing and the subsequent failure.

Breaking of the connecting rod freed the piston, which knocked out the rear cylinder head and carried away part of the cylinder and valve housing. The engineer, who was standing right near the cylinder, was so severely scalded by escaping steam that he died the following day.

Figure 3 showed the engine with a temporary repair which was ingeniously applied in record time, thus preventing a lengthy interruption of the industry.

Improper Regulation *of* Dampers *and* Valves Causes Cast Iron Economizer *to* Explode

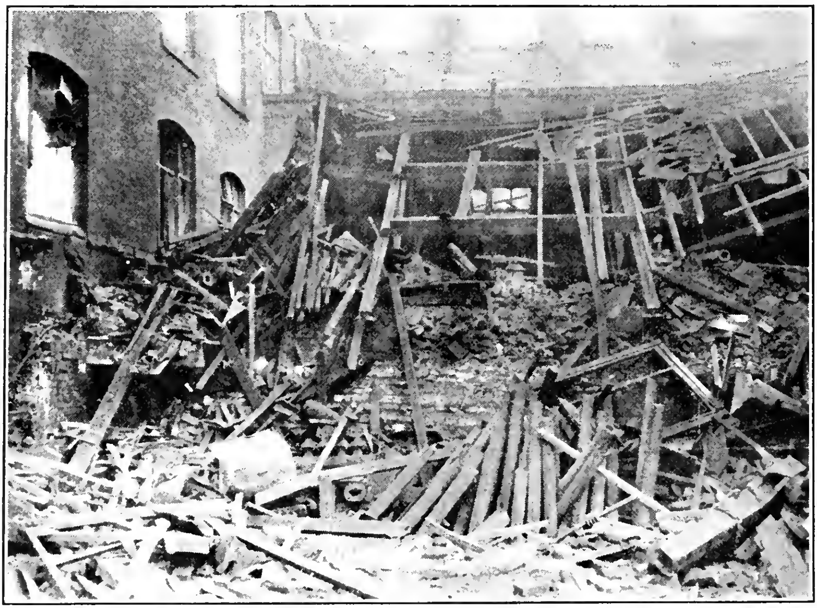
FAULTY manipulation of the dampers and feed line valves on an economizer of the ordinary cast iron type recently caused a very serious explosion that not only destroyed the apparatus itself but wrecked the building housing it. The accompanying illustration is a photograph of the wreckage.

Although this explosion took place in an English mill, the economizer was of a type widely used in this country, and for that reason several points brought out in the investigation by the English Board of Trade are of considerable interest.

The economizer was made up of 144 cast iron tubes fitted into top and bottom headers with the customary taper joints. It had a blow-off valve as well as a safety valve which was set to lift at 195 pounds, about fifteen pounds above the normal working pressure.

On the evening before the accident the fireman followed out his customary procedure of raising the water in the boilers somewhat above the working level, shutting down the feed pump, closing the feed line valve between economizer and boilers, and blowing down the economizer. As the boilers were to be kept partly active through the night to furnish steam for heating the mill, he banked the fire on half the grate surface under each boiler and arranged dampers to by-pass the flue gases around the economizer.

In the morning the fireman broke the bank, opened the damper, and switched the flue gases back through the economizer. However, he did not start the feed pump or open the valve in the feed line between the economizer and the boilers. As the economizer had been partly emptied of water when it was blown down the evening before



and there was no chance for a circulation of water through it, the hot flue gases started to generate steam which overheated the metal and probably caused serious expansion stresses at the joints between the tubes and the upper header. The explosion occurred about half an hour after the fires were stirred up. It is suspected that even though the gases were by-passed around the economizer during the night, there may have been enough leakage past the damper to keep the tubes fairly hot, so that steam was quick in forming after the full supply of flue gas was shunted through the apparatus.

An examination of the fractured tubes showed that many of them had been affected internally by graphitic deterioration. Wall thickness was generally well maintained but at some points the greater part of the cast iron seemed to have been converted into a graphitic structure. At places this graphite had broken away from the tubes, leaving a very much reduced thickness of good cast iron. Undoubtedly, this change in the nature of the material had taken place over a long period, for the economizer was twenty-five years old.

A feature that makes it difficult to determine the physical condition of these economizers is the extreme inaccessibility of a large part of the internal surface of tubes and headers where the cast iron corrodes in a manner that may be very deceptive. The inside of the structure will usually be found covered with some scale and much soft mud or sludge which, when removed, leaves a surface of apparently sound iron. In many cases close examination reveals that the iron has become soft and spongy. Like the graphite " lead " in a pencil, it may be cut readily with a knife or scraper. The problem is to determine how deeply this soft material extends into the metal, and this can be found only by scraping with a knife, chisel, or special tool. Extensive scraping over large areas should be avoided, as the sound material is protected by the corroded layer and will corrode at an increased rate if exposed.

Particular attention should be paid to external signs of leakage in bottom boxes, for wet soot is a powerful corrosive agent. Sometimes dampness in the soot pit will be caused by water dripping from a relief valve or even by sweating produced by the introduction of cold feed water. In either event, corrosion is bound to be serious if the condition is allowed to continue.

For convenience in operation economizers are usually fitted with a tight inlet valve, and with a stop valve and a check in the line to the boiler. This stop valve should be locked in the " open " position during ordinary operation and should be so placed that the check may be overhauled without shutting down the boiler. There should be a good-sized blow-off connection, fitted with a valve in an accessible place and piped as in good boiler practice.

Safety valves should be of ample size and, for large economizers, two such valves are preferable. When there are two or more safety valves they should be at the ends or ends and middle of the top longitudinal header.

Escape pipes from safety valves should be open ended and as short and direct as possible. It is important that they lead clear of the casing and be so placed that boiler room attendants will be given immediate notice when the valves are operating or leaking. The practice of leading these escape pipes to a sump tank is not recommended, for when the escape is thus hidden from view a leak may exist for some time without detection. The spring loaded, lock-up, pop type valve has been found best suited to this sort of use, and it should be set to blow at from 10 to 15 pounds above the boiler pressure.

Economizer flues should have shut-off dampers on both sides of the vessel, independent of the regulating damper and not connected to any automatic regulating device. It is important that these dampers be kept in good repair so that they shut easily and tightly. Sliding dampers appear to fulfill this requirement perhaps a little better than leaf dampers.

An important point in connection with the operation of economizers is that the soot pit doors be removed as soon as the shut-off dampers are closed, and left off until the shut-off dampers are opened again. This prevents the accumulation of an explosive gas mixture within the casing.

When preparing to give economizers an internal cleaning it is well to remember that a slight deposit of scale will not be very detrimental to economy, and will afford considerable protection to the iron. For this reason, as well as because it is so easy to disturb the soft graphite layer of corroded iron, turbine boring tools such as are used in the tubes of water tube boilers are not recommended except in most extreme cases. Then the job of cleaning should be entrusted only to a man who understands the precautions necessary to avoid injury. However, there are several forms of fire tube soot scrapers that have proved more satisfactory tools for cleaning economizers under average conditions.

"The Boiler Book's" Reputation Travels Far

From far-off Bombay, India, comes the following rather unusual request for a copy of "The Hartford's" Boiler Book, a collection of data for use in the design and installation of boilers, which — since the first edition was published by the engineering department, seven years ago — has found a useful place in the libraries of designing engineers in many countries:

"Dear Sir: I shall feel extremely grateful to you if you would kindly send me free of cost a copy of your work and entitled 'The Boiler Book' published by your Company.

"As I like to be in touch with recent works I hope you will do me a complimentary favour by sending your famous book. Hoping to get one copy if you can spare. Hoping to be excused for the trouble of intruding as well on your valuable time. An answer will oblige. I beg to remain honour Sir,

"Yours most obediently,

"Bapujee Edaljee, Chief Engineer"

(Note: "The Boiler Book" is available for general distribution at $1.00 a copy.)

Bursting Disc Wrecks Turbine While Machine *is* Running *at* Normal Speed; Injures Engineer

A 3,000 kw. turbo-generator at the Akron, Ohio, plant of The Quaker Oats Company exploded without warning on September 20th, 1929, when a third-stage rotor disc burst while the machine was running at normal speed. (See Figure 1.) The watch engineer had a narrow escape from death or serious injury, for only two or three seconds prior to the accident he had been leaning over the turbine, observing the tachometer. He had just left the machine when a piece of debris struck him a glancing blow on the head, rendering him unconscious. Had he not started away when he did, he would have been directly in the path of the broken disc as it crashed through the casing.

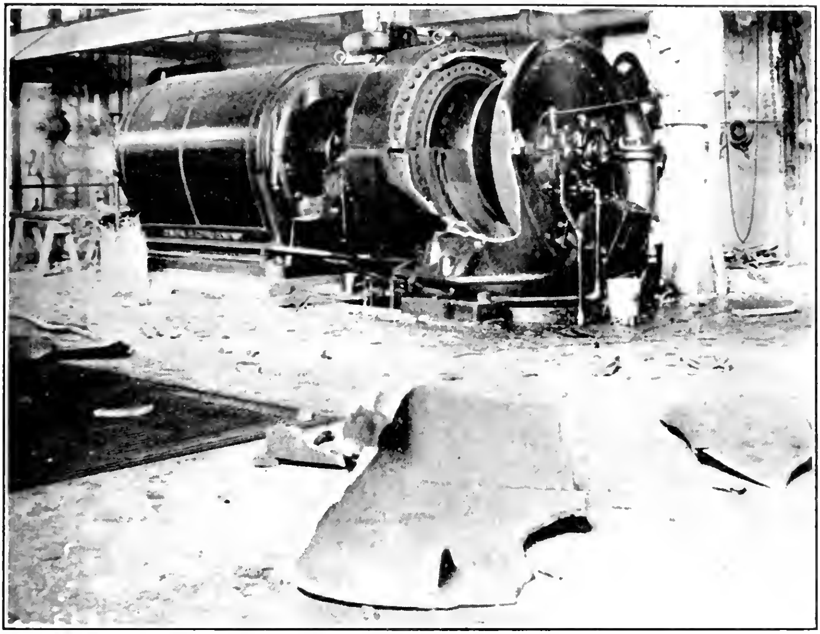


Figure 1

The explosion occurred at 7 o'clock in the morning while the usual day load was building up. Just before the crash the engineer observed that the load was about 2,400 kw. and the speed a trifle below 3,600 rpm., so it is reasonably certain that there was no overspeed. Moreover, the emergency governor springs, when examined after the accident, bore none of the marks typical of runaway wrecks. As a rule, springs of the type used in this emergency governor break when considerable overspeed takes place, but even when they do not break their ends are almost always worn off.

The initial rupture was in a diametrical direction across the keyway and through one of the balancing holes in the disc. There was also

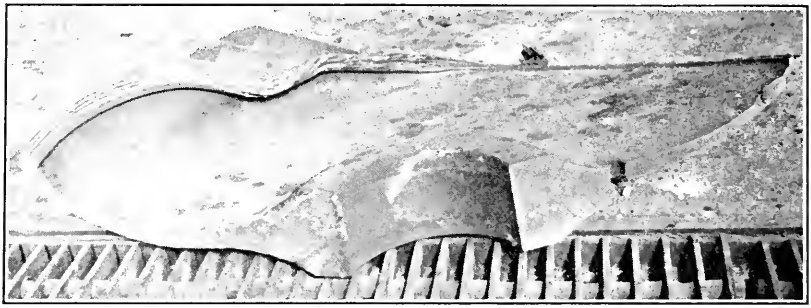


Figure 2

a break in the disc rim extending through about a third of the circumference, but this failure evidently occurred subsequent to the other.

From the appearance of the broken disc (shown in Figure 2) it seems probable that there was progressive failure over a considerable period of time at a point immediately adjacent to the keyway. This broken area showed a silky fibre not in evidence on the roughly torn portion of the surface where rupture was evidently instantaneous. Although the progressive crack may have existed for some time prior to the accident, it was located on the inner side of the disc at a point where an inspector could not gain access.

In acknowledging receipt of "The Hartford's" draft for $25,024.98, which was sent within twelve days of the accident, the assured wrote in part: "In all my experience of adjusting losses I never before received payment in full of the loss so quickly, and your company is certainly to be commended for this fairness and promptness."

CHANGE IN PAR VALUE OF STOCK

At a special stockholders' meeting of The Hartford Steam Boiler Inspection and Insurance Company, held on December 18, 1929, it was voted that, on January 15, 1930, the par value of the Company's issued and outstanding capital stock be reduced from $100.00 per share to $10.00 per share, and that the number of shares be correspondingly increased from 30,000 to 300,000.

Several Recent Cases Demonstrate Inspectors' Worth *in* Searching Out Dangerous, Hidden Defects

WHILE examining a Scotch Marine boiler recently, an inspector noticed slight leaks at a girth seam and around the manhole reinforcement ring. On questioning attendants, he found that they were aware of the leaks and had made an unsuccessful attempt to stop them by caulking. The condition was such as might indicate cracks in the plate, so the inspector had the engineer remove enough

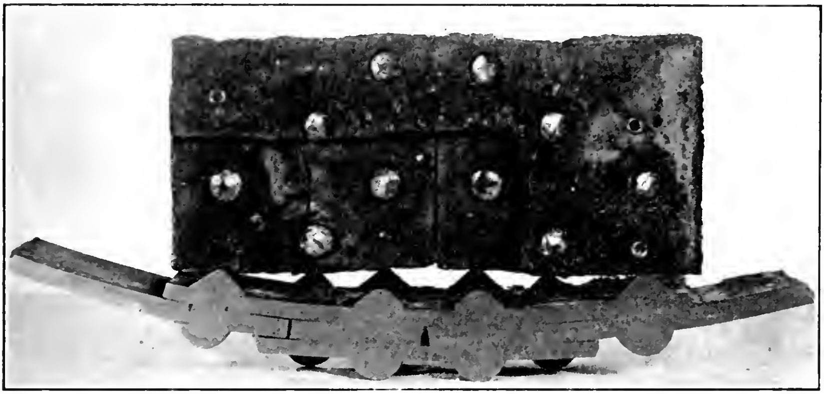


Figure 1

of the lagging to permit examination of the longitudinal seam. There he found four broken rivets and two others that appeared to be cracked.

The engineer did not share the inspector's apprehension, and instead of granting a request to have the butt strap removed, he urged that the rivets be redriven and the boiler put back onto the line. However, after considerable urging, he agreed to allow a hydrostatic test. A hammer test of rivet heads with the boiler under 150 pounds water pressure brought to light several more defective rivets. The inspector had just finished marking them for removal when the seam gave way in the middle course. Needless to say, that brought the test to a halt.

From the appearance of the rivet at the extreme left in Figure 1 it is evident that slippage of the plate had subjected the outer row of rivets to a heavy shearing stress. Had the rupture taken place while the boiler was in service there is little question but that there would have been complete separation at the joint, and a violent explosion.

Called on to examine a horizontal tubular sawmill boiler on which the owner had applied for insurance, an inspector was given to understand by the mill superintendent that the boiler was not only comparatively new but was such an "unusually good un" that it should carry 150 pounds pressure without any difficulty. The vessel was 48 inches in diameter, 14 feet long, and was made with two single sheet courses, of 5/16-inch plate, lap riveted. It was to be used at a pressure of 125 pounds to supply steam to an engine.

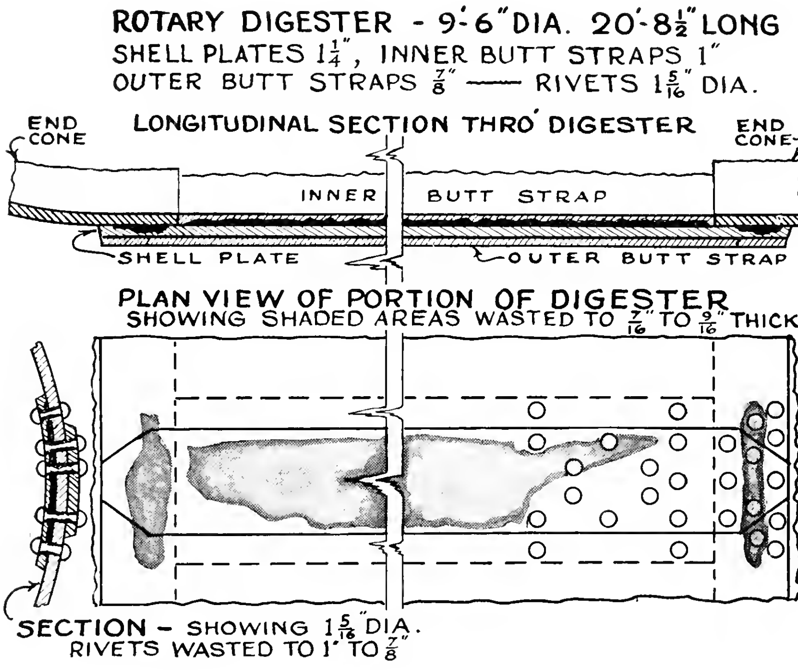


Figure 2

Although a generous coating of paint had been applied to the shell and heads, the inspector saw enough at first glance to convince him that the superintendent's appraisal was a little over-optimistic. He judged the boiler to be somewhat over 20 years of age and figured, from plate thickness, size, and method of riveting, that even when new, it could have been used for no more than a pressure of 104 pounds with a factor of safety of five.

It was evident that external corrosion had caused some deterioration, and while preparing to enter the manhole the inspector saw that the cast-iron reinforcing ring was broken. However, it was not until he crawled inside that he discovered just how serious a condition the boiler was in. Each course was grooved and cracked intermittently for three-quarters of its length. At some points along the seam it took no more than a firm hammer blow to puncture the plate.

In reporting the case the inspector wrote: "There was no difficulty in arriving at the approximate length of time it would have taken to terminate the boiler's usefulness — as well as that of any persons who might be in the immediate vicinity — had this 'good un' been continued in service."

With the exception of wasted rivet heads and two or three rivets, there was no outward evidence that the butt strap seams of a rotary sulphate digester were seriously defective, but an inspector recently uncovered a condition so dangerous that an explosion would almost certainly have resulted had the vessel been continued in use.

The inspector noticed that the inside heads of countersunk rivets had been built up by welding and, in applying the hammer test, found that not only were some of the rivets loose but that the seam had a peculiar "hollow" sound. This led him to suspect that the sulphate liquor might be affecting the plate under the straps.

When the loose rivets were cut out it was discovered that some of the shanks had been reduced to less than half of their original diameter. Further investigation disclosed the condition as sketched in Figure 2. The sketch shows only the joint in the main shell of the vessel, but the same condition existed in butt strap seams of both end-cones. It is noticeable that wasting occurred at points where it could not be seen until after the straps were removed.

Two other digesters in the same plant were found similarly affected and, along with the first one, were retired from service.

Arriving at a dairy to inspect a horizontal tubular boiler on which this Company had just been asked to issue a policy, the inspector found that the top manhole cover, located in the rear head, had not been removed. From the fact that the nuts were rusted solidly to their bolts he concluded that the plate had not been disturbed for a long time. This guess was confirmed by the attendant's explanation that he had never before been asked to take this cover off.

Curious to find out just how close a check had been kept on the boiler's condition, the inspector asked the attendant to remove several bricks from the rear combustion chamber arch so as to permit a thorough examination of the head. He found the metal so badly corroded that it was possible to drive a small testing hammer through it at four places. Transferring his attention to the front head, he found the metal below the bottom row of tubes wasted from an original thickness of ½ inch down to 3/16ths. As corrosion had affected the shell plate to an equally serious extent, repairs were not practicable.

Although the owner was surprised to learn that his boiler was in a dangerous condition, he was glad that the defects had been discovered in time to prevent an explosion and very willingly accepted the inspector's recommendation that the vessel be retired at once.

Taps from the Old Chief's Hammer

"CHIEF," said the Department Manager, sticking his head in through the door of the old fellow's office, "what have you been up to now? They tell me you went ahead and ordered repairs on one of the Metropolitan Utility Corporation's high-pressure boiler drums in spite of the fact that two representatives of the manufacturer, a metallurgist, and even the plant's own engineers didn't think it could be done."

The Old Chief turned and regarded his caller for a moment in silence.

"It wouldn't have been a very keen piece of work if I had let them throw away a perfectly good drum, would it?" he asked.

"Apparently not, under the circumstances," laughed the other, slapping the old fellow affectionately on the shoulder. "As a matter of fact, Vice President Berkman just had me on the 'phone a few minutes ago and said you'd saved him something like $65,000."

A slow smile appeared on the Chief's face. "Well now, it's not up to me to dispute that point with Mr. Berkman, but I don't think we saved him that much. Fifty thousand is my estimate."

"Anyhow," insisted the other, "he's tickled with the way you handled the job. From what he said, the stories he'd been reading in the technical papers for the past year or two had just about convinced him that when caustic enbrittlement once made its appearance the boiler was as good as gone."

"Well," said the Chief meaningly, "just because we got him out of a big repair bill this time he shouldn't get the idea that it's not a serious thing. As a matter of fact, caustic embrittlement is about the worst ailment a boiler can contract, excepting a lap seam crack. And we don't find so many of them nowadays since most of the new boilers are being built with butt strap joints. However, we do run into quite a lot of embrittlement cracking and there's only one way to keep it from ruining the boiler — catch it just as soon as the first symptom appears.

"Take Berkman's case as an example. We'd been inspecting that boiler ever since it was installed and, knowing that they were using self-purgative feed water of the kind that frequently causes cracking, our inspectors were keeping a close lookout for leakage and were tapping rivet heads at every opportunity."

"Just a minute, Chief," the younger man broke in. "I'm not right up to the minute on some of these new wrinkles of the inspecting game, so I've got to ask you to tell me just what it is the inspector finds out about the presence of caustic enbrittlement when he taps rivet heads with his hammer."

"Well now," the older man explained, "there are two conditions which are absolutely necessary in order for caustic to attack boiler steel. The first is a high concentration of caustic, and the other is steel in which local stresses are pretty close to the elastic limit. The only place in a boiler where ordinarily you can have both of these conditions at the same time is in the seams, where the caustic can gradually build up to a concentrated state, and riveting pressure, along with other factors, puts high stresses in the metal. When you bring those things together you can look out for trouble, and the first thing to give way is usually the rivet shanks. Sometimes a rivet will crack in two, and then again you'll find rivets that have cracked only part way through the shank. An experienced inspector has a knack of bringing his hammer down on the head in such a way as to put a sort of twisting stress in the rivet. If the shank is broken all the way across, the rivet will start to turn out, like a screw. If it's cracked only part way, the inspector can tell it by the feel and his blow will frequently snap the rivet off.

"Up until a week ago we'd never found the slightest sign of anything like caustic cracking in the boilers up at the Metropolitan station, but when Inspector Freeman dug out a tiny, bitter-tasting buckshot from an outside seam he knew right away there was concentrated caustic in the joint. No sooner had he started to work on the rivet heads than one of them came off.

"I went right down there after he'd 'phoned me, and we polished out two rivet holes for examination under a magnifying glass. Sure enough, there were the tell-tale hair-line cracks radiating from the walls of the holes — cracks so fine that you couldn't see them with the naked eye.

"Of course we reported the condition to the Chief Engineer and he called up Mr. Berkman. Feeling that an investment of about $375,000.00 might be involved, Berkman asked if we'd mind if he brought in some of the manufacturer's men and a metallurgist to check up on the diagnosis. Naturally, we were glad to have them, so next day we all looked over the drum and later held a conference downtown in Berkman's office. There was no question in anyone's mind but that the boiler had been affected by caustic embrittlement and, on the assumption that it was better to be safe than sorry, the boiler men and the metallurgist said they thought the wisest plan would be to discard the drum entirely and put in a new one. The plant engineer thought so too.

"However, when they got to figuring how they were going to get the old drum out and the new one in they saw it was going to be an expensive job. There was no way of doing it without cutting into two of the main building supports, a procedure involving a lot of shoring up that would make the job cost something like twice the amount it would ordinarily take to replace a drum that size.

"Finally, Berkman turned to me and asked my opinion. I said I wasn't ready to give one, and wouldn't be until I'd had a better opportunity to go over the drum and find out definitely the extent to which the plate had been affected. All hands agreed that such a plan would be advisable before any definite steps were taken, so we decided to adjourn the conference until the end of the week.

"To make a long story short, Freeman and I went right to work and within two days we had satisfied ourselves that, with one exception, the rivet hole cracks were so short that reaming anywhere from a sixty-fourth to a thirty-second of an inch of metal from the walls of the holes would eliminate the cracks entirely. The one crack that was longer ran back into the plate at such an angle that it wasn't particularly serious. We had nipped this case of embrittlement right at the outset before it had a chance to cause material damage.

"Berkman had left the city on a business trip right after the meeting and wasn't expected back until the day of our second conference, so under our instructions the engineer went ahead with the repairs and had the boiler ready to fire up early Friday morning."

"Say," interposed the Manager, "weren't Berkman and the others surprised when you walked into the meeting and told them the trouble was fixed?"

"Well, to tell the truth," laughed the Chief, pausing to tamp down the ash in his pipe, "there wasn't any meeting. Berkman got back to the city several hours before we expected him and he showed up at the plant just as they were cutting the boiler into the line. Unknown to me, the Engineer had wired him as soon as we decided the drum could be repaired, so he had 'phoned the others that the conference was adjourned 'sine die'."

Caught in the Separator

SIX GOOD REASONS

Pat Murphy attended a plant safety meeting. The boys had been given some pointed instructions and the safety man wanted to check up results.

"Pat," he said, "can you give me six good reasons for safety?"

Now, Pat wasn't up on his reading, but he was rather quick with his come-back. "Sure," he replied. "The four little Murphys, me wife an' meself."

A Bostonian was showing a visiting Englishman around. "This is Bunker Hill Monument where Warren fell, you know." The visitor surveyed the lofty shaft thoughtfully and said, "Nasty fall! Killed him of course?"

EMOTION

A man was discovered by his wife one night standing over his baby's crib. Silently she watched him. As he stood looking down at the sleeping infant, she saw in his face a mixture of emotions — rapture, doubt, admiration, despair, ecstasy, incredulity. Touched and wondering alike at this unusual parental attitude and the conflicting emotions, the wife with eyes glistening arose and slipped her arms around him.

"A penny for your thoughts," she said, in a voice tremulous with tenderness.

Startled into consciousness, he blurted them out:

"For the life of me, I can't see how anybody can make a crib like that for three forty-nine!"

BREAKING IT GENTLY

Murphy had been careless in handling the blasting powder in the quarry and Duffy had been deputed to break the news gently to the widow.

"Mrs. Murphy," said he, "isn't it today the fellow calls for the weekly payment for Murphy's life insurance?"

"It is," answered Mrs. Murphy.

"Well, now, a word in your ear," said Duffy. "Sure ye can snap your fingers at the fellow today."

Doctor: "Your husband must be kept absolutely quiet. Here is a sleeping draught."

Wife: "When do I give it to him?"

Doctor: "You don't, you take it yourself."

WRONG VICTIM

Jack: "I called on Mabel last night, and I wasn't any more than inside the door before her mother asked me my intentions."

John: "That must have been embarrassing."

Jack: "Yes, but that's not the worst of it. Mabel called from upstairs and said, 'That isn't the one, mother.'"

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., January, 1930

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.

President Corson's Tribute to the Late Mr. Sherwood F. Jeter

THE death of Sherwood F. Jeter, Vice President of our Hartford Steam Boiler Inspection and Insurance Company, came with such an overwhelming shock that we in the home office, who had seen him in such apparent health and strength but a few days before find it difficult even now to realize that our friend and the man on whom we had all depended for the direction of the technical affairs of this Company is not going to return to his place with us. But the sense of the loss it means to our institution and of the deep personal sorrow to all in it who knew and loved him lies heavy in our hearts.

Vice President Jeter's broad acquaintance with all features of power engineering and his intimate knowledge of steam boiler construction and operation especially fitted him for the direction of the engineering side of our business. Under him it has progressed with the development of modern power plant equipment and maintained the high reputation which our Company has enjoyed in its peculiar field of insurance protection. Mr. Jeter himself has been widely recognized throughout the country as an expert in the safeguarding of power production and his

advice has been constantly sought and freely given in developing new apparatus. I and my associates have been proud of the place which he has thus gained among the engineers of the country and recognize the prestige to our Company his attainment in the engineering field has brought about.

Personally, Mr. Jeter thought and talked with a directness and straightforward honesty of the trained engineer. His judgments were clear and formed on a close analysis of the facts to be considered. His sincerity impressed itself on all who had contact with him.

He was devoted to the interests of the Company he served and loyal to everyone in it. It has been my privilege to feel the strength and support of his friendship, and the sorrow that is mine I know but reflects the general sorrow which his death has brought to our organization and to a wide circle of his friends and ours throughout the country.

WILLIAM R. C. CORSON,
President.

Vice President Sherwood F. Jeter, recognized not only by his colleagues in this Company but by engineers throughout the country as a leading and influential authority on the engineering aspects of power plant insurance, died on the morning of December 31, 1929, at Hartford, Conn. Death came unexpectedly while he was seemingly well on the road to recovery from a surgical operation, performed three days before.

Born in Columbus, Ga., in 1872, Mr. Jeter was a graduate of the Georgia School of Technology. In 1893 he began his career as an engineer for the Mexican Telephone Company at Mexico City, and five years later he established his first connection with The Hartford Steam Boiler Inspection and Insurance Company as a boiler inspector at the Company's New Orleans office. He remained with the Company at New Orleans, Pittsburgh and Hartford until 1906 when he left to accept a position as master mechanic for the Pittsburgh, McKeesport and Connellsville Railway at Connellsville, Pa. In the latter part of the same year he was retained as chief engineer by the Bigelow Company at New Haven, Conn., and while there he redesigned the Hornsby water-tube boiler to conform to manufacturing and operating conditions in the United States.

Returning to The Hartford Company in 1910 as supervising inspector, Mr. Jeter was given charge of the Company's inspection work throughout the country. In 1915 he was promoted to the post of chief engineer and, in 1927, he was made vice president with full responsibility for the engineering side of the Company's business.

Mr. Jeter was long a member of the American Society of Mechanical Engineers of which he was for three years a manager and for two years a vice president. He had served on the Society's Boiler Code Committee since 1913 and had had an important influence in helping to establish standards of safe boiler construction now recognized throughout the country. He was one of the founders of The Hartford Engineers Club and was one of its past presidents.

Recent Instances *of* Embrittlement *in* Steam Boilers

By Frederick G. Straub*, *Urbana, Ill.*

The author discusses briefly the cause of the recent boiler explosion at Crossett, Arkansas, attributing the failure to embrittlement produced by soda-ash treatment on a boiler feed water too low in sulphate content. Other instances of cracking of seams in steam boilers are also described. Emphasis is placed upon the advisability of regular inspection of leaky seams in steam boilers, particularly when the boiler water does not meet the A. S. M. E. recommendation.

As a result of the explosion of one of the boilers in the power plant of the Crossett Lumber Company at Crossett, Arkansas, on May 30, 1929, the question has been raised as to how much attention must be given to the examination of boilers in order to prevent explosions of this nature. The author has been able to gather data in regard to steam boilers which have been badly cracked, as well as from those which have actually exploded. These data have been gathered through the courtesy of the boiler manufacturers, the steam boiler insurance and inspection companies, and various operating companies whose boilers have cracked.

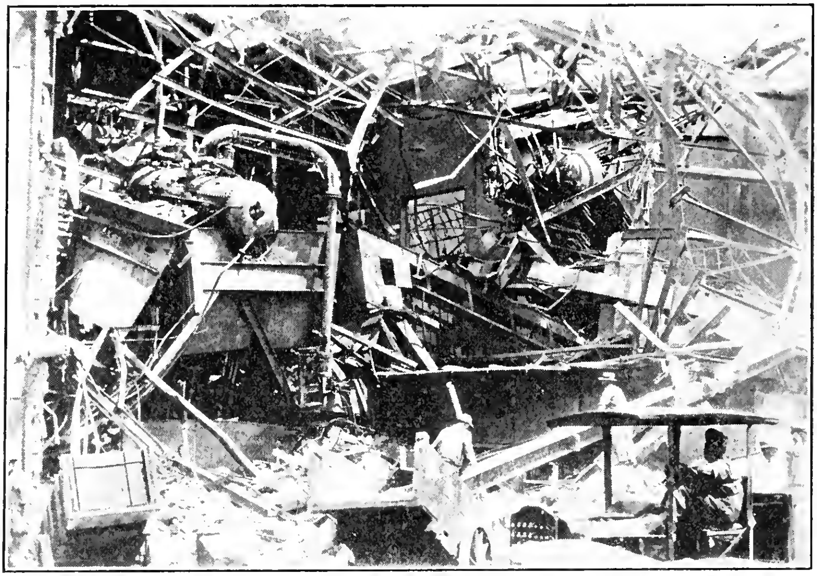
All of the instances of cracking which will be discussed are typical instances of embrittlement cracking. The criterion of whether or not embrittlement cracking has occurred is the manner in which the cracks proceed through the steel. If the small incipient cracks are truly intercrystalline and the metal is good in all other respects, it is felt that the cracking may be classed as embrittlement. One must realize that an examination of a large crack where the plates have started to pull apart will reveal transcrystalline failure. Also, where cracks have not started the plate will have regular slip lines and will experience transcrystalline failure when subjected to stress. Embrittlement cracking is caused by chemical weakening of the grain boundaries, and where the weakening has not taken place the plate is normal. If the weakening progresses far enough, static failure (transcrystalline cracking) will naturally occur due to overloading the weakened plate.

The boiler plant at Crossett, Arkansas, consisted of six 500-hp. boilers operating at 215 lb. pressure. The boilers were about six years

* Mr. Straub is Special Research Assistant in Chemical Engineering at the University of Illinois Engineering Experiment Station. This paper was read at the annual meeting of the American Society of Mechanical Engineers in New York, December, 1929.

old. During the first two years of operation the make-up water was taken from a pond and received no treatment. Because of dirty steam and some scale, a system of treatment was started using a deconcentrator in connection with soda ash, and this method of treatment had been in use about four years when the explosion occurred.

Boiler No. 6 exploded. The seam opened up the entire length of the drum and both heads blew out. Figure 1 shows a portion of the plant after the explosion. Boiler No. 5 was knocked out of its setting



and badly damaged. When two of the remaining boilers were subjected to hydrostatic tests, they were found to be badly cracked. The cracking took place from rivet hole to rivet hole in the riveted areas. Examination of the fine incipient cracks showed them to be typical embrittlement cracks.

Table 1 presents the results of analyses of the make-up water for these boilers after treatment with soda ash, and Table 2 gives the results of analyses of the water from one of the boilers. The boiler water was analyzed daily for alkalinity, but no attention had been paid to the sulphate content, which was decidedly low.

In addition to the Crossett explosion, data are available in regard to embrittlement in the following locations: Virginia, Ohio, Michigan, Louisiana, New York, Colorado, and Minnesota. The main data in regard to these plants are as follows:

Virginia. Three 500-hp. water-tube boilers operating at 425 lb. pressure cracked after two years of operation. A crack opened up in one boiler for a length of over 7 ft. from rivet hole to rivet hole. Rivet heads cracked off and cracks were found in all three boilers. The small cracks were found to be typical embrittlement cracks.

The make-up came from a well and was not treated. It contained

TABLE 1 BOILER-FEEDWATER ANALYSES

(Results in parts per million)

Location of plant	Crossett. Ark.	Va.	Ohio	Mich.	La.	N. Y.	Colorado	Minn.
Source of water	Pond	Well	Well	Well	Well	Surface	Surface	Surface
Treatment given	Soda ash	None	Zeolite	Zeolite	None	Hot process	Soda ash	Zeolite
Sodium chloride	..	7	12	15	39	2	10	16
Sodium sulphate	6	10	45	20	1	8	5	8
Sodium carbonate	16	213	206	119	257	35	5	290
Calcium carbonate	45	8	4	4	2	5	8	4
Magnesium carbonate	20	7	0	2	2	0	7	3
Iron and aluminum oxide	..	3	3	..	4	1	..	2
Silica	..	25	..	..	12	26	..	2

TABLE 2 BOILER-WATER ANALYSES

(Results in parts per million)

Location of plant	Cressett. Ark.	Va.	Ohio	Michigan	La.	N. Y.	Colorado	Minn.
Steam pressure, lb. per sq. in.	215	425	145	150	200	175	380	200
Sodium hydroxide	368	565	2180	850	1608	510	350	900
Sodium carbonate	170	155	660	510	869	120	110	257
Total alkalinity	680	1020	3200	1700	3750	834	600	1507
Sodium sulphate	225	50	710	320	5	357	600	340
Ratio of sodium sulphate to to total alkalinity	0.3	0.05	0.2	0.2	0.0	0.4	1.0	0.2
Recommended A.S.M.E. ratio	2.0	3.0	1.0	1.0	2.0	1.0	3.0	2.0

a large amount of sodium carbonate and very little sulphate. The boiler water was analyzed daily for alkalinity, but no record was kept of the sulphate content.

Ohio. Four 722-hp. boilers operating in Dayton at 145 lb. pressure were found to be badly cracked after one year's operation. The cracks occurred in practically all the seams of the drums. The boilers were in a dangerous condition when the cracking was detected. Tube ends were also found to be badly cracked. The cracks were typical embrittlement cracks.

A well water was used for make-up water, and was zeolite-treated before being fed to the boilers. The sodium carbonate content was high in respect to the sulphate content. A high caustic alkalinity was carried in the boiler water.

Michigan. Pontiac. Three 500-hp. boilers operating in Pontiac at 150 lb. pressure were found to be badly embrittled. The boilers were five years old. For three years the water treatment used gave a high sulphate and low caustic content in the boiler water. The water used during the last two years reversed this condition and gave a water which did not meet A. S. M. E. Boiler Code recommendation. The cracks were found to be typical embrittlement cracks.

Louisiana. Rivets were found cracked off from the boilers after four years' operation at 200 lb. pressure. No straps were removed and no cracking could be detected in the plates by means of an external examination of the boilers. The rivet heads were found to have cracked in an intercrystalline manner.

The water in use was a well water practically free from sulphate and contained sodium carbonate.

New York. Two 500-hp. boilers were in operation at this plant. The steam pressure was 175 pounds. One boiler had been in use one year on hard water before the second boiler was installed. At the time the newer boiler was installed, a hot-process lime softener was put in operation. The resulting boiler water was low in sulphate and high in causticity. After seven years' operation, sixteen rivet heads were found cracked from the inside of one of the seams of the newer boiler. When the butt straps were removed they were found to be badly cracked. The cracking was typical of embrittlement cracking.

Colorado. Serious cracking was detected in a 1300-hp. boiler operating at 380 lb. pressure. The boiler was three years old. A fairly pure make-up water was used and soda ash treatment was given. At times sodium sulphate, phosphate, and tannin were used. A composite of these analyses gave the following information:

Ratio $\frac{Na_2\ SO_4}{\text{Total Alkalinity}}$	Portion of the three years
Below 1	14 per cent
Between 1 and 2	32 per cent
Between 2 and 3	32 per cent
Above 3	22 per cent

The phosphate content was zero at times, and high at other times. The cracks were found to be intercrystalline and could be readily classed as embrittlement cracks.

Minnesota. One 500-hp. boiler operating at 200-lb. pressure had been in operation on zeolite-treated river water for about seven years. The insurance* inspector notified the operators about the danger of embrittlement because of the high causticity in the boiler water, at least two years before the cracking occurred. The operators asked the water-treating company about the possibility of danger and were told that no trouble would result from the use of their treatment. Consequently no attention was paid to the sulphate content. The boiler developed serious cracking, and only timely examination by the cautious inspector* saved an explosion. The cracking was found to be typical of embrittlement cracking.

Other cases are on record, but these serve to show clearly that various types of boilers operating at different pressures are encountering embrittlement. The only factor common to all boilers is the occurrence of high causticity in the absence of sufficient sulphate content. Tables 1 and 2 show clearly that these boilers did not meet the A. S. M. E. recommended ratios for the prevention of embrittlement.

The data from the embrittled boilers cited show that the cracking took place in boilers made by practically every large boiler manufacturer. It also occurred in seams subjected to high temperature as well as those entirely away from the heated areas. Boilers receiving excellent fabrication cracked just as rapidly as those not so well made.

Most of the cases were detected before it was too late as the results of timely inspection. A few had reached the dangerous stage, due to the fact that no attention was paid to the type of water in use. It was not realized that waters not embrittling in nature may be readily made so by certain methods of water treatment.

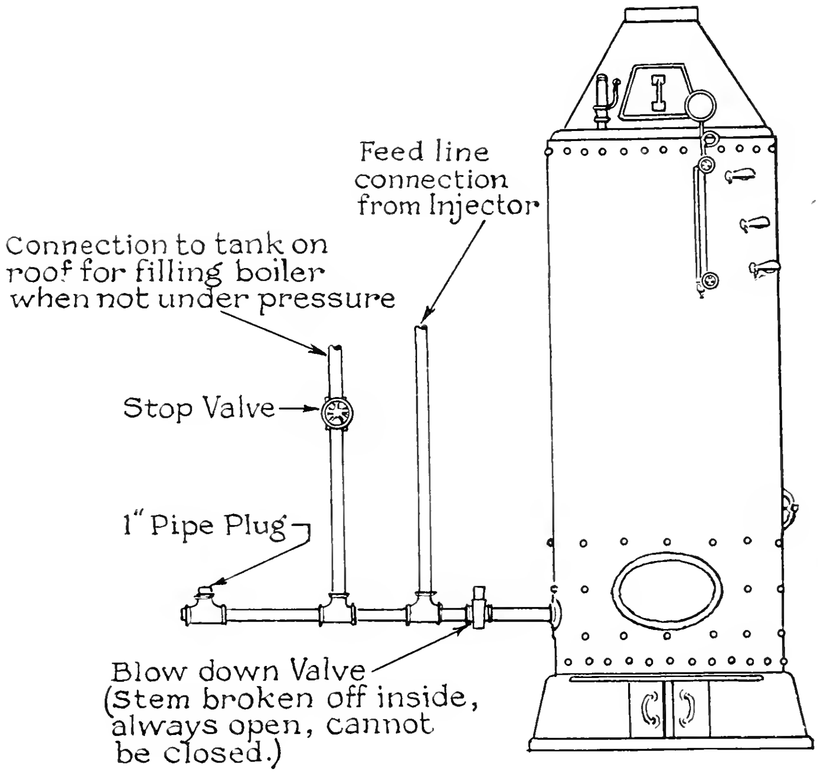
In view of the data presented, the author would like to take this opportunity to emphasize the section of the A. S. M. E. Boiler Code which reads: "Pending further operating data from boilers in service, it is recommended that the requirements of Pars. 1-44 of Section VI of the Code be extended to all riveted seams, and that careful examination of all seams be made if leaks occur and do not remain tight after caulking."

* An inspector of The Hartford Steam Boiler Inspection and Insurance Company. — (Editor's Note.)

An Example of Extreme Ingenuity

AS the only valve in the blow-off line herein illustrated was broken in such a manner that it stood always in the " open " position, the line itself being closed by means of a pipe plug screwed into a fitting at the extreme end, there was little wonder that the inspector who discovered the layout had to ask the operator to explain the method of blowing down the boiler. The procedure, as outlined by the operator, was as follows:

First, he let the pressure off the boiler. Then he unscrewed the pipe plug from the end of the blow-off line and substituted an ordinary bottle cork in its place — an operation that must have required rather expert manipulation. The next step was to raise steam pressure to about 25 pounds, after which the operator took a safe position some



distance behind the end of the blow-off pipe and dislodged the cork by striking it with a long-handled hoe.

One thing certain about this method is that once the blow-down got under way it made a complete job of emptying the boiler, for there was no way of stopping the discharge until the pressure was exhausted.

With the blow-off line in such a condition the boiler would be uninsurable and, in many states, its use would be illegal. As a consequence we must refuse, most emphatically, any recommendation of the arrangement as a pattern for other boiler operators to follow. There is no denying, however, that it showed considerable ingenuity on the part of the operator at this plant.

From the Editor's Scrapbook

"Konel", a new metal developed by the Westinghouse Electric and Manufacturing Company as a substitute for platinum in the manufacture of radio tube filaments, may prove useful in a much wider field. Its extreme toughness at the high temperatures under which most metals become soft and lose strength, is said to make this new alloy suitable for the parts of internal combustion engines which are subjected to intense heat. Cobalt, nickel, and ferrotitanium are used in making "konel". It can be manufactured in quantities for a few dollars a pound, whereas platinum is valued at something like $180 an ounce.

Suffering from a severe drought which threatened to curtail their hydro-electric power supply, the cities of Seattle and Tacoma, Washington, recently asked the Navy Department to lend them the power plant of the aircraft carrier Lexington. On December 18th the ship's generators were tied in with the shore transmission lines and commenced supplying 20,000 kw. of power for twelve hours a day.

Eventually, radiation of heat from the earth's interior may make our terrestrial globe too cold for habitation. However, that is something for folks who come a million or so years hence to worry about. So efficient as a natural heat insulator is the blanket of rock which forms the earth's outer crust that the amount of heat escaping in a year is no more than enough to melt a skin of ice an eighth of an inch thick.

Ninety men who had a part in constructing the three new boilers at the East River Station of the New York Edison Company recently attended a luncheon served in the combustion chamber of one of the huge boilers. Immediately after the meal the wooden platform and table were set afire, the boiler being thus formally put into service.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1928

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 599,693.18
Real Estate		300,423.66
Mortgage and collateral loans		1,296,386.75
Bonds and Stocks		17,475,629.38
Premiums in course of collection		1,288,819.44
Interest accrued		151,132.41
Other Assets		18,205.76
Total Assets		$ 21,130,290.58

LIABILITIES

Reserve for unearned premiums		$ 8,619,119.83
Reserve for losses		377,212.80
Reserve for taxes and other contingencies		1,894,758.35
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,239,199.60	
Surplus to Policyholders		**$10,239,199.06**
Total		$ 21,130,290.58

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WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

Department	Representatives
ATLANTA, Ga. . . . . 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md. . . . . 5 South St.	Lawford & McKim Inc., General Agents. P. E. Terroy, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
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CHICAGO, Ill., ... 209 West Jackson Boulevard .	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio. . . . First National Bank Bldg. .	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, . . . Leader Bldg.	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
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NEW ORLEANS, La. . . 1128 Hibernia Bank Bldg. .	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., . . . 80 Maiden Lane . . .	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., . . 429 Walnut St. . . .	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
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TORONTO, Canada, . . . Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

Vol. XXXVIII No. 2 April 1930

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Two Plants Experience Costly Turbine Explosions

A VERY disastrous turbo-generator explosion occurred on October 7th, 1929, at a power plant in Texas. A 6,000-kw. machine was so badly damaged that only the turbine casing and the generator frame could be salvaged. The owners were reimbursed to the extent of $25,000, the limit at which the unit was insured, but the total loss was over $80,000.

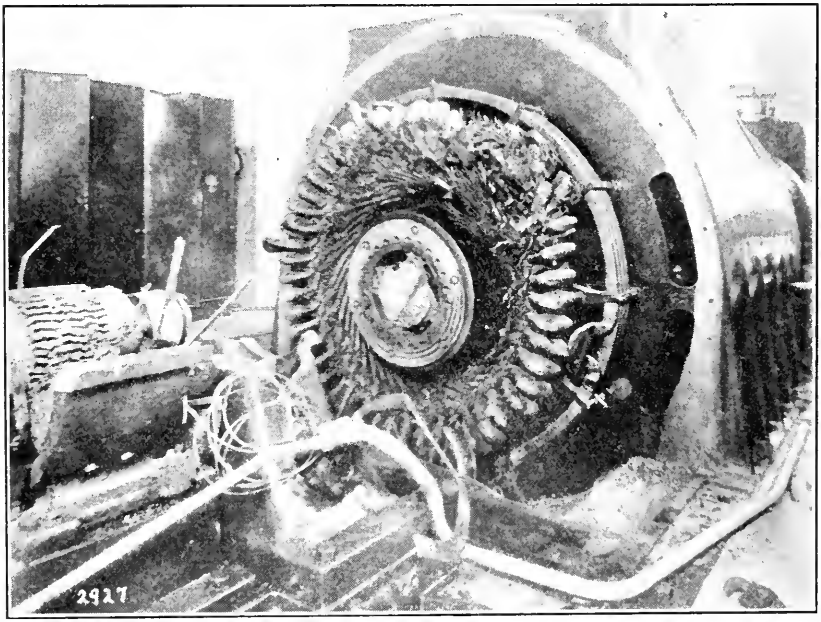


Figure 1

The machine had been in operation about one year during which the generator had given periodic trouble because of a tendency to vibrate when starting or whenever there was a sudden, large change of load. However, the unit was running smoothly just before the accident. From the appearance of the rotor it was clear that overspeed had been a prominent factor in causing the wreck, but it is thought possible that vibration may have contributed in that it could have caused the shaft to "whip" seriously when the turbine reached a critical speed after the load was suddenly lost.

At the time of the explosion the turbine was connected in parallel with a smaller machine and with a high voltage outside line. Noting a sudden drop in the a. c. voltage, accompanied by "hunting" on the part of the governor, the operator cut out the automatic voltage control and sought to correct matters by hand regulation. While he was thus engaged, the machine lost its load and he tripped the emergency governor to shut it down. At that instant the explosion occurred.

The turbine shaft and generator shaft were heavy, one-piece forg-

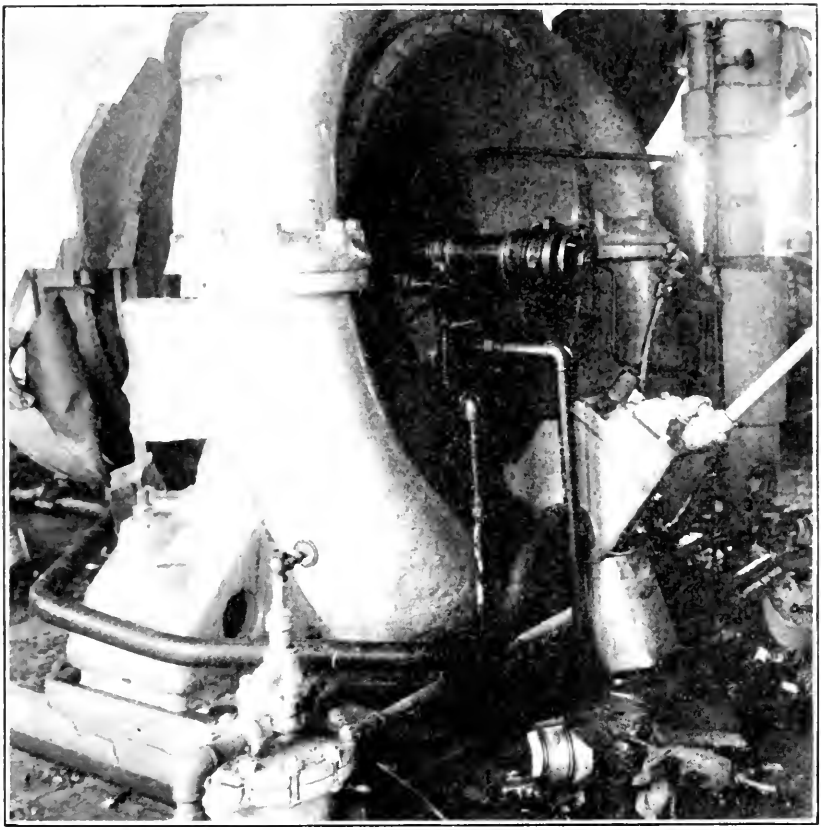


Figure 2

ings, supported on three bearings and fastened together by a rigid coupling. A fourth bearing supported the end of the exciter shaft which was joined to the outboard end of the generator shaft by means of a flexible coupling.

Figure 1 shows the exciter end of the generator as it appeared immediately after the accident. It is apparent that the shaft was broken flush with the rotor and that the bearing as well as the exciter was destroyed. This portion of the shaft parted from the flexible coupling and was hurled across the room. With the overhanging weight of the electrical rotor thus suspended from the middle bearing, the shaft was subjected to a tremendous bending stress that caused it to break flush with the inboard end of the rotor. The shocks sprung the steam rotor so badly that the blading was destroyed and the rotor itself had to be replaced.

Two employes of a power company in Indiana were fortunate in escaping with but relatively slight injuries when, on February 3rd, a 2,000 kw. turbo-generator exploded while they were standing beside it. The steam end of the machine was completely ruined without usable salvage, but the generator came through the wreck undamaged. Figure 2 is a view of the steam end shortly after the accident. Insurance was carried in The Hartford Steam Boiler Company.

The explosion occurred at 11:30 at night, three or four minutes after the load had been shifted to a smaller unit. An operator was slowly closing the throttle while the machine idled when, without warning, the rotor burst and came through the housing. The attendant who was at the throttle was hurled across the room and was cut about the head and arms by flying pieces of metal while the other attendant, in the act of entering the pit underneath the machine, escaped by inches a hail of debris that tore past him and out through a window. He was dazed by a glancing blow.

Fortunately, the company had two stand-by plants available for taking over the load. These were put in operation before morning so that service was resumed before mills dependent on the current were started.

Blame Combustible Vapors for Tank Explosion

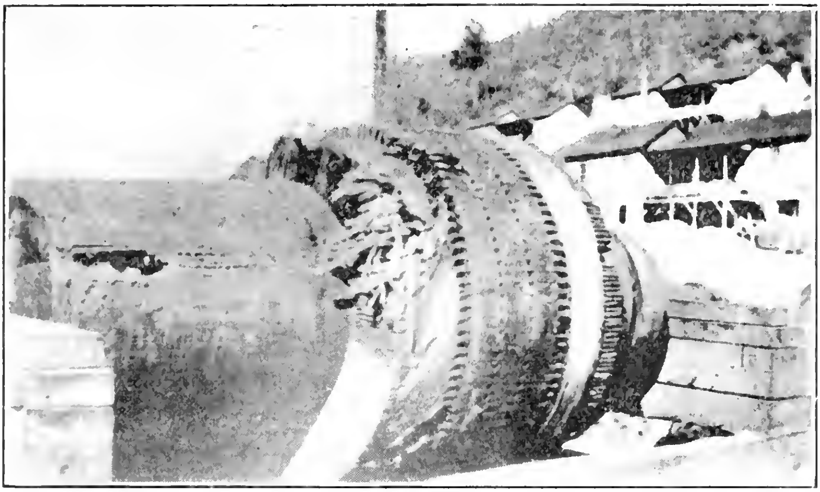
A recent air tank explosion in a Philadelphia manufacturing plant was caused, it is believed, by spontaneous ignition of combustible vapors in the tank. The compressor was located in a paint-spraying room, and there was no provision for keeping the vapor from being drawn into the compressor intake.

Most persons having to deal with compressors recognize the importance of choosing suitable lubricating oil and of not using so much excess oil that some of it is bound to be vaporized and carried over into the air tank. Equal caution should be exercised in seeing that the air supply is not contaminated, especially by substances which, when mixed with air, may be ignited by compression and heat.

Lack *of* Thorough Cleaning Results *in* Breakdown *of* Rotary Converter Armature

By K. A. Reed, *Elec. Eng.*

THE accompanying picture shows, in a fair degree, the extent of the damage caused by a breakdown of the armature of a 200-kw. rotary converter operating at 275 volts, 1,200 r.p.m., 3 phase, 60 cycles. It was the practice of this assured to attempt to blow out his rotary converters by means of a "hand bellows" instead of providing a source of compressed air for this purpose. Due to a lack of proper



air pressure as a result of the use of the hand bellows in cleaning, an appreciable amount of carbon and copper dust from the commutator brushes and collector ring brushes accumulated in the armature winding, or perhaps in the equalizers of the armature, and when a ground developed on the winding, the armature failed in many places as shown in the picture.

It was necessary to supply a complete new set of armature coils, a complete new set of equalizers for the armature, a complete new set of risers between the collector rings and the armature coils and an appreciable number of commutator bars, as well as new laminations for the armature and new mica insulation for the commutator. The field coils were more or less seriously damaged both from the arcing that developed when the armature failed and from the whipping action of the front armature band which was burned in two when the armature coils became short circuited.

This rotary converter supplies direct current power for a coal mine and the service is naturally quite severe. In addition there are times when electrical apparatus in that class of service is not given the care and attention that is necessary for normal life. In many cases an excessive quantity of "make-up" oil is poured into the bearings and the overflow is drawn into the winding. This oil forms a wonderful binder for coal dust from the mine, as well as carbon and brass dust from the commutator and the collector rings. Such a mixture is of course highly inflammable and it is a good conductor. Therefore, when a failure that might ordinarily be of a minor nature occurs, the resultant damage is great. Repairs in this particular case cost approximately $1,600.00 and the machine was out of service for several weeks.

Due to their inherent characteristics and to the fact that both the d.c. end and the a.c. end of a rotary converter armature embody live exposed parts, the commutator and brush rigging on one end and the collector rings with their brush rigging on the other end, machines of this type require the highest type of maintenance and operation in order to secure proper operation and satisfactory life. Care should therefore be taken to keep rotary converters absolutely clean and to keep the windings free from an accumulation of foreign matter (which retards ventilation in addition to providing a serious electrical hazard) and special pains should be taken to see that "make-up" oil is supplied in the correct quantity in order to avoid drawing oil into the windings along with the ventilatng air. Overspeed devices and reverse current protection should of course be checked periodically to be sure that these appurtenances are in proper functioning condition at all times.

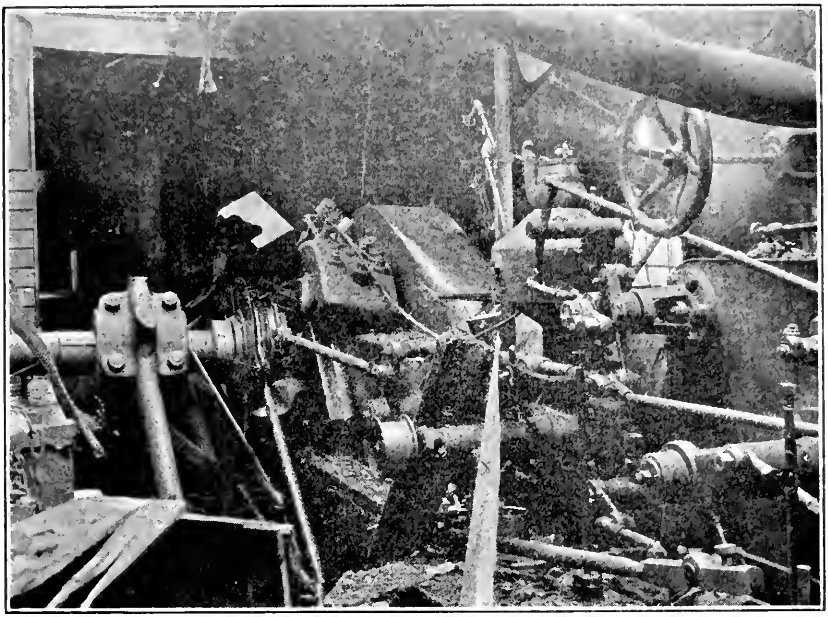
By a timely investigation of the cause for ammeter readings of 355, 365, and 290 amperes on the generator switchboard, an electrical inspector recently prevented an accidental shut-down that would have cost a paper mill several times the amount of its insurance premium.

The electrical inspector had called the plant engineer to the ammeters and was in the act of explaining that the unbalanced condition would require an immediate search for a motor that was single-phasing when suddenly the load dropped and the three ammeters read alike. With this clue to work on, they found that a 75 h.p. squirrel-cage motor had just been taken off the line and that poor compensator contacts had been causing it to single-phase.

Installation of new contacts prevented a certain roast-out of the motor and possible serious damage to the generator.

Flywheel Explosion Wrecks Engine, Closes Mill

EXTENSIVE property damage was caused by a flywheel explosion on January 9th at the plant of the S. Austin Bicking Paper Manufacturing Company, Downington, Pa. The production losses sustained during the enforced shut-down following the accident must have been even more serious, for newspaper reports indicated that



operations had not been resumed by the end of January.

The wheel was fourteen feet in diameter with a face of 36″, and was in use on a Corliss-type engine of 350 hp. Circumstances seem to warrant the belief that the wreck was caused by breaking of the main belt and subsequent damaging of the governor mechanism when the broken end of the belt whipped around and struck it. Immediately prior to the wreck plant lights went out, apparently indicating that the generator, driven by the engine through a jack shaft and pulley from the main shaft, had stopped.

Fragments of the wheel carried away the engine room roof, one piece traveling 250 feet and crashing into a second-story room of the Swan Hotel. Another piece, sailing over buildings in the business section and embedding itself into the pavement of the Lincoln Highway, narrowly missed striking several automobiles.

The paper manufacturers were not carrying engine insurance. Had such a policy been in force with a use and occupancy clause they would have been reimbursed not only for the direct property damage but also for the loss of production caused by the long shut-down.

Plant Owners Lose Lives as Boiler Explodes

TWO owners of the Blue Ribbon Laundry at Dallas, Texas, were killed almost instantly and an employe had both legs broken when, on Sunday, January 19th, a Scotch-type boiler used for heating water, exploded and completely demolished the sheet iron building in

which it was housed. Had the accident occurred on a week-day the number of casualties might have been greater, for the building in which laundry employees worked was badly damaged. There was no boiler insurance to cover the property damage, estimated at $25,000.

Purchased second-hand about five months previous to the accident, the boiler had a patch 36 inches wide running along the bottom of the shell from head to head. This patch was secured by electric welding, and in the explosion both longitudinal welded seams were torn apart for their entire length. The shell itself was hurled about 150 feet into the yard of a residence, while parts of the boiler and the iron shed landed on housetops a block away. Firemen pulled the victims from beneath the wreckage.

The boiler had been washed out and had been under pressure only a short time when it failed. Apparently the pressure at which the explosion occurred was around 100 pounds, for the steam gauge, found amid the debris, stood at that pressure. The safety valve could not be located.

Inspection *and* Insurance *of* Pressure Vessels *in the* Paper Mill Industry

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By William D. Halsey, *Mech. Eng.**

It has been the author's purpose in this paper to point out certain disastrous accidents that have occurred in connection with digesters and other pressure vessels used in the paper and pulp industry; to indicate what conclusions were reached through investigation of the causes of these accidents; and to recommend precautions to avoid such accidents.

THE sulphite digester is of considerable concern to the insurance inspector because of the fact that the sulphite liquor has a corrosive action on steel. Although sulphite digesters are, of course, lined in some way, imperfection or leaks in the lining permit the liquor to reach the steel shell, and thus do considerable damage. When two such leaks occur, one above the other, there is the possibility of liquor circulating through the two openings, between the lining and the steel shell, thus causing a grooving in the shell which can readily go to dangerously extensive proportions before discovered.

It is impossible to detect from the inside the extent to which such action may have occurred and the only positive way to be certain that no damage has taken place is by making an examination of the shell with the lining removed. It is for this reason that the insurance inspector is particularly anxious to be notified when a lining is to be renewed so that he may have an opportunity to make a thorough inspection of the condition of the steel shell.

One case of this kind of trouble will be pointed out because of the interesting way in which it developed. Figure 1 shows the upper part of the digester, and it appears that a small defect developed in the lining

* From a paper prepared for the annual meeting of The Technical Association of the Pulp and Paper Industry held in New York, February 18-20, 1930.

just opposite the center line of the butt strap joint, and at the height indicated by the line XX. Figure 2 shows the cross section at this point. The liquor penetrated the digester brick lining and the cement backing until it reached the inner butt strap. At this point some deterioration, although not extensive in area, occurred, but involved in this deteriora-

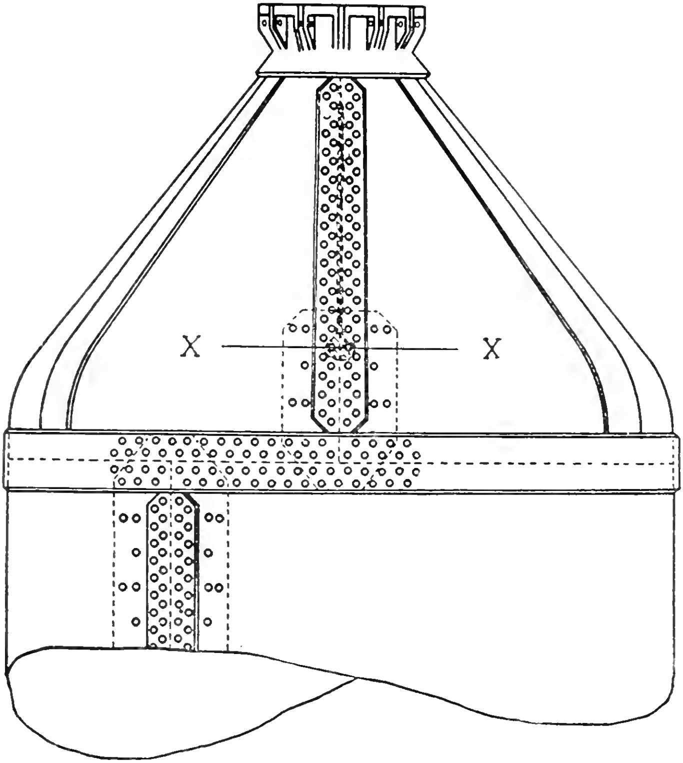


Figure 1

tion was one of the rivets. The liquor following through this rivet and eating out the metal between the rivet hole and the edge of the shell plate at the joint, soon reached the open space between the shell plates at the joint. Here of course there was a channel possibly ⅛″ by 1⅛″ running the whole length of the joint and covered on both sides by the butt strap. However, this gave the liquor opportunity to corrode the outer strap, and when discovered a channel had been cut in the outer strap so that for a considerable distance it was only ⅛″ in thickness.

That a disastrous explosion did not occur in this case was attributable solely to the fact that the defect occurred about 4′ from the upper girth seam so that the cone top was still supported by the girth seam. However, had this leak occurred at one of the butt straps in the lining in the cylindrical shell of the digester, the corrosive action might easily have extended over the entire length of the course with resulting weakening of the structure which would, without doubt, have resulted in an explosion.

Visual inspection of the inside of the steel shell of the digester with the lining removed is of course most conclusive as indicating whether or not any corrosion has taken place. However, where such inspections

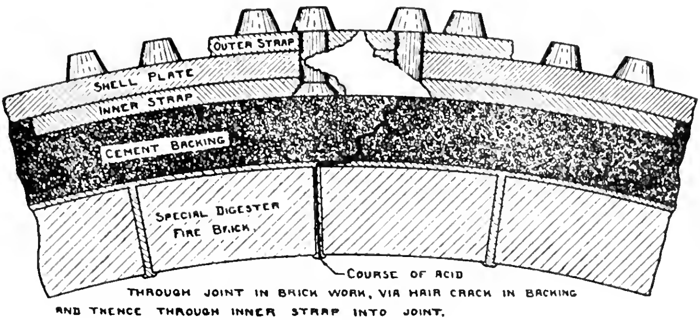


Figure 2

Approximate section at X-X showing the manner in which corrosion took place.

cannot be made at frequent intervals, it is recommended that ¼″ test holes be drilled through the steel shell of the digester at intervals of about 12″ vertically and horizontally, the holes being staggered in a vertical direction. If leakage occurs, it is almost certain to appear through one of these test holes before extensive damage has been done to the plates. It is well appreciated that the work of drilling such holes is great, but it is believed that the measure of safety gained fully justifies such work.

On new digesters being built, the drilling of these holes is not such an expensive item and it is well to specify that the test holes be made larger, say ½″, and drilled at intervals of 6″. When such holes are drilled in sulphite digesters, they should be kept clean so that leakage will appear through them and furthermore, the external surface of the digesters should be kept clean and painted a light color to aid in detecting leaks.

Single Butt Strap Construction

Some digesters have been built with single outside straps and this form of construction was involved in a notable accident which took place some years ago.

With the single butt strap construction, the stress is transferred across the joint from the plane of the shell plate to the plane of the butt strap and back again to the plane of the shell plate on the other side of the joint. Such stressing of the joint causes a bending of both the strap and the shell plate, the stress being concentrated along the outer row of rivets in the shell plate and the inner row of rivets in the butt strap. In addition to the pressure, the temperature also has some effect on the stress which is set up. The repeated bending of this nature over a long period of time resulted, in the case in question, in a crack developing in both the circumferential seam strap and the longitudinal seam strap. There followed a disastrous explosion involving a property loss of $80,000. Two employees were killed and two were injured. That there was not a greater casualty list was probably due to the fact that the accident occurred on a Sunday evening when the number of persons in the mill was at a minimum.

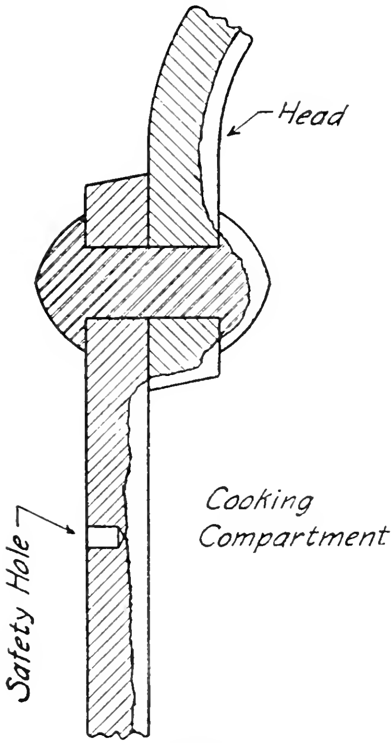


Figure 3

It has been the experience of the insurance inspector that whenever the butt straps on the single butt strap construction have been removed the straps and sometimes the plate have been found cracked. Digesters of this construction therefore require careful watching in this regard and in the interest of safety a reduction in pressure is advisable on such digesters reaching an appreciable age unless the straps are removed to make certain that no cracks or defects exist.

Where cover plates on digesters are secured by bolts, as they usually are, a danger exists in the method by which these bolts are tightened by the operator. It is the tendency for the operator to tighten a bolt at some one point, and continue around the head tightening the bolts in sequence. Such procedure, however, can very easily result in overstressing the bolts, because of the lever action which results between the cover plate and the gasket, when the bolts on the opposite side are tightened. The proper procedure is to bring all nuts snug without making them tight and then go from one nut across the diameter of the head to the opposite nut and then work on the two nuts on the diameter at right angles with those just tightened. After this the other nuts may be tightened in about the same procedure. The operator should be warned particularly not to make up any one nut fully tight before the others.

When referring to digester difficulties and defects the writer will not attempt to discuss those things which are more commonplace, such as the selection of steel, proper methods to be used in the shop for the manufacture of the digesters or other things of this nature which although affecting the life of a pressure vessel are at the same time points generally common to all such vessels. It will be the intention more to discuss those points which relate to some of the peculiarities of digesters as found by the insurance inspector.

Sulphite liquor is known by all to corrode steel, and consequently no one is surprised when it is found that wastage of the plate has taken place where the liquor has come in contact with it. To protect the steel the digester is lined. In the case of the *sulphate* digester however, no lining is used as it has been considered that the liquor used was not corrosive.

Corrosion in Sulphate Digesters

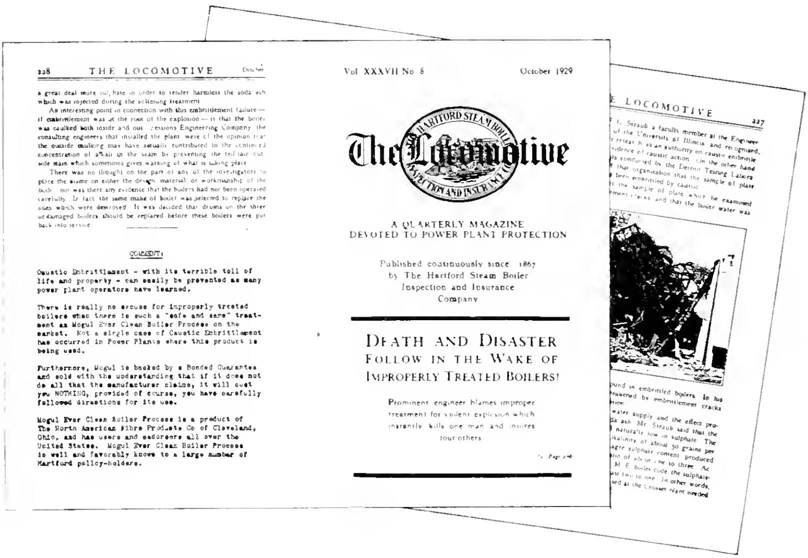
That considerable wastage of the plates does take place in sulphate digesters was brought very forcibly to the attention of the insurance companies a few years ago, when a digester used in this process exploded, killing three persons, injuring four others and causing a property loss of $150,000.

As is usual with digesters used in this process, the vessel was of forge welded construction, the plates being originally ½″ thick. The digester which failed separated into four parts and the ruptures appeared to follow the welds to a considerable extent. Measurements of the plates following the accident indicated that wasting had taken place until the metal had been reduced to a thickness of 5/16″ in some places. The indications were that in the lower girth seams and for about a third of the distance around the vessel, little of the metal had been actually joined in the weld, and at this point the joints slipped apart with very little tearing. The only portions of the joint that appeared to have been thoroughly welded were at the edges of the scarf of the weld. Furthermore, in certain portions of the joint there was a polished

(Continued on Page 58)

Compound Maker's Advertising Pamphlet Explained

EARLY in February a concern that sells a compound for treating boiler water prepared and distributed a four-page advertising pamphlet so closely resembling THE LOCOMOTIVE in make-up, typography, and page-size, that it had the appearance of being a part of an issue of this magazine. As shown in the accompanying cut, the



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a great deal more sulphate in order to render harmless the soda ash which was injected during the softening treatment.

An interesting point in connection with this embrittlement failure — if embrittlement was at the root of the explosion — is that the boiler was caulked both inside and out. ...essions Engineering Company, the consulting engineers that installed the plant, were of the opinion that the outside caulking may have actually contributed to the continued concentration of alkali in the seam by preventing the tell-tale outside stain which sometimes gives warning of what is taking place.

There was no thought on the part of any of the investigators to place the blame on either the design, material or workmanship of the boiler, nor was there any evidence that the boilers had not been operated carefully. In fact the same make of boiler was selected to replace the ones which were destroyed. It was decided that drums on the three undamaged boilers should be replaced before these boilers were put back into service.

COMMENT:

Caustic Embrittlement - with its terrible toll of life and property - can easily be prevented as many power plant operators have learned.

There is really no excuse for improperly treated boilers when there is such a "safe and sane" treatment as Mogul Ever Clean Boiler Process on the market. Not a single case of Caustic Embrittlement has occurred in Power Plants where this product is being used.

Furthermore, Mogul is backed by a Bonded Guarantee and sold with the understanding that if it does not do all that the manufacturer claims, it will cost you NOTHING, provided of course, you have carefully followed directions for its use.

Mogul Ever Clean Boiler Process is a product of The North American Fibre Products Co of Cleveland, Ohio, and has users and endorsers all over the United States. Mogul Ever Clean Boiler Process is well and favorably known to a large number of Hartford policy-holders.

Vol XXXVII No 8 October 1929

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

DEATH AND DISASTER
FOLLOW IN THE WAKE OF
IMPROPERLY TREATED BOILERS!

Prominent engineer blames improper treatment for violent explosion which instantly kills one man and injures four others

LOCOMOTIVE 227

pamphlet had on its front cover this magazine's registered trade-mark, volume and date line, and its publisher's statement, reproduced with such exactness by a photographic method that resemblance to the original was almost perfect. There was nothing in the pamphlet to show that it was not put out by The Hartford Steam Boiler Inspection and Insurance Company. Moreover, to make the illusion more complete, pamphlets were brought to Hartford and mailed here (in plain envelopes) so as to bear the Hartford, Conn., post mark. Below the center of the front page the boiler compound concern inserted scare headlines about explosions, deaths and disasters due to improperly treated boilers, and on the back cover it printed in typewriter type four paragraphs of "comment", making it appear as though our Company were commending the compound.

Inquiries received by our Company have indicated that many persons to whom the pamphlet was mailed or shown mistook it for an issue of THE LOCOMOTIVE and were thus led to believe that this Company was recommending the boiler compound as an inhibitant of caustic embrittlement. In order to correct this erroneous impression in the minds of persons who have not received the letter of explanation (which, at our request, has since been issued by the boiler compound manufacturer) we point out here that The Hartford Steam Boiler Inspection and Insurance Company had not endorsed or recommended either the compound referred to in the pamphlet or any other proprietary article used in connection with power plants. The pamphlet was prepared and distributed without our knowledge or consent.

New Steel Mill Power Plant, Using Advanced Features *of* Design, Is Model *of* Efficiency

SERVED by six 2,000-h. p. boilers which operate at 425 pounds pressure and utilize both blast furnace gas and pulverized coal as fuel, the new power equipment of The Youngstown Sheet and Tube Company at Youngstown, Ohio, amply deserves the interest being shown in it by outside engineers. As a particularly fine example of the present-day trend toward higher efficiency in industrial power plants, it embodies an arrangement of heat exchangers, bleeder heaters, traps, evaporators, and preheaters that recover and make use of stray heat units at almost every turn.

Boiler Superintendent "Bob" Smith, competent guide and host extraordinary, displayed some little modest pride in showing the plant to the writer on the occasion of a recent visit with Mr. George Bruce, the Hartford Steam Boiler's Youngstown agent. It was pardonable pride, however, for Mr. Smith started dreaming years ago of just such a plant, and this one is really his "baby."

"First I want to show you the equipment we used up until a little over a year ago," said Mr. Smith, leading us down a railroad siding to what evidently was a disused boiler house. Standing at one end of the gloomy, deserted structure, he pointed down the firing aisle of a battery of twenty-five water tube boilers under which the last ember had long since burned out and in which no tube-cleaner would ever work again.

"We had ninety-four boilers about this size, located in four separate boiler houses," explained our guide, "and it took a crew of 219 men to work them. Now we're handling the load with the six big fellows in No. 5 Boiler House and for all three shifts we use only 29 men. That includes the electricians, sweepers, clerks, coal unloaders, and pulverizer operators. There isn't a fireman or an ash handler in the place; everything is automatic. Actually, one man at the control board can do just about all the operating that's needed without exerting himself."

While we were on our way from the old boiler house to the engine room Mr. Smith explained that up until less than two years ago the plant had been largely steam-driven, thus necessitating steam lines to engines in all parts of the mill. In deciding to revamp the power, the plan was gradually to electrify many of the mill drives and to make the change over from steam to electricity as easy as possible by arranging for a secondary low-pressure steam supply for such equipment as could not be run by the 425-pound steam from the new boilers. To effect this without keeping any of the old, low-pressure boilers in service, the plant installed six evaporators to take heat from the 425-pound steam and furnish the secondary mains with 150-pound steam for heating, process work, and engines not yet replaced by motors.

"Here's a baby we'd be glad to let you take home for a watch-charm," said Mr. Smith, pushing open a door and ushering us into the presence of a tremendous, cross-compound blowing engine that seemed almost as big as a house. "Four of these fellows are awaiting the gang with the blow-torch," he explained. "There's nothing wrong with them except that they don't fit in where we're whittling down steam consumption to obtain better economy. Each one can blow 42,000 cubic feet of air a minute against fifteen pounds pressure, but in doing that it hogs 69,000 pounds of steam an hour. Look at the size of one of these elephants and compare it with one of the three turbo-blowers we have installed to take their place. Each one of the new blowers will move 65,000 cubic feet of air a minute against twenty pounds pressure on an hourly steam consumption of only 37,000 pounds. That's quite a saving in the course of a year."

"This is like the packing plant that was supposed to salvage every part of the hog except the squeal," we remarked after Mr. Smith had given us a brief technical explanation of the features of which he suggested we take particular note.

"That's so," he agreed with a smile, "but we're trying to find a way of using the squeal, too."

A detailed technical description of the various refinements encountered in the plant has no place in an article of this scope, but we think that many of our readers will be interested in a general picture of the way efficiency has been improved at Youngstown.

Feed water for the low-pressure line is taken from the river and run through a sand filter before being treated for hardness. It obtains its first heat while serving as cooling water in a condenser from which it is led to a trap discharge where it absorbs heat enough to raise its temperature to about 260°. At that temperature it passes into the shells of the evaporators and is turned into steam at 150 pounds. This steam, as mentioned before, is used for heating, for plant process work, and to run such prime movers as have not yet been replaced by electric drive.

High pressure steam from the boilers is supplied only to turbo-generators, turbo-compressors, and to the coils of the evaporators so that, in effect, the system is a closed one and all condensate is returned as feed water. As a result it has never been necessary to shut down the boilers for cleaning the internal heating surfaces and even when boilers have been opened for inspection nothing more than a soft-bristled desk brush has been needed to sweep out the light, flaky deposit of sediment.

Turbine equipment using 425-pound steam is all of the kind known as the extraction type, in which small quantities of steam are taken from the machine at several points between the intake and the exhaust and made to pass through a series of heaters. In the regenerative system, as it is called, as much as possible of the heat not consumed in useful work is used to raise the temperature of the condensate before it is returned to the boiler. This same system is applied to the three turbo-blowers as well as to an 18,000-kw. turbo-generator of which a duplicate unit will soon be put into operation to reduce the quantity of current now being purchased outside.

Naturally, the hub of the new system is the boiler house, where six boilers of the Stirling type burn both blast furnace gas and pulverized fuel. Gas is the major fuel, the feeding of coal being controlled by an automatic arrangement that admits just enough to make up for any deficiency in the amount of gas available. Combustion air for both fuels is drawn by fans through air-cooled boiler walls and pre-heaters.

Coal is carried to the top of the building by skip-hoists, passes through crushers and into bins from which it falls by gravity to the pulverizer mills. A stream of air carries the powdered fuel to the top of the building again where it is trapped by a cyclone separator and started on its way through screw conveyors to the various burners. Boiler performance and load conditions may be read right up to the minute from recording meters; automatic regulating devices— without manual manipulation and with remarkably little supervision on the part of the men on watch—make adjustment with uncanny skill for changes in the load and fluctuations in the supply of blast furnace gas.

After standing behind one of the boilers for several minutes and watching the precise working of its regulating mechanism, the writer remarked on the fact that so few men were required on the operating floor.

"There's nothing to be done," explained Mr. Smith. "That fellow down there," pointing to the only man in sight at the moment, "doesn't seem to be overwhelmed with work, does he?"

We had to admit that such was the fact, for the man in question was going about his duties in a most leisurely fashion.

"Come on," said Mr. Smith, taking us toward an adjacent building. "For some reason or other, everyone I've taken through the plant seemed to want to spend most of the time in the boiler house. As a matter of fact my chief interest is over here where we do our water treating."

He led the way between two rows of treating tanks to a laboratory where a young man, a college graduate as we discovered, was busy with test tubes and breakers.

"This goes on all the time," Mr. Smith explained. "Continual testing to make sure that the water is kept as near right as possible. A fellow who didn't know that came to see me not long ago with a proposition which he claimed would save us money. I asked him how it worked and he said that his firm would analyze our feed water free of charge every four months. You can imagine what a big help that would be when our own chemist here is making a test every few minutes."

Taps from the Old Chief's Hammer

SEATED restfully in the smoker while the icy fingers of a severe late-winter blizzard raked the frosted car windows spitefully, Inspector Joe Benson was thinking—with satisfaction—that another hour would find him back in the warmth and comfort of headquarters. There he would have three or four days of comparative ease, working on routine matters and arranging details incident to another trip into the hinterlands. Heavens knows, he thought, a fellow was entitled to some kind of a breathing spell after a trip of the kind he'd just finished—three weeks of battling with snow-blocked roads and sub-zero temperatures in a plant-to-plant trek through wilderness.

Benson had gone through the morning paper once and, for want of anything better, was about to start through it again when a hand grasped his shoulder and someone settled into the seat beside him. He glanced up to see that it was none other than the Old Chief.

"How are you, Joe?" inquired the old fellow. "You must have jumped off the roost with the chickens to catch this train."

"You bet I did," laughed Joe, "but what about you? I thought you always came in later with the other commuters."

"There's a lot to be done at the office today, son," explained the Chief, "so I'm getting off to an early start. By the way, though, you're just coming in from a trip. How'd you find the new route? Have any trouble?"

"No trouble finding the mills," was the reply, "but, believe me, the cold and the snow made tough traveling. However, I think I've dug up something for 'the book'. I'll bet you never heard of an engineer so tender-hearted that he wouldn't let an inspector work out in a cold boiler shed; an engineer who insisted on dismantling the boiler and bringing it into a warm place where the inspector could work in comfort. That's what they did for me at that little chicken-scalding plant in Jonesville. Lifted the boiler up bodily and carried it down to the office—in a wheelbarrow. What do you think of that?"

"You can't make me bite on that one, Joe," laughed the Chief, nipping off the end of a cigar and lighting up. "I'm acquainted with that plant and the boiler, too. One of those darned little miniature affairs that can be lifted around like a teakettle. My young man, I made the first inspection on it something over twenty years ago and helped old Mr. Jones out of a tangle that an incompetent erector got him into. You'd have laughed to see the way that erector set the boiler up. He'd screwed the fusible plug into the safety valve opening, closed up the hole where the plug was supposed to go with a solid iron blank, and hadn't installed the safety valve at all because he mistook it for a whistle. On top of all that, he'd neglected to provide a means of feeding water, so up until then they had been blowing off pressure and cooling the boiler every time they wanted to fill 'er up.

"The old gentleman certainly thought well of the help we gave him in straightening things out. Next time I called was on a bitterly cold winter's day and, to show his gratitude, he made me stay in the office and smoke a cigar with him while a couple of his men 'unhitched the kettle' as he expressed it, and trundled it in."

"Gee-whiz," said Joe, as the speaker paused to relight his cigar, "if everybody was that thoughtful this business of inspecting boilers would be a whole lot easier."

"Sure," agreed the older man, chuckling, "but we can't expect all of 'em to bring their boilers to us in wheelbarrows. We'd be satisfied if

(Continued on Page 55)

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., April, 1930

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

Company Establishes Branch Office at Baltimore

ON April 1st the newly established Baltimore Branch Office, under the management of Mr. James P. Kerrigan, Jr., took over direct charge of all the Company's activities in the territory comprising the District of Columbia and the states of Virginia, Maryland, and parts of West Virginia and North Carolina.

For over sixty years the firm of Lawford & McKim had managed faithfully and most successfully all the Company's business in that region, and it was natural that termination of this old business arrangement should occasion deep regret not only by the Company but by its agents as well. However, it was recognized that adoption of the new administrative method would bring important advantages to each.

Establishment of the branch office is in line with the Company's general policy elsewhere in the country where experience has shown that the intricacies of boiler and machinery insurance, with its many modern and varied forms of coverage, may be handled most successfully and economically through the direct contact between the Company and its patrons and agents which the branch office method affords. Lawford & McKim will continue to handle their own boiler and machinery business through the new branch office, and release from responsibility for the Company's affairs gives to their other lines of insurance the undivided time and attention required by an ever-increasing volume of business.

Manager Kerrigan entered the Company's employ in 1913 as an inspector for the Philadelphia Department. Except for a brief period during which, in an emergency, he served as acting chief inspector at Baltimore, he remained in Philadelphia until June, 1922. At that time he was called to Hartford to take over the duties of adjuster, and on January 1, 1927, he was made chief adjuster, a post that afforded opportunity for observing the application of engineering insurance to a wide variety of industries and processes. A broad knowledge of the business, together with unquestioned executive ability are two of the important qualifications which fit him for his new and responsible post.

Mr. Philip McKeon, who has been appointed chief adjuster to succeed Mr. Kerrigan, comes to the Home Office from the New York branch office where since 1926 he has been in charge of adjusting losses. Mr. McKeon joined the Company at Philadelphia in 1920 and while serving there as an inspector he demonstrated qualities which brought about his appointment as adjuster in 1925.

J. W. Smuck Made Ass't Chief Inspector

Mr. J. W. Smuck has been advanced to the position of assistant chief inspector of the Seattle Department. Mr. Smuck came with the Company as an inspector at Portland, Oregon, June 1, 1920. On February 1, 1928, he stepped up to the position of directing inspector, in which capacity he served until the first of this year.

New Quarters for Chicago Branch Office

The need for more office space in which to handle its rapidly growing volume of business has necessitated the removal of this Company's Chicago Branch Office from its headquarters at 209 West Jackson Boulevard to Suite 1150 in the Insurance Exchange Building, 175 West Jackson Boulevard. The transfer, effective March 10th, has meant relinquishing an address with which the Company had been identified since 1920, but this is more than offset by the procurement of more commodious quarters in the center of Chicago's insurance district.

E. M. Murray Promoted at St. Louis Office

Having served with marked success as resident agent at Kansas City, Mo., since August 11, 1921, Mr. E. M. Murray has been called to St. Louis to become assistant manager of the Company's branch office there, the promotion taking effect April 1. Mr. Murray became a special agent for the Atlanta Department on July 1, 1914.

Power, Work and Prosperity

IF, as economists claim, prosperity is a fruit of productive work, we need not look far for an explanation of the general well-being of all classes in this country. As pointed out recently by Dr. Thornton Read of Columbia University after a survey of conditions in the fifteen leading countries, the United States does about one-half the world's work with approximately one-sixteenth of the world's population.

Dr. Read's index figure for each of the various countries is the sum of the amount of horsepower developed mechanically and the amount developed by manual labor. He claims that the 120,000,000 population of the United States, aided by its many power-driven machines, does within 5 per cent. of the amount of work done by the 1,111,000,000 approximate population of the fourteen other leading countries.

It is interesting to note that China and India, where labor is not multiplied by machinery, lead the world in the amount of work accomplished by unaided human labor, but lag considerably behind the United States, Great Britain and Germany in the work done by men with powered machines. The work done in the United States alone is equivalent to the manual work that could be done by ten times as many men as there are in China.

Victim of Heating Boiler Explosion Wins Suit

A verdict of $35,000 was awarded recently to a St. Louis, Mo., woman for injuries she sustained when a cast iron heating boiler exploded in the basement of a store and dwelling in December, 1927.

In this case suit was brought in the amount of $75,000. Another victim of the accident has filed suit for $50,000.

The boiler was used in a hot water heating system, and it was thought that freezing weather rendered the relief valve inoperative. There was no boiler insurance.

Fatigue Cracks Found in Boilers of 58 Destroyers

The Bureau of Engineering of the U. S. Navy has reported that because of the finding of fatigue cracks between tube holes of boiler drums 58 destroyers must be retired from service as unsafe.

The type of boiler affected utilizes a drum that is not absolutely round, being somewhat flattened on the side where the tubes enter it. In cases where such flattened surfaces are not sufficiently stiffened, fluctuations of pressure have a tendency to cause bending and eventual cracking. Inspections of land boilers frequently reveal cracks attributable to this cause, particularly at the turn of the flange in unstayed bumped heads of water tube boilers. Cracks of this nature have led to violent explosions.

Taps from the Old Chief's Hammer

(Continued from Page 51)

they'd just prepare the boilers so it wouldn't be up to us to dig out soot and remove the manhole covers. You'd think, wouldn't you, that if a plant engineer were interested in his boilers and wanted to have 'em examined thoroughly he'd at least have them ready when the inspector arrived.

"Now that we're on the subject, though, did you ever hear about Spencer's inspection in a ship that was at the bottom of Galveston Bay? That was one 'for the book', as you call it.

"You probably remember the government's experiment with concrete ships during the War. Well, one of those vessels, named the 'Selma', was sold eventually to a private shipper who used her more or less successfully until one day she struck a snag coming into Galveston and opened up a crack in her hull. They drydocked her and tried to find some way of making repairs, but when they saw how much it would cost they towed her out to a shallow part of the bay about twelve miles from the city and lowered her into a specially prepared bed with just her deck and superstructure above water at flood tide.

"One evening I got a wire from a fellow in Galveston who was interested in buying the ship's boilers. He wanted me to have someone look them over and report on their condition, so I 'phoned Spencer to meet him at the hotel and arrange with the shipowner to have the boilers made available for inspection. Of course, I hadn't heard what had happened to the 'Selma' and had no idea she was half submerged twelve miles out in the bay. Had I known that I would have given Spencer different instructions. As it was, he got on the job bright and early in the morning, secured the owner's permission for the inspection, and set out with the buyer in a hired motorboat for the place where the ship was sunk.

"They arrived on board just after the tide had started out and naturally the boiler room was partly filled with water. The boilers themselves were full, just as they had been left after the last run, so Spencer explained to his companion that they would have to wait until the tide fell enough to allow him to go below decks and drain them. The idea of sitting around didn't appeal to the buyer, who decided to leave the inspector and return for him after lunch.

"Spencer had no objection, so off chugged the launch while he sat down to smoke his pipe and wait for the tide to let him get to work. The job turned out to be a tough one, for the boilers had been exposed to the salt water for months and showed signs of considerable corrosion. However, he finished up about one o'clock and went up on deck to await the boat that was to take him ashore. In the meanwhile the tide had turned and before very long water was gurgling back into the cracked hull in a manner that made Spencer thankful that he had no more work to do below-decks. Moreover, what in the morning had been no more than a gentle breeze now gave signs of turning into a gale, and as Spencer sat there smoking in the lee of the deck house he found it difficult to give his undivided attention to the far-famed beauties of Galveston Bay.

"Off in the distance he could see sails and the smoke from several steamers, but the spot they had picked out as the old 'Selma's' grave was several miles from any of the ship channels. With nothing to eat, nothing to read, and no sound to break the monotonous splash of the waves that were by then breaking over the deck, Spencer was in no cheerful mood when sunset found him still waiting. What if something had happened to the man who was supposed to take him ashore, he thought. Suppose the fellow had been called away from the city on business and had forgotten all about him. In his mind's eye he could see himself waiting there for days until some boatman came near enough the abandoned 'Selma' to give him aid.

"Sitting there in the darkness, his last match long since used up in keeping his pipe lit, Spencer watched with anxious eye as ship lights moved between him and shore. There seemed to be plenty of activity but none of the boats drew any nearer to the spot where he was marooned. It was not until ten o'clock that he made out a small light bobbing up and down on the water and slowly coming closer. Sure enough, before long he picked up the encouraging, 'chug, chug' of a one-lunged gas engine and in a few minutes he was on his way shoreward, completely fagged out and as hungry as a bear.

"The boatman explained, with due apologies, just how the thing had happened. It seemed that the prospective purchaser, after reaching shore, decided that there was no reason for his going out to the 'Selma' again. Consequently, he arranged with the boatman to go out and get Spencer about two o'clock. In the meanwhile the boatman dug up another ferrying job which kept him busy the best part of the afternoon and by the time he was free again he had forgotten all about Spencer. It was not until he was in bed and dropping off to sleep that he remembered the man waiting for him twelve miles out in the bay.

"Yes, Joe," continued the Chief, dropping the cigar butt onto the floor and grinding out the last spark with his heel, "in this business of inspecting boilers you'll run across folks who are thoughtful as well as those who aren't. All in all, though, most of them are good fellows who want to do all they can to help you give their equipment the kind of attention it deserves."

Already the train was sliding along the platform. Passengers with coat collars turned up in preparation for a scramble through the snow to waiting cabs, were crowding the aisle in front of the doors.

"Come on," said the Chief, reaching for his overcoat and briefcase, "This rag chewing is all right to help pass the time, but it isn't getting any work done. Let's go."

REAL RELAXATION

First Executive: Did you enjoy your vacation?
Second: Yeh, but there's nothing like the feel of a good desk under your feet again.—Life.

Butcher: "You know, Mrs. Murphy, I'd give you anything in the shop."
Mrs. Murphy: "I know yez would, but yez won't get away wid it."

DECELERATION

Prisoner (explaining why he broke the speed law): "You see, your honor, everything I do, I do fast."
Judge: "Good. Let's see how fast you can 'do' sixty days."

Inspection *and* Insurance *of* Pressure Vessels *in the* Paper Mill Industry

(Continued from Page 45)

appearance as if a small amount of rubbing had been taking place there for a considerable period of time. The wasting away of the interior of the digester removed part of the metal from the sound portion of the joint and thus seriously weakened it.

It is to be noted that the interior surface of this digester was such that no one would suspect that any wasting had taken place.

Following this accident an investigation was made of a number of digesters used in the sulphate pulp industry and located in various parts of the country. This investigation of the thickness of such digesters after they had been in service for a period of years was made by drilling and at that time a record of the thickness of 66 digesters was obtained. The age of these digesters varied from one year to thirty-five years and wasting was found in every one, the reduction in thickness varying up to 68% of the original thickness. In some few instances the wasting had not been so severe as to require any immediate action, but in a large number of cases it was necessary to greatly reduce the pressure. In some instances the pressure reduction meant a virtual condemning of the vessels so that they had to be replaced.

In the majority of cases it was found that the most serious wasting took place in the upper third or quarter of the digester, but that was not always so, as there were some instances where the shell was wasted more near the bottom than at the top.

It has been felt that the wasting is due partly to a chemical action and partly to a mechanical action or erosion caused by the chips being in a state of agitation in the digesters. Some thought was given to the possibility of chemical action taking place by reason of the liberation of carbon-dioxide in the sulphate process. However, wastage was also found in the straight soda digesters where it is understood no liberation of carbon-dioxide takes place.

The action of sodium hydroxide on steel has been the subject of study by a number of investigators and it has been shown that as the concentration of sodium hydroxide is increased the potential of the iron or its tendency to enter a solution is at first very markedly decreased but with increasing concentration of sodium hydroxide the electrolytic potential increases and even passes beyond the potential in a neutral solution. Whether or not this has any bearing on the question of wasting in soda or sulphate digesters the writer is not prepared to say.

It is believed that the question is one worthy of further investigation.

The interest of the insurance inspector with regard to sulphate digesters is not in deciding what solution should be used, but in determining what steps can be taken to detect possible weakening of the vessel with the solution that must be used. The problem is somewhat different than where it is desired to detect whether any leakage has taken place through the brick lining. In the sulphate digester it is desired to know when wastage has extended to such a degree as to weaken the structure. This wastage has appeared to be fairly uniform around the digester but it varies from top to bottom. The recommendation that the insurance inspector makes is that sulphate digesters be drilled from the outside to a depth that will represent a reasonable minimum thickness for safety. (See Figure 3.) When the metal becomes wasted away to an extent that the bottom of the holes communicated with the interior of the vessel, leakage would occur and call attention to the fact that undue wear had taken place. Such holes need not be over 3/16″ in diameter and if drilled on 24″ centers or even 12″ centers could not weaken the structure to any appreciable degree. Furthermore, since these holes do not pass entirely through the shell no leakage can take place.

Digesters are, of course, frequently provided with an exterior insulating covering and in such case the value of the test holes should be maintained by providing short lengths of copper or brass tubing which may be driven into the test hole and extend through the covering.

The drilling of such telltale holes is strongly urged upon all users of sulphate and soda digesters and where new digesters are being built in the shops very little expense is added by having the holes drilled at the time of manufacture. In any event the expense of having such holes drilled is a minor matter when considering the question of safety to life and property.

Paper Machine Drying Cylinders

In a paper mill there are potential possibilities for a disastrous explosion ever present in the paper machine drying rolls. Only a few years ago such an accident caused the death of two men and injury of eight others. Property loss was estimated at $100,000.

In order properly to drain a drying roll of this nature, it is necessary to have some kind of piping or arrangement within the roll. These devices, if kept in operation, ordinarily are satisfactory and accomplish the purpose while the roll is in operation. There is always, of course, the possibility that they may become deranged, permitting the roll to accumulate water. It frequently occurs that a valve on the steam line may leak somewhat so that during a period of idleness, steam leaks into the roll and condenses there. The draining devices generally will not remove such water of condensation while the roll is standing idle and should the steam pressure be turned on to the full extent with an appreciable amount of water in the roll a water hammer is certain to be set up. Such water hammer action will rupture a construction which otherwise would sustain a fairly high pressure.

To obviate the possibility of water accumulating in this way, the steam line should be arranged with two valves and a drain connection between on which, of course, there should be a valve. When shutting down the paper machine for any period of time the two valves in the line should be closed and the valve on the drain line opened. Then, if there is any leakage of steam it will be shown in the drain line and steps can be taken to correct the condition, while at the same time there will be no possibility of steam entering the rolls during the idle period.

Paper machine rolls may also be ruptured by too high a steam pressure. Where live steam is used to supply the rolls, it is customary to feed it through a regulating or reducing valve. However, it should be borne in mind that regulating valves will not always close tight and may easily become deranged. The insurance inspector therefore requires that a safety valve be placed on the steam line between the regulating valve and the rolls, the setting of this safety valve to be the maximum pressure allowed on the roll. With this arrangement, if the reducing valve fails to function properly the safety valve will prevent an undue accumulation of pressure which might cause an explosion.

The insurance inspector, in visiting a plant, views conditions from a particular standpoint—safety. He is not especially concerned with the process used in any one instance, but he is vitally interested in how that process may affect safety of life, limb and property. With that in mind he frequently does see and can point out hazards which may not have appeared to others who live with the equipment day in and day out.

WEBSTER SAYS HE'S RIGHT

"I wants to be procrastinated at de nex' corner," said the negro passenger.
"You want what?" demanded the bus driver.
"I wants to be put off, boss. Ain't dat what de word means?"

Chief Engineer (disapproving the technique of the new steam-fitter's helper): "So you're a mechanic!"
Pat: "Indade I'm not. I'm a McCarthy and proud of it."

SUMMARY OF INSPECTORS' WORK FOR 1929

Number of visits of inspection made (boilers and engines)	279,950
Total number of boilers examined	542,823
Number of boilers inspected internally	193,462
Number of boilers tested by hydrostatic pressure	14,360
Number of boilers found to be uninsurable	924
Number of shop boilers inspected	23,291
Number of premises where pipe lines were inspected	33,462
Total number of engines and wheels examined	60,523
Number of uninsurable engines and wheels	214

SUMMARY OF DEFECTS DISCOVERED

Nature of Defects.	Whole Number.	Dangerous.
Cases of sediment or loose scale and adhering scale	77,591	3,840
Cases of grooving and internal and external corrosion	44,682	2,238
Cases of defective bracing	826	241
Cases of defective staybolting	3,146	620
Settings defective	8,542	826
Fractured plates and heads	2,427	423
Burned plates	2,728	362
Laminated plates	151	22
Cases of defective riveting	1,720	372
Cases of leakage around tubes and defective tubes and flues	25,369	6,485
Cases of leakage at seams	5,408	408
Water gauges defective	3,506	592
Blow-offs defective	4,160	1,262
Cases of low water	562	273
Safety valves overloaded or defective	2,642	691
Pressure gauges defective or missing	6,742	638
Miscellaneous defects in boilers	9,562	803
Flywheels found overspeeded	62	9
Cases of cracks found in engine parts and wheels	532	163
Defective governors	328	141
Miscellaneous defects in engines and wheels	52	1

GRAND TOTAL OF THE INSPECTORS' WORK ON BOILERS FROM THE TIME THE COMPANY BEGAN BUSINESS TO JANUARY 1, 1930

Visits of inspection made	7,193,036
Whole number of inspections (both internal and ext.)	14,190,988
Complete internal inspections	5,456,958
Boilers tested by hydrostatic pressure	506,795
Total number of boilers condemned	38,664
Total number of defects discovered	7,443,368
Total number of dangerous defects discovered	829,927

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1929

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 562,819.36
Real Estate		306,494.68
Mortgage loans		1,083,248.86
Bonds and Stocks		18,384,883.03
Premiums in course of collection		1,669,195.41
Interest accrued		160,573.97
Other Assets		23,959.34
Total Assets		$ 22,191,174.65

LIABILITIES

Reserve for unearned premiums		$ 9,289,882.04
Reserve for losses		452,334.69
Reserve for taxes and other contingencies		2,065,632.12
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,383,325.80	
Surplus to Policyholders,		**$10,383,325.80**
Total Liabilities		$ 22,191,174.65

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 Charter Perpetual

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BALTIMORE, Md. . . . . 5 South St.	JAMES P. KERRIGAN, JR., Manager. P. E. TERROY, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., . . . 404-405 City Savings Bk. Bldg.	W. G. LINEBURGH & SON, General Agents. A. E. BONNETT, Chief Inspector.
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NEW YORK, N. Y., . . . 80 Maiden Lane . . .	C. C. GARDINER, Vice-President. E. MASON PARRY, Chief Inspector.
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SAN FRANCISCO, Cal., . . 114 Sansome St. . . .	C. B. PADDOCK, Manager. L. J. REED, Chief Inspector.
SEATTLE, Wash., ... 707 Arctic Bldg.	E. G. WATSON, Mgr. and Chief Inspector. J. W. SMUCK, Ass't Chief Inspector.
TORONTO, Canada . . . . Federal Bldg.	H. N. ROBERTS, President The Boiler Inspection and Insurance Company of Canada.

DEFECTS
—Dangerous, 20,410

In examining a total of 603,346 boilers and engines in 1929, "Hartford Steam Boiler" inspectors discovered 20,410 defects classed as DANGEROUS.

Year in and year out since 1867, the inspection force of America's pioneer engineering insurance company has patrolled equipment of its assured, on guard against hidden, insidious weaknesses that threaten safety of life and property.

The experience gained throughout sixty-three years' specialization in this highly exacting line of work makes the protection of "Hartford Steam Boiler" insurance more valuable now than ever before.

THE HARTFORD STEAM BOILER
INSPECTION & INSURANCE CO.
Hartford, Conn.

Vol. XXXVIII No. 3 July 1930

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Long Study *of* Embrittlement Has Led *to* Effective Means *for* Detecting Cracks in Early Stages

ALTHOUGH the discovery some years ago of a rational theory to explain caustic "embrittlement" pointed the way to methods for controlling its ruinous effects on boiler seams, the knowledge of what it was and how to treat feed water so as to prevent it did not at once clear up all the problems with which boiler men were confronted.

For some time after this form of distress was recognized as the result of caustic action both the owner and the insurance companies counted themselves fortunate if discovery of a case was made in time to permit retirement of the boiler before it exploded. The reason was, of course, that "embrittlement" cracks invariably appeared in seams and under straps where the finding of them was most difficult if not quite impossible until they reached the stage where leakage occurred. By that time the boiler had usually been so thoroughly weakened that it was in danger of exploding.

Of course The Hartford Steam Boiler Inspection and Insurance Company could not be satisfied to cope with the difficulty on such an unsatisfactory basis. It soon discovered that as a rule caustic action had been at work in a boiler for ten years or more before its effects became evident and, with this in mind, it lost no time in undertaking an exhaustive study of the situation to find methods whereby the condition could be caught in its early stages. Its aim was not only to reduce the chances of serious accidents but, where possible, to save boiler owners the heavy expense and inconvenience of immediately replacing boilers that had been extensively affected before the condition was discovered. As a result, its inspectors are now recognizing the presence of "embrittlement" long before it has progressed to the danger point; and frequently their prompt discoveries, when followed up by repairs and changes in the method of treating feed water, make it possible for the owner to continue use of the boiler for some time.

The theory of "embrittlement" and the general principles of feed water control for preventing it were discussed at some length in The Locomotive of October, 1928, so no attempt will be made here to go over that ground; but the chronological history of "embrittlement" and the way in which The Hartford Steam Boiler developed the technique by which its inspectors are now coping with it is somewhat of an interesting story.

When, in 1895, the University of Illinois undertook an investigation to determine the changes and inter-action going on in a steam boiler for the purpose of obtaining data covering the process of scale formation, its prevention, and the causes of corrosion, the investigators encountered a certain natural feedwater in northern Illinois that evaporated without leaving an appreciable amount of scale. This water came from deep wells and was characterized by a rather large content of sodium carbonate and little or no sulphate. Because of its freedom from the tendency to cause scale it was referred to as "self-purgative" and was looked upon as ideal for use in boilers.

At that time, as at present, THE LOCOMOTIVE maintained as complete a record as possible of the boiler accidents occurring in the United States and in 1897, when the Company's attention was attracted to a large number of explosions reported from the territory noted for its good water, it deemed the situation worthy of special notice. In fact, with the discovery of a case of cracking at DeKalb in 1902 and several other cases in the territory where this feed water was in use, the Company became suspicious that the water might have properties other than the one for which it was noted, and that these other properties might be leading to the trouble. As a result, it warned its men there to keep a close watch for evidences of cracking.

However, no one then had any idea that the *caustic* content of the water was really at the root of the trouble. It was not until 1907 that this thought was suggested in a paper read before the Iron and Steel Institute of England by C. E. Stromeyer, chief engineer of the Manchester Steam Users' Association. Stromeyer referred to an instance of cracking in boiler steel as being similar in appearance to cracks he had noted in the metal of caustic evaporators. Three years later, in a published memorandum, he again referred to the influence of caustic soda on mild steel used in the construction of evaporators, saying, in part:

" . . . the top and bottom ends of the evaporator tubes cracked and even fractured and a large number of rivet heads snapped off. A careful examination of the tubes revealed that the cracks were confined to those parts of the ends which had been stretched by the expander . . . It was also found that the central portion of the tubes were not in the least affected. . . . These facts, for which there is as yet no scientific explanation, suggest that closed boilers working under pressure should not be used for the concentration of caustic liquor unless it is very weak, for the shell plates of these boilers are in tension and are likely to become brittle."

At that time there was no thought of comparing conditions inside a caustic evaporator with those inside a steam boiler, for although

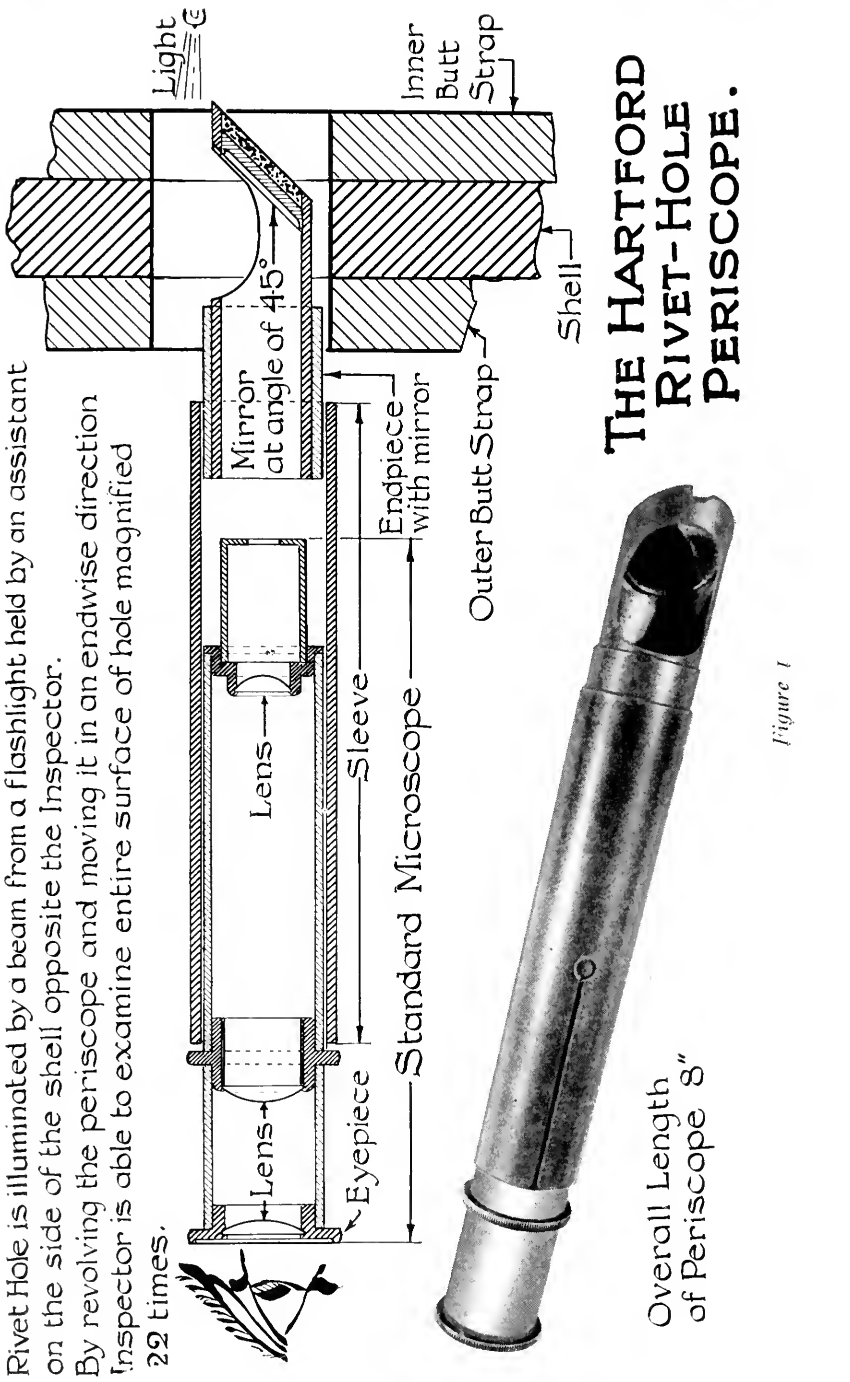

Rivet Hole is illuminated by a beam from a flashlight held by an assistant on the side of the shell opposite the Inspector.
By revolving the periscope and moving it in an endwise direction Inspector is able to examine entire surface of hole magnified 22 times.
Light
Inner Butt Strap
Mirror at angle of 45°
Shell
Outer Butt Strap
Endpiece with mirror
Lens
Sleeve
Standard Microscope
Lens
Eyepiece
THE HARTFORD RIVET-HOLE PERISCOPE.
Overall Length of Periscope 8"

Figure 1

it was recognized that self-purging feed water did produce some caustic, it was inconceivable then that enough could be present in usable feed water to permit a high degree of concentration. It was not until several years after Stromeyer's observations were published that a close consideration of this possibility brought out evidence to show that there was indeed a striking similarity between what Stromeyer had found in caustic evaporators and the condition that was causing distress in boilers using the self-purgative feed water common to parts of Illinois and Wisconsin.

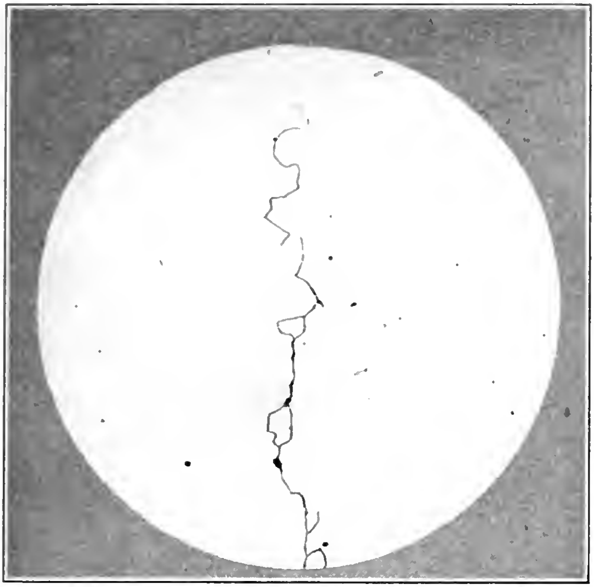


Figure 2
An actual photograph of an "embrittlement" crack magnified to 100 diameters. This gives an idea of the microscopic dimensions of the fissures which the inspectors find with the aid of the periscope.

In 1912 boiler distress made its appearance in the power plant of the University of Illinois, where sodium carbonate feed water was in use. The resultant discussion and investigation carried on by a committee of which Professor C. R. Richards was chairman and of which Professor S. W. Parr was a member, led to the strong suspicion that the sodium carbonate content of the water, which had always been regarded as ideal for boiler use, was actually responsible for the cracking. Their examination of the crystal structure at the fissures led them to term the cause "hydrogen disease," on the assumption that hydrogen given off by a chemical change of the sodium carbonate under heat and pressure had attacked the cement binding the crystals together.

While this committee was engaged in preparing a bulletin (No. 94) to record its findings, other boilers in the University power house gave out and the same trouble made its appearance in boilers of a traction company at Urbana. Then, at about the same time, a violent explosion took place at Bloomington, Illinois, where feed water conditions were essentially the same as at Urbana.

Interested in the fact that the scientists' opinions bore out its own suspicion that feed water was the key to the trouble, The Hartford Steam Boiler immediately started to compile all available information regarding accidents resulting from cracking of riveted seams of boilers in that territory. It found that some plants using the self-purgative water had had as many as three instances of cracking.

Cracking of the rear girth seam of a boiler at Appleton, Wisconsin, in 1920, was discovered by one of the Company's inspectors under conditions which permitted it to obtain more detail than was possible in the ordinary inquiry, that frequently could not be instituted until some time after the accident occurred. As a consequence, a very thorough investigation was made of every condition that might have had a bearing on the failure. The conclusion was, in brief, that the inter-crystalline cracking was directly attributable to the nature of the feed water and not to any shortcomings in either workmanship or material, as some had suggested.

While the investigators of the University, the engineers of The Hartford and some others were deeply concerned with what had been found, there was little nation-wide interest in the condition. The type of feed water involved occurred only in a narrowly restricted territory and was thus of little concern to boiler operators elsewhere. However, in 1925, when utility interests were centering their attention upon the installation of expensive, large-capacity boilers which, operating at a high rate of evaporation, would require approximately five per cent. of treated make-up water, they thought it advisable to look further into the matter of caustic cracking. For that purpose they induced the University to take up again the investigation it had started in 1912.

At the University's request, The Hartford Steam Boiler furnished a large number of specimens of plate containing cracks in riveted seams, at the same time placing at the University's disposal information the Company had developed in its own investigations. J. P. Morrison, now assistant chief engineer of this Company's boiler division but then chief inspector of the Chicago Department, was largely instrumental in securing these samples and, later, in giving the University's scientists opportunity for studying conditions in boilers where Company inspectors had come upon cracks.

After exhaustive studies in both the laboratory and the field, Professor Parr and Mr. F. G. Straub finally developed and demonstrated the

Figure 3

After seam leakage or the snapping off of a rivet head under the inspector's hammer has given evidence of the presence of caustic action, a close examination of the rivet hole wall through the Hartford Periscope frequently results in the finding of cracks so small as to be invisible to the naked eye.

theory which is now generally accepted as explaining the effect of caustic on boiler steel. At the same time, however, they showed that "embrittlement" cracking could be caused not only by feed water in which high carbonate and low sulphate contents occurred naturally, but also by treated waters where the system of treatment produced water of similar characteristics. With the appearance of the University's Bulletin 155, and later when Bulletin 177 was issued, boiler men in general began to recognize that "embrittlement" could no longer be regarded as a condition peculiar to Illinois and Wisconsin, Texas and Colorado; but that with the tendency toward higher pressures and increased rates of evaporation, it could be encountered in boilers in practically any part of the country, if proper attention was not given to feed water treatment.

While the scientific research had been under way at the University, the engineering department of this Company had been engaged in a diligent study of its own, inquiring exhaustively into every case of cracking to which it had access, acquainting itself with the physical characteristics common to all cases, and assembling data for future use in diagnosing the condition. As mentioned earlier in this article, the Company's purpose was to close in on "embrittlement"; to become so well acquainted with the early symptoms that inspectors could discover the condition at its beginning.

At first this was by no means an easy task, for even after inspectors had been trained to recognize the tell-tale traces of the presence of caustic action, it was sometimes extremely difficult to convince plant officials that the symptoms justified cutting out rivets for a closer examination. Such evidence as an insignificant-looking "buckshot" of salt outside a rivet or caulking edge did not always impress men of the plant as indicative of something seriously wrong. Nor were they inclined, at first, to attach especial significance to the snapping off of rivet heads, or to a slight leak at a seam, even though sometimes they admitted that repeated caulkings had failed to stop it. However, inspectors stuck to their guns in such cases, and many an assured was later to thank the Company for its insistent stand.

The job of detecting "embrittlement" symptoms and of making the examination to determine whether or not cracking has started is most certainly not one for the amateur. In fact, so much of the skill and knowledge required for the work can be obtained by no method other than experience, that an article of this scope can do no more than touch on it briefly. Even after outward symptoms leave little doubt that caustic action has started, and rivets have been cut out to permit a close look at the walls of the rivet holes, the cracks are frequently microscopic and can be seen only under a strong magnifying glass. The ordinary reading glass, used in conjunction with the proper lighting arrangement, has been found very useful for this purpose, but it is not entirely satisfactory. It is difficult to focus, especially in cases where plates are thick and rivet holes are long.

Figure 1 shows the Hartford Rivet Hole Periscope, designed in 1928 by Assistant Chief Engineer Morrison especially for the purpose of searching for fine rivet hole cracks. This instrument has proven of utmost value in many occasions and is one of the means whereby early discovery of caustic action has been made possible. Cracks so small that they are entirely invisible to the naked eye are magnified twenty-two times by the reflecting mirror and lens, and no matter how deep the hole the instrument permits a minute examination of every portion of the wall. Besides this instrument, two others of somewhat different principle have been designed by the Company's technical department, and are proving of great aid to inspectors.

Figure 4

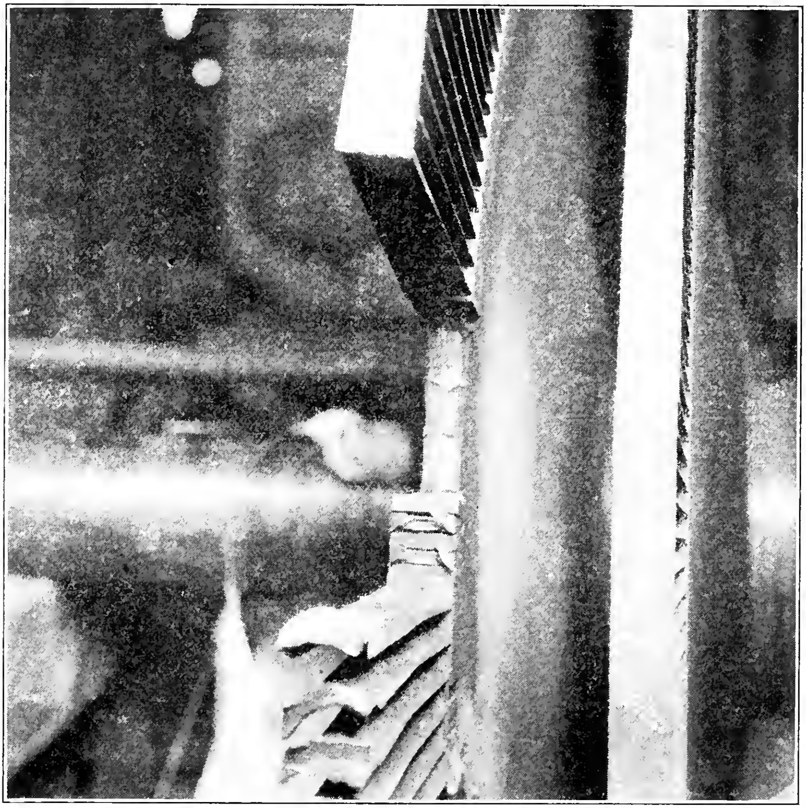
The periscope in use by an inspector on the mud drum of a water tube boiler. Muriatic acid and fine emery cloth are used to polish the hole so that, to the naked eye, its surface appears bright and smooth.

Thus the campaign against caustic "embrittlement," the insidious agent that was once feared chiefly because so little was known of it, has developed to the point where The Hartford Steam Boiler is able now to apply the fruits of long experience to detecting its presence before boilers have become dangerously weakened. How much the Company's efforts have saved in life and property cannot be estimated, of course, but in the past few years its inspectors have discovered about 500 cases of caustic cracking.

Turbine Damaged as Piece Breaks from Disc

A CRACK in a turbine disc just below the roots of the blades led to the accident herein illustrated when a piece of the disc holding six blades broke away and damaged a 4,000 kw. machine extensively. Examined after the accident, the disc was found cracked at eight other points around the rim. Evidently these cracks were of the progressive kind, for less than a quarter of the fracture had the appearance of a fresh break. This accident occurred on April 16 at a manufacturing plant in Illinois.

The turbine had been shut down for minor adjustments after eight weeks of continuous operation, and attendants, preparatory to putting



it under load again, had brought it up to speed and were testing the emergency device. Observers saw the emergency valve trip the instant the admission valve was raised. Simultaneously, however, there was a commotion inside the casing, accompanied by such severe vibration that the expansion joint in the steam connection between the high pressure and low pressure parts of the turbine distorted and ruptured.

In addition to the breaking of the disc, blades on another disc were loosened, the spindle bent, bearings broken, and the low-pressure casing damaged in several places. Pieces of metal went into the condenser and ruined about 60 tubes. The owner carried insurance in The Hartford Steam Boiler Inspection and Insurance Co.

Four Injured *as* Ammonia Gas Explosion Demolishes Boiler House *of* Syracuse Plant

A RECENT serious accident in an ice and refrigerating plant at Syracuse, N. Y., has again demonstrated that ammonia gas and just the right proportion of air form a mixture which is highly inflammable and explosive. (For a discussion of this hazard see THE LOCOMOTIVE, Vol. 33, Pages 76 and 241.)

The accident occurred after bursting of a valve filled the compressor room and an adjoining boiler house with ammonia. Evidence seemed to indicate that the mixture of ammonia and air was set off by an electric spark. Four persons were injured, the boiler house was demolished (as shown in the illustration) and considerable damage was done to the compressor room and the machinery in it. Property damage amounted to about $37,000.

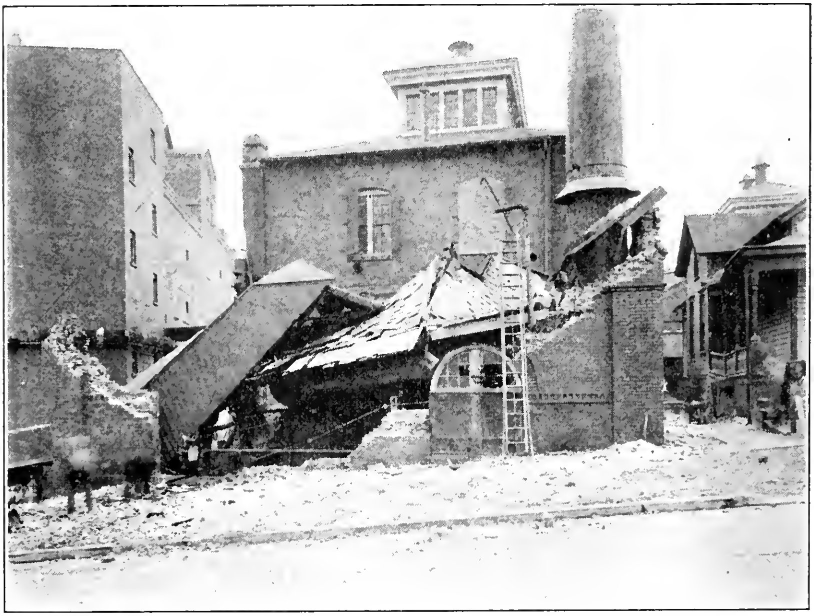
There were five motor-driven compressors in the plant, three of the horizontal type and two vertical. All of them could be used interchangeably to operate several cold storage rooms and ice-making plants in adjoining buildings. The engineer had just started one of the vertical machines and had left the room momentarily on other duties when the night watchman, who also was familiar with refrigerating machinery, entered the compressor room and found the compressor knocking and laboring. He started to close the suction valve and while he was doing so a by-pass valve on the machine broke, showering him with liquid ammonia and driving him from the building.

Both the engineer and the watchman tried to get back into the compressor room to open the motor switch and close a valve in the line from which ammonia was escaping, but when dense fumes forced them to abandon their efforts the engineer ran to the transformer house a block away and there cut off the current.

The night watchman, who was standing near the compressor room, said that the engineer had had just about time to reach the transformer house and throw the switch when there came a flash of fire through the compressor room and the adjoining boiler house, and a crash which tore down the boiler room walls and collapsed the roof.

Investigators considered several theories in arriving at an explanation of just how the accident occurred, but the one most amply sustained by evidence was that after the breaking of the by-pass valve a mixture of just the right proportion of ammonia and air collected in the rooms and was ignited by an arc from a circuit breaker which opened automatically the instant the switch was thrown in the transformer house.

The night watchman suffered burns and injuries from falling brick. A man living nearby noticed the smell of ammonia and was approaching the plant when the boiler room wall fell and pinioned him. Injured, he was dug from beneath the debris by volunteer rescuers. A son who participated in his father's rescue was burned.



In a house standing within a few feet of the boiler room a man, his wife, and a small daughter were badly jarred when the blast shook the house, damaged the wall and roof. The woman claimed to have suffered additional injuries by inhaling ammonia gas.

Although the building housing the boilers was practically destroyed, and all piping was torn down, only one of the three horizontal tubular boilers was damaged. That one sustained a dent when struck by a heavy timber.

In the compressor room two 100-hp. motors, two 5-hp. motor generator sets, and a switchboard were ruined by fire. Very fortunately the owners had insurance to cover both the direct property loss and the claims for personal injuries.

Exploding Flywheel Pierces Hospital Walls

THE Elizabeth (N. J.) General Hospital was plunged into darkness on the night of May 23rd when the 8-foot flywheel of an engine used to furnish light and power exploded and hurled heavy fragments through masonry walls of both the power house and hospital building. That no one was injured was considered remarkable, for a piece of the flywheel rim demolished the main switchboard in the engine room, tore out a section of brick wall, and swept through a room of the hospital building in which nurses had been at dinner but a few minutes before.

Another large piece of metal, weighing several hundred pounds, plunged through a frame structure used as living quarters by hospital employes and came to rest two blocks away after striking the roof of a residence. Smaller pieces of debris were scattered over a wide area. Another generator was struck and badly damaged.

While nurses sought to reassure frightened patients, an emergency crew from the electric light company fell to work establishing a connection with outside power lines, so that within two hours the buildings were again illuminated. Fortunately, there were no operations in progress at the time.

Derangement of the engine governor was blamed for the accident. A fireman noticed the engine picking up speed and called a warning to the engineer, but the crash came before either of them could close the throttle.

Heating Boiler Explosions Snuff Out Lives *and* Cause Heavy Property Damage

DOWN in the sub-basement of Research Hospital, Kansas City, two men received fatal injuries and a third was painfully burned on March 6th when a garbage incinerator exploded, trapped them in the path of flying debris, scalding water and steam. Two of the victims, brothers, died in the hospital within a few hours.

Fortunately for hospital patients, the heavy construction of the sub-basement confined the full effects of the blast to the boiler room. Even so, the concussion was severe enough to shatter glass in an elevator that ran from the basement to the upper floors.

The incinerator was in use as a hot water supply boiler and was connected to a supply tank on which there was a safety valve to prevent overpressure. A stop valve in the line between boiler and tank provided

Figure 1

a means whereby the boiler could be closed off from the system for cleaning and inspection. Through oversight, this stop valve was closed while the boiler was in operation, and as the boiler itself had no relief valve there was nothing to prevent a dangerously high pressure from forming. Failure occurred by tearing of the furnace sheet around the riveted flange at the stack opening.

Another accident of somewhat the same nature occurred in the 15-story Consolidated Building at Indianapolis, Indiana, the night of April 22 when a hot water heater exploded, crashed up from the basement to strike the steel framework of a marble staircase and damage the building to the extent of $6,000. Although three persons were injured, the casualties might easily have been more numerous had the explosion occurred at a time when the offices and a bank on the ground floor were crowded with people.

Aside from extensive damage to the marble stairway, shown in Figure 1, ironwork of the elevator shaft was bent, a large plate glass window was blown out of the bank, and several door frames and smaller windows were broken. Effects of the concussion were found as high

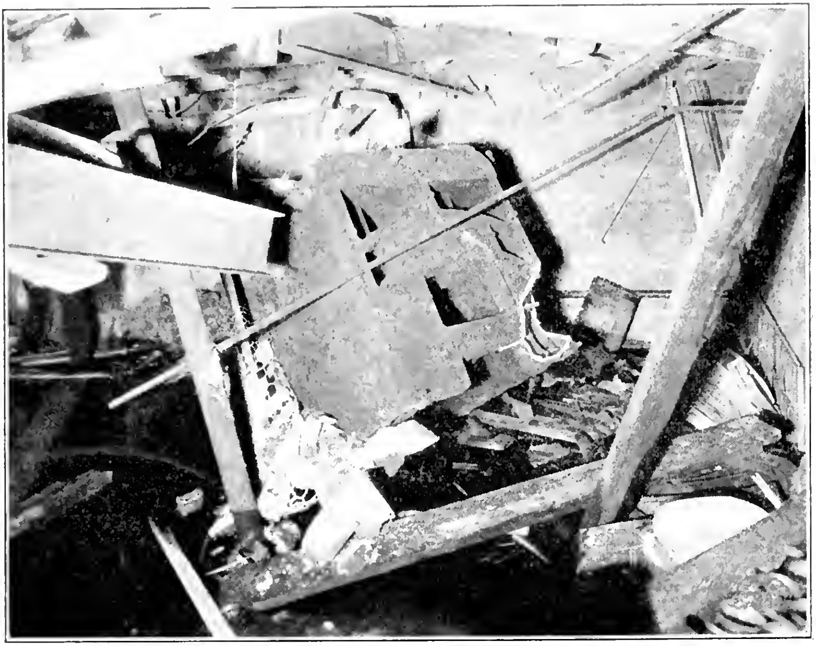


Figure 2

as the fourth floor, where window panes were shattered. Down in the basement piping, wiring, and equipment near the exploded heater were damaged extensively.

The hot water supply equipment for the building consisted of two heaters connected to a common supply tank. Each heater had a relief valve, and in the lines connecting the heaters to the tank were stop valves to permit cutting either heater out of service.

The heater which exploded had been in continuous service thirty days and the day shift had burned down the fire and closed the stop valve in its discharge line preparatory to cooling and cleaning the vessel. Unaware of the plan of the day men or that they had closed the stop valve, the night attendant proceeded to build up a fire when he came on duty. He was standing about 30 feet from the heater when it exploded.

Theoretically, the relief valve should have prevented overpressure, for when it was tested afterwards it opened at a pressure of 90 pounds per square inch. However, there was some lime and scale in it; evidently enough to make it stick. It is possible that the jar of the explosion loosened it, thus permitting it to open when a test was applied.

Protected by insurance in The Hartford Steam Boiler, the owners were reimbursed to the extent of their loss.

Both of the accidents just described involved boilers made of steel, but heating boilers of the cast iron type can go to pieces with equal violence. Figure 2 shows the wreckage of such a boiler after it had exploded beneath a bakery in Baltimore, Md., December 30, 1929.

Seventeen persons were working in a room directly over the basement at the time of the explosion and although a portion of the floor was torn up and wreckage was tossed around, all escaped serious injury.

The boiler was equipped with an oil burner. It was thought that a defect in the thermostatic control arrangement allowed pressure to exceed the safe limit.

Monoxide Gas From Novel Source

While changing their clothes in a locker building on Brunot Island in the Ohio river below Pittsburgh, Pa., where they were employed in erecting a new power plant for the Duquesne Light Company, twenty-six men were overcome by gas that came from a novel source.

At a loss to explain the presence of gas in the changehouse, engineers called on the Pittsburgh Experiment Station, United States Bureau of Mines, for an investigation. Using their carbon monoxide detectors, the experts found that there was from 1 to 2 per cent. of monoxide gas in the atmosphere of the building.

One end of Brunot Island had been built up over a period of twenty years by the dumping of power plant cinders which, forty feet deep in some places, had given evidence from time to time of being on fire. When the new intake tunnel was driven under this cinder-bed compressed air evidently forced its way up through the cinders in sufficient quantity to encourage more active combustion. The resultant monoxide gas seeped out through cracks in the ground and entered the change-house.

Would Burn Coal Underground

Coal mining may become a lost art if time proves the practicability of an idea of Leo Ranney, well-known in coal and oil refining circles. Mr. Ranney proposes to set fire to the coal deposits and allow the fuel to burn underground, piping the resultant gases to the surface. Patents to cover the process have been applied for.

Mr. Ranney explained that by controlling the burning coal, either petroleum or carbon dioxide may be produced. From the former, he said, gasoline may be refined; while from the latter, dry ice can be manufactured—both at low cost. It was further explained that the gas can be piped to the consuming area or burned at the mouth of the mine and used to generate electricity.

While he would not reveal the workings of his process specifically, Mr. Ranney said the first production work would start either in Illinois or Pennsylvania.—*Scientific American.*

Lightning Protection Equipment Must Be Properly Selected *and* Adequately Maintained

By K. A. Reed, *Chief Eng.*, Electrical Division

THE "open season" for lightning is with us again and in order to secure the best protection that any lightning arrestor is capable of giving, it would be well to carefully check the condition of the arrestors, the leads between the lightning arrestors and the ground plates. The plates themselves should, of course, be of proper design and correctly installed. Particular care should be extended to lightning arrestor equipment in the "lightning infested" sections of the country, due to the greater hazard in such territory.

The application of lightning arrestors for a given location should be given very careful consideration in order to secure the type best suited for the particular kind of apparatus under consideration, taking the voltage and other details into account. In most cases best results can be secured by referring lightning arrestor problems to a reputable manufacturer for recommendations as to the correct type of arrestors for the job.

The ground wire between the lightning arrestors and the ground plate should be of ample size for both mechanical strength and current carrying capacity; it should be as short as practicable, free from sharp bends, and securely attached, with ample contact surface, to the ground plate. Needless to say all joints should be soldered in order to make the resistance of the circuit as low as possible.

There are a number of types of "ground plates" and among those most generally used might be mentioned, a sheet of copper, or other low resistance non-rusting material, buried in the ground, one or more pipes driven into the ground (commonly known as driven grounds), and the water mains of the power plant, or city water works system. Regardless of the type of ground plate that is selected it is, of course, necessary to have it located in permanently moist earth and the ground resistance (or the resistance between the ground plate and the earth) should be as low as possible. This particular point is one of the most important of all factors entering into lightning protection, inasmuch as the best lightning arrestor built cannot function properly unless the ground plate and other details are adequate and properly installed.

In many cases where there is dry sandy soil, or where there is a great deal of rock in the earth, it is necessary to treat the earth surrounding the ground plate with mineral salts. Such conditions more frequently exist with respect to "driven grounds," due probably to the small contact area between the pipe (or pipes) and moist earth. It is also often necessary with respect to driven grounds to drive several pipes into the ground and connect them all together by soldered leads in order to secure proper ground resistance. In general the ground resistance should not exceed seven to ten ohms as a top figure, while from three to five ohms would give far better protection, inasmuch as the lower

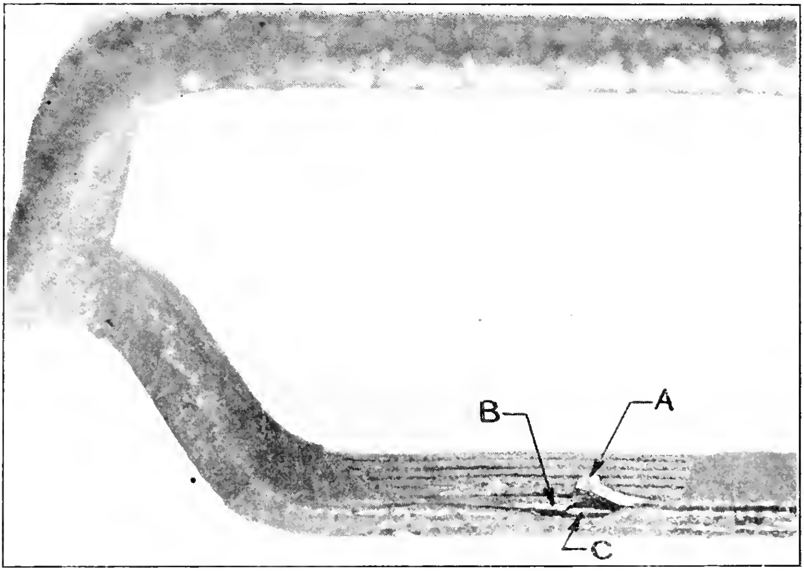


Figure 1

the resistance to ground, the better will be the protection that is afforded. There are, of course, many views on this particular point and a great many studies are in progress on the subject at this time.

A great deal has been said and written about the value of choke coils used in conjunction with lightning arrestors, and many choke coils are in service at the present time. However, studies of the subject conducted by the larger electrical manufacturers over a period of several years indicate that not only may very little benefit be derived from the installation of choke coils, but in many cases they are in reality detrimental. Therefore, in all cases where the installation of choke coils is contemplated the problem should be referred to a large, reputable manufacturer for recommendations.

It should be borne in mind that no type of lightning arrestor has yet been developed that will absolutely keep all lightning discharges out of electrical apparatus and this fact emphasizes the absolute necessity for considering every detail involved in a given layout. In finding its way to ground lightning follows no prescribed course of action; in many cases the damage is slight and of a freakish character, while in others the damage is severe and of a clear cut nature. Examples of these extremes are shown in Figures 1 and 2.

Figure 2

A stator coil from a small water wheel generator is shown in Figure 1, and the damage done was very nominal. The turns of this coil were made up of two conductors in parallel and the stroke of lightning grounded and burned in two one of the two parallel conductors of one of the turns, at a point several inches within the slot.

One end of this conductor was forced out of position approximately one eighth of an inch as shown at "A" in Figure 1 while the other end of the conductor was only slightly disturbed as shown at point "B." The adjacent parallel conductor was undamaged as shown at "C."

Figure 2 shows the damage done to a high tension coil in a 10,000 kv-a. transformer. Evidently the stroke of lightning was direct and near the transformer bank, for as a large amount of copper from several turns of this coil was destroyed and a number of other coils were seriously damaged.

It is highly improbable that any type of lightning arrestor now being built would have prevented either of these failures, although experience seems to show clearly that in a vast majority of cases where suitable lightning arrestor equipment is correctly installed, proper functioning of the arrestors and the safeguarding of the protected apparatus, should be expected.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., July, 1930

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Danger Lurks in Moments of Carelessness

A FIREMAN at a Southern mill was fatally scalded a few weeks ago when, without finding out definitely whether the boiler had been completely emptied, he knocked in a manhole cover preparatory to washing the boiler out. Unfortunately, such accidents are still encountered in spite of repeated warnings of the need for extreme care in preparing to open a boiler.

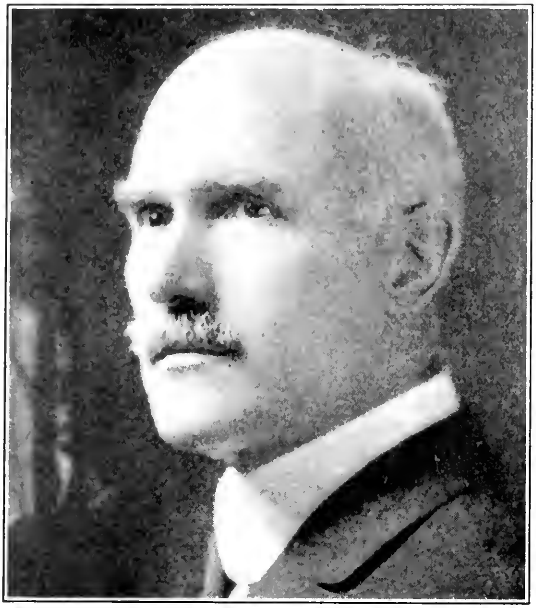
Forgetting to close the blow-off valve after a boiler has been drained is another source of danger to both inspector and plant employe. Not a few men have been badly scalded when another unit in the battery was blown down and live steam backed up from the header into the idle boiler or drum.

Then, too, lack of thorough ventilation has also taken its toll when, impatient to get the job of cleaning over with, a man has entered a boiler too soon and been suffocated by foul air.

All the hazards of boiler room work are by no means confined to the period when the boiler is under pressure. Certain precautions are necessary even when a boiler is supposed to be idle and empty.

Mr. E. R. Fish Joins the Engineering Staff

MR. EDWARDS R. FISH, well-known in the field of power engineering as an authority on boiler design and construction, became associated with The Hartford Steam Boiler Inspection and Insurance Company's engineering staff on May 1 as chief engineer of the boiler division.



For some time previous to his coming with this Company Mr. Fish was consultant to the boiler engineering department of the Combustion Engineering Corporation. Before that he was vice-president of the Heine Boiler Company, an organization with which he became identified in 1893 after periods with the power plant department of the General Electric Company and the Lewis Locomotive Valve Gear Company.

Long a member of the boiler code committee of the American Society of Mechanical Engineers, he is chairman of the sub-committee on unfired pressure vessels. He is also on the Society's power test code committee and chairman of its sub-committee on boiler testing. At one time on the council of the A. S. M. E., and for a term president of the American Boiler Manufacturers' Association, he is now a director of the American Uniform Boiler-Law Society.

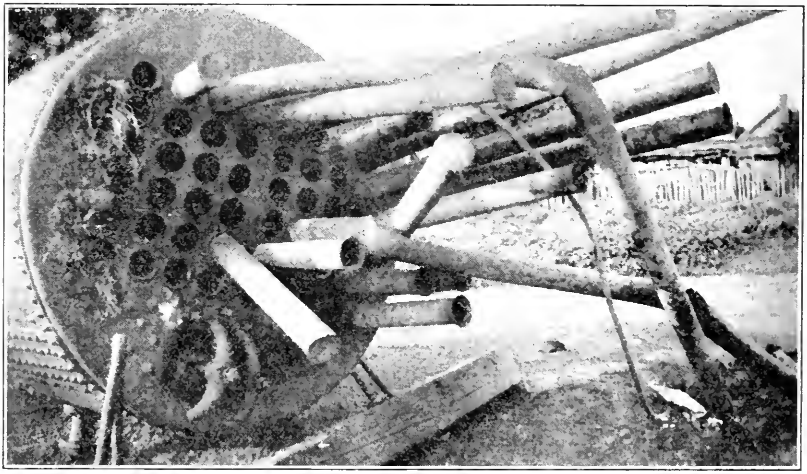
Mr. Fish is a native of Georgia, received his early technical education at the St. Louis Manual Training School, and graduated with the degree of mechanical engineer from Washington University.

Air Tank Kills Three When Head Blows Out

Three men were killed when, in spite of the protection afforded by a compressor relief valve and a motor cut-out switch, an air receiver exploded and wrecked a building in Rensselaer, N. Y. The vessel was about 18 inches in diameter and 54 inches long. Failure occurred by the tearing out of a welded head.

Explosion Blows Tubes Out of Boiler

UNUSUAL, in some respects, was a recent accident at an Alabama planing mill where several tubes of a horizontal tubular boiler lost their grip in the front tube sheet and were blown entirely out of the boiler. It was said that some of the tubes had not been beaded and that on others the work had been done improperly. Two men were killed, the boiler house wrecked, and part of the mill damaged.



The accident occurred in the morning before the mill machinery was started up. There was little doubt that considerable over-pressure was present, even though the explosion ruptured neither the shell nor the tube sheets. When the front sheet bulged, after pulling away from three through stays and breaking another, the tubes pulled out and allowed steam and hot water to escape through the tube holes with terrific force. The two victims were caught in the path of this scalding flood and their bodies hurled 200 feet. Reaction shot the boiler backward about a hundred yards.

One tube traveled a quarter-mile to lance its way through the roof of a store, while another went 500 feet from the starting point. Parts of the cast iron boiler front were found a quarter-mile away.

Feed water in use at this plant was stored in a hole dug beside the boiler house and as a consequence considerable mud was carried into the boiler. Thus it was thought that some overheating and softening of the tube sheet may have contributed, along with the improperly beaded tubes, toward causing the accident.

Hot Water Tank Goes Out Through Roof

THE accompanying illustration shows only part of the damage caused on May 20th when a hot water supply tank exploded in a residence at El Paso, Texas. Tearing out of the lower head allowed the vessel to shoot upward through two floors and pass out through the roof. When it descended it pierced the roof of a house across the street, crushed a bed, and splintered the bedroom floor.

Seated in the living room of the house when the blast came, a woman was hurled to the floor as pieces of furniture were overturned, windows blown out, and walls cracked. Had she been in the part of the house through which the tank passed on its precipitate journey she could scarcely have escaped serious injury or death, for gaping holes in the floors gave ample proof of the force with which the tank was hurled. Estimates of the damage placed it in excess of $5,000.

When questioned by newspapermen, the owner explained that he had taken out every form of insurance protection with the exception of explosion coverage. He had not regarded the tank, which was of the ordinary variety commonly used with gas coil-heaters, as capable of exploding with such violence.

Men Injured While Wetting Down Ashes

TWO men were badly injured by an unusual sort of furnace explosion at a Milwaukee factory recently while they were engaged in wetting down ash preparatory to cleaning out the combustion space. Apparently the explosion was caused by water gas, created by contact of water with an incandescent layer of coal particles under the ash.

The boiler was of the water-tube type, horizontally baffled and without a bridge wall. Powdered coal was the fuel and, according to the engineer, some time before the accident he had used a carload of coal which was unusually hard to burn. He noticed that some of it settled to the bottom of the furnace where, after about three weeks' running with a better grade of coal, it remained as an incandescent layer under the ash. Although the explosion was not particularly violent, it gave off a flash of flame which burned the trapped workmen severely.

Additional evidence of just how the explosion occurred came to light next day when other workmen resumed the task of wetting down the ash and succeeded in producing several similar detonations. Fortunately, they had taken warning from the experience of their predecessors and remained outside the boiler setting while playing the hose.

Claim Damage Due to Air Reversing Turbo-Blower

CARELESSNESS or lack of skill in shutting down a turbo-blower when it is one of a battery of two or more connected in parallel to a common header may result in serious damage to the machine by reason of its being run backwards by compressed air. An accident of this sort occurred recently in an English steel mill. Essential facts, reported in *Power,* were as follows:

There were two large turbo-blowers installed to supply the air to a blast furnace, the intention being to have one set as a stand-by. Delivery pipes were connected to a common header and a shut-off valve was placed on the delivery side of each blower. So that the spare set should always be ready for use, it was the practice to run them alternately.

The accident happened when, during the absence of the chief engineer, it became necessary to change over from one set to the other. This operation had to be done without interrupting the blast so the second engineer ran the spare set up to speed before shutting down the first blower. When the spare blower was ready to take the full load he ordered his assistant to shut the steam valve on the first blower. The assistant did so, but he did not close the air delivery valve. The result was that the blower end of the first set acted as an air turbine, and started the unit revolving in the wrong direction.

The assistant did not notice the stopping and subsequent reversal of the machine, which took place very quickly. However, seeing that the blower did not slow down, and still not noticing that it was turning over in the wrong direction, he again endeavored to close the steam valve, which was already shut off. The machine raced, the governor, of course, being out of control. A final smash was averted only by failure of the oil pump. The pump was designed to run only one way, and when the reversal of rotation occurred it no longer operated, with the result that the main bearings quickly heated up to the seizure point.

Fortunately, the spare set carried the load until the first one was ready to run again. Subsequently, automatic shut-off valves were fitted to the air deliveries.

Seated on Exploding Tank, Man Escapes with Life

AN employee of a plant in Greenville, Texas, recently had a most remarkable escape from death when a welded steel tank used for receiving condensate from a steam line exploded while he was seated on it. The man was hurled to the ceiling and then crashed to the floor, but in spite of a fractured skull, a broken arm, and other serious injuries, he recovered.

The tank was slung horizontally in brackets fourteen feet from the floor, being connected to the steam main by means of a ¾″ pipe. A 1″ pipe connected it to a vacuum line through which it discharged the condensate into a feed water heater. There were stop valves in both the inlet and the outlet connections, and the tank was protected by a safety valve set at what was considered a safe working pressure. After the accident this valve was found so blocked with scale and sediment that it could not function.

Immediately prior to the accident the tank had been out of use. It was while preparing to put the tank back into service that the accident occurred. An employe had climbed atop the tank where, after being assured by a helper that the discharge line valve was open, he opened the inlet valve.

It would seem that either the helper was mistaken in believing the outlet valve to be open or else the outlet line was stopped up, for from the twisted and torn condition of the tank after the explosion it was evident that it had been subjected to considerable pressure.

Taps from the Old Chief's Hammer

ALTHOUGH the Old Chief delegated numerous routine details to his capable understudy, Tom Preble, there were some things in connection with the running of the department which he steadfastly refused to let anyone but himself handle. Selecting new men for inspecting work was one of them, and it was a matter of keen satisfaction to him that of the candidates he tested and approved very few failed to develop into capable inspectors.

The old fellow had very definite ideas on the subject of picking men—and certain tests whereby the newcomer was made to demonstrate that in addition to having proper technical training he was conscientious and possessed a faculty for observing things. This last point loomed big in the old man's mind. He knew from experience what an indispensable factor it was in the not too easy work of finding defects. For that reason, one of the tests to which every new man was subjected was to be sent out to inspect a boiler of which the Chief was acquainted with every wart and wrinkle. Nearly always it was some boiler that had been condemned and abandoned by one of the plants in the city but, of course, this fact was not explained to the man who was to make the inspection. As a matter of fact, he was led to suppose that someone was interested in buying the boiler second-hand and wanted a report on its condition.

Thus it was that after several weeks under the tutelage of an experienced hand, Inspector John Boughton had gone out to inspect one of the Chief's pet trial horses. He had carefully written out a report and was in the old man's office to discuss it.

"Well," said the Chief brightly, after scanning with practised eye the paper on which Boughton had described the numerous shortcomings of which he had found the old boiler guilty, "you seem to have done a complete job. In your opinion we wouldn't be justified in recommending it as a bargain, eh?"

"No, sir," declared Boughton emphatically. "That boiler's too far gone for anyone to think of using it. It would be just plain suicide, sir."

"Did you tell the engineer what you found?" asked the Chief.

"Yes, sir, I did, and I'm afraid he's holding it against me because I drove my hammer through the head."

"So?" ejaculated the Chief, a note of surprise in his tone.

"Of course I'm sorry it happened?" explained Boughton earnestly, "but you know as well as I do that it doesn't take much of a tap to puncture metal that's eaten down to the thickness of cardboard. I saw that the head was in bad shape and I figured that if anybody was thinking of putting the boiler in use it was up to me to find out exactly how far it had deteriorated."

Pleased at the thorough way in which Boughton had gone about the assignment, the Chief had already formed a liking for the young man. So he listened sympathetically while the inspector told his story. It seemed that although the engineer had shared Boughton's poor opinion of the boiler, he had, nevertheless, chided him for not having treated the old derelict more gently. "He said that poking a hole in it spoiled whatever chance he had of finding a buyer," concluded Boughton.

"Let's find out what was on Jim's mind," said the Chief, picking up the 'phone and giving a number. Evidently the party on the other end of the wire was in a jovial mood, for when the Chief hung up he was grinning broadly.

"That old rascal was just stringing you along," he said. "He knows as well as you do that the proper buyer for his wreck is a junk dealer."

"So he was only joking, after all," exclaimed Boughton, relief in his voice. "He had me thinking that I'd sure put my foot in it."

"Speaking of putting your foot in it reminds me of an experience I had when I was new at the game," laughed the old man, a reminiscent twinkle in his eye. "The difference is, though, I really did get into a jam.

"They'd sent me out from the Atlanta Department to make the rounds in a territory where most of the boilers were at cotton gins which, as you know, are idle a big part of the year. Well, my trip was scheduled so that I arrived after the gins had closed down for the season and, being new to the territory, it looked to me like as easy a job as anyone could ask for. It wasn't so easy, as I discovered later, for although the boilers were well cooled down, most of them had been left full of ashes and soot at the end of the ginning season. Even at that, I was getting out the work in great shape until one morning I ran into a bit of unexpected trouble in the form of a watersnake family.

"I had gone all over this particular boiler with the exception of the rear tube sheet and as I got down on hands and knees to crawl through the rear soot door into the setting I noticed some strange tracks on the ground. They didn't mean anything to me, so in I went and climbed up onto the blow-off pipe for a close look at the boiler. I don't know whether I heard a noise or whether it was just intuition that caused me to look down, but right below me was a whole flock of moccasins, wriggling out through the soot door just as fast as they could go.

"Man alive, I'll tell you I was scared. My one ambition was to get out of there as quickly as possible. Of course, the easiest way out was the way I had entered, but there wasn't enough money in Georgia to tempt me to use it. Talk about Daniel! Say, I would have traded places with him willingly, for I wasn't half as afraid of a lion as I was of those snakes.

"The upshot of it was, I decided that escape lay through the rear arch, so I lost no time in falling to work with my hammer. It was a grand and glorious feeling when finally I poked my head into the open air, but as I did so who should I see standing there but the gin foreman, his face a picture of surprise and bewilderment.

"Well, to make a long story short, the foreman was inclined to be peeved at the way I'd wrecked the arch, but when I explained my reason for doing so he couldn't help laughing. Even at that, he gave me to understand that it would be up to me to repair the damage. I had to cancel plans for spending Sunday with my folks and devote the day to laying brick.

"So you can just forget about poking a hole in Jim Nelson's old boiler," concluded the Chief. "When you get to know Jim better you'll understand that he was just trying to have a little fun at the expense of a new inspector."

"A Bolt Fell into the River"

The *New York Times,* in a recent issue, carried the following special dispatch from Pittsburgh:

"Six hundred boiler makers went out on a steamer. The boiler burst, but they didn't fix it. They were delegates attending the Pennsylvania Boiler Makers' Association convention. When the accident occurred they came back to Pittsburgh on another boat.

"The why of it was not satisfactorily explained. There were about as many explanations as there were boiler makers.

" 'You see, bud, a fellow doesn't want to work on his holiday,' said one.

" 'I don't work on that kind of boiler,' said another.

" 'The wives and ladies attending the convention were aboard, so the boys just couldn't work,' was another alibi.

" 'You see, the water was low and the safety valve blew off and a bolt or something fell into the river. All the keepers of Lucifer's furnace could not fix it without that missing bolt,' declared a fourth."

If the newspaper reporter who wrote the story had ever seen the fearful damage caused by a safety valve blowing off and "a bolt or something" falling into the river he would have understood why fixing the boiler was out of the question.

At a laundry in Savannah, Georgia, stopping up of a wire screen spark arrester on the smoke stack led to a furnace explosion which injured a fireman and caused about $2,000 property damage.

The "top piece" had collected so much soot and cinders that draft was impaired, thus permitting a combustible gas mixture to form in the stack and uptake. In addition to bursting the stack, the blast tore out sidewalls and front of the setting, dropping the boiler down across the bridge wall.

Caught in the Separator

IT HAS HAPPENED

Ben: "What was the trouble over at Batz brickyard? I hear they had to patch the boiler."

Henry: "Expansion."

Ben: "Expansion of what?"

Henry: "Expansion of the fireman. He got so fat that he couldn't get into the boiler to clean it."

NO JOKE, EH?

Last winter an enterprising coal merchant in New York sent out a letter to prospects that said, among other things: "No joke about it . . . We're hauling the best kind of coal. . . . It's so low in carbon content that very little ash remains after burning."

Well, we've always lumped slate and ash in the same category, but maybe there is a difference, after all.

YOUR MOVE, SIR

In a country newspaper appeared the following advertisement:

"The man who picked up my wallet in Fore street was recognized. He is requested to return it."

In the next issue this reply was published:

"The recognized man who picked up your wallet requests the loser to call and get it."

BACKFIRE

"Jimmy, I wish you'd pay a little more attention to your manners. You're a regular little pig at the table."

Deep silence on Jimmy's part. So father, in order to impress him more, added: "Do you know what a pig is?"

"Yes sir," replied Jimmy meekly, "it's a hog's little boy."

NOTHING BUT

He: "You're so good at conundrums—try this."

She: "Sure, go ahead."

He: "Take away my first letter, take away my second letter, take away all my letters, and I am still the same. What am I?"

She: "That's easy. You're a postman."

COMMENDABLE MODESTY

Pat was buying his ticket at the shipping office.

"And what about your trunk?" asked the clerk.

"For what would I be wantin' a trunk?" queried Pat.

"To put your clothes in, of course," replied the agent.

"What!" cried the scandalized Pat, "and me go naked?"

MY DEER SIR

"Yes," enthused the new parson who, having called together a group of the younger element to organize a bible class, wanted the young men to know that he, too, had a certain liking for sport, "I had a most enjoyable trip in the Adirondacks. The first day I shot a buck."

"Did you win or lose?" one of the benighted souls wanted to know.

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1929

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 562,819.36
Real Estate		306,494.68
Mortgage loans		1,083,248.86
Bonds and Stocks		18,384,883.03
Premiums in course of collection		1,669,195.41
Interest accrued		160,573.97
Other Assets		23,959.34
Total Assets		$ 22,191,174.65

LIABILITIES

Reserve for unearned premiums		$ 9,289,882.04
Reserve for losses		452,334.69
Reserve for taxes and other contingencies		2,065,632.12
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,383,325.80	
Surplus to Policyholders,		**$10,383,325.80**
Total Liabilities		$ 22,191,174.65

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

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Vol. XXXVIII No. 4 October 1930

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Two Killed, Five Injured, *as* Explosion Demolishes Three Water Tube Boilers *in* W. Va. Mill

CHOOSING the very moment on the afternoon of July 29th when hundreds of workmen, right hands upraised, were reciting their impressive daily pledge to preserve safety, a terrific boiler explosion killed two employees and seriously injured five others at the

Figure 1

Clarksburg, W. Va., tin plate mill of the Weirton Steel Company.

The blast rocked the adjoining small settlement of Despard as if an earthquake had struck it, sending debris hundreds of feet to pierce houses and injure two persons. Three boilers of a battery of seven of the Stirling type were demolished, steam piping and stacks torn down, and the major portion of the boiler house wrecked, thus bringing mill operations to a complete halt. Figure 1 is a general view of the boiler house after some of the wreckage had been cleared away.

The initial failure consisted of the blowing out of the plain or solid head in the mud-drum of Boiler No. 4, as shown in Figure 2. This boiler and Boiler No. 3 were each of 350 horsepower rating and were placed together in a single setting. In a row with them were five newer 500-

horsepower boilers, set singly. Operating pressure for all boilers was 145 pounds.

The style of setting used for the smaller boilers was such that the plain heads of their mud-drums were enclosed in masonry and were inaccessible for exterior inspection. An accumulation of soot, ashes, and moisture in the narrow space between the setting and the head that failed had led to considerable external corrosion, and the weak-

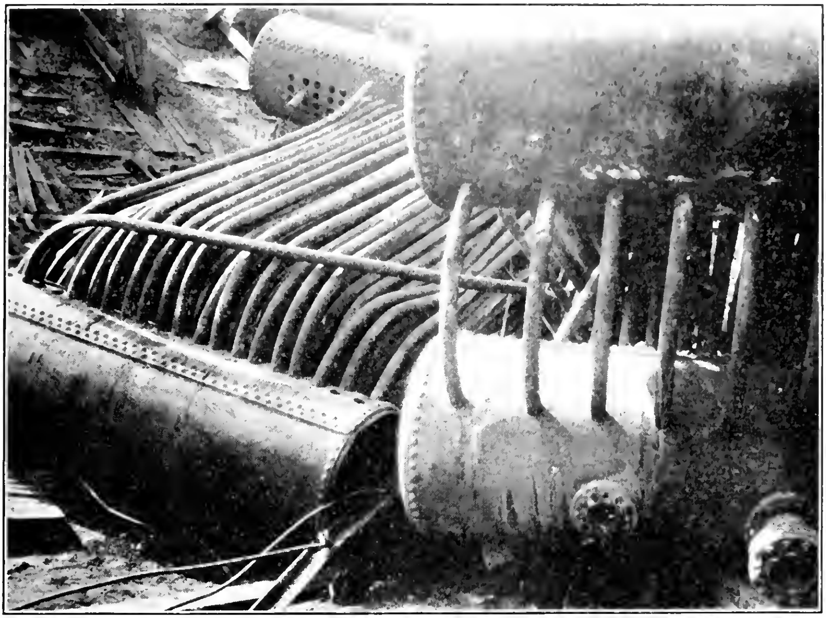

Figure 2

ening thus caused was further aggravated by the obsolete, somewhat flattened design of the head in which breathing action would produce flexing at the sharp turn of the flange.

When the head blew from Boiler No. 4 it drove the mud-drum of Boiler No. 3 endwise in such a way that tubes of the rear bank pulled loose and the reaction of steam and water escaping through the tube holes skyrocketed the rear top drum into an open field several hundred feet away. Boiler No. 5, which stood next to the exploding boiler on the other side, was swept from its setting and damaged beyond repair. Fortunately, it was not under pressure at the time.

Employees were changing shifts when the explosion took place, so seventeen men were in and around the boiler house. The steam plant foreman and one of the water tenders were killed instantly, and five of their fellow workers were injured so badly that they had to be taken to the hospital. A railroad wrecking crane was pressed into service immediately to haul away the tangled debris and permit a search for victims buried in the ruins. The body of the water tender, pinned under tons of twisted metal, was not recovered until after four hours of digging by the emergency crew.

The small settlement of houses and stores that lay within a few hundred feet of the boiler house was literally showered with hot firebrick, pieces of metal, and other wreckage, two persons sustaining injuries from such missiles and several others having narrow escapes. It is said that a brick traveled 700 feet to crash into a barber shop and strike the proprietor on the head, while a hot firebrick sailed almost as far to land on a bed beside an invalid. One woman, who had been seated on the porch of her home preparing vegetables for supper, left her chair just an instant before it was crushed beneath a heavy piece of metal. A section of a fire door entered a butcher shop and smashed its way through the stout ice-box door.

However, it was a steeple-jack who had what was perhaps the narrowest escape of all. During the day he had been up at the top of one of the six stacks, painting it. He descended twenty minutes before the explosion brought it crashing down.

2 Deaths, Heavy Property Loss in Digester Blast

Failure of the longitudinal seam of a digester at a sulphite mill in Berlin, N. H. on August 12 caused the death of three men and serious injury of nine others. The explosion tore out the side of the building and damaged the acid reclamation equipment so extensively that a long shutdown of the entire plant was anticipated. Property damage was estimated at $200,000, and the use and occupancy loss was expected to reach $90,000 or $100,000. It is understood that this was covered by insurance.

The digester was 18 feet in diameter and 47 feet high, the longitudinal joint being of the butt and single strap design. This strap tore from end to end.

The size and number of skyscrapers in New York City have, from time to time, been the subject of comment to the effect that sooner or later so much weight would cause Manhattan Island to sink. To allay fear on that score, an engineer recently pointed out that the more buildings there are, the lighter becomes the load on the island. For instance, the new Chrysler Building weighs approximately 60,000 tons, whereas the rock and earth excavated for its foundations—and disposed of at sea—weighed about 130,000 tons.

So-Called Minor Accidents Take Tragic Toll

DAMAGE to surrounding property is seldom as severe in the case of blow-off pipe failures and tube ruptures as it is when a boiler explodes. However, when it comes to killing and maiming attendants, accidents of this sort are frequently well up toward the top of the list.

Bursting of a fitting in a blow-off line at the Grimes, Iowa, plant of the Grimes Packing Corporation killed two persons and injured two others a short while ago. At Aberdeen, South Dakota, two power plant employes lost their lives when a tube ruptured in a boiler at the Northwestern Public Service Company plant. In each case the property damage was relatively small.

One of the victims of the accident at Grimes was a woman employe who had entered the boiler room for just a few minutes during the midnight lunch period. She and one of the boiler room helpers were almost directly in front of the boiler when the elbow in the blow-off line gave way and sent a stream of scalding steam and water out through the fire door. Another attendant, not in the direct line of the discharge, made his escape by throwing himself to the floor and crawling through steam and hot water to a doorway. A third man was severely scalded in a courageous attempt to rescue the victims.

It is thought that the accident was the result of a casting flaw in the elbow. A new elbow was installed and the boiler was put back into service. It was in operation less than a month before the nipple between the new elbow and the blow-off pad broke flush with the elbow and added another casualty to the list. This time an attendant fell in a frantic effort to escape from the room and sustained painful burns before a fellow workman could carry him to safety.

When examined after the accident, the nipple and other parts of the blow-off line showed signs of extreme overheating. Oil was being used as fuel.

The boiler room maintenance superintendent and an ash handler lost their lives at Aberdeen. The former was on the top gallery of the boiler examining a draft fan motor and the latter was down in the ashpit when a tube pulled out of the sheet and shot steam and hot water into the combustion chamber with enough violence to open the explosion doors and burst the roof of the boiler. Failure was attributed to a light deposit of oil which allowed the tube to overheat and buckle.

Incidentally, this accident resulted in slight damage to a turbine. When failure of the tube dropped the pressure and caused the non-return valve to cut the damaged boiler from the line, the whole load was automatically placed on a companion boiler. This abrupt demand for steam made the boiler prime badly and a large slug of water went over to the turbine.

Rupturing of a boiler tube at the Chester, Pa., plant of the Scott Tissue Company on September 9 resulted in the death of two men and the serious injury of a third. The men were at work in the combustion space of a boiler next to the one to which the accident occurred. The force of escaping steam and water tore down the fire brick wall separating the boilers and showered the men with white-hot coals.

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7 Killed, 9 Injured in Locomotive Blast

Seven men were killed and nine were injured on September 9 by the explosion of a track locomotive in the yards of the Reading Railroad at Philadelphia. Newspaper reports stated that the engineer had experienced trouble with the injector and that a crew of shop men were trying to make repairs when the blast occurred, hurling the engine over onto its side, demolishing a small workshop, and blowing the windows out of a string of empty passenger coaches on a nearby siding.

Open Feed Heater Explodes, Ties Up Plant

A plant in Pleasant Hill, Mo., was recently closed down for twelve hours by the explosion of an open feed water heater of cast iron construction which was using exhaust steam from feed pumps and auxiliaries. Theoretically, it should not have been possible for excessive pressure to build up within the heater, for the apparatus was not only vented to atmosphere through a three-inch pipe in which there was no stop valve, but was equipped with a safety valve supposed to open at 15 pounds.

According to *The American Architect,* radiators in the new Waldorf-Astoria Hotel, New York City, are going to do double duty. In the winter they will furnish heat, but in the summer they will be connected to a refrigerating system and chill the room to the guest's taste.

Recent Explosions *of* Hot Water Supply Heaters *and* Tanks Cause Heavy Property Damage

THE coming of cold weather and the firing up of heating boilers in the thousands of residences, schools, apartment houses, stores, theatres, and office buildings of the country marks the beginning of another "open season" for explosions of both steel and cast iron boilers and cracking of sections of the latter type. That few such acci-

Figure 1

dents occur in summer is due, of course, to the fact that not many heating boilers are in use at that time. However, there is less seasonal fluctuation in the use of hot water supply boilers and tanks, and the last several months have witnessed many accidents to this type of equipment Following are brief accounts of just a few:

The gymnasium of the Gerstmeyer School, Terra Haute, Ind., was damaged to the extent of about $10,000 on May 27 when a tank used to supply hot water for shower baths exploded with extreme violence. One head of the tank emerged from the building and landed 200 feet away, while the shell burst through a wall and came to rest 80 feet from its starting point. Figure 1 shows the extent to which a side of the building was damaged.

Fortunately the explosion occurred at night. Had it chosen a time when the gymnasium was crowded with people, the result might have been even more serious.

Figure 2

Mr. and Mrs. C. D. Collins of Watertown, Mass., were asleep in the second story of their comparatively new $10,000 home on the night of July 11 when a hot water supply tank in the kitchen below them exploded, passed upward within ten feet of their bed, and went out through the roof. The concussion bulged outside walls, buckled floors, and weakened the frame structure so seriously that, in the opinion of builders, there was doubt whether it would be cheaper to attempt repairs than to erect a new house. Persons in nearby houses were hurled from their beds by the force of the blast and a policeman who was standing within fifty feet of the Collins home was thrown from his feet.

Figure 2 is an exterior view of the house after the explosion. The tank can be seen in the foreground, and the jagged hole in the roof shows where the vessel left the house on its skyward journey.

A high school building in Evanston, Illinois, was damaged to the extent of several thousand dollars on the evening of July 8 by the explosion of a steel hot water supply boiler in the basement. This heater was equipped with a relief valve intended to operate at 60 pounds but when the valve was tested after the explosion it did not open until a pressure of 150 pounds was applied. Photographs of the wrecked boiler show that the wrapper sheet tore loose at the welded seam.

According to a news dispatch, an exploding hot water tank caused about $50,000 damage to the Hotel Roosevelt, at Pontiac, Mich., on February 18. This explosion shook business buildings and residences within a radius of two blocks and sent huge slabs of concrete through the wall of a bowling alley 150 feet from the hotel.

Six rooms on the first floor and five on the second were wrecked, while walls and floors of the third story were bulged. That only one person was injured was considered remarkable by police and fire department officials. One guest, who escaped injury, was hurled from his bed up against the ceiling of a first floor room.

Why Staybolts Have Holes in Them

There's a reason for everything——including axial holes in staybolts—but until the matter was explained to him the other day by the engineer of a large building, Inspector James L. Crowley always thought that the holes were tell-tales for disclosing broken bolts.

While examining a locomotive fire-box boiler used for heating at 20 pounds pressure, Crowley noticed that nails had been driven into two of the staybolts. A coal scoop hung from one nail; the engineer's coat from the other. In view of the low pressure at which the boiler operated Crowley didn't suppose that the nails had been applied to stop leakage from broken bolts, but to make sure the engineer understood the importance of keeping the tell-tale openings clear he asked him whether he knew why they put holes in staybolts.

"Sure I know," said the engineer. "Don't you?"

"Well," laughed Crowley, "I'm trying to find out whether you know."

"They're supposed to be used in lagging the boiler," explained the other.

"How?" inquired the puzzled inspector.

"Well they ain't got this boiler lagged up around the front end, but it ought to be. If the fellow who installed it had done the job right he would have driven nails into those holes, stretched wire from one nail to the other, and given the front of the boiler a plastering of asbestos. The nails and the wire would have held the lagging in place until it set."

It is now possible to produce synthetic cellulose filaments two and one-half times finer than those of real silk. More than 4,225 miles of such gossamer is required to weigh a pound.

Turbo-Generator Fields Require Careful Inspection

By W. L. Hartzell, *District Engineer,* Electrical Division

A TURBO-GENERATOR field is one of the heaviest and most rugged parts of electrical apparatus built. Some of the larger size fields weigh as much as sixty tons and are machined from a solid piece of metal. The windings, which are mica insulated, are of very heavy strap copper and are placed in machined slots cut in the solid metal. The ends of the coils are banded or supported by heavy shroud rings made of the toughest alloy steel.

With such construction, trouble, either mechanical or electrical, would seem impossible, yet many engineers feel that the turbo-generator field or rotor is far more hazardous than the armature or stator.

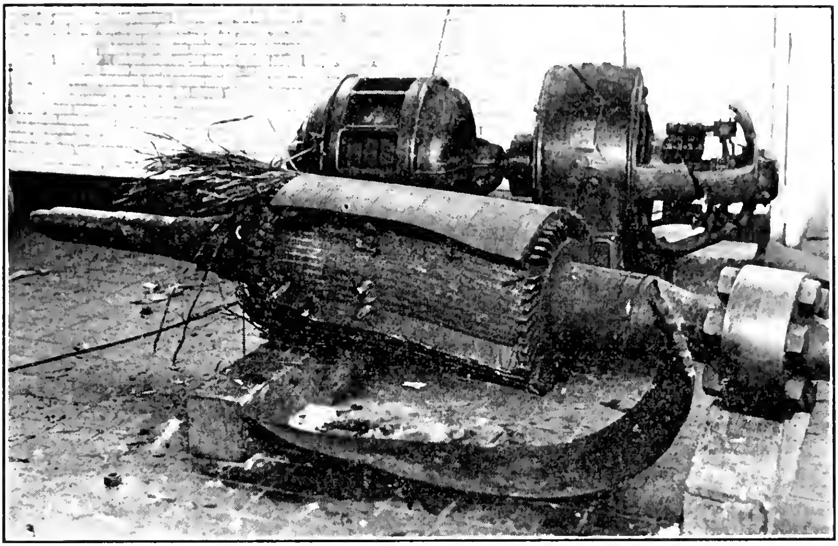
Most accidents to turbo-generator fields are very costly and not infrequently a failure is very destructive. For example, the shaft of a large turbo-generator recently snapped in two. The heavy rotor whipped around at high speed and wrecked the stator, making it necessary to replace the entire generator.

At the plant of one of our assured the heavy alloy steel shroud rings supporting the end turns of the field winding gave way because of overspeed. One of the rings wedged between the rotor and stator so tightly that it broke the frame of the stator and caused it to rotate with the rotor, thereby wrecking the entire unit. The illustration shows a failure of this type.

At another plant the rivets in the blower assembly on one end of the field worked loose and allowed one of the supporting rings of the fan to rub against the end bell. This disrupted the supporting ring while it was revolving at high speed and it was thrown out against the stator coils, cutting them and tearing them open. The resulting internal short circuit in the damaged coils produced a terrific explosion inside the machine. In fact, these short circuits were so severe that they developed mechanical strains sufficient to bend the shaft and shear the coupling between the generator and steam turbine. It was necessary to rewind the entire generator, straighten the shaft, and furnish a new coupling and new blowers.

These are some of the more spectacular of the failures that occur, but such cases constitute only a small fraction of the troubles encountered in the fields of turbo-generators. As an example of a frequent class of trouble,—a turbo-generator which operated in parallel with several other similar machines in an industrial plant very gradually developed symptoms. The excitation required a little more field current, the machine got warmer and also refused to carry its share of the load.

This generator was very well maintained; it was kept perfectly clean, had never been overloaded, and had always operated under exactly the same conditions as the other generators in the plant. On checking the insulation resistance of the windings our inspector found it to be zero, or that a grounded condition existed. The field was taken out, the brass wedges removed, and twelve burned spots were disclosed in the mica insulation where leakage of current had taken place



from one coil to another. As the breakdown of the mica was along a path ⅞" in length, it was evident that the normal exciting current at 125 volts could not possibly have been responsible for the trouble, and some other cause had to be found. It was finally located in the main oil switch for the generator, and was very simple. The oil switch mechanism had apparently not been adjusted properly. Burning had taken place on the contacts of one pole of the switch to the extent that they would not close. As a consequence the generator was being operated single phase or with unbalanced phase relations and under this condition there had been induced in the field a disturbance of sufficient magnitude to break down ⅞" of mica insulation.

Impending trouble in the winding of a turbo-generator field is usually indicated in advance, and one of the surest signs of approaching trouble is a decided drop in the insulation resistance. When insulation resistance readings show such a drop and the value is below normal, the cause of the low reading should be removed. If the cause is not removed and the reading continues to drop, the hazard increases accordingly, and when a zero reading is obtained (or a ground exists) the winding is in a dangerous condition.

The first step when low readings develop is to clean the field thoroughly by blowing out the windings and ventilating ducts with compressed air. This procedure is sometimes difficult because the ends of the coils are supported by heavy shroud rings and considerable dust and dirt can collect on the inner side of the end turns of the coils and where the coils leave the slots. It is therefore often found that an ordinary straight nozzle is not effective in ridding the windings of foreign matter.

By experimenting with different devices for the removal of this foreign matter, we have found that a right angle nozzle is very much more effective and in fact is essential in most cases. Such a right angle nozzle can be made in a few minutes by taking a piece of ⅛" pipe or copper tubing, bending it at right angles, and then cutting off one end just above the bend. This pipe or nozzle can be inserted in the ventilating passages and the air directed against the bottom side of the coils in such a way as to remove dirt that could not be disturbed with the ordinary straight nozzle.

It is also very essential to keep the insulation around the collector rings and leads to the field coils clean and free from oil and dirt. This can best be accomplished by washing the insulation with carbon tetrachloride, which is not inflammable, or with some other cleaning fluid such as naphtha or gasolene. The use of either of the latter solvents calls for great care, however, because of their inflammability.

Whenever the above treatment fails to bring the insulation resistance up to a normal value, it is necessary to open the field and determine what is causing the trouble. Such work should in general be done by one of the manufacturer's engineers. Most troubles can be eliminated at nominal expense if discovered and given immediate attention when they begin to develop. Otherwise they may lead to serious shut-downs and heavy repair bills.

The custom of christening new boilers by setting up tables in the combustion chamber and serving dinner to a group of guests seems to be growing popular. Out in Portland, Oregon, the Pacific Northwest Public Service Corporation recently entertained the mayor and forty-eight others at such an event, the dinner serving to acquaint his honor with the size of a 2,650 horsepower steam producer.

Water Cooled Furnace Walls:—Reasons *for* Their Development *and* Methods *of* Application

By E. R. Fish, *Chief Engineer*, Boiler Division

As the result of changed operating conditions, one of the relatively recent radical developments in boiler practice is the extended use of cooled furnace walls. With the introduction of improved methods of burning fuel requiring the use of only small amounts of excess air, furnace temperatures were greatly increased over the older and generally accepted practice of many years. With the old methods, satisfactory refractory linings were readily obtainable but to the stress of modern methods these same linings were wholly unsuited.

Those plants that pioneered in high furnace temperatures were promptly faced with the problem of furnace wall maintenance. Boiler outages for wall repairs, together with the actual cost of those repairs, quite offset the promised gains of economy and capacity due to the intelligent application of the principles of combustion. Some method of cooling the refractory walls was the logical thought and many schemes were proposed and tried, practically all of them being based on the use of air ducts. Such cooling is dependent on the rate of heat transmission through the refractory material and the rate of flow and temperature of the air which affect its heat absorbing properties. Attempts along this line were thus only partial solutions of the problem as they could not meet the extreme conditions of many plants.

The next logical step was to cool the walls by some medium that would absorb heat with sufficient rapidity to avoid deterioration due to high temperatures. The answer to this was the water-cooled wall and it has been amply demonstrated to be a satisfactory solution.

It was at first feared that the cooling effect on the combustion processes would be detrimental, but experience proves this not to be the case. The evolution of water-wall design has been largely the result of trying out various arrangements and it has not as yet been standardized, although it is generally conceded that vertical or substantially vertical tubes are necessary and practically all water-walls are now so designed. However, the details of the disposition and arrangement of the tubes vary widely. They may be plain tubes spaced apart but entirely protected by brickwork or they may be only partially so protected. They may be provided with metal blocks intimately attached to the tubes, which blocks may or may not be partly faced with a high grade refractory.

Another plan is so to arrange the tubes that they are in contact and thus give almost an entirely cooled surface, which is not the case with any of the previously mentioned arrangements. A widely used modification of this idea is the "fin tube", consisting of a tube to which two narrow, thin strips of metal are welded diametrically opposite each other along the portion of the tube exposed to the heat.

Whether the entire periphery of the furnace should or should not be protected is still a controversial question and many installations will be found where water-walls are used in widely varying degrees.

Being exposed to direct radiant heat rays as well as to actual contact with the hot gases, the rate of heat absorption is exceedingly high, much more so on the average than in the boiler proper, excepting possibly the boiler tubes that "see" the furnace. Thus as the use of water-walls grew it very quickly became evident through expensive experiences that the means for supplying the exposed tubes with water and for the escape of steam formed within them must be ample and unimpeded. It takes but a very slight resistance or interference with the orderly flow inside the water-wall tubes to so upset the proper functioning of all the factors that overheating will result. Operators and designers quickly found that if this trouble is to be avoided it is also necessary to keep the interior surfaces absolutely free from any coatings that interfere with the rapid absorption of heat through the metal.

These considerations have usually made necessary a very complicated arrangement of external pipes and tubes so disposed as to supply water uniformly to all parts and to take away the steam, but this interferes greatly with the inspection and care of the entire unit. However, until these systems were laboriously worked out, there were exasperating and expensive failures due to local over-heating. Such troubles have now been largely elminated.

The whole water-wall system is practically universally an integral part of the boiler unit since it is included in its circulating system, and is therefore subject to all the rules and regulations that apply to a boiler as such. Water-walls are now an accepted part of a boiler plant and they require as careful attention as the boiler itself. They are, however, each subject to idiosyncrasies of its own that can be learned only by careful and continuous observation in service, and by critical and searching inspection when out of service.

It is possible for overheating troubles to result from too great localization of heat because of some peculiarity of the fuel burners or other furnace characteristics. The following is cited as an example of the effect of a peculiar furnace condition which was encountered in one of the plants herein described and illustrated.

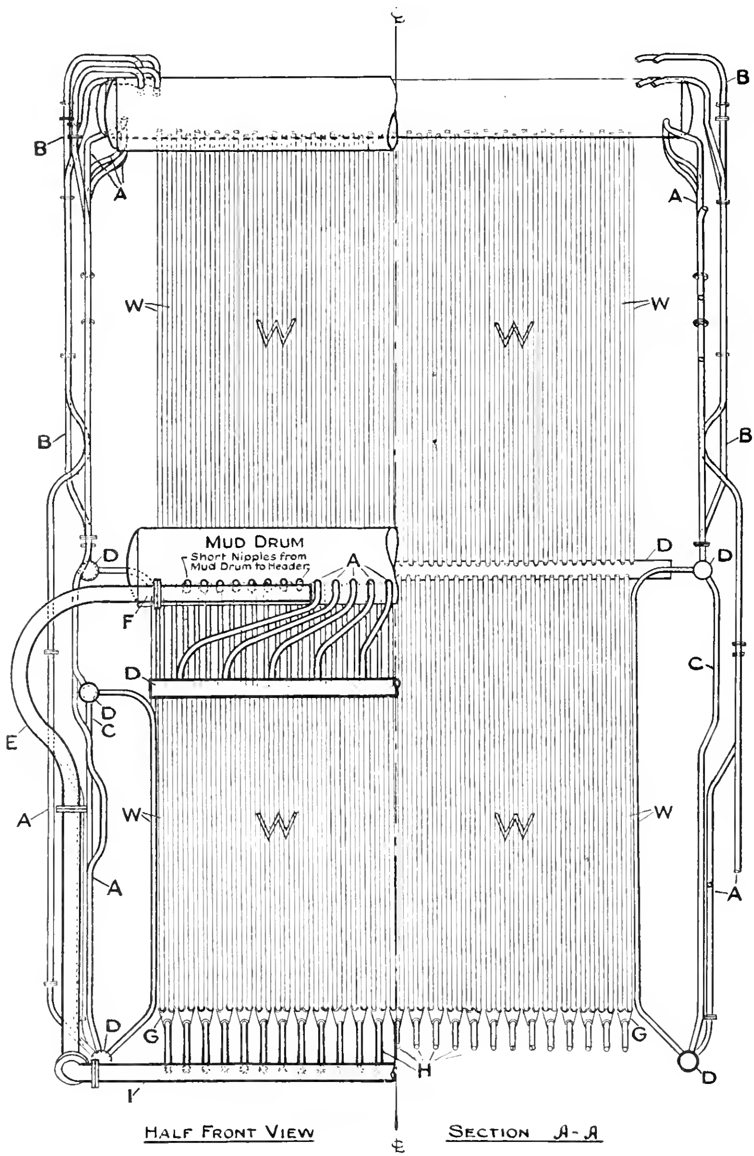
Two large vertical, bent-tube-type boilers, installed about a year apart, had almost completely water-wall cooled furnaces. They were fired with powdered coal through eight horizontal burners arranged in two rows in the lower part of the front of each furnace. The burners had vanes which directed the issuing mixture sidewardly, the upper row to the right and the lower row to the left. Trouble was experienced in the older boiler by the failure, near their upper ends, of a couple of tubes of the left sidewall. As the furnace was about 25 feet high it was difficult to make a close examination until repairs to some superheater tubes made necessary the construction of a scaffold inside the furnace. A careful scanning of the side wall tubes showed there was a well defined but restricted area near the top in which over-heating was quite apparent and where further failures were probable.

Preparations were at once made to replace those tubes. A minute examination of all the rest of the furnace walls and particularly the corresponding area on the opposite side showed all tubes to be in first class condition. The whole layout was perfectly symmetrical, so the one-sided trouble could not be assigned to deficient circulating characteristics. Critical observations of the flame action and combustion processes in the companion boiler seemed to indicate that the swirl of burning fuel from the bottom burners in its upward trend impinged intimately against the left sidewall tubes near the top. The corresponding swirl from the top burners just missed the top of the right sidewall tubes, above which there are the boiler tubes and a relatively small area of fire brick wall. As this theory of the effect of the swirling gases seemed to be the right answer, it was suggested that the vanes of the left hand end burner of the top row be altered and thus sufficiently change the flame direction to prevent impingement.

This case is cited to emphasize the need for close attention to small details of operation, and the possibility of thus often finding the solution of a difficult situation.

With powdered coal as fuel there are operating difficulties connected with the disposal of ash and slag, one of the phases of which involves the proper arrangement of the furnace bottom. There are several variations of water-cooled bottoms which consist of some form of inclined tubes, sometimes bare, sometimes wholly or partially covered with refractory. The so-called water screen is a series of widely spaced bare tubes located well above the bottom of the chamber. None of these give much, if any, trouble, and avoid the difficulties resulting from the deposition of fused ash.

As good examples of water-wall design two recent installations now



Water-cooled Furnace Using Powdered Coal as Fuel Drawing shows relation of Vertical Bent Tube Type Water Tube Boiler to Water Walls and the Circulating Connections

A - Water supply.

B - Steam outlet.

C - Water circulator

D - Water wall tube header

E - Down comer

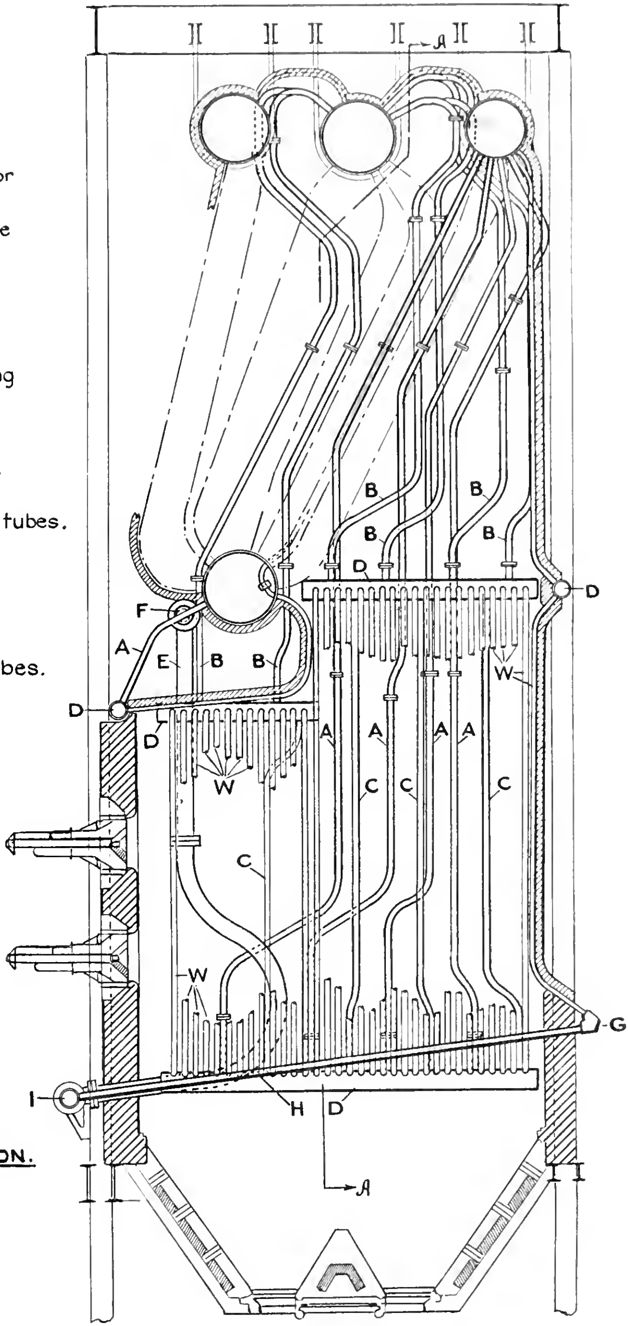
F - Water collecting header

G - Junction box.

H - Water screen tubes.

I - Water screen header

W - Water wall tubes.



SECTIONAL SIDE ELEVATION.

in successful operation are used as the basis of the sketches. The boilers are diagrammatically shown, one of which is of the vertical bent tube type operating at 450 lbs. pressure and rated at 1,800 hp. The other is of the cross-drum horizontal straight tube type operating at 450 lb. and rated at 1,000 hp. Effort has been made to bring out the general arrangement of the water-walls and the circulating connections, omitting many details necessary for proper operation but irrelevant for our purpose.

The following description refers to the bent tube boiler illustrated on pages 112 and 113.

The heat absorbing portions of the water-wall tubes are the only parts within the casing. All the headers, water supply pipes and steam offtakes are on the outside. With the exception of the front wall containing the pulverized fuel burners and small areas of the side walls above the furnace proper, all walls are water-cooled. Special attention is called to the arch tubes whose header is supplied directly from the lower boiler drum by a number of tubes distributed along its length. The steam discharge is directly into and through this drum by connectors leading into one of the rows of boiler tubes. Reference to the lettered parts will give an adequate conception of the whole.

W—Water-wall tubes exposed to the furnace heat. These are bent outwardly into the headers and are of the fin tube type spaced on 7″ centers.

A—Water supply connections showing how the uniform distribution of the water is attained. There are two sources of supply, one from the ends of one of the upper drums, the other from the bottom drum.

B—Steam offtake tubes leading to the middle upper drum.

C—Circulating tubes connecting upper and lower wall tube headers.

D—Water-wall tube headers, all entirely outside the setting.

E—Water supply down comers from collecting headers leading to water screen header, one at each end.

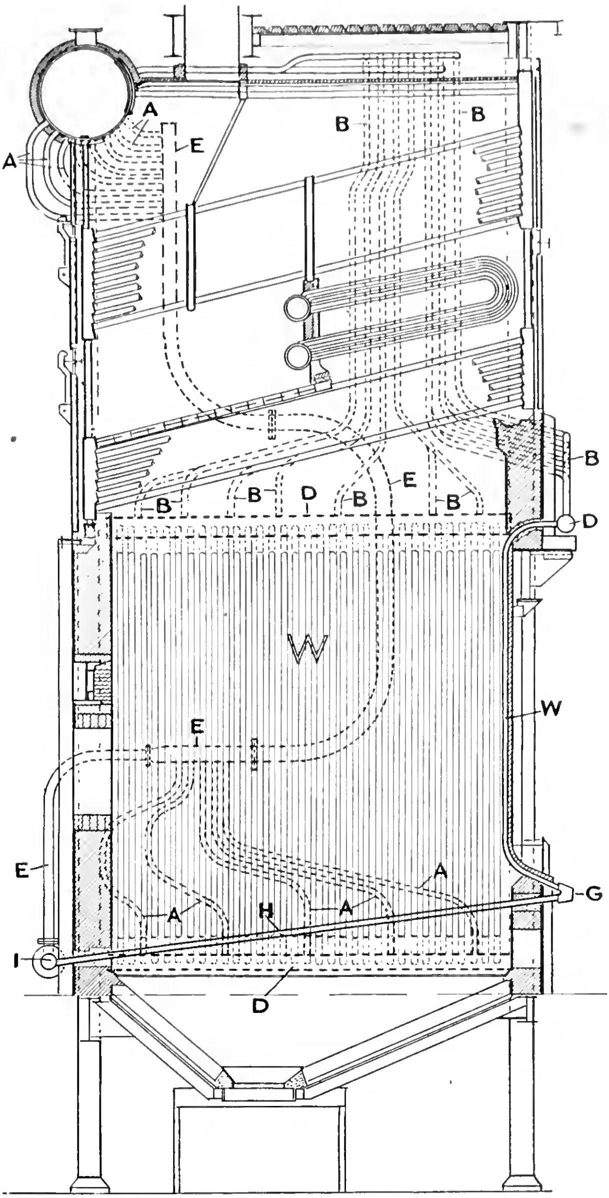
F—Water collecting headers connected to drum by series of short tubes along the length. A header at each end.

G—Junction boxes connecting water screen tubes with rear furnace wall tubes. Two of the latter to one of the former.

H—Water screen tubes, which are plain tubes on 14 inch centers.

I—Water screen header supplied with water at each end.

The letters on the illustration on page 115 refer to parts having the same functions as in the other illustrations.



Drawing showing relation of Cross Drum Horizontal Straight Tube Boiler of the sectional header type to Water Walls and Circulating Connections. Powdered Coal as Fuel.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., October, 1930

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Releasing Sub-Atomic Energy a Problem of the Future

DR. ROBERT A. MILLIKAN, renowned physicist, Nobel prizeman, and president of the American Association for the Advancement of Science, does not believe that man will eventually learn to release for his own use some boundless store of sub-atomic energy. He feels that there is no hope of obtaining more energy from atoms than we would have to expend to get it.

On the other hand, in speaking before the recent World Power Conference, Mr. Arthur Stanley Eddington, who also is famous as a physicist, had this to say: "We build a great generating station of, say 100,000 kilowatts capacity, and surround it with wharves and sidings where load after load of fuel is brought to feed the monster. My view is that some day these fuel arrangements will no longer be needed . . . A year's supply of fuel for the station will be carried in a teacup—namely, thirty grams of water."

In our haste to capture the natural stores of energy which lie underground as oil or natural gas, the equivalent of thousands and thousands of tons of coal has daily been allowed to float away into the air. Only lately have we become anxious to impound and put to use the natural gas which is released when an oil pocket is punctured. At Cromwell, Oklahoma, it wasn't so long ago that 1,200,000,000 cubic feet of gas was blown out into the air every twenty-four hours —the equivalent of 200,000 barrels of oil or 48,000 tons of coal going to waste.

Assuming that Eddington may be right and Millikan wrong, it may still be some time before we find the secret of making a teacup of water run a power plant for a year. Until then, any effort we can make to conserve the sources of energy we now have will not be misplaced. A bird in the hand is worth two in the bush.

Thomas B. Richardson Joins Engineering Staff

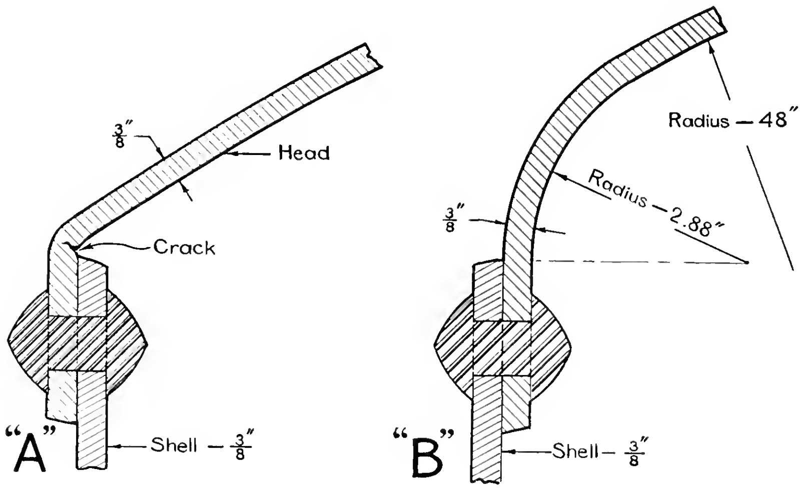
BECAUSE of the increase in the volume and variety of turbine risks the Company is called upon to inspect and underwrite, and the prospect of an even greater volume of such business, the officers have felt it advisable to add to the Company's staff of engineering specialists one who has had close contact with that class of machinery.

In announcing the appointment of Mr. Thomas B. Richardson as chief engineer of the turbine and engine division of the Engineering Department, the Company believes itself fortunate in having secured for this place a man who has had broad experience in the construction, erection, and operation of these prime movers and is thoroughly familiar with all developments in this class of apparatus during the past twenty years.

A graduate of Alabama Polytechnic Institute, Mr. Richardson entered the turbine department of the General Electric Company in 1910. After shop training with that company he was sent out into the field and was given increasing responsible charge of the installation, operation, and inspection of steam turbines in the middle west and in the southern states. He comes to us endorsed and warmly recommended by officials of that company and by others who know him as one thoroughly expert in turbine design and construction, and well qualified to direct a service for preventing accidents to that class of apparatus.

Shape of Head Blamed for Failure of New Claves

THE recent failure of a comparatively new copper autoclave in a plant at Mobile, Alabama, serves to illustrate how quickly fatigue cracks can develop in heads of pressure vessels when the design is such that it permits flexing at the corner of the flange. This vessel had been in service only sixteen months, but even in that short time and under the very moderate steam pressure of sixty pounds it had



developed cracks from the inside surface at the corner of the head flange that weakened it to a dangerous degree.

Fortunately, the rupture occurred while the clave was cold and under hydrostatic pressure. Had the head failed at a time when the cooking process was going on there might have been serious property damage and even death or injury of workmen.

There were four claves of the same age and design, each 48 inches in diameter and with a top head that fitted outside the shell and had an unusually sharp bend at the flange, as shown at "a" in the illustration. The head was only slightly spherical, being more in the shape of a somewhat flat cone. This, of course, permitted fluctuations of steam pressure to work the head in and out or, as it is customarily termed, to "breathe", and the stresses thus set up were concentrated at the sharp bend along the flange. Moreover, with the end of the shell inside the skirt of the head and covering the turn of the flange, the resulting cracks were so hidden that they could be seen only after the head was removed.

Workmen had charged the vessel and were building up water pressure preparatory to turning on steam when the head suddenly cracked open at a point along the flange. Four other cracks were found after the head had been removed. In view of this discovery, the investigators were naturally suspicious of the other claves and on removal of another head they found several cracks of a similar nature. It was evident that to continue the vessels in service would be dangerous, so it was decided to install new heads on all claves of the battery.

In order to comply with the A. S. M. E. Code for Unfired Pressure Vessels, such heads should be shaped like sketch "b", and instead of fitting outside the shells they should fit inside, so as to leave the turn of the flange uncovered and open to inspection.

Forge Shop Boiler Succumbs to Lap Seam Crack

A HORIZONTAL tubular boiler used for supplying steam to two steam hammers in a California forge shop developed such a deep groove along its horizontal lap seam that it exploded, wrecked the building, and sent debris through the roofs of dwellings several blocks away. Writing of the case in a recent issue of the *California Safety News,* Chief Boiler Inspector F. A. Page of the Industrial Accident Commission, had the following to say:

"A lineman working on a telephone pole four blocks away was thrown from his perch by the force of the explosion and, but for his safety belt, would have fallen and perhaps been killed.

"Five employes and two visitors were in the shop and within thirty or forty feet of the boiler at the time of the explosion. Of these three were more or less seriously hurt, one employe suffering a compound fracture of the right arm, while both of the visitors suffered broken ribs. Had it not been for two large steam hammers standing between the boiler and the persons in the shop, protecting them by their bulk from flying bricks and debris, probably all would have been killed.

"The greater part of the boiler shell, weighing approximately 3,800 pounds, was thrown 350 feet, passing through an empty lot, across a street, and landing in an empty lot without encountering anyone on its travels. . . . Plate glass store fronts were broken within a radius of five blocks, goods were shaken off the shelves in drug stores and restaurants as if by an earthquake. In fact, many people thought it was one until advised of the explosion.

"The boiler referred to was a horizontal tubular of two sheet construction, 54 inches in diameter, 16 feet long, 3/8 in. shell, joint efficiency .707.

"Failure took place at one of the longitudinal seams where the shell had been weakened by corrosion and deep grooving under a heavy coat of scale. The theory has been advanced that this grooving was, perhaps, started and augmented by vibrations set up by the intermittent flow of steam caused by the action of the steam hammers, and that the corrosion was caused by the breaking away of the scale when the boiler was blown down while the brickwork was still hot, lifting and carrying away a thin layer of the oxidized surface of the shell each time."

(It is possible that the hook-up at this shop was such that there was a wide pressure fluctuation in the boiler. Such fluctuations have been known to result in fatigue and cracking of lap seams, and explosions from lap seam cracks have been numerous. And, too, the bending to which a lap seam is subjected when there is a large variation in pressure, is unquestionably conducive to grooving, for the light layer of rust is continually being cracked off to expose fresh metal. The boiler mentioned above was being operated at 100 pounds pressure. No doubt it was installed before the present code went into effect in California, for a new boiler of similar size and construction would be limited to a pressure of 15 pounds.—Editor's Note.)

1929 Boiler Accident List Published

For many years the Company has maintained a record, taken from its own files, from newspaper clippings and from various other sources, of as many as possible of the boiler accidents occurring in the United States. Until 1928 that information was published in tabular form in THE LOCOMOTIVE but then it was decided to devote the space thus occupied to matter of more general interest. As a consequence the information has since been published annually in pamphlet form. A few copies of the pamphlet containing 1929 accidents are now available for distribution to persons who are interested in such data.

Taps From the Old Chief's Hammer

TOM PREBLE, assistant to the Old Chief, was awakened from a sound and satisfying sleep by the jangling of the telephone. Even as he rolled from bed and started to pick a precarious way through the darkness toward the head of the stairs, instinct told him that it was the boss who was calling and that there would be no more sleep for him. He was right. It was the old man—with news that some time after midnight a piece of equipment had gone up at the Brewster Mill, snuffing out the lives of two employes and perhaps injuring others. Preble knew what that meant, so tarrying neither for his customary morning shave nor for breakfast he slipped hurriedly into his clothes and was off on his way to the office.

The first streaks of dawn were lighting up the sky to eastward as he pointed the nose of his car downtown. In the light traffic of that early hour he expected to make speed. However, his immediate attempt was thwarted by the abrupt flashing of a red light directly ahead of him and as he waited through what seemed an interminable sixty seconds for the red light to give way to green, he grumbled impatiently at the contrariness of automatic signals.

The moment he opened the door of the outer office a cloud of tobacco smoke eddying from the chief inspector's sanctum told him that for all his hurry the old fellow had arrived ahead of him, so he tossed his hat onto the nearest desk and strode back to find the Chief busily engaged with a bulky folder of inspection reports.

"There's nothing here that would explain it," said the old man, shoving the folder aside and turning to face his aide. "Benson has had those boilers for the past three years and none of his reports show anything out of the ordinary."

"So it was a boiler explosion, was it?" inquired the younger man, who had gathered from his brief telephone talk with the Chief that there was some doubt as to just what had happened.

"Don't know yet," explained the other. "The only word we've had so far was a flash 'phoned over from the telegraph office. All it said was just 'Explosion Brewster Mill one-forty this morning, two killed.' There's a chance that it might be one of their turbines. We won't know for certain until Benson can get there and 'phone us. He ought to be calling in pretty soon now, for I wired him at his hotel in Tremont before I called you."

"What's the program in the meantime? Shall I wait until he calls or had I better start for Mantaloque? I can make it in a little over two hours, you know."

"Wait around a bit and dig out the data on their turbines so we'll have it handy if it's needed," directed the old gentleman who, as was usual with him, seemed as undisturbed by the emergency as if he were ordering dinner or arranging a golf date.

Preble was out in the main office in quest of the turbine data when the telephone rang. Hastening back, he sat anxiously on the edge of a desk while the Chief talked for several minutes with someone, evidently Benson.

"Well," exclaimed the old gentleman, hanging up the receiver and turning to his companion, "neither one of our guesses was correct. It was the main steam pipe that let go. Benson says a steam-fitter and his helper were trying to put one of those emergency clamps onto a leaky joint while the line was carrying something like 200 pounds steam pressure. Evidently something gave way when they took up on the set screws, for the joint pulled apart. Neither one lived until the ambulance surgeon got there."

"Gee, that was tough," murmured Tom. "The plant had insurance on the lines, didn't it?"

"It used to have it, but the manager asked that it be taken out of the policy at the last renewal," declared the Chief. "However, I told Benson to stick around and do what he could to help get things straightened out."

The old fellow leaned back and stared thoughtfully at the blackened bowl of his pipe.

"Now there's an example of just what I've always claimed," he said at last. "There's no sense of cutting down the strength of a good, stout chain by leaving a weak link in it. That plant and any other that has boiler insurance should never be without insurance on steam pipes. I've seen too many pipes rupture not to know how much trouble they can cause.

"Of course the poor fellows who were killed down there this morning shouldn't have tried to make repairs while the pipe was under pressure. It's risky to tamper with anything like that, whether it's a pipe, a boiler, or only an air tank. But, pshaw, when you come right down to it, there's lots of others who don't appreciate the danger they're running when they go to work on something that is already stressed by internal pressure. They see a little leak somewhere and they can't resist the temptation to use a wrench or a caulking tool. First thing you know they've gotten into the habit of doing such things and they've forgotten all about it being dangerous. Either that or else getting away with it a few times gives them the idea that nothing can happen. Sooner or later, though, something breaks and there's a hurry-up call for doctors."

"You know, Chief, we mortals have a weakness for taking chances," broke in the younger man, a twinkle in his eye. "I can remember you telling me of how in the old days you used to crawl into fireboxes and caulk the tube ends of railroad locomotives while the boilers were under pressure."

"Now there you go throwing that up to me," was the old man's good-natured retort. "You forget, young man, that that was a case of getting a train out on schedule—and you're also overlooking the fact that I was an apprentice then and had a whole lot left to learn. I'll admit it was a piece of recklessness that I'm not particularly proud of.

"But anyway, to get back to the subject of making pipe repairs with those emergency clamps, I had a rather unusual experience at a furniture factory in Zenith several years ago.

"I was traveling at that time and, as I was slated to spend the week-end in Zenith, I thought I'd go out Saturday morning and make a friendly call on Tom Jackson, an engineer with whom I had worked several years before. Tom and I were standing out in his engine room talking over old times when I noticed a pair of steamfitters apparently getting ready to apply one of those clamps to a joint that was leaking steam rather badly. From what I knew of Tom he wasn't the kind of a fellow who would let his men take unnecessary chances, so I called his attention to what the steamfitters were planning to do and asked why they didn't postpone the job until after twelve o'clock, at which time the mill was to close down.

"Tom explained that they were planning a fishing trip for over the week-end and wanted to get the leak fixed up so they could get away right on the dot at noon, but when he saw that I was somewhat surprised at his letting his men go to work on a pipe carrying steam at 125 pounds pressure he called over to them to leave off, promising that he would put the clamp in place that afternoon.

"Naturally, having been the one to influence his decision, I offered to stay and help, so after we'd had a bite of lunch Tom dug up a suit of overalls for me and led the way down to where they kept their tools. During lunch he had remarked that he didn't understand why the joint should leak, for the line had been put in new just a few days before. On the strength of that information, I suggested that instead of making repairs with a clamp it would be a good idea to take the joint down and see why it was leaking. So that's what we finally did, and when we backed the pipe out of the fitting we found that it had been held by only two turns of the thread.

"You can guess what would have happened if those steamfitters had been allowed to go on with the job. Just as soon as they tightened down snug on the set screws to jam the movable section of the ring up against the fitting they would have jacked that pipe loose as sure as you're a foot high. And with 125 pounds of live steam to do the cooking, they would have been as thoroughly boiled as anything you ever saw.

"Tom, I could tell you several stories of men I've seen caulking rivets on boilers under steam pressure, and of others who didn't hesitate at touching up a leaky head seam of an air tank with a welding torch, but right now I'm beginning to feel hungry. What about stepping out for a bite of breakfast?"

Half a Century Ago in THE LOCOMOTIVE

The first attempt to substitute a steam engine for horses in cultivating land was made in 1855 by John Fowler, an Englishman, said THE LOCOMOTIVE in its issue of August, 1872. Fowler subsequently "expended $350,000. in experiments, but after a few years had nothing left to represent this amount of invested capital except a lot of old machinery."

However, Fowler had started something, for by 1872 steam plows were used extensively for cultivating large acreages, one sugar cane farmer in India employing 400. That farmer was the pasha.

July, 1879: "All the celluloid made is produced by a single company, with factories in Newark, N. J. This company makes only the raw material, which it sells to various manufacturing companies for so much per pound and a royalty on their net sales . . . The cost of the crude article to the buyers is regulated by the producing company according to the use to be made of it and the competition met with in other materials. For instance, $4. or $5. a pound are charged for celluloid which is to be made into jewelry, while only $2. are charged if it is designed for umbrella handles."

April, 1871: "A correspondent of the *Scientific American* writes that he had seen a steam boiler advertised which saves thirty-eight per cent of fuel; a valve which saves fifteen per cent.; a governor which saves ten per cent.; a fire grate which saves twenty per cent.; metal packing and damper regulator which saves twelve per cent.; and a lubricator which will save one per cent.—making in all a saving of 101 per cent. Combining all these improvements, an engine would, he thinks, run itself and produce an additional one per cent. of fuel which might be used for domestic purposes."

Caught in the Separator

The mill foreman came upon two darkies walking slowly up the road, single file.

"Say, why ain't you two boys working?"

"We'se working, boss, sho' nuff. We'se carrying this plank up to the mill."

"What plank? I don't see any plank."

"Well, for land's sake, Abe, ef we ain't done gone an' forgot de plank."

—*Trumbull Cheer.*

In the reconstruction days in South Carolina a carpet bag judge, without reason or justice, fined a young lawyer $10. in gold for contempt of court. One of the older and greatly respected lawyers at the bar respectfully protested in behalf of the young lawyer and was immediately fined $10. in gold also for contempt of court. Whereupon General Wade Hampton arose in the back of the room, came forward and placed two ten dollar gold pieces upon the clerk's desk. The clerk passed the money up to the judge, who asked General Hampton what the money was for. Rising in the back of the court room, General Hampton replied: "I just wanted to let the court know that I have twice as much contempt for it as anyone here." —*Readers Digest.*

NO SENSE TO IT

My wife's sense of humor is bad. The other day I heard a good conundrum and decided to catch her on it.

"Why are men like mules?" I asked her when I went home.

"Don't judge all men by yourself," was her meaningless answer.

Motorist: "Is it very far to the next town?"

Native: "Well now, it seems further'n it is, but it ain't." —*Trumbull Cheer.*

BEAT HIM TO THE PUNCH

"No wonder she didn't accept you. Why didn't you use a little tact? For instance, you could have started out by telling her that you were unworthy of her."

"That's just what I was going to do—but she told me first."

BLAME THE HEAT FOR THIS ONE

A traveler from Missouri tells us that it was so hot out there this summer that several folks were injured in their watermelon patches by the explosion of melons. Some of the more progressive farmers installed safety valves.

First Executive: "Did you enjoy your vacation?"

Second Executive: "Yes, but I was glad to get back. There's nothing like the feel of a good desk under your feet again."

The favorite food of Mr. William Walker, aged 107 and the oldest man in England, is pork. Vegetarians maintain that he is bound to suffer for it in the long run. —*Punch.*

Conscience is a still, small voice that tells us when we are about to get caught. —*Arizona Producer.*

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1929

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 562,819.36
Real Estate		306,494.68
Mortgage loans		1,083,248.86
Bonds and Stocks		18,384,883.03
Premiums in course of collection		1,669,195.41
Interest accrued		160,573.97
Other Assets		23,959.34
Total Assets		$ 22,191,174.65

LIABILITIES

Reserve for unearned premiums		$ 9,289,882.04
Reserve for losses		452,334.69
Reserve for taxes and other contingencies		2,065,632.12
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,383,325.80	
Surplus to Policyholders,		**$10,383,325.80**
Total Liabilities		$ 22,191,174.65

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

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A MULTIPLE *RESERVE*

You are entitled to look upon your power plant insurance as a RESERVE FUND—a substantial reserve on which you can rely when an accident occurs to your insured equipment. As such, your insurance serves you well, for it releases your own money to the needs of your own going business.

But do you know the full benefit of your insurance? Do you know that there is a multiple feature to your RESERVE FUND *that distinguishes it from many other forms of insurance?*

For instance, if your plant should sustain an accident that exhausted every dollar of the policy limit in paying the loss, your insurance protection for future accidents would not be affected. As the amount of indemnity is stipulated for loss from each accident insured against, you would have the same protection fund against loss from each and every such accident that may occur within the three years or other term for which the policy is written.

In that respect your "Hartford Steam Boiler" policy is better than a RESERVE FUND of your own money, for the amount paid out for one accident does not reduce the amount available for other accidents.

Vol. XXXVIII No. 5 January 1931

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Two Cases *of* Caustic Embrittlement Found *in* Boilers After Broken Rivets Furnished Clues

THE encountering of caustic embrittlement recently in two large batteries of water-tube boilers located in regions where this kind of boiler trouble had not previously made its appearance should impress on plant men the importance not only of avoiding the use of feed-water treating methods that are capable of producing water of improper sulphate-carbonate ratio, but of reporting at once to plant officials or the insurance company the finding of broken rivet-heads and leaks at riveted joints.

At one plant in the western part of New York state the drums of seven boilers of the Babcock and Wilcox cross-drum type were affected

Figure 1

so extensively that their continued use would have been dangerous. At another plant, located in Utah, six out of a battery of 14 boilers of the Stirling type had to be taken out of service.

In the cross-drum boilers the place where the caustic attack centered was the butt strap forming the ligament for the horizontal circulator tubes. This seam was not easily accessible from within the drum because of the presence of a steam baffle plate. In fact it was only by removing this plate, which was not ordinarily done except when the circulator tubes were to be cleaned, that the inside rivet heads were exposed to view.

When preparing boiler No. 8 for cleaning in December, 1929, attendants found that one of the rivet heads had broken off and fallen down behind the circulator plate. They called the shop repair gang to replace the rivet and while the riveting work was under way several other rivet-heads were shaken off by the vibration. In all, eleven rivet-heads either fell off in this way or were knocked off under the hammer test. Later, plant attendants had a similar experience with boiler No. 7, but as repairs could be made by the plant gang they did not deem the trouble serious enough to warrant reporting it to plant officials.

The first suspicion of the presence of embrittlement came in October of last year when one of the engineers happened to be present while workmen were removing the circulating plate from boiler No. 1. With the seam exposed, this engineer tried hammer testing a few of the rivet heads and found that he was able to snap two of them off. He reported the condition to the officials and they in turn asked the Hartford Steam Boiler Inspection and Insurance Company to send an inspector for a complete investigation.

Figure 2

One of the peculiarities of the case was that no signs of leakage could be seen at rivet heads or seams of any of the boilers in which rivets had been broken. However, after driving out the shanks of some of the broken rivets and polishing the walls of the holes with emery cloth, the inspector was not long in detecting several fine, hair-line cracks. Although invisible to the naked eye these cracks were clearly apparent under a magnifying glass.

While examining boiler No. 6, in which the cracks seemed to be in the first stage of development, the inspector was told of the previous finding of broken rivets in boilers Nos. 8, 7, and 1, so he was more or less prepared for what was disclosed when the butt-strap of boiler No. 1 was removed and the shell plate was found cracked for a distance of 42 inches along a line of rivet holes. Pieces of shell plate taken from this seam are shown in Figure I. None of the other boilers were affected quite as badly as this one but all were cracked to such an extent that it was deemed best to order new drums.

Soda ash and lime were used in treating the feed water at this plant. It is thought that until two years ago the carbonate content of the treated water was very high in proportion to the sulphates. Since then, however, care had been taken to regulate this ratio in conformity with the proportions recommended for the 225 pounds at which the boilers operated.

Leakage of the mud-drum seam under the bridge wall during a hydrostatic test and the subsequent finding of broken rivets prompted the examination that disclosed embrittlement cracks in six of the fourteen boilers at the Utah plant. Figure 2 is a reproduction of a microphotograph showing one of the rivet hole cracks magnified about eight times.

Until 1917 the feed water at this plant was treated with boiler compound. At that time a soda ash and lime system was installed but no effort was made to regulate the quantities of these materials in keeping with the nature of the water. It was not until 1923 that a good method of control was established and really not until 1929 that a routine check was started on the sulphate-carbonate ratio. There seems to be little doubt but that caustic action got a foothold during the long period when no check was kept on this ratio and when much more soda ash may have been used than the scale-forming impurities in the feed water warranted.

New Hazard for Welders Pointed Out

The *Zeitschrift für Gewerbehygiene,* a German magazine, recently published an account of an accident that should be especially interesting to persons whose work involves the use of acetylene cutting torches in boilers or other closed vessels.

Two men were inside a boiler doing some cutting by means of these torches. They had finished a considerable portion of their work when the man who was attending to the gas supply on the outside heard calls for help. Both welders emerged from the boiler with their clothes blazing so fiercely that they sustained very severe burns.

The cause of the accident was rather unusual although, according to the German author, it was quite understandable. The torches were in working order and were being correctly handled. However, as the cutting work required an excess of oxygen, this gas quickly filled the vessel and permeated the men's clothing. When a spark accidentally struck the clothing of one of the workmen the oxygen-impregnated cotton material burst into a lively combustion.

Oxygen is both odorless and tasteless and as a consequence its presence even in large quantities cannot readily be detected. Because of these qualities the foregoing incident seems to point to the necessity of thoroughly ventilating boilers and tanks when cutting or welding is going on inside. In some cases even the use of a blower may be advisable.

Frequent Finding *of* Serious Defects Where Least Expected Keeps Inspectors *on the* Alert

MOST power plant men appreciate the importance of boiler inspections, for they know that defects of many kinds may develop in a boiler without giving outward signs of their presence, and that such defects threaten the safety of property and lives. But others, less familiar with the situation, know so little of the inspector's real work that they find it difficult to understand what the man with the hammer and electric torch sees in a profession that not only obliges him to spend hours each day working his way around the cramped interior of a boiler drum and crawling through soot-laden gas passages, but which, in addition, would seem dull and monotonous in the extreme.

The truth of the matter is that inspecting work is neither dull nor monotonous. There are few inspectors who have not had their share of thrills, some of them hair-raisers, in the finding of defects so serious they could have brought about the destruction of the power house and every one in it. The fact that the inspector never knows when he will encounter such a condition makes each new job an interesting one. It explains, too, the reason for his thoroughness in going over shell plate, heads and rivets with his hammer, in searching into recesses difficult of access, and in studying marks on the metal that may easily be mistaken for harmless scratches but which may be evidence of something more serious. The following cases selected from records of the past few months give some idea of the inspector's job and how he goes about it.

In examining a horizontal tubular boiler 54-inches in diameter in a stave mill, an inspector noticed that the pins of three of the four pin braces securing the flat dome head were missing and that in an attempt to provide stiffening for the head some one had installed two through rods from the head to the neutral sheet. Realizing that because of the flexibility of the neutral sheet these rods furnished little if any support for the head, he looked at once to see whether there was evidence of cracking at the turn of the flange. What he saw prompted him to ask the superintendent's permission for slotting the head at eight points around the circumference of the flange. This was done, and when a hydrostatic test was applied a sharp blow with a hammer caused water to spurt out of seven of the eight slots, as shown in Figure 1. It was found that the crack extended around practically the entire circumference of the dome and that at some places less than an eighth inch of sound metal was left. There is not the slightest doubt but that this defect would have resulted in an explosion had the boiler been continued in operation.

At another plant where there were eight water-tube boilers of the Stirling type set in pairs, the clue that led to the inspector's discovery of a serious condition was the finding of water in the inboard ends of

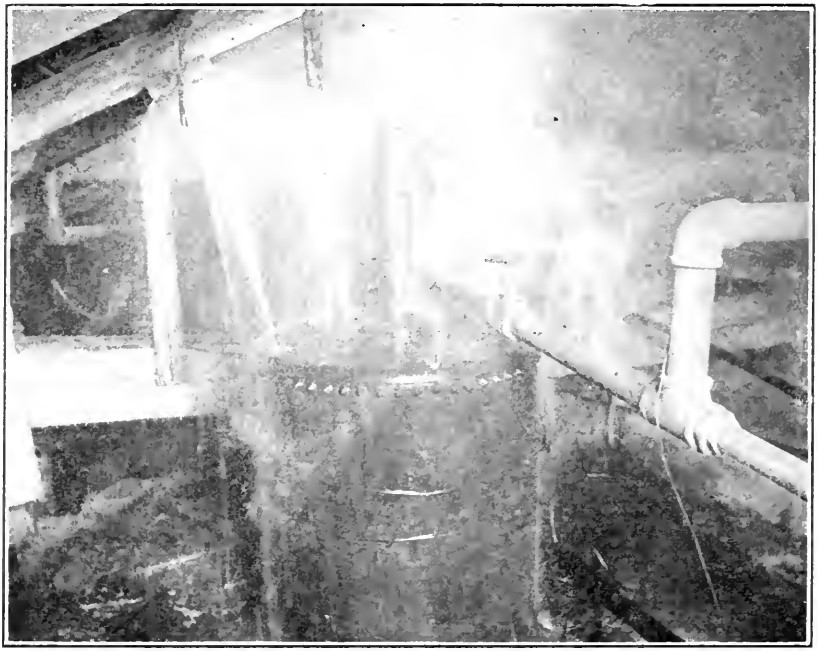


Figure 1

the upper drums of one of the boilers. This indicated that the drums had sagged down and led him to suspect that the supporting "I" beam between the boilers had either been warped by exposure to furnace heat or had deteriorated otherwise, a condition that could be expected to place an excessive strain on some of the blank drum heads to which supporting lugs were attached. Such proved to be the case, for the lugs of the middle drum blank heads were entirely clear of the beam, thus throwing all the inboard weight on the blank heads of the front and rear drums. Brickwork prevented an examination of the outer surfaces of the heads but by digging through a layer of hard scale inside the boiler the inspector uncovered an 18-inch crack along the turn of the flange beneath the lug of the blank head of the rear drum. The portion of the head containing the crack is shown in Figure 2. Similar cracks were found in the corresponding heads of three other boilers. It is not difficult to imagine what might have happened had these cracks not been discovered.

These two cases cited above involved the finding of defects in the equipment which the inspector was sent to examine. Sometimes, however, he comes upon dangerous conditions of another sort, as the following account will illustrate. This inspector was on a street car riding past a plant at which he was accustomed to inspect boilers, when he

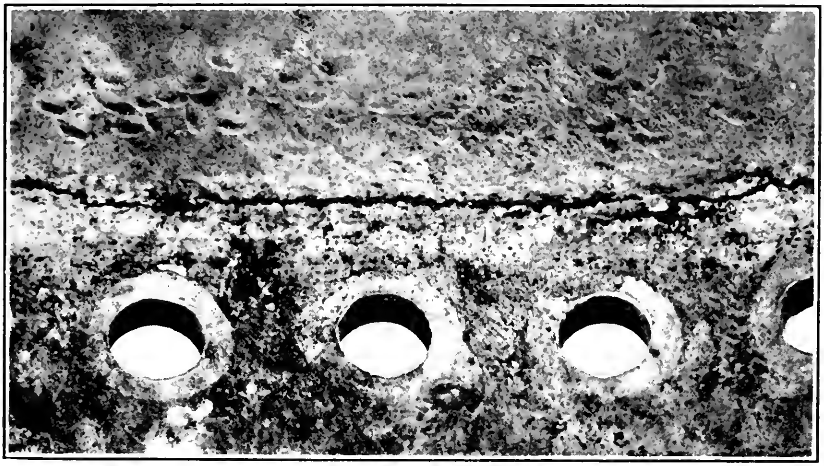


Figure 2

noticed that a new horizontal tubular boiler, recently purchased, had been removed from the yard and taken inside. Thinking that he might be of some service during the installation of the new boiler, he left the car and entered the plant.

The equipment at this plant consisted of two boilers placed side by side and slung from "I" beams that went across over them and were supported by being imbedded at both ends in the building walls. At the time of the inspector's arrival No. 1 boiler was under steam and old No. 2 had been carted out to make room for the new one which had been put in place and slung from new beams that went across about two feet above the old ironwork. Between the old boiler and the new there was only a loose wall of fire brick and under the new boiler a bricklayer was at work laying up the outside wall.

The inspector took one look and his hair almost stood up on end, for in order to get the new boiler in the workmen had cut the old ironwork in two with an acetylene torch so that the whole weight of No. 1 boiler, which was under pressure, was slung from beams that were supported at one end by only a loose wall of fire brick. Telling the bricklayer to get out from under the boiler and keep a safe distance away, the inspector sought out the superintendent and called his attention to the dangerous condition. It was the superintendent's turn to feel his hair raise on end. He lost no time in securing tackle and men to fasten the poorly supported end of the beam to the roof timbers.

Even when the presence of a flaw is obvious to the inspector, it is sometimes so faintly visible that some plant men either cannot see it at all or are not inclined to consider it serious. Two such cases came up recently.

In looking over the cast iron steam outlet nozzle on a large water tube boiler the inspector saw what he took to be a very fine, irregular crack on the under side of the flange. A boiler maker who was called in to remove the nozzle advised the manager that he had serious doubts as to the presence of a crack, but the latter upheld the inspector to the extent of ordering the nozzle removed and struck with a sledge hammer. One blow was sufficient to disclose a crack that extended a long distance around the nozzle and almost all the way through the metal.

After removing an accumulation of soot from around the safety valve nozzle of a large boiler, the inspector noticed an irregular mark on the neck of the iron casting. A close examination satisfied him that a serious crack existed, so the matter was called to the attention of both the engineer and the owner with a request that a new nozzle be installed before the boiler was put back into service. Later that day, the engineer called the chief inspector to report that although the nozzle had been removed and the mark filed to a depth of three-sixteenths of an inch, no crack was visible. The inspector returned to the plant for a re-examination and, with the aid of a magnifying glass, had no difficulty this time in showing the engineer a crack which was plainly visible for more than half the distance around the casting.

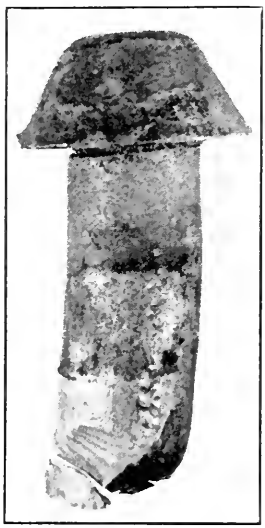
At a stone quarry an inspector noticed that leakage had developed along the double-riveted longitudinal lap seam of an air receiver that was in use under 100 pounds pressure. As the seam showed evidence of recent caulking, he was suspicious, so he persuaded the master mechanic to let the pressure off immediately. Although the caulking edge was chipped back 3/8″ at points showing leakage, no crack could be seen, even with a magnifying glass. However, when 50 pounds hydraulic pressure was applied the crack could be seen with the glass and when

80 pounds was reached the plate separated so far that it was plainly visible to the naked eye. This tank was located at a point where men were working at all times. An explosion would almost certainly have killed one or more of them.

A small swelling of the asbestos covering over a horizontal tubular boiler, indicating the presence of a leak, was the clue that started another inspector off on a search that ended in the discovery of a crack that ran from rivet hole to rivet hole for quite a distance along the longitudinal seam of a quadruple riveted butt-joint. Here again the outward evidence of trouble was so slight that neither the engineer nor the owner was prepared for what was ultimately found until the removal of rivets disclosed a complete separation of the plate.

An Example of High Stress in a Rivet

CAUSTIC embrittlement had nothing to do with the cracking of the rivet shown in the accompanying illustration, for it was found by an inspector during a recent shop inspection of a new boiler. The failure was attributed to stresses set up in the rivet shank directly under the head at the time of driving.



In this connection it is interesting to note: (1) That where caustic embrittlement is encountered one of the first symptoms is usually the snapping off of rivet heads; (2) that the theory by means of which this caustic action is explained is that caustic centers its attacks on the parts of the metal that are stressed very close to the elastic limit.

The question has sometimes been raised by some who hesitate to accept the embrittlement theory as to just how much basis there is for the assumption that extreme local stresses can exist at points in a boiler seam. From the evidence shown here, as well as from similar cases encountered at other times, it seems to be a fact that such stresses not only can but do exist.

According to newspaper reports fifty or more persons were taken to hospitals as the result of a refrigerating system accident in a Cleveland store on December 9. More than 500 persons were in the building when a ton of ammonia was released by the breaking of a fitting on an ammonia compressor.

Steam Accumulator Plays Role *of* Storage Battery Where There Is Large Fluctuation *in* Steam Demand

By E. R. Fish, *Chief Engineer,* Boiler Division

ENGINEERS generally recognize that a boiler plant can be most efficiently operated under uniform conditions, that is, at constant ratings and constant pressures. Hence any arrangement or apparatus that conduces to this end is very desirable. To attain this condition in plants that have a varying demand for steam, and there are few that do not, particularly if there are wide fluctuations in loads,

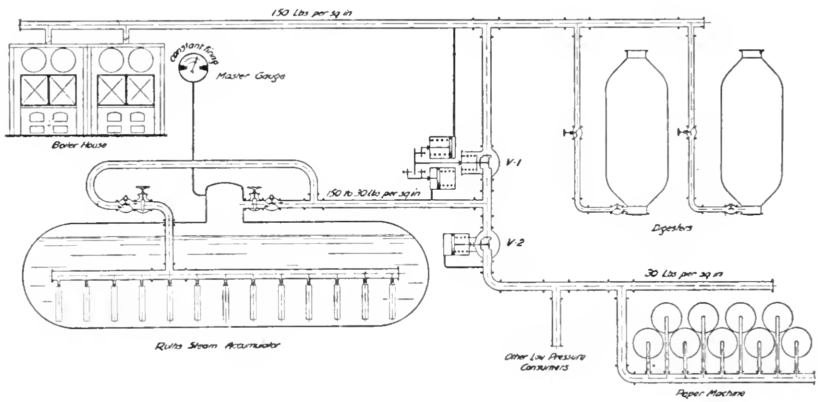


Figure 1

some means must be provided for building up a reserve which can be used when the demand exceeds the normal steam production. This is the function of the steam accumulator. In reality this device is a means for storing heat and then giving it out when needed. In principle it may be likened to a flywheel which stores up and gives out mechanical energy when conditions require.

While the general features of this system have long been known, it is only within the past very few years that a practicable arrangement has been evolved. It has had much greater vogue in European countries than in America, but there are now a considerable number of such installations over here. This development was worked out by Dr. Johannes Ruths of Sweden and is known by his name. The basic principle of operation is that when the pressure is reduced on water that is at a temperature corresponding to the pressure, part of the water is changed into steam by the excess heat. In order to make use of this principle in a practicable way, the water storage must be in a receptacle separate from the boiler and in it the pressure must vary between much wider limits than could possibly be permitted in the boiler. These fluctuations of pressure must be confined to the accumulator, as the tank is known. This condition is reached by means of regulating valves and it is on these that the operation of the whole scheme is dependent.

A description of the application of the system to a pulp and paper mill not making any power will give an adequate understanding of

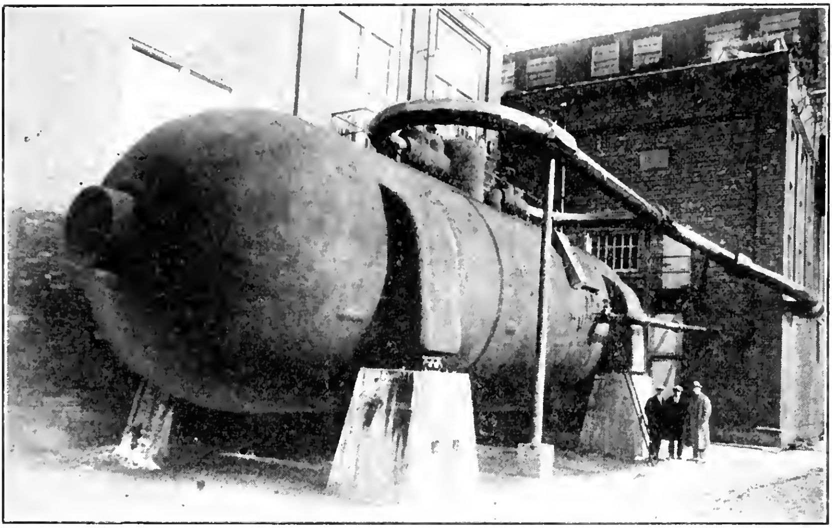


Figure 2

how it works. The arrangement is diagrammatically shown in Figure 1. The accumulator is connected to the main steam pipe by a single line and two regulating valves—V1 and V2. V1 is a compound valve controlled by the boiler or line pressure, 150 lbs. in this case, which is maintained constantly. V2 is a reducing valve which maintains the pressure of the paper machine line, in this case 30 lbs. The boilers are fired at a constant rate which gives the *average* steam consumption. If at any instant steam production and consumption are in balance, all the 30 lbs. steam will be delivered directly from the boilers to the paper machine through valves V1 and V2, no steam passing to the accumulator. If an extra demand for steam by the digesters occurs at the beginning of a cook, the 150 lbs. pressure will tend to drop. However, a very slight decrease in this pressure causes the regulating valve, V1, to throttle the steam flow so as to maintain the 150 lbs. pressure practically constant. Consequently, less steam is delivered through V1 to the accumulator line, the pressure in which, therefore, begins to drop. Thereupon, the check valve in the dome of the accumulator opens, the pressure begins to fall and steam will be formed and delivered through the reducing valve V2. Thus the accumulator system has taken care of a

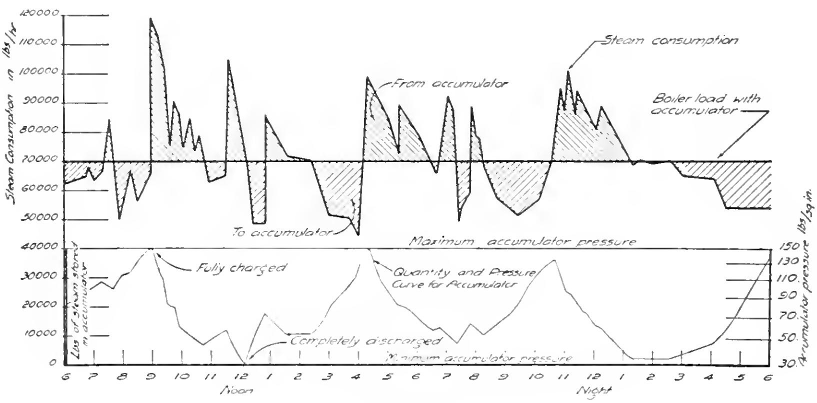


Figure 3

This set of curves shows the performance of an accumulator installation which is working in accordance with the arrangement shown in Fig. 1. The steam quantities shaded from lower left to right are supplied by the boiler, which is operated at constant rating, in excess of the demand, and the areas shaded from upper left to lower right are peak loads supplied from the accumulator. The curve below shows how the pressure fluctuates in the accumulator and the same curve also represents, in a different scale, the amount of steam stored at each moment in the accumulator.

big load in the digester house by holding back sufficient 150 lbs. steam and supplying the low pressure steam from the storage.

If, on the other hand, a digester is being emptied, steam then being cut off, the 150 lbs. pressure tends to rise. The excess is automatically passed by valve V1 to the accumulator and if more steam is supplied than is required by the paper machine through valve V2, the pressure increases, the check valve in the charging line opens, admitting the surplus steam to the water space of the accumulator where is is condensed and the heat stored until the consumption of steam again exceeds the supply from the boilers. An increased demand for steam at 30 lbs. will be supplied by steam directly from the accumulator through the reducing valve V2. Likewise if a paper machine is shut down, the steam which it would normally use is passed to the accumulator and stored.

The accumulator must be designed large enough to care for all fluctuations that occur during the normal operation of a plant and such fluctuations will therefore not be noticed at the boilers which continuously operate at a fixed rate.

Should the accumulator become entirely discharged or fully charged, the rate of firing the boilers must be altered accordingly. It is possible to provide for several different operating pressures, the principle being exactly the same as the simple arrangements described.

The accumulator proper is a large cylindrical tank designed for the maximum pressure. It is filled to about 90% of its volume with water and thoroughly insulated. It is generally installed outside without other protection than a water proof covering. The supports are usually long, heavy brackets that distribute the stresses over a wide area and which rest on pedestals so arranged as to take care of expansion and contraction movements in all directions.

There are a considerable number of interesting points in connection with the theory and operation as well as many ingenious devices that contribute to the practicability of the system which cannot be pointed out here.

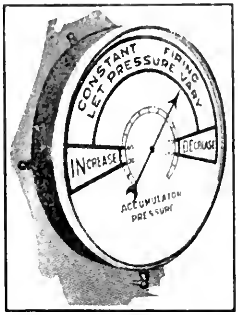


Figure 1

Accumulators have been built in a great variety of sizes, the largest being 16½′ in diameter by 64′ long for 150 lbs. pressure ranging down to one about 6′ in diameter by 7′ long. They have all been built of riveted construction.

This system has proven of great value in those industries using considerable amounts of process steam at low pressure, such as pulp and paper mills, textile mills, chemical works, sugar mills, etc.

The cuts used here as illustrations were made available through the courtesy of Ruth's Steam Storage, Inc.

Figure 2 shows an accumulator installed and ready for operation. Figure 3 is a curve showing the variations in steam demand and how, through the working of the system, the load on the boilers is constant. Figure 4 is the master gauge which indicates the operation of the accumulator and serves to warn the boiler room men should a change in the rate of firing become necessary.

"Weather" Control in Railway Coaches

As a means of adding another degree of comfort for passengers, several of the large railroads are experimenting with air conditioning as applied to dining and sleeping cars. Among those who have at least one car so equipped are the Baltimore and Ohio, the Sante Fe, and the Missouri-Kansas-Texas.

The Story Behind a Bent Crosshead Key

By H. J. Vander Eb, *Ass't Chief Eng.*, Turbine and Engine Division

THE crosshead key shown below was bent due to water entering the low-pressure cylinder of a compound Corliss engine. The circumstances under which this occurred some years ago were rather unusual in that there was practically no other damage to the engine. As a rule when engine breakdowns occur from excessive water entering the cylinders the damage is quite extensive and often the engine is a complete wreck.

In the installation in question when the engine was being shut down

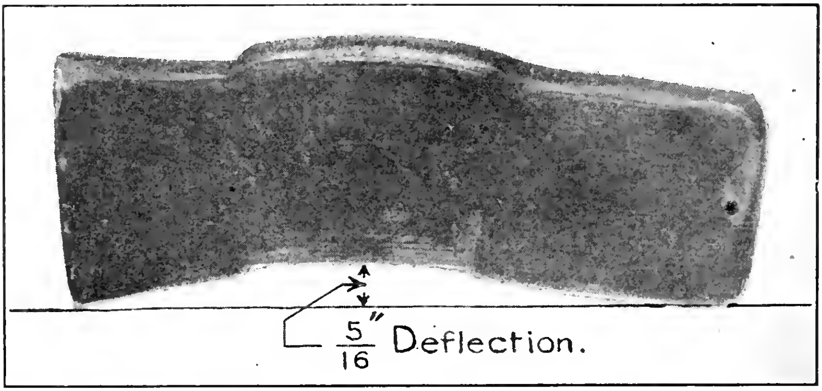


Figure 1

one evening it was noted by the operator that the last revolution of the belt wheel ended with a rather severe shock as if there were a sudden obstruction. He examined the engine and wheel for any possible damage but could not readily find anything wrong.

The next morning when attempts were made to start up the engine there was a loud knocking at the head-end of the low-pressure cylinder. It was so bad that it was necessary to stop the engine at once. Upon a more careful inspection of the reciprocating parts it was discovered that the piston rod had moved out of the crosshead about 5/16" which bent the crosshead key as shown in Figure 1. This was just about enough to destroy the clearance between the piston and cylinder head so that the piston hammered against the cylinder head at every revolution.

The engine had been in operation regularly all day without trouble of any kind and then when the throttle was closed and while the engine was still turning over slowly from momentum the water had apparently entered the low pressure cylinder.

Had the engine had more speed when this water entered, the cylinder head would undoubtedly have been pushed out and other incidental damage to the cylinder would have occurred as is commonly the case under such circumstances.

It was not immediately clear where the water could have come from but a careful check up of all the possibilities of the exhaust connections (shown in Fig. 2) made it evident that apparently water had accumulated in the exhaust pipe so that it may have reached a level as indicated by the dotted line. The float vacuum breaker must have stuck

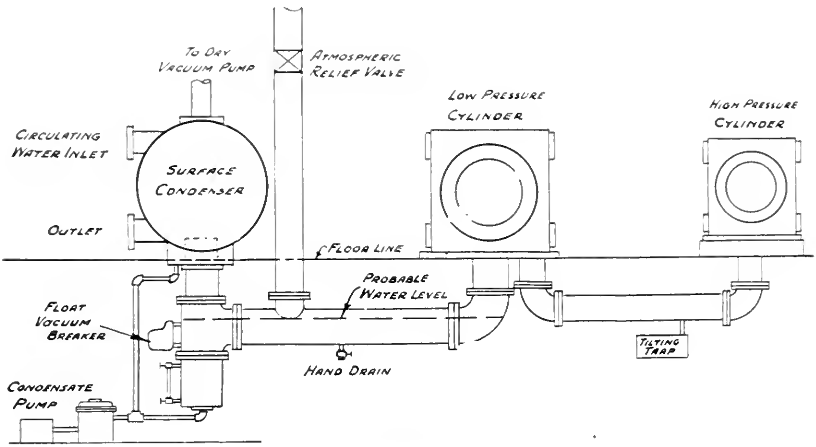


Figure 2

closed so that it did not open earlier while the engine was still under load. The vacuum breaker apparently released itself or may have been opened by hand during the last few strokes of the engine. This allowed the water in the exhaust pipe to be driven into the low-pressure cylinder.

The condensate pump which was also float operated, apparently had run too slowly or may have been stuck for some time prior to the shutting down of the engine.

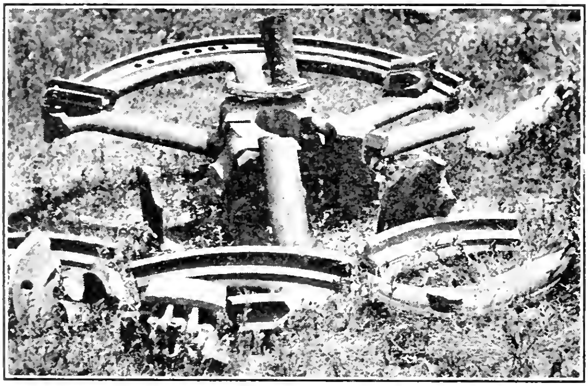
This would explain the accumulation of condensate in the exhaust pipe.

A group of employes at a vegetable oil plant had a narrow escape from death or serious injury a few weeks ago when, in an attempt to find a leak in a large steel tank used for storing pitch, they admitted steam to the vessel. When pressure reached 45 pounds the tank tore in two at the riveted girth seam and one end was driven fifty feet with enough force to bend a 90-pound railroad rail. It so happened that at the instant the rupture occurred none of the workmen or observers was standing directly in line with either end of the tank.

Lubricating Oil Caused Overspeed Wreck

COMPLETE wrecking of a crankcase compression oil engine as a result of lubricating oil mixing with the air charge and causing overspeeding, was discussed recently by Orville Adams in *Power* as follows:

"A great many engines of this type have no filtering equipment for lubricating oil, and, consequently, no pump to remove the oil from the crankcase, depending upon gravity drainage. If sludge accumulates and the crankcase is not kept clean, which will happen in worn engines experiencing blow-by of gases past the pistons, there are possibilities that oil will accumulate in the crankcase in a short time. In cold weather the lubricating oil, already viscous, may refuse to flow even through a comparatively free drain pipe. This, of course, results in accumulation of oil in the crankcase, even though the compression in the crankcase exerts pressure that tends to blow the oil out of the drain pipes.



"When, for any reason, the lubricating oil so accumulates that the end of the rod strikes the surface, the oil is churned into a mist which, of course, is carried into the cylinder by the intake air. The engine governor has no control over the oil-charged air. Lubricating oil when mixed with air burns as readily as fuel oil. The faster the engine runs, the more the condition is aggravated, and the remaining oil in the crankcase is whipped into a fine mist and more of it taken in at each stroke. In a few seconds the speed may reach an exceedingly high point, resulting in a flywheel rim speed several times higher than the wheel was designed for as in the case cited above."

In the particular case under discussion the engine was totally wrecked, as was some of the mill machinery. The illustration shows broken parts of the wheel.

Flywheel Wreck Kills Man, Tears Engine to Pieces

DESCRIBED by an inspector who has seen many engine wrecks as "one of the most devastating and peculiar" accidents of its sort he had ever come across, a flywheel explosion in a southern woodworking plant on October 27th killed an engineer and reduced the engine to fragments so small that there was not a piece left but that could be picked up easily, excepting the rear end of the engine bed to which the cylinder was attached.

The engine was of the center crank type with a cylinder diameter of 10 inches and a 12-inch stroke. It was equipped with both a flywheel and a belt wheel and was used to drive the fuel chain for feeding sawdust to the boilers. Half an hour before the plant was to shut down for the day the main belt broke and the chief engineer and his assistant, who were standing in the boiler room, dashed up the short flight of steps leading to the engine room in an effort to reach the throttle. The engineer had reached the top and was running toward the engine when both wheels burst, hurling a piece of metal that decapitated the assistant, severed the main cables leading from the switchboard to the mill, and plunged the plant into darkness. Another piece of the flywheel rim pierced the engine room roof, shot skyward and crashed through the roof of the sawmill into the filing room where it missed the saw filer and his assistant by inches.

The rest of the wheel flew in all directions, knocking down the side of the engine room and almost destroying the roof. Engine bed and pillow blocks were smashed to pieces and moved from the holding-down bolts, which were entirely sheared off. No part of the engine remained intact except the crank shaft and the piston.

Although the governor seemed to be in working order when examined after the accident, there can be no doubting the obvious fact that it did not act quickly enough in shutting off steam. The plant carried boiler insurance, but it had no insurance on the engine.

It is interesting to note that on the day the above-described accident occurred, there was a similar wreck that caused $10,000 damage at a dairy in Tennessee. In this case the flywheel was on an engine used to drive the compressor of a 40-ton refrigerating machine. The rim broke away from the spokes and sent pieces weighing from 80 to 120 pounds smashing through an ammonia tank, through the roof of the pasteurizing plant, and through the brick smokestack about 100 feet from its base. One piece struck a workman a glancing blow. Although he was knocked unconscious, he escaped serious injury. In the compressor room the 6-foot flywheel of a companion unit was demolished, a 6-inch steel pipe was sheared off, and building beams were cut through as if by a giant axe.

Oddly enough, although the belt-driven flyball governor did not keep the engine from running away it did shut it down after the wreck. The governor was so located that condensate from the valve stem would drip onto the belt. As plant attendants recalled having had trouble in the past with the belt slipping, it is supposed that this is what caused the accident. Here again, the plant had no insurance on the engine although it did carry boiler insurance.

A third serious flywheel explosion occurred on November 15 at a fibre plant in Illinois where a workman was killed instantly and the engine room and mill buildings were badly damaged.

WE MAKE OUR ADVERTISING BOW

Engineers and many others know the Hartford Steam Boiler Inspection and Insurance Company from contact with it. Insurance brokers and agents know it. Yet we believe that the proper function of any business or institution is to present its story to *all* of business—to the end that not only will our friends know us better but those who do not now know us will learn of the purpose of engineering insurance and of the "Hartford Steam Boiler's" place in that highly specialized field.

With this in mind the Company will present a series of advertisements in the *Saturday Evening Post* during the coming year. The first of these, which is displayed on the opposite page, tells the source of the famous old seal. The next will tell dramatically of the founding of the Company. Subsequent advertisements will deal with interesting phases of the Company's activities.

We believe the readers of THE LOCOMOTIVE will find interest in these advertisements, the first five of which will appear in the *Post* of January 17, January 31, February 28, March 28, and April 25.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., January, 1931

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.

Practicability of Claude's Plan Still a Question

THE last few years have witnessed the solution of so many scientific problems that had been looked upon as "impossible" that we hesitate to side with those who have already condemned as commercially impracticable George Claude's plan for producing power from sea water.

Claude's experimental plant in Cuba, of which much has been written, proved little more than the fact that the temperature difference between warm water obtained at the surface of the ocean and colder water brought up from thousands of feet below can be utilized to drive a turbine. As a matter of fact, that was about all Claude could hope to prove, for, as he himself points out, by using a turbine not designed for the low pressure involved and auxiliary equipment large enough to handle a power unit ten times the size of his experimental machine, he could not expect to obtain efficiency. These things, he feels, largely account for the fact that in order to produce twenty-two kilowatts of electric energy with his turbo-generator he had to borrow eighty kilowatts from another source to run the plant's auxiliaries.

Whether or not Claude's confident expectation of being able to build commercial plants for $60. per kilowatt capacity is justified, on the basis of what his experiments have shown and what he figures can be done, is something that only actual trial can demonstrate. In any event it will be interesting to see what can be developed along this line by an inventor whose practical achievements in air liquefaction, ammonia synthesis, and with the Neon lamp have already won him world-wide recognition.

A. P. Francis Made Assistant Manager

Announcement has been made of the appointment of A. Philip Francis as Assistant Manager of the Company's Atlanta Department office. Mr. Francis assumed his new position on January 1.

After completing the mechanical and electrical engineering courses at the Georgia School of Technology, Mr. Francis served for a time as a salesman and later as manager of the Chicago office of the Miller Manufacturing Company. He became associated with the "Hartford Steam Boiler" on January 1, 1929, as Special Agent in its Chicago Department office. The many friends and clients of the Company who came to know him in that capacity will be pleased to learn of his well-merited advancement.

Expect Revival of Plea for Metric System in U. S.

PROPONENTS of the metric system, who urge the replacement of our present English system of weights and measures by the simpler system now standard in most large countries, are hopeful that this year may bring definite progress toward their goal. The International Chamber of Commerce, which in May will meet for the first time in the United States, is expected to urge adoption of the metric system by the United States as one of the final steps toward world-wide standardization, and Representative Fred A. Britten of Illinois is said to plan a legislative bill which, if passed by Congress, would make the metric system standard here.

The proposal to throw out our system of pounds, feet, gallons, and bushels is not new. Attempts to interest the country in discarding our alleged cumbersome system in which units of length and volume bear no relation to units of weight have been made from time to time for a great many years. At the Pan-American Conference it was pointed out that the United States loses annually millions of dollars in trade with other countries because of our antiquated forms. To date, however, the arguments in favor of a change have failed to prevail against the general belief that the confusion, expense and inconvenience of installing a new system would outweigh any advantages.

In view of the prospects of a general discussion of the metric system this year, both at the meeting of the International Chamber of Commerce and in Congress, it is interesting to recall that as far back as 1898 the Hartford Steam Boiler Inspection and Insurance Company, of which Mr. J. M. Allen was then president, recognized the difficulties experienced by American engineers when faced with the necessity of converting metric quantities into their English equivalents or interpreting important technical discussions appearing in European engineering journals. As a result the Company prepared and issued then a 196-page handbook containing an interesting explanation of the metric system and its derivation, and page after page of conversion tables by means of which quantities given in one system could easily and quickly be translated into the other. More than likely copies of the book can still be found in the libraries of many of the older engineers, for the book was given wide distribution and the red leather cover in which it was bound was sufficiently staunch to resist many years of wear.

In a preface to the book President Allen said: "The metric system of weights and measures is used so universally in foreign books and periodicals, that much time is consumed and no little annoyance incurred by the American reader in translating these units into their English and American equivalents by the aid of any of the reduction tables that have yet been published. It therefore occurred to the undersigned that a handy pocket volume, for facilitating comparisons of the kind, might be acceptable to engineers and scientific workers generally. This is the raison d'etre of the present little book . . . Its (the metric system's) advantages are many, and the only really serious objection appears to be, that the change from our present units to the new ones would be more or less confusing and annoying for the first few years. Much of this annoyance and confusion could be prevented by providing school children with cheap sets of metric measures and weights, and requiring each child to measure and weigh a certain number of objects every week. In this way the units and their names would become tolerably familiar to the next generation, and the transition would be easier.

However, the schools did not follow Mr. Allen's suggestion. The passage of thirty-three years finds the "next generation" but very little more familiar with the metric system, and the chief difficulty the proponents of its adoption face is still that "the change from our present units to new ones would be more or less confusing and annoying for the first few years."

Taps From the Old Chief's Hammer

"CHIEF," asked Tom Preble, hanging his overcoat on the clothes tree and seating himself a the desk opposite the one at which the old gentleman was busy with pencil and slide rule, "when Mr. Jasper from down at the brass works was in to see you three or four weeks ago didn't he say something about having a boiler that he would like to bet was the easiest steamer anywhere around here?"

"Why, yes," admitted the older man, pausing to make several deft moves with the slide rule and jot down the result on a piece of paper. "Come to think of it he did brag some about a boiler that was always popping no matter how carefully the fireman checked the fire."

As the Old Chief's assistant and right hand man, Preble enjoyed a certain degree of familiarity that others in the department would have hesitated to assume. "Well," he chuckled, "next time you see him you want to get him to tell you what he thinks of his boiler now."

"Why, what's the trouble?" the Chief wanted to know.

"The trouble is that the boiler Mr. Jasper thought so well of has turned out to be the worst slacker in the whole battery. We were inside the boiler this morning and found the holes in the dry pipe so badly loaded with scale that it wasn't possible to get very much steam out of it. No wonder they had to check the fire to keep the safety valve from lifting."

"H'm, so that's what it was?" mused the Chief. "When did you say you found this out? This morning?"

"Yes. Mr. Jasper called up before you got in and asked to have someone go down and look the boiler over. It seems that since work slacked off several weeks ago they've been getting along on just two boilers, the one Mr. Jasper thought so highly of and its companion. Day before yesterday he was down in the boiler house and he couldn't help noticing that one boiler seemed to be taking more coal and requiring a whole lot more draft than the other. He got to figuring that if the one boiler was that much better than the other it would be a good idea to take the coal eater off the line and see if the easy steamer, with a little forcing, wouldn't handle the load by itself.

"So the night before last he told the fireman to keep No. 3 banked in the morning and see what No. 4 could do alone. It didn't take long next morning to get the old safety valve simmering on No. 4, and everything looked rosy. The trouble came when the engineer opened the throttle on the mill engine and couldn't get enough steam to turn over with. From all accounts he and the fireman had it out hot and heavy for a few minutes, until after weighing all the pros and cons they finally agreed that something must be wrong with the boiler. There was nothing they could do but break the bank and cut No. 3 in. When Mr. Jasper heard about it he ordered them to cool No. 4 down, so it was all ready for us when we got down this morning and then we found the stopped holes in the dry pipe."

"Huh," mused the Chief when the other had finished, "Just like some men, wasn't it? Fine and dandy as long as it could get by on appearances, but no good the minute it had to go on its own and show what it could do. By the way, though, have I ever told you about my finding a drypipe in which more than two-thirds of the holes were plugged with rivet blanks?"

"No," the younger man admitted. "I've never heard that one."

"Well," mused the Chief, pausing to light a pipe which he had been filling while Preble talked, "I came across it back in the days when I was out on the road inspecting, but even after thirty years it still stands out in my mind as one of the most peculiar cases I ever came across.

"One of the stove works down in Chattanooga had purchased a new horizontal tubular boiler and a new four-valve engine, both of which appeared to me to be in good order when I inspected them previous to the acceptance test. I had no inkling that everything wasn't satisfactory until about six months later the chief called me into his office one afternoon and said that the owners were having their troubles trying to make the engine carry the load. He wanted me to go down and see what was wrong.

"I went next day and, sure enough, I found that even with boiler pressure right up to the popping point the engine wouldn't handle anywhere near the load at which it was rated. After looking the engine over thoroughly I came to the conclusion that there was nothing wrong with it, so I turned my attention to the boiler—and there I came upon the superfluous rivets that were causing all the trouble.

"When I mentioned the rivets to the engineer he was at a loss in trying to explain how they came to be there, but after a little reflection he smiled and said they must have been put there by the boiler erector.

"It seemed that very shortly after the new equipment was put in service the boiler showed a tendency to jump up and down in its setting. Of course, the management wasn't going to stand for any such behavior on the part of new equipment for which it had paid out its good money, so the boiler shop and the engine builder were asked to send representatives over for a joint investigation. Neither of these men had ever experienced anything like that before and they couldn't figure out what on earth made the boiler act that way.

"The boiler erector's guess was that the trouble originated in the engine, but when the erector demonstrated how solidly the engine was set by standing a silver dollar on edge on the cylinder it was evident that another guess was in order. But neither could they find anything wrong with the boiler, although they went over it from stem to stern, so they finally came to the conclusion that the trouble must be in the steam piping—probably too rigid. The upshot of it was they called in a gang of steam fitters and had them take out two sharp turns and put in sweep bends. When this didn't have the desired effect they tried putting a large separator in the steam line near the engine, figuring that it would act as a receiver and give a more uniform flow of steam from the boiler.

"However, none of these things seemed to do any good. They were beginning to think that the case had them buffaloed when the boiler erector suddenly got a clue. He noticed that the vibration didn't commence until the throttle was about a quarter open and by experimenting a little he discovered that with the load then being carried the engine didn't require a wide open throttle. He kept on closing the throttle little by little until the governor had lengthened the cut-off all it could, and in that way he found that not only did the engine have no trouble in maintaining speed with the throttle nearly closed but that there was no sign of vibration at the boiler.

"From this he concluded that the load was far under the engine's capacity and that with the wide open throttle the short cut-off was playing hob because of the suddenness with which the flow of steam in the main was being started and stopped. Having satisfied the others that this was the cause of the trouble, he promised that he'd fix things if they'd have the boiler cooled down that night so he could get into it next day, which was a Sunday.

"It so happened that he got to work next morning ahead of the engineer. By the time the latter arrived the erector had done whatever he wanted to do inside the boiler and was just replacing the manhole cover. You'd naturally suppose that the engineer would have been curious enough to ask what the man had done, but he didn't ask and the erector didn't volunteer to tell him. The matter was soon forgotten for the plant ran as smooth as silk when it was started up Monday morning.

"The trouble they were having when they called me in six months later was due to the fact that the load had gradually increased until the partly plugged drypipe wouldn't let enough steam through to meet the engine's demand."

"Pshaw," was Preble's comment when the Chief paused in his narrative to relight his pipe, "if the trouble was what they thought, why didn't it stop when they installed the separator? A big container like that in the steam line should have ironed out any shock."

"Yes," agreed the older man, "that's one of the things I had in mind when I told you this was a strange case. Even assuming that the trouble was really due to the engine being underloaded and that having the engine run with a lengthened cut-off was what was necessary to stop it, I've never been able to figure out why the erector went to all the trouble of plugging the drypipe when the same effect could have been had either by partly closing the stop valve at the boiler or by operating the boiler at reduced pressure. Of course, it may be that he didn't want to suggest reducing pressure to say 40 pounds on a new boiler that had been bought to carry 125 pounds, but why he preferred his method to partly closing the stop valve is something that has always remained a mystery to me. If you ever figure it out, let me know."

Empty Boilers Do Not Cause Explosions

The other day a news dispatch from Chicago stated that an attendant had averted "possible death or injury to 70 nuns and patients" of a local hospital by the timely discovery of a boiler that had been emptied and was "on the verge of an explosion." Circumstances surrounding the apparently intentional draining of the boiler led the police to believe that "a plot to blow up the hospital had been frustrated with little time to spare."

The belief still persists in some quarters that boiler explosions come generally from lack of water. Not long ago the editor received a letter from an engineer who, in discussing explosions, said that "of course it is well known that the most violent boiler explosions come from low water."

As a matter of fact the most violent explosions occur when there is a rupture of a boiler in which there is plenty of water. Low water has dropped many a crown sheet, burst many a tube, and in other ways played havoc with boilers, but as the destructive force of a boiler explosion is due to the energy released and as this energy is directly proportional to the amount of water in the boiler it is evident that the less water there is present the less violent will be the blast. In the case of the Chicago hospital boiler, which was found entirely empty, there could scarcely have been an explosion that would have endangered the lives of patients. The worst that could have happened would have been the ruining of the boiler because of overheating.

Furnace Explosion Causes $10,000 Damage

A furnace gas explosion that recently played havoc at a large oil refinery in the south occurred with such violence that it not only destroyed the boiler setting and the breeching, but transmitted enough pressure through the main smoke flue to crush in a brick wall and twist several structural steel beams of an adjoining building. The flue, of steel construction six feet square, passed between the outer brick wall of the boiler room and a similar wall of a building containing the feed water treating plant. Thirty feet of this wall was bulged inwardly with enough force to crumple up the building beams.

According to the boiler room foreman the blast occurred while attendants were in the act of lighting the gas burners. From accounts of witnesses, it seems possible that there were actually two explosions within a fraction of a second of each other, the first taking place in the boiler setting and the second in the smoke box.

Property damage was placed at $10,000 by the plant engineer, who estimated that it would take two months to get the boiler in operation.

Panic-stricken Christmas shoppers in a New York apparel store engaged in a headlong rush for exits when an electrical transformer failed with explosive violence beneath the sidewalk in front of the store, blew out all the show windows on the ground floor, wrenched loose lighting fixtures in the basement, and filled the premises with acrid smoke. The blast was so severe that it was heard for several blocks. Firemen lost no time in quelling a blaze that started in the basement near the transformer vault but business in the store was demoralized for the rest of the day. Customers who returned to search for pocketbooks and wraps were obliged to use the stairways, for the breakdown of the electric supply rendered the elevators useless. Fortunately, only two persons were injured.

Newspapers Report Many Heating Boiler Explosions

NEWSPAPER clippings and reports sent in by correspondents in all parts of the country continue to remind us that so-called low-pressure heating boilers explode—and usually with destructive results. In Atlanta a tenant has brought suit against his landlord for damage to furniture caused by the explosion of a cast iron heating boiler on the night of November 26. Damage to the boiler and to the building amounted to about $1,500.

With a roar that could be heard a mile, an exploding hot water supply tank in a residence at Pillsbury's Bluff, Maine, wrecked the building and showered neighboring houses with debris. One wall was bulged out as though a giant hand had attempted to push it from the rest of the house, lower floor partitions were ripped out, and doors were hurled a distance of 100 feet or more. A two-months-old baby, asleep on the porch of a house across the street, had a miraculous escape from injury when broken glass and splinters of wood rained down on him. There was no one in the damaged house at the instant the explosion occurred.

In Chicago one person was killed and two others were injured when a cast iron boiler used for heating a restaurant let go on October 18th. The explosion rocked the neighborhood for several blocks around, causing property damage of about $3,000.

A theatre in Washington, D. C., was the scene of a violent explosion on October 20th, the blast being severe enough to almost demolish a brick annex in which the cast iron vessel was housed. Had the boiler been located under the theatre, as many are, the accident could easily have claimed a heavy toll in killed and injured. In this case, property damage amounted to approximately $1,500.

One person was injured on December 6 when a sectional heating boiler exploded in a residence in Nassau, N. Y.; an explosion of the heating boiler in a New York City apartment house on October 1 had the same result; and a similar accident at the home of a resident of Sioux City, Iowa, claimed a third victim of injuries.

Newspaper clippings that have come to the editor's desk during the past two or three months tell of explosions of such things as heating boilers, hot water supply boilers, and hot water tanks at the following locations: Residence, New Dorp, Staten Island, N. Y.; Bottling works, Bronx, N. Y.; College building, Bangor, Maine; Residence, West Ottawa, Ill.; Residence, Worcester, Mass.; Fraternity house, Potsdam, N. Y.; Drug Store, Brooklyn, N. Y.; Home for girls, Milwaukee, Wisc.; Residence, Camden, Ill.

Caught in the Separator

IN THE CLUTCHES

The Girl: "When she married him he was a struggling author."
The Cynic: "He couldn't have struggled hard enough."

—*The Humorist.*

A LAWYER TELLS THIS ONE

In a small town an old resident owned a goat, possible value $1.50. The goat was belligerent. His battleground was Main Street. When tax bills appeared, the owner found the goat assessed at $20. Indignant, he went to the assessor and laid his complaint before him. Taking down a well-worn copy of the town ordinances the assessor read aloud the following passage: "Property abutting on Main Street shall be assessed at $10. per front foot."

THE RIGHT SPONSOR?

The bore was telling the assembly in the smoking room how he had made his money.

"When I started out in business," he said pompously, "I resolved that my motto should be 'Get thee behind me, Satan'."

"Excellent," murmured an approving voice from the rear of the room. "There's nothing like a good backing right at the start."

HOW LIKE US ALL

"James, call up my dentist and see if he can give me an appointment."

"Yes, sir."

"And—er—James, don't press him."

NOT IF HE KNOWS HIS OATS

A small boy astride a donkey was taking some supplies to an army camp in Texas not long ago. He reached camp just as a detachment of soldiers, preceded by a band, was on parade.

The lad dismounted and held the bridle of the donkey tight in his hand.

"Why are you holding onto your brother so hard," teasingly asked one of a group of soldiers who were standing nearby.

"I'm afraid he might enlist," replied the youngster, without batting an eyelash.

OR ELSE A FULLBACK

Teacher: "We should never be discouraged too easily. Look at Napoleon. He would stop for no obstacle; he refused to be turned aside by anything, but kept on relentlessly to his destination. What do you think he became?"

Pupil (hopefully): "A truck driver?"

SO THAT'S THE SECRET!

Prospective buyer of a very small motor car: "Er — how does one get in?"
Salesman: "You don't get into it, sir, you put it on."

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1929

Capital Stock, . . $3,000,000.00

ASSETS

Cash in offices and banks		$ 562,819.36
Real Estate		306,494.68
Mortgage loans		1,083,248.86
Bonds and Stocks		18,384,883.03
Premiums in course of collection		1,669,195.41
Interest accrued		160,573.97
Other Assets		23,959.34
Total Assets		$ 22,191,174.65

LIABILITIES

Reserve for unearned premiums		$ 9,289,882.04
Reserve for losses		452,334.69
Reserve for taxes and other contingencies		2,065,632.12
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,383,325.80	
Surplus to Policyholders,		**$10,383,325.80**
Total Liabilities		$ 22,191,174.65

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

Incorporated 1866 | Charter Perpetual

Department	Representatives
ATLANTA, Ga. . . . . 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md. . . . . 5 South St.	James P. Kerrigan, Jr., Manager. P. E. Terroy, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., . . . 404-405 City Savings Bk. Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., ... 175 West Jackson Boulevard .	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio, . . First National Bank Bldg. .	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, . . Leader Bldg., ...	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER, Colo., ... 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Manager and Chief Inspector.
DETROIT, Mich., ... 2401-7 First Nat'l Bank Bldg.	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., . . . 56 Prospect St. . . .	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., . . 1128 Hibernia Bank Bldg. .	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., . . 80 Maiden Lane . . .	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., . . 429 Walnut St. . . .	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., . . 1807-8-9-10 Arrott Bldg. .	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., ... 319 North Fourth St. . .	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., . . 114 Sansome St. . . .	C. B. Paddock, Manager. L. J. Reed, Chief Inspector.
SEATTLE, Wash., ... 707 Arctic Bldg. . . .	E. G. Watson, Mgr. and Chief Inspector. J. W. Smuck, Ass't Chief Inspector.
TORONTO, Canada, . . . Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

Aside from Indemnity

Electrical Machinery Insurance is indispensable to thousands of industrial plants. This is not entirely due to prompt payment of losses although, of course, that is important. Of even greater importance, however, is the effect of careful, intelligent inspections in reducing the chance of accidents and in helping keep equipment in operating condition.

The assured gets the benefit of such inspections in the lessening of hold-ups and delays that would cost dearly in loss of production and upset delivery schedules.

Electrical Machinery Insurance may be applied to Motors, Generators, Transformers, Oil Switches, Switchboards, Rotary Converters, and other types of electrical apparatus.

Vol. XXXVIII No. 6 April 1931

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Recent Developments *in* Fusion Welding Make Possible Its Use *in* Pressure Vessel Construction

By W. D. Halsey, *Ass't Chief Eng., Boiler Division.*

NO SOONER had man discovered the art of working metal than there came the desire—and the necessity, if his discovery was to be of benefit—to join together such parts as his facilities and ability permitted him to make. No doubt, he early found that his crudely made wrought iron could be joined, part on part, by raising the temperature to such a point that the metal became soft, plastic, almost molten, and in such state could readily be fused together under the blows of a hammer. Such a process we have long known as forge welding. In some brilliant mind in the age of early man, riveting as a means of securing two parts was given its start and later—in relatively more modern times—there came the use of machine screws and bolts. Man's limitations widened, there came the ability to fabricate metal in parts of larger size, but always the demand increased for structures of still greater magnitude, fewer component parts, and methods of securing together such parts in a simpler and more efficient manner. It appeared that this demand might be met when a concentrated heat of high temperature became possible through the application of electric current and the various types of gas torches.

Boilers and pressure vessels have long been built with riveted seams. Experience has taught us how to construct a properly riveted seam and how to compute its strength with a considerable degree of accuracy. But under certain conditions, a riveted seam will leak and in a vessel requiring very thick plates it becomes extremely difficult, even impossible, to use such a form of construction. Forge welding has also been applied to the construction of boiler drums and pressure vessels, but this process also, while making possible to a high degree the fabrication of a vessel free from leakage, has its limitations.

Fusion welding, the term now more general accepted instead of autogenous welding, is the process of securing two pieces of metal by the application of concentrated heat of high temperature to the edges of the pieces to be joined, usually with the addition of some filler metal at the joint. The edges of the metal at the joint are brought to a molten state by the high temperature of an electric arc or the flame of a gas torch and the additional metal required is provided in the form of a rod or wire which is likewise melted into the joint. The process appears simple. Its application seems easy. Unfortunately, it is neither as simple nor as easy as it would appear.

It will be readily appreciated that the ultimate desire for a welded joint is that it have as nearly as possible the same characteristics of soundness, strength and ductility as the metal that is joined, commonly referred to as the base metal. The Hartford Steam Boiler Inspection and Insurance Company has followed the development of fusion welding from its early days, but unfortunately the Company has not, until recently, been satisfied that fusion welded joints with the desired properties were being *consistently* obtained. Indeed, this Company has in its files a large and impressive list of failures of fusion-welded vessels, totalling many thousands of dollars damage and, more serious, the loss of many lives. Examination has been made of many such vessels that have ruptured. In a very large number of cases the cause of the failure had been a poorly made weld, either unsound in itself or lacking in the proper bond between the weld metal and the base metal. A typical case will be found on Page 166 of this issue of THE LOCOMOTIVE in the account of the failure of a fusion-welded vessel resulting in a property loss of nearly $9,000 and the loss of a life.

As a result of these investigations this Company has heretofore been very reluctant to accept fusion-welded vessels for insurance. One great difficulty has been the lack of any ready means of determining, after a vessel had been placed in service, whether the welding was sound and properly made. The exterior appearance of the weld is not a safe guide because mere good appearance is not particularly difficult to obtain.

To construct properly a riveted vessel of any appreciable size, considerable equipment is required. To the early builder of fusion-welded vessels it appeared that much of this expense could be avoided by the use of only a pair of rolls to form the cylindrical part of the vessel, and the purchase of welding equipment which in itself did not entail a very large expenditure of money. Dished heads may be purchased from a number of sources and it seemed therefore, that one could set himself up in the business of fabricating fusion-welded vessels at relatively small expense. Furthermore, fusion welding has always been desirable from the standpoint of freedom from leakage. Thus it developed that many rushed into the business of fabricating fusion-welded vessels without a full appreciation of the many and intricate problems that are involved in the making of a properly welded joint.

In recent years the picture has changed very materially. With the ever increasing demand for larger and larger vessels suitable for higher and still higher pressure and also for entire freedom from leakage, there has been in the recent past a very intensive study of the problems connected with fusion welding.

In the making of a fusion-welded joint many things are involved. There is needed the advice of the chemist, the metallurgist, the testing engineer, the electrical engineer and many others. It is indeed a very scientific problem. Consider only the problem of surrounding a pool of molten metal at very high temperature with the relatively cold mass in the walls of the vessel. With the consequent expansion and contraction there results the possibility of setting up more or less severe stresses in the weld or in the metal adjacent to it. Such stresses are referred to as "locked-up stresses". There is no question whatsoever but that such stresses do exist. How severe they may be and what their distribution is, have not been positively determined; but in many cases, and particularly in vessels of heavy plate thickness, steps must be taken to relieve such stresses if the vessel is to be safe for use.

Steel, while it is being melted or while in the molten state, will readily absorb oxygen and nitrogen from the atmosphere if it is not properly protected. Such absorption will result in a brittle, porous weld of inadequate strength.

One might think that the fusing of the added metal to the base metal at the joint would be a simple operation. However, considerable skill is required to obtain a proper bond and much thought has been given to the overcoming of this difficulty. It is primarily a problem that can be overcome only by the skill of the welding operator. Such skill cannot be obtained in a few hours.

As has been indicated above, much thought has been given to, and considerable research work has been done on the proper method of making a fusion welded joint that will have the desired properties of strength, ductility and soundness. Today there are a number of concerns that have solved the problem and that are fabricating unfired pressure vessels as safe to operate as those of riveted construction.

The Hartford Steam Boiler Inspection and Insurance Company has every confidence in the safety of a fusion-welded unfired pressure vessel that has been properly constructed. However, the difficulty has been to separate the "wheat from the chaff". Some manufacturers have solved the problem. Others, through a lack of appreciation of the difficulties involved, have not, as this Company views the situation, made a satisfactory solution.

This Company has fully appreciated the desirability of fusion-welded construction for many classes of service. To meet the situation it detailed one of its engineers, some time ago, to give the problem careful consideration in order that it might be able to advise its assured where properly constructed fusion-welded vessels might be obtained. Special methods of testing and inspection have been developed and these methods have been widely recognized as proper and adequate. A careful investigation has been made of the work of certain manufacturers who have sought our approval of their fusion-welded vessels and to some of them this approval has been given. In several cases this Company has demonstrated to shops that have been doing welding for years that their methods did not produce results approximating the quality necessary for our approval and the most progressive of these concerns have lost no time in seeking a means for improving their product. Naturally, this Company is careful, in carrying on its advisory work, not to divulge confidential information or methods in use at other plants, but rather to point out just wherein a welder's finished work falls below par and to stimulate him to make the research necessary to achieve the required results.

A manufacturer who desires to obtain the approval of this Company first of all submits a "procedure control" or specification for his method of making a weld. He then proceeds to make several welds by such "procedure control" under the observance of a representative of this Company. These welds are cut into coupons or specimens for various kinds of tests involving the determination of tensile strength, ductility, and soundness. If the tests indicate that the "procedure control" will produce a weld of the desired properties, approval of the process is given. Arrangements are then made for inspection during the course of construction of a vessel in order that this Company can certify to the purchaser that, in its opinion, the vessel is safe for use.

Manufacturers of fusion-welded vessels who have obtained the approval of this Company are placed on an "Approved List". This list is constantly being added to and is on file at the various departmental offices of this Company, so that our assured may, upon inquiry, obtain the names of manufacturers who are in a position to construct fusion-welded vessels which will be acceptable for insurance.

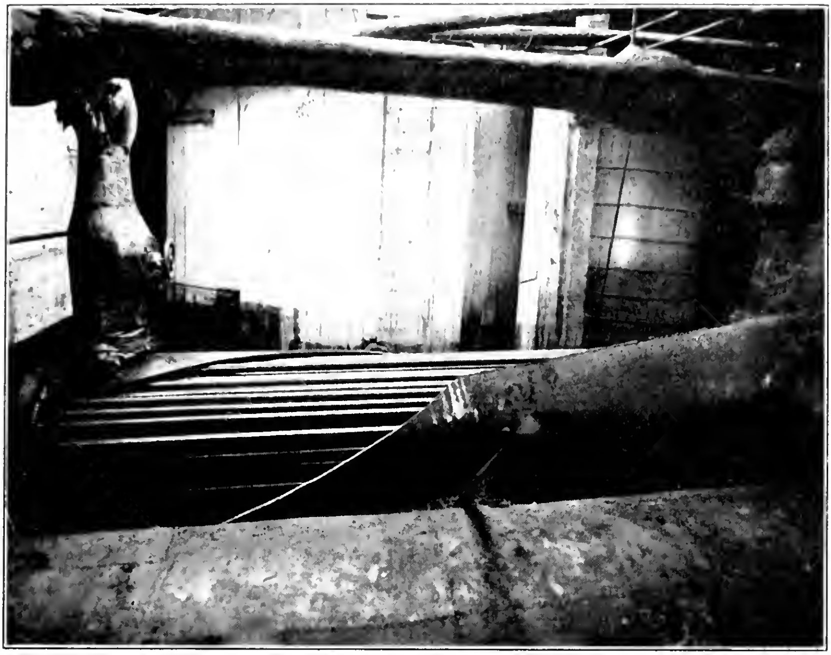
The Boiler Code Committee of The American Society of Mechanical Engineers has been giving very careful thought over an extended period of time to the drafting of an adequate code for the construction of fusion-welded unfired pressure vessels. In this work the Code Committee has had the close cooperation of this Company. It is clearly recognized by both that there are various grades of welding, differing as to physical properties and each suitable for certain classes of vessels. The Hartford Steam Boiler Inspection and Insurance Company early recognized this fact and information regarding the classification that it has made of the various types of vessels and the grade of welding it will accept for insurance on each is also available at its branch offices. Without doubt some such classification will be adopted by the Boiler Code Committee as is evidenced by the "Proposed Specifications for Fusion Welding" which appeared in the March, 1931. issue of "Mechanical Engineering".

The future also holds much promise for the fusion-welded power boiler and the Hartford Steam Boiler Inspection and Insurance Company has given this subject very careful consideration. Such a boiler, when constructed by a manufacturer on this Company's "Approved List" in accordance with its requirements for fusion-welded power boilers, will be as acceptable for insurance as a properly constructed riveted boiler is at present.

Explosion of Brine Cooler Kills 1, Injures 2

AN OPERATOR at a large storage plant in Missouri was in the act of starting the brine circulating pump of a compression refrigerating system on the afternoon of October 23, 1930, when the shell of a brine cooler near which he was standing exploded and injured him so severely that he lived but a few minutes. Two other men who were present in the room were badly burned by the release of approximately two and a half tons of liquid ammonia. Their rescue was effected with the greatest difficulty by other employes who had to contend not only with suffocating fumes but with an explosion of ammonia vapor that became ignited, it was thought, by sparks from electrical equipment. Machinery in the compressor room was badly damaged by the blast which carried away part of the roof over the exploded tank and hurled down several doors. The loss from direct damage, amounting to $8,760, was covered by insurance in the Hartford Steam Boiler Inspection and Insurance Company.

The brine cooler, which had been in use about twelve years, had a shell 42 inches in diameter and 16 feet long. Gas welding had been used in forming the longitudinal and girth seams, as well as for joining the ends of the shell to the cast steel tube sheets. Failure occurred by the tearing apart of one of the longitudinal seams, the break following along the seam for several feet before changing direction and going into the solid plate, as shown in the illustration. It was plainly evident that the welding had been poorly done. In fact, test coupons taken from another part of the seam after the accident were so weak at the point



of welding that they broke while under the slight pressure necessary to straighten them before they could be put into the tensile testing machine.

Because it was strongly suspected that the welded seams in several other vessels of the same age and make were in as poor condition as those of the exploded tank, the owners decided to replace them with others having riveted seams.

Accidents of the kind described above are by no means uncommon. The explosion of a similar tank in a St. Louis apartment house in 1925 killed one man and injured six; another such explosion in 1927 seriously injured an attendant and caused $15,000 damage at an ice plant in New Orleans.

Tube Rupture Results Fatally

One man was fatally scalded and two others were badly burned in January, when they were trapped in the sub-basement of a Louisville, Ky., office building by a tube rupture in one of the heating boilers. The accident blew open the fire doors with a detonation severe enough to be heard in all parts of the 10-story building.

Suggestions *for the* Safety *and* Preservation *of* Main Steam Turbine Units

By T. B. Richardson, *Chief Eng. Turbine and Engine Division.*

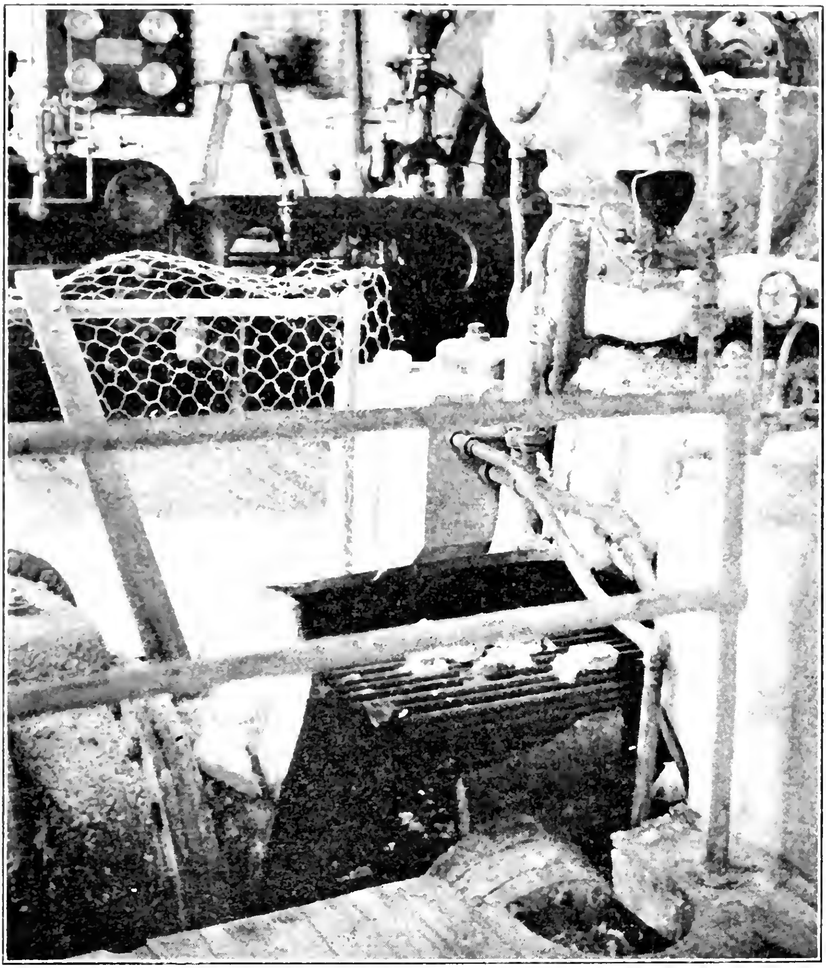
The steam turbine is a machine that is affected, like any other mechanism, by the heavy service to which it is subjected. For this reason it sometimes happens that parts originally safe for the stresses they were designed to sustain become unsafe, and automatic safety devices that started out in perfect working order lose their ability to function. In such cases safety may hinge on the intelligence and quick observation of the operating engineer, who should not only understand all details of the installation with which he is working but should be in a position to keep himself posted at all times as to the condition of each device on the machine.

It is hoped that the following article, touching many of the important points with which every operator should be conversant, will be helpful to those of our readers who have turbines in charge.—Editor's Note.

TO SECURE safe operation of turbines there must, of necessity, be certain fundamental features incorporated in the initial installation. Aside from the correct leveling and alignment of the unit, one such important requirement is the proper connection of piping. The erector should never begin at the turbine and pipe away from it; instead he should bring the piping to the unit. After the piping has been permanently supported and before making the last flanged connection at the turbine, the flange faces should be perfectly parallel to avoid throwing strains on the turbine casing.

If there is a stop valve in any turbine exhaust line, or in any bleeder line, there should be an automatic atmospheric relief valve sufficiently large to prevent over-pressure in the turbine casing, such relief valve being connected in the line between the turbine casing and any such stop valve, with a setting of a few pounds above the normal pressure in the line.

On turbine extraction lines, non-return valves are essential, in case live steam from a reducing valve also feeds into the line, or if there is a large receiver capacity connected to the extraction line, or when two or more turbines bleed into the same line. The most desirable type of non-return valve is one held open by an oil piston with pressure from the regular turbine oiling system and the piston opposed by a strong spring so that in event oil pressure fails for any reason or if the emergency governor releases the oil pressure under the piston, the spring will automatically close the non-return valve. Further, on ex-



In the accompanying article the author stresses the need for frequent and thorough checks to determine the condition of all safety devices. The importance of this is clearly illustrated by the above photograph of a surface condenser explosion at a utility plant on December 6. The cause was, failure of the atmospheric relief valve to open when the circulating water was accidentally lost, the valve having been stuck closed.

A piece of the condenser shell weighing about 200 pounds was blown through a window, and the condenser tubes and copper expansion joints were bent so badly that they had to be renewed. If the flying piece of metal had struck the governor end of the turbine or the governing mechanism of the engine with the large fly-wheel shown in the picture the accident would have had much more serious consequences.

traction lines, the lowest point in the loop should be connected to a steam trap of sufficient capacity to handle under all conditions of pressure or vacuum any water that may accumulate in the loop. Likewise on any exhaust loop, as for instance one leading to a barometric condenser, a vacuum trap should connect to the lowest point in the loop.

When steam turbines operate in parallel with hydro-electric systems that are susceptible to any appreciable frequency variation it is desirable to have a switch installed at the trip valve so that in event the turbine is motored from the system up to the point of tripping the emergency, the actuating of the switch at the trip will energize the main generator switch to disconnect the turbine from the system. In such instances a small by-pass steam connection is advisable to prevent over heating of the turbine rotor at such times as motoring of the turbine may occur with the main control valves entirely closed.

Too much importance may not be laid on keeping the main governor and the control valves which it operates in the very best state of repair. The prevention of overspeed, in case of sudden loss of load, depends, primarily, on the proper functioning of the main governor and, in turn, on the control valves being adequately tight so that when closed there cannot be sufficient leakage of steam through the valve to overspeed the unit. In cases of overspeeding the statement is usually made that it occurred because of failure of the emergency governor to function properly. In reality it was because the main governor or its connections, including the control valves, failed to hold the speed down, as is expected and required. The operator should test the control valves at least twice a year for tightness, as their proper functioning as well as that of the main governor is the chief consideration. The emergency governor is an added safety device that, unlike the main governor, does not work except on comparatively rare occasions and thereby is more likely to become inoperative and not available when actually called upon to function. For this reason it should be tested at regular intervals, preferably each time the unit is shut down, except that once per week is ordinarily of sufficient frequency. In no case should a machine be allowed to go more than three months without such a test.

Most of the recently designed units depend on oil for the transmission of the main governor control and this fact, together with the dependence of main bearings and thrust bearings on proper lubrication, necessitates close attention to keeping the oil properly filtered and free from water. The primary and contributory cause of many turbine accidents can be traced to poor lubrication, as for instance in thrust bearing failures with the resultant serious damage to rotating parts. It is true, however, that thrust bearings may fail because of being overloaded at such times as the steam passage areas are diminished by unusual deposits on the buckets. Increased stage pressures for a given load will generally indicate this latter condition. In any event, so much depends on the thrust bearing and its proper maintenance of correct axial clearances that not only is it essential to give much attention to filtering the oil and on small units making a complete change of the oil at least once every three months, but also it is desirable to make periodic internal inspections of the thrust bearing. The axial clearance in the thrust itself should be between four and six thousandths of an inch with a maximum of not over ten mils. In order to check the position of the rotor and thereby determine the extent of wear on the thrust the operator may make periodic micrometer measurements between a fixed stationary point and some accessible shoulder along the shaft.

For securing best service the following points on operation and maintenance should receive constant attention:—

1. Keep the unit clean and free from dust, dirt and leakage of steam, water or oil.
2. Maintain smoothness of operation. At any appreciable *change* in vibration, any unusual sound, any change in amount of load the unit will carry, or any observed change in amount of steam the unit requires for a fixed load, the operator should shut the unit down at once and have the cause determined.
3. Bearing temperatures should be constantly observed. If units are not provided with sight holes in discharge oil lines from each main bearing for observing the amount of oil flowing and taking oil temperature readings, it is advisable to have a small pipe coupling welded to the discharge line at a point above the oil level in the tank and a removable pipe plug for screwing into the outer end of the coupling: this is on the basis that it is more important to be able to determine the actual oil flow than to depend on oil pressure gauges at the bearing entrance.
4. Once a day, when load conditions permit, the operator should partly close the throttle valve, if same is also used as a trip valve, to make sure the valve stem moves freely through its packing.
5. The turbine should not be kept in service unless it is known that the emergency devices are in condition to operate.
6. Know that the controlling valves will close tightly and shut off the steam.

7. Inspect frequently the steam strainer, the knife edges and bearings of the main governor, as well as parts of the emergency tripping device.
8. Once each year or at such longer periods as extraordinarily favorable operating conditions may warrant, make a complete dismantled inspection of each unit. This annual dismantled inspection is a matter which this Company strongly recommends, and at such times it invariably wants to have one of its inspectors on hand to go over the interior of the machine thoroughly. In a majority of plants, where an experienced repair crew is not available, it is economy to have this annual dismantling conducted by the manufacturer's turbine erector. The erector should be required to supervise repairs and, cooperating with the inspector, to list renewal parts required for the following:—All internal parts of turbine such as blading, nozzles and shaft packings; throttle valve, steam strainer, trip valve, control valves, main bearings, thrust bearing, main governor, emergency governor, flexible couplings, the atmospheric relief valve, non-return valves, the oil pumps and their worm and gear drives, and the auxiliary oil pump. At this time the oiling system, including the piping, should be given a thorough cleaning, and a close examination should be made of the generator and field windings for cleanliness and to determine whether revarnishing of the coils is necessary.

The securing of longer and more dependable service, without any doubt warrants the expense incurred by the owner, and the additional care required for close observance of the above points.

Leaky Fusible Plug Eroded Tube

While investigating a case of tube leakage in a water-tube boiler, an inspector recently came upon a rather unusual circumstance. The soft metal of the fusible plug had been melted out apparently for some time, but a deposit of flint-like scale had so nearly closed the opening through the plug that there had not been enough leakage to attract the operator's attention. However, the opening had been large enough to permit the escape of a thin jet of steam and this jet, impinging on one of the tubes, had cut its way entirely through the metal. Examples of tube and drum erosion caused by jets of steam are not uncommon, but it is seldom that the fusible plug can be cited as the cause.

Unusual Electrical Troubles *of an* Interesting Nature

By Kenneth A. Reed, *Chief Engineer, Electrical Division.*

FROM time to time serious electrical troubles of an unusual nature, arise that may, in most cases, be foreseen and avoided by good engineering in operation and design of switchboard wiring. A more or less common cause of trouble of the nature under consideration is operating polyphase turbo-generators (having solid core rotors) with the current per phase unbalanced, and the extent of the

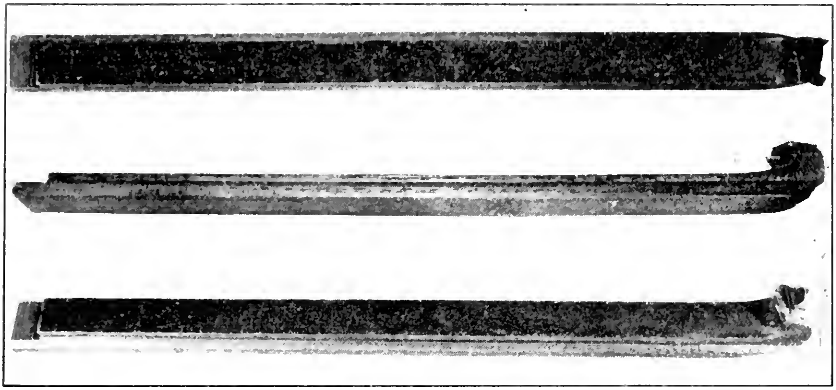


Figure 1

damage to the rotor as well as the time in which the damage occurs varies with the amount of unbalancing.

In general, the maximum damage occurs in the shortest time when a machine of this type is operated single phase, with practically full load current. It is estimated that serious rotor damage may occur, under such conditions, in as short a time as two minutes.

Badly unbalanced phase current, or single phase operation, produces circulating currents in the rotor core, and these currents, naturally follow the path of least resistance—usually through the slot wedges to the retaining rings that support the end turns of the rotor winding. High resistance contacts in the paths of these currents, such as butt contacts, where a number of wedges per slot are used, or where the shoulders of the end wedges fit under the retaining rings, produce rapid heating with resulting serious damage.

Figure 1 shows three views of one of several wedges from a solid core turbo-generator rotor, that suffered damage several months ago. In this particular case there were two wedges per slot and the second wedge in each slot where damage occurred was in practically the same condition as the wedge shown in the figure.

As will be noted from the picture, the metal at the inside end of the wedge softened as a result of the high resistance contact in the path of the current flow, brought about by the butt joint between this wedge and the other one in the same slot, and centrifugal force threw the softened metal outwardly into the air gap. The entire length of the wedge was of course drawn through the slot for a distance equal to the up-turned end of the wedge.

By the use of a magnifying glass ridges can be seen in the up-turned end of the wedge, where it rubbed the stator laminations. Had operation continued with the wedge rubbing on the stator iron, and the rotor traveling at 3600 rpm, a serious wreck would unquestionably have occurred. The direct cause of the unbalancing, or more probable single phasing, has not yet been discovered.

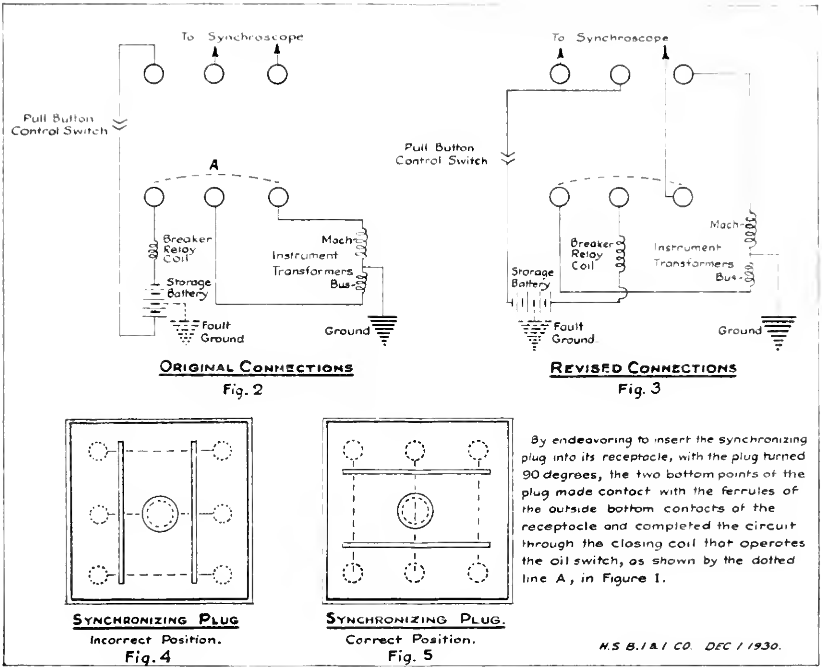
In general the phase currents of polyphase machines with solid core rotors should not be permitted to become unbalanced in excess of approximately 10%. Naturally some machines, due to design, will operate satisfactorily and safely with a much greater unbalance of phase current, but the 10% rule mentioned above should in general be followed in all cases.

A case of trouble due to the method of wiring a switchboard is shown in Figures 2, 3, 4 and 5. The original connections in Figure 2 show clearly how serious trouble may arise with a given synchronizing "hook-up" should a fault ground develop at about the mid-point of the control storage battery, and should the operator inadvertently attempt to insert the synchronizing plug in its receptacle when the prongs are turned 90° from their normal position.

The spacing of the contacts of the plug and receptable is such that the four corner points are the same distance apart in either a vertical or a horizontal position. Therefore if the plug should be turned 90° it could be placed in the receptacle if it were not for the middle prongs.

It was found however, in the case under consideration, that when the operator attempted to insert the plug, at an angle, into the bottom contacts of the receptacle first, as is the usual practice, the two bottom prongs of the plug touched the ferrules of the bottom outside contacts of the receptacle and the circuit was completed through the relay closing coil for the oil switch, as shown by the dotted line "A" in Figure 2, and the machine was thereby thrown on the line.

The operator was very much mystified by the fact that the synchronoscope stood at the position of synchronism when the plug was correctly inserted in the receptacle and he could not make the pointer move by attempting to vary the speed of the incoming generator, as is necessary when endeavoring to place an incoming unit on the line. He was further mystified by the fact that the pull button control switch still indicated that the oil switch was open—thereby proving that this



ORIGINAL CONNECTIONS
Fig. 2

REVISED CONNECTIONS
Fig. 3

SYNCHRONIZING PLUG
Incorrect Position.
Fig. 4

SYNCHRONIZING PLUG.
Correct Position.
Fig. 5

control switch (which has a mechanical indicator) had not been operated.

After the Chief Engineer was summoned and the matter was further investigated, it was found that the generator was actually on the line and it was only through extremely good fortune that it happened to be in perfect synchronism at the exactly psychological instant that the operator incorrectly tried to insert the synchronizing plug into its receptacle.

The fault ground on the battery circuit was located and removed and the connections to the synchronizing receptacle were changed as shown by the above revised connection sketch, Figure 3. It is therefore, now impossible to complete a circuit through the closing coil of the circuit breaker, under any condition of fault ground and improper application of the synchronizing plug.

Bursting Ring Damages Large Generator

THE power plant of a large industrial concern sustained a loss estimated at $25,000 when, early in February, a 5,480 kv-a. turbo-generator was damaged by the bursting of the retaining ring over the inboard end turns of the rotor windings. According to the watch engineer, he had just started to warm the unit preparatory to putting it on the line and had not brought it quite up to speed when the accident occurred. He was struck and slightly injured by a small piece of debris, but fortunately escaped being struck by a large piece of the ring that passed over his head and out through a window.

The accident not only ruined the windings but it broke a piece out of the casing, cracked the generator frame, destroyed the fan and made necessary the replacement of about 2½ inches of stator laminations. A piece of metal struck a 4,120 kv-a. companion unit, piercing the sheet metal cover.

Examined after the accident, the retaining ring appeared to have had an old crack that ran from a ventilating hole about four inches into the metal. Whether the failure originated there or, as some thought, it started with the breaking off and jamming of fan blades, could not be determined.

Turbine Loses Load and Runs Away

An overspeed accident to a turbo-generator unit was described as follows in a recent issue of *Power:* "The power plant equipment of a coal company in Wyoming . . . included two 300-kw., 250-volt, 1,800 rpm. compound-wound turbine-driven generators, operated non-condensing. The generators furnished power for locomotives, hoists, and other equipment in a mine not far from the plant. Owing to the unusual demand for coal at the time, there were several cases of oversight on the part of the man in charge of the plant.

"Considerable trouble was experienced in keeping the circuit breaker closed on the main direct-current feeder because of the heavy overload being carried. The chief electrician was notified of the condition on numerous occasions, and remarked that he was tired of being troubled with what he termed "an insignificant item". And with the idea in mind of eliminating the inconvenience he reset the circuit breaker to the maximum capacity.

"One afternoon, while the operator was performing his duties outside the plant, he heard an unusual noise in the plant and upon entering found the machine running away.

"When the machine was finally stopped it was found that the armature was stripped of the winding, the brush rigging was broken, the governor was out of commission, and several parts of the machine were broken and strewn about the plant. The trouble had started with a heavy short circuit caused by a bare feeder cable dropping on the track rail and water pipe in the mine. Owing to the drag on the generator, all steam inlet valves on the turbine had opened wide, causing the machine to overspeed when the short opened."

(Editor's Note—While stating that after the accident the governor was found to be out of commission, the account does not explain whether it was damaged in the wreck or whether it was out of order before the accident. In any event, the fact that overspeeding occurred would seem to indicate that some part of the speed regulating mechanism was at least sluggish if not inoperative.)

Two Die While Testing Tank With Air

THE danger inherent in the use of compressed air instead of water when testing vessels for tightness was again demonstrated by a recent tank explosion that resulted in the death of two men and injury of a third. Having a diameter of eight feet and a length of twenty-five, the tank contained such a large store of energy in the form of compressed air that when the head let go the vessel was hurled bodily through the side of the building, and the head was driven up through the roof. The concussion was felt for blocks.

According to reports, the tank was intended for the storage of oil under pressure and was made of tank steel. The dished head was somewhat flat and apparently had been cold-flanged to a sharp radius to form the skirt. Seal welding had been used between the end of the shell plate and the turn of the flange, presumably to insure tightness.

At the time of the accident one man was working on the head and another was on top of the tank going over the longitudinal seam. The former was one of the victims, while the other victim was a workman who happened to be in the path of the tank as it shot with tremendous force down the length of the room and out through the wall. The man who was on the tank was dropped to the floor and injured, though not seriously, when the vessel suddenly slid from beneath him.

With the exception of a point at which two rivets of the head seam sheared, the rupture occurred around the head on a line where the seal welding joined the knuckle, the head coming out like a shallow saucer. It would seem reasonable to suppose that the heat of welding may have weakened a part of the head where, because of the very sharp bend, it was subjected to the greatest bending stress from the internal pressure tending to force the head outward. If, as is thought to have been the case, the skirt had been flanged cold, there may have existed serious internal stresses which were further aggravated by the localized heating effect at the time of welding.

As near as can be learned, the pressure within the tank at the time of the accident was 115 pounds. According to the designer's figures, the tank should have withstood the pressure safely.

Two Recent Cases of Caustic Cracking

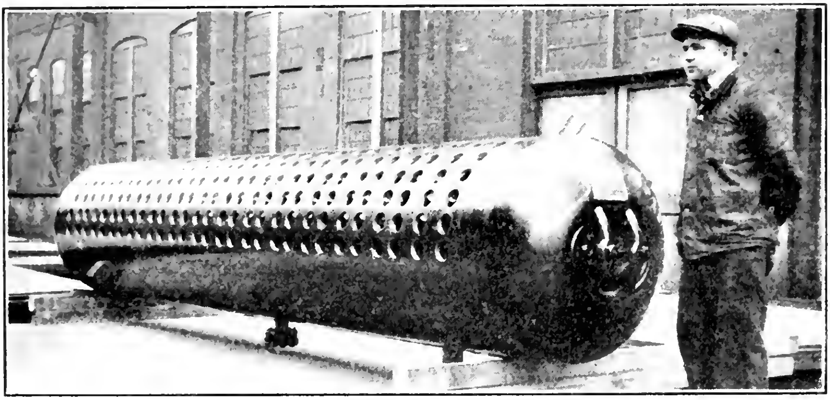
SUCH factors as local stresses and seam tightness play so important a part in governing the rate at which caustic action takes place in a boiler that, even when the exact carbonate-to-sulphate ratio of an embrittling feed water is known, it is impossible to predict with any degree of accuracy how long the boiler will operate before cracks appear.

The finding of embrittlement cracks in two cross-drum boilers in January came more than five years after this Company warned the owners that an analysis of feed water showed it to be of a kind that would produce embrittlement. Thus warned, the owners installed a system of treatment designed to overcome the unfavorable carbonate-sulphate ratio of the deep-well water they were using, but the caustic that had concentrated in the boiler seams during the period before the water treatment was started proved sufficient to keep the embrittlement action going. As a result rivet heads eventually commenced to snap off under light blows of the inspector's hammer, and an examination with a Hartford Rivet-Hole Magniscope revealed cracks radiating from the rivet holes.

In the case cited above the boilers had been under close observation for five years for the first signs that the plate had been affected, so the discovery of cracks came as no surprise. However, in another case of caustic cracking encountered a few weeks ago in a horizontal tubular boiler the fact that the boiler was connected to a closed heating system and used nothing but condensate from radiators and heating coils as feed water, made difficult, for a time, all attempts to explain how caustic could have entered the boiler. An examination of the piping system dispelled the mystery, for it was found that steam from the boiler passed through coils in tanks used for heating a strong alkali solution. From time to time these coils developed leaks, and although it was impossible for the contents of the tank to pass into the coil while the latter contained steam at boiler pressure, such leakage did take place at night when the steam was shut off. At that time some of the caustic solution would seep into the coil and reach the hot well from which it would be forced into the boiler when the feed pump was started in the morning.

First Fusion-Welded Power Boiler Drum in U. S.

AN EVENT that will doubtless be looked back upon as a milestone in the history of boiler-making occurred within recent weeks at the plant of Brown Paper Mills, Inc., Monroe, La., where the first fusion-welded power boiler drum ever to be used in the United



States was installed on a water-tube boiler intended for operation at 200 pounds pressure. The drum was made by the Babcock and Wilcox Company at its plant in Barberton, Ohio, by a welding method developed by its engineers. It was inspected during construction by representatives of the Hartford Steam Boiler Inspection and Insurance Company. In addition to a careful investigation of the physical properties of the welds, the X-Ray was resorted to for an accurate determination of the soundness of the joints.

The drum is 36 inches in diameter, 17 feet in length, and made of 13/16" firebox steel plate. Heads are of the semi-elliptical type. The above photograph shows the drum as it was being prepared for shipment on February 21.

It is interesting to note that the drum replaces one of riveted construction in which caustic embrittlement had made its appearance. The welded vessel has no seams, of course, in which caustic concentration can take place.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

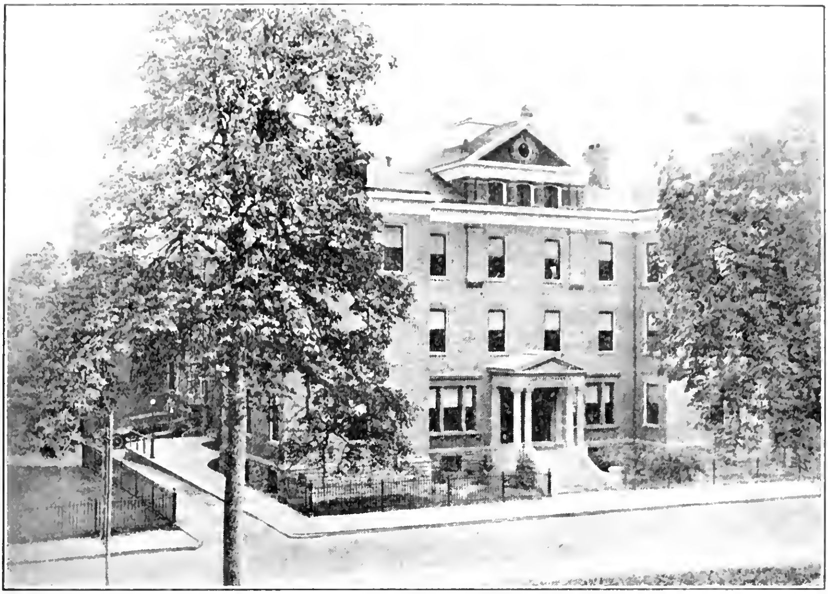
HARTFORD, CONN., April, 1931

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.

Company Plans New Home Office Building

BY THE time this issue reaches our readers workmen may already have started tearing down the comfortable, old building that has served as this Company's home office since 1908. In its place will be erected a modern, fireproof, 3-story structure better suited to the growing needs of a business which, limited at one time to the inspecting and insuring of steam boilers, is now called on to apply its protection to the many kinds of pressure vessels, engines, turbines, and electrical machines used in modern industry. The decision to replace the present building was made on February 25, at a meeting of the board of directors who authorized the officers to proceed with the work as soon as plans could be drawn.

The old home office building, as well as the plot of ground on which it stands, have an interesting background, rich in tradition. In 1785 the land was purchased by Oliver Wolcott, Jr., Secretary of the Treasury under Presidents Washington and Adams, and later governor of Connecticut. When, in 1822, the plot came into the possession of Henry L. Ellsworth, a prominent architect and mayor of Hartford, he erected a beautiful brick residence which was known as the Ellsworth Mansion and which still forms a part of the present structure.



Ellsworth, Professor Charles Davis, of the United States Military Academy, and Isaac Toucey, governor of the state, in turn used the mansion as a residence until 1872. At that time it was bought by an insurance company and converted to its use as a home office building. It was purchased from that company by the Hartford Steam Boiler Inspection and Insurance Company.

The buildings has been enlarged and modernized several times during the past fifty-nine years, but even today the part that formed the Ellsworth Mansion is distinguishable because of its narrow English brick.

While the new building is under construction the home office personnel will lease other quarters, and there will be no interruption of business.

Bursting Diesel Cylinder Injures Men

Newspaper accounts of a recent accident aboard a British submarine in which six men were injured, one of them seriously, give as the cause the explosion of a Diesel engine cylinder. The press reports are not specific in their explanation but they suggest that bursting of the cylinder may have been brought about by overheating and consequent seizing of a piston, a type of accident to which these engines are inherently subject.

F. G. Parker Made Assistant Chief Inspector

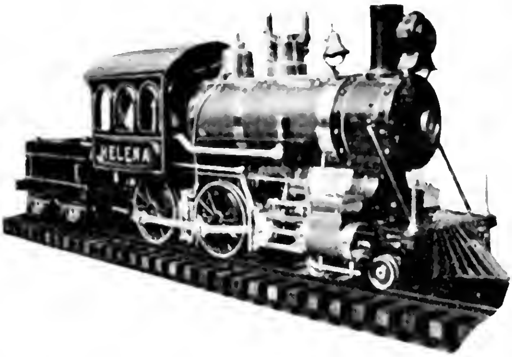
Announcement of the appointment of Mr. Frank G. Parker at the first of the year as Assistant Chief Inspector for the Denver Department was received at the editorial desk too late for inclusion in the last issue. It is with pleasure that we publish that information now. Coming with the Company in July, 1925, as an inspector, Mr. Parker was in 1928 made office assistant to Chief Inspector Webb of the St. Louis Department. His competent handling of the important matters entrusted to him while serving in that capacity demonstrated his qualifications for the post to which he has been advanced.

A Locomotive Model With Remarkable Detail

COPIED with remarkable exactness from the American-type locomotive that was at one time in common use on almost all railroads for light, fast passenger service, the miniature working model shown here was built by Mr. Robert Fisher, master mechanic of the Copley (Pa.) Cement Manufacturing Company. Three years of spare-time, averaging fifteen hours a week, were required to manufacture and assemble the parts. The amount of detail work involved in the undertaking will be evident from the following description:

The locomotive measures three feet in length without the tender, stands eighteen inches above the rails, and weighs 200 pounds. It has a Stephenson link valve gear, a double-feed hydrostatic lubricator for cylinder lubrication, steam brakes, spring equalizer, automatic couplers, standard waste-packed cellar boxes for the journals, and sanding equipment. The throttle valve is located within the dome and is of balanced, double-seated construction, the throttle rod being carried through the boiler head and attached to the throttle lever in the cab, as in standard practice.

The boiler is 5½ inches in diameter, 26 inches long, and is made of double-riveted lap-joint construction from eighth-inch steel plate. Twelve ¾″ copper tubes form the flues, water-legs are supported by 180 stay bolts, and the 7″ x 9″ firebox is fitted to burn either coal or liquid fuel. Steam is supplied to the cylinders by means of a dry-pipe, which passes through the front head, just as in modern, full-size engines. Boiler attachments consist of a quarter-inch safety valve loaded to blow at 90 pounds, a water glass, steam gauge, a ⅜″ blow-off, and a ⅜″ injector feeding into the side of the barrel through the conventional locomotive check-valve. With the exception of the steam gauge and the



injector, every part that went into the building of the engine was made by Mr. Fisher.

We are indebted for the photograph and description of the engine to Inspector E. C. LeGates who, in transmitting them to us, called attention to the fact that in many respects the "Helena" resembles the old "Comet" pictured in this Company's seal. However, the "Comet" has large drivers and a wood-burner type stack.

Watt Devised Basis for Figuring Horsepower

THAT the horsepower bears some approximate relation to the working capacity of an average horse is generally understood, but how many of our readers are acquainted with the following version of how a horsepower was fixed at "33,000 foot-pounds per minute"? According to the *Stone and Webster Journal,* an automobile owner, realizing how hazy his notion of the term "horsepower" was, recently did some investigating and uncovered these facts:

The horsepower unit was formulated about 1780, soon after steam engines were developed to a point where they could be put to practical use. Many of the early engines for use in the mines, mills, breweries, and distilleries in England were made by James Watt, and in most cases they replaced horses which had been previously used to develop power. It became necessary for Watt to devise some striking and easily understood illustration of the power of his engines and the work they could perform, in order that he might give customers and prospective users an idea of the adaptability of his machines to their uses. Since the engines were to replace horses he talked of the power of his engines as compared to the power of a certain number of horses.

In "Watt's Blotting and Calculating Book" under date of August, 1782, we read: "Mr. Worthington, of Manchester, wants a mill to grind and rasp logwood and to drive a calendar, the power for all of which is computed to be about that of twelve horses. Mr. Wriggley, the millwright, says a mill-horse walks in a circle 24 feet in diameter and makes 2½ turns per minute. Two and a half turns equals 60 yards per minute, say at the rate of 180 pounds per horse."

By translating the 60 yards into feet and multiplying by the 180 pounds assumed by Watt as the "drawbar" pull of a millhorse, we get 32,400 foot-pounds per minute as a horsepower. Watt used this figure in his calculations but later, evidently for the sake of having a round number, fixed 33,000 as the basis for designing his engines. This figure is the standard today.

How nearly the quantity now accepted as a horsepower comes to equalling the rate at which a horse can work would seem to depend somewhat on the accuracy of the figures Watt used as the basis of his reckoning. If Wriggley and Watt were correct in assuming that an average horse would walk two and a half times a minute around a 24-foot circle while exerting a pull of 180 pounds on the "whiffletree," then our figure for the horsepower has, apparently, a fairly rational basis.

Death Takes Pioneer in Turbine Development

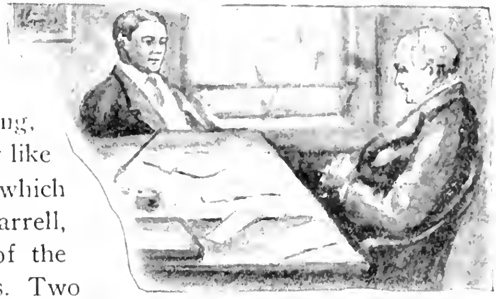
BEFORE the time of Sir Charles Parsons, whose death occurred in February, many attempts had been made to utilize steam in machines based on the rotary principle, but these rotary engines had not been able to compete in efficiency with the then highly developed reciprocating engine. Thus, although the statement sometimes made that Parsons invented the turbine is not strictly true, it must be acknowledged that he and DeLaval were the ones to whom must be accorded the largest credit for developing the turbine to practical usefulness.

Parsons commenced his work on turbines in 1884 while associated with a firm of British engineers. His first turbo-dynamo sets were small ones for ship lighting, operating at speeds of between 14,000 and 18,000 rpm. Later, on going into business for himself, he turned his attention to larger units, building several machines for utility lighting plants.

Strange as it may seem now, one of the factors that slowed Parsons' progress was the absence of a demand for high-speed machinery. Direct current electricity was then standard and the speeds obtained by reciprocating engines seemed more suitable for dynamos than were the high speeds of turbines.

However, with the advent of alternating current generators high speed came into its own. A handicap in Parsons' early years, it is now the very thing that permits the generation of enormous quantities of power in a machine that would be a pygmy alongside a battery of enough large reciprocating engines to afford the same output.

Taps From the Old Chief's Hammer



IN SPITE of a partly open window through which floated a breath of warm air suggestive of Spring, a dense cloud of smoke hung like a canopy over the desk at which sat the Old Chief and Bob Darrell, the young works manager of the Balsam Creek Wire Works. Two brier pipes, both stoked with a special mixture from the Chief's humidor, were working at capacity, and an unmistakable air of good fellowship pervaded the room.

The friendship between the Chief and old Phil Darrell, father of the present visitor, had been one of long standing. In fact, it dated back to the days when the Chief was on the road as a boiler inspector and Phil Darrell was foreman in the wire works boiler room. The warmth of the relation then born had in no wise diminished as the passing years saw the inspector rise to the head of his department and the boiler room foreman become works manager. So the pang of regret experienced by the Old Chief when ill health eventually forced his friend to retire from active duty was somewhat softened by an announcement of the mill owners that Darrell's oldest boy, Bob, was to be appointed to the position.

Thus it was that the mantle of the old man's friendship fell naturally upon the burly shoulders of young Bob who, appreciating the Chief's broad knowledge of power plant matters, availed himself frequently of advice that was always given freely and cheerfully.

However, young Darrell had not come up through the power plant as had his father before him. Consequently there were times—particularly when he was crowded by a full production schedule—when he wondered whether the old fellow wasn't just a bit over-zealous in the sort of inspections he demanded of his inspectors. Not that Bob didn't want things safe around the power plant, of course, but he rather thought that the insurance company, as represented by the Old Chief, was causing a little unnecessary delay and inconvenience sometimes by being more thorough than conditions warranted. Because of this feeling, he was prone to stall for time when a request was made to have a boiler prepared for inspection. Usually it required two or three reminders from the Chief's office before Bob took steps to see that his own engineer got a boiler ready for an inspector to go to work on.

Finally a condition arose in which the Old Chief, after several fruitless requests, became peremptory in his insistence that brickwork be taken down so as to permit a thorough inspection of the heads of certain old mud drums. It happened that this request came at a time when an accumulation of small troubles at the plant was weighing heaviest on the young man's mind; so, piqued at what he thought was a somewhat unreasonable attitude on the Chief's part, he appeared at the office to argue the thing out. However, he finally acceded to the old fellow's request. It was well that he did, for when the brickwork was dug away it was found that the blank mud drum heads on two companion boilers were badly thinned by corrosion at the turn of the flange—so much so that small cracks had started in a place or two. Darrell needed no persuasion then to convince him of the urgent need of replacing the heads and, being too much of a chip from the old block not to admit his error, he made a point of calling on the Chief next day to apologize for his previous failure to cooperate.

"What I can't understand, though, Chief," he declared, "is why those heads should have gone like that. I'm not a power plant man, as you know, but it seems to me that there shouldn't be much opportunity for external corrosion where the heads are so well protected by masonry."

"Bob, my boy," smiled the older man, leaning back and placing his hands behind his head, "that's a natural question. Ever since I've been in this business I've had trouble making boiler owners understand the necessity of tearing down brickwork once in a while so we can take a look at what's going on underneath it. However, any power plant man—your dad, for instance—knows what the danger is with those old-style shallow heads.

"As a matter of fact, several things play a part in causing the heads of mud drums to deteriorate. Corrosion contributes toward it; the flexing in and out of the head under varying pressure has a share in it. Just about every coal that's mined contains more or less sulphur which burns and mixes with the soot and ashes as sulphur dioxide. Combined with moisture this sulphur dioxide forms sulphurous acid, and that acid is extremely corrosive on steel or iron.

"No matter how well the head of the mud drum is sealed into the brickwork by asbestos, sooner or later the asbestos crumples out. Then soot, carrying sulphur dioxide with it, begins to filter back into the space between the head and the brickwork. This soot will absorb moisture almost like a sponge and it isn't long before sulphurous acid gets to work on the steel.

"Now, take those mud drum heads in your boilers. They're of the old design, somewhat flat, and because of that the head acts like a diaphragm, 'breathing' in and out as the boiler pressure fluctuates. Now-a-days they're bumping heads to a shorter radius and decreasing the knuckle so as to get away from that action as much as possible, but whenever the head can come and go with the pressure it tends to set up bending strains at the knuckle, as you can see. That's the reason the corrosive action is more pronounced at the knuckle, for each time the head flexes, a little of the rust scale flakes off and exposes fresh metal for the acid to work on. Another factor is that the thinner the knuckle becomes the more flexible the head gets to be. By and by the bending causes cracks, and if things go on long enough the head goes out some fine day and scatters the boiler-house and a few workmen all over the landscape.

"Of course, this matter of having trouble getting the owners' consent to remove brickwork so as to permit us to look at these heads is something we're up against all the time, although I don't think it's as bad now as it used to be. The condition represents just one of the many kinds of structural weaknesses which, although they can't be seen when the boiler is all set up, it is our endeavor to find. All in all, I'd say we get pretty good cooperation from plant men in taking out rivets, removing lagging, and cutting away brickwork so that we can really examine hidden parts, but—just as in your case—now and then someone who doesn't understand just what we're looking for and why we're looking for it, balks at the extra time such an examination takes.

"By the way, though, that reminds me of an inspector I knew years ago who had his own way of handling a situation wherein he and an owner disagreed at the advisability of operating a dangerously cracked boiler.

"One of the plants on Jenkins' route was a stave mill, away out in the country. The boiler happened to be an old one of lap-seam construction and the first thing that struck Jenkin's eye that morning was the fact that leakage had been taking place along the seam. He investigated further and found unmistakable evidence of a lap seam crack. I don't know whether you appreciate just how serious a thing like that is, but anyone who operates a boiler with such a defect is just clamoring for election to the suicide club. Well, anyway, this particular mill owner didn't know a lap seam crack from a broken grate bar, so he just wouldn't listen when Jenkins told him the boiler couldn't be fired up.

He'd been using the boiler for a good many years, he said, and didn't understand why it should suddenly become unsafe.

"Seeing that argument was not going to get him anywhere, Jenkins washed up, changed his clothes, and left. The first chance he had, which was at the nearest small town, he 'phoned his chief inspector and made a report, asking what should be done. Of course, the only thing that could be done under the circumstances was to suspend insurance but, thinking of the folks at the mill, the chief inspector urged him to go back and again try to argue the owner out of his foolhardy plan.

" 'Oh, I'm not worried about him using the boiler for a few days,' Jenkins said.

" 'But I thought you told me he was planning to fire it up right away,' exclaimed the chief, surprised.

" 'Sure, he intended to, all right,' the inspector explained, 'but he can't until he gets another hand hole cover. I've brought his away in my tool bag.'

"Of course, the company doesn't condone the method old Jenkins used, but he was such a conscientious fellow that I don't believe he drew a very severe reprimand for this particular case. After all, it was the boiler owner's interest he had in mind."

Build Experimental Boiler for 3,500 Pounds

The first boiler in this country to be used at 3,500 pounds pressure has been built by the Babcock & Wilcox Company for Purdue University. It is an experimental model with which the engineering department of the university plans to investigate steam at and above the critical pressure—the point at which steam and water have the same density.

High Thermal Efficiency of Mercury Unit

It is interesting to note that while the best long-period record for steam stations last year was a kilowatt-hour of electrical output on 12,455 Btu, the mercury boiler at Hartford was reported to have averaged a kilowatt-hour on 10,310 Btu over a period of 10 months. However, the overall station showing is probably not quite as far in favor of the mercury turbine as this comparison would seem to indicate, for the latter must bear a heavier overhead in the form of greater plant investment.

Caught in the Separator

ADVICE MUST BE PAID FOR

An impecunious young lawyer once received the following letter from a tailor to whom he was indebted:

"Dear Sir: Kindly advise me when I may expect a remittance from you in settlement of your account. Yours truly, J. Snippem."

The follower of Blackstone immediately replied:

"Dear Sir: I have your request for advice on a certain subject in which you are interested, and beg leave to say that not having received a retainer from you I cannot act in the premises. Upon receipt of your check for $100. I shall be very glad to look the matter up for you and acquaint you with the results of my investigation. I am, sir, with great respect, your most obedient servant. B. B. Shot."

Little Jimmie was being reprimanded by Dad for using the word "damned" and his older sister, who had recently entered high school, attempted to put in a word in Jimmie's defense.

"Why father," she said, "William Shakespeare uses words like that."

"Well", snapped Dad, "if Jimmy doesn't want a good tanning he'd better quit running around with him."

The human brain is a wonderful organ. It starts working the minute we get up in the morning and doesn't stop until we get to the office.—*Skelly News.*

"Mr. Drum, when you-all gonta pay me that ten dollahs you owes me?"

"Next week!"

"Yeah, but that's what you done tol' me last week."

"Un-huh, and that's just what I'm going to tell you next week, 'cause I'm not a man that says one thing one week and sumpthin' else the next."—*Continuity.*

BLOODLESS DUELING

"You's a liah," said Cal.

"Say dat again," retorted Wash, "and I'll bust yore jaw."

"Considah it said again."

"Considah yore jaw busted."

The Archbishop had preached a sermon on married life.

Bridget: "'Twas a fine sermon his Reverence would be after givin' us."

Maggie: "Indade, an it's meself is wishin I knew as little about matrimony as his Reverence."—*OilPull.*

"Papa", asked the little boy visitor as the Senate session opened, "why does the minister pray for congress?"

"He doesn't," replied his father. "He comes in, finds out what new ways they've figured out for spending money, and then prays for the country."

The new ash handler, thinking he was being called on to do more than one man's share of work, decided to register an indirect protest to the boiler room foreman.

"How have you got my name spelled on your list there, boss?" he asked.

"Let's see," mused the boss, referring to the list. "I've got it S-i-m-p-s-o-n."

"That's all right, then," said the ash handler. "I thought you might have made a mistake and written it Sampson."

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1930

Capital Stock, - - $3,000,000.00

ASSETS

Cash in offices and banks		$ 501,765.85
Real Estate		326,522.00
Mortgage loans		1,044,502.72
Bonds and Stocks		17,330,488.36
Premiums in course of collection		1,213,648.12
Interest accrued		158,019.59
Other Assets		13,445.96
Total Assets		$ 20,588,392.60

LIABILITIES

Reserve for unearned premiums		$ 8,956,350.39
Reserve for losses		413,085.83
Reserve for taxes and other contingencies		910,105.27
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,308,851.11	
Surplus to Policyholders,		**$10,308,851.11**
Total Liabilities		$ 20,588,392.60

CHARLES S. BLAKE, Chairman Board of Directors
WILLIAM R. C. CORSON, President and Treasurer

Incorporated 1866 — Charter Perpetual

Department	Representatives
ATLANTA, Ga. . . . . 1103-1106 Atlanta Trust Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md. . . . . 5 South St.	James P. Kerrigan, Jr., Manager. P. E. Terroy, Chief Inspector.
BOSTON, Mass., ... 4 Liberty Sq. Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., . . . 404-405 City Savings Bk. Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., ... 175 West Jackson Boulevard .	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio, . . . First National Bank Bldg. .	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, . . . Leader Bldg., ...	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER, Colo., ... 916-918 Gas & Electric Bldg.	J. H. Chesnutt, Mgr. and Chief Inspector. F. G. Parker, Ass't Chief Inspector
DETROIT, Mich., ... 2401-7 First Nat'l Bank Bldg.	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., . . . 56 Prospect St.	F. H. Kenyon, General Agent. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., . . . 1128 Hibernia Bank Bldg. .	R. T. Burwell, Mgr. and Chief Inspector. E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., . . . 80 Maiden Lane . . .	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., . . . 429 Walnut St.	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., . . . 1807-8-9-10 Arrott Bldg. .	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., ... 319 North Fourth St. . .	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., . . 114 Sansome St., . . .	C. B. Paddock, Manager. L. J. Reed, Chief Inspector.
SEATTLE, Wash., ... 707 Arctic Bldg.	E. G. Watson, Mgr. and Chief Inspector. J. W. Smuck, Ass't Chief Inspector.
TORONTO, Ont., Canada, . Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

WHEREVER there's a weak or vulnerable point there is danger. No matter how strong the cable—or the insurance plan—if it contains a weak spot it cannot be one hundred per cent. efficient. To cite an instance. A paper manufacturer, knowing well the need of engineering insurance, had taken out protection on every boiler, engine, generator, and air tank in his power house. In addition, he had secured Use & Occupancy insurance to meet the continued expenses of an idle plant in case a power house accident should tie up production.

BUT—out in his mill there was a small, variable-speed turbine driving one of the most important units of the paper making process. On that there was no insurance; the manager, when arranging for his policy, had decided not to insure it. Thus, in a plant where the value of insurance was recognized, where the management sought the strongest safeguard it could find, there was a vulnerable point that might have caused no end of trouble—chiefly because of a stoppage of production.

In this case it so happened that in again going over his insurance plan the manager realized his error and had it corrected. But what if an accident had occurred in the meanwhile—an accident that kept a vital producing machine idle for a long period?

Vol. XXXVIII No. 7 July 1931

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Disastrous Explosion Results *from* Corrosion *of* Blind Head That Was Buried *in the* Setting

CORROSION that had taken place unobserved behind the masonry in which the blind head of a mud drum was buried caused the explosion of a water tube boiler at a municipal light and pumping plant on the night of April 5. Three men were killed

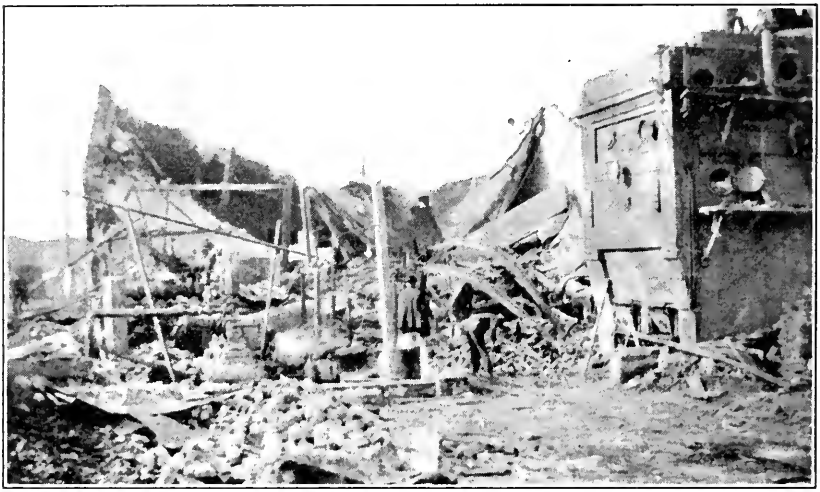


Figure 1

and three were injured. The fireman, his brother, and another workman were the ones who lost their lives; the injured were unemployed men who were in the boiler room in search of work.

The explosion demolished the boiler house and damaged the engine room to such an extent that for a short time the town was without light and the water supply was jeopardized. As an emergency measure, the town's electrical system was tapped into an industrial power plant and a locomotive was borrowed from the railroad to furnish steam for operating the water system pumps. A view of the wreckage is shown in Figure 1.

The boiler, rated at 150 horsepower, was the older of two comprising the battery. For several years the load had been carried by the newer and larger boiler, the old one being fired up occasionally to permit the cleaning of its companion. In common with many similar boilers built years ago, the vessel that exploded had drums in which the heads were bumped to a long radius with a somewhat sharp turn at the flange.

From the appearance of the head after the accident, it was suspected that the thinning of the head by corrosion had progressed to a point where cracks had started near the turn of the flange, and leakage through these cracks had encouraged corrosion at an even more rapid rate, so that the under side of the shell plate was pitted as far back as the blow-off connection.

When the explosion occurred the head tore loose from its skirt around almost the entire circumference, but remained hinged at the top where the metal had not been so deeply corroded. The shock loosened the tubes in the three top drums, the rear drum being hurled into the pump room, the center drum landing on top of a 200 kw. engine-generator, and the front drum traveling 550 feet to come to rest in a field.

Figure 2

Several weeks prior to the accident the plant engineer noticed corrosion on the under side of the shell plate and by drilling a hole through the plate satisfied himself that the metal was still sufficiently thick. However, as so frequently is the case, the place where corrosion had made the greatest inroads was on the head—and that was buried in masonry.

Throughout the country there are still in use thousands of the older water tube boilers set in such a way that the blind heads of mud drums are concealed in brick-work. Because of the expense involved it is sometimes difficult for an inspector to induce the owner to tear down enough brickwork to permit a thorough examination. Nevertheless, an occasional examination of these heads should be made for the protection of life and property against explosions such as the one described above.

The old style bumped head generally used in water tube boilers until a few years ago has a sharp turn at the flange that renders it particularly susceptible to corrosion because of the stresses set up by the flanging process and those caused by "breathing" action. When such heads are buried in brickwork, an accumulation of soot and ash will ofttimes pack between the head and the masonry. When this soot becomes moist, its sulphur dioxide content will form sulphurous acid, a substance that is very corrosive to steel.

Figure 2 is a picture of a boiler drum that had been wasted so seriously that an explosion would certainly have resulted had it been continued in service. An inspector discovered the condition at the time the boiler was offered to this Company for insurance. It will be noted

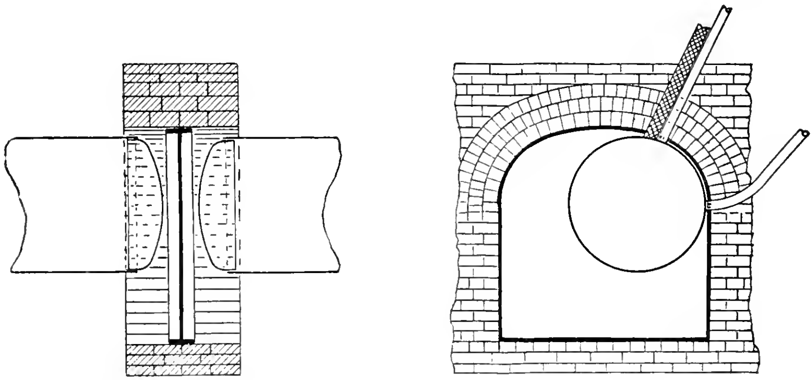


Figure 3

that the end of the shell plate had thinned down to little more than cardboard thickness. The head itself was likewise wasted and had cracked near the turn of the flange

In order that mud drum heads may be readily accessible for inspection and that there may be less opportunity for the accumulation of ash around the heads, this Company recommends the use of either a furnace wall division plate as illustrated in Figure 3 or else some similar arrangement. This plate may be made of cast iron, or of plate steel at least ¼" thick reinforced with angle irons. Not only are these division plates urged for all new installations, but it is strongly recommended that they be installed in the settings of boilers now in use where heads are covered by masonry. The expense of altering the setting is not great, and is more than justified in the interest of safety.

At Birmingham, Alabama, a residence was ruined beyond repair when, in January, a hot water supply tank exploded and shot through the roof with enough force to carry it 350 feet from the house. Fortunately, no one was at home at the time. This tank was heated by means of a gas coil.

Crack in Turbine Disc Found Just in Time

The effectiveness of the inspections of steam turbines insured in this Company was strikingly illustrated a few weeks ago when, after noting that vibration had increased considerably since his last examination of the unit while it was in operation, an inspector was able to point out as the cause a disc so badly cracked that an explosion would have been inevitable had the machine been continued in service.

At the time of his "in motion" inspection, the inspector called the owner's attention to the seriousness of the vibration and asked that turbine specialists be called in to unhouse the unit and make such repairs as they found necessary to eliminate the trouble. After the machine had been opened, the inspector took advantage of the opportunity to make an internal examination. It was then that he found the crack, which extended between two steam equalizing holes and gaped open almost a sixteenth of an inch.

That the crack was not discovered immediately by the men who opened the machine was due to the fact that, in coming to rest, the rotor stopped with the cracked part of the disc underneath the shaft.

Quick Action by Engineer Saves Turbine

The alertness of an operating engineer in a large utility plant undoubtedly prevented a turbine accident of major proportions recently. Noting what appeared to be excessive vibration in a 25,000 kw. machine, he immediately shut it down and cut another unit into the line. When the top half of the casing was removed it was found that ten buckets of the eighth stage had become dislodged and had ripped out the shroud bands. The buckets had broken off at their roots and in wedging between the disc and the diaphragm had buckled the latter. As a result all the buckets of the eighth and ninth stages were distorted, with small pieces broken off.

But for the engineer's prompt action the machine probably would have destroyed itself. Instead of involving a repair bill of about $12,000, the accident might have necessitated replacement of the turbine.

Two men were painfully scalded in their home at Bridgeport, Pa., on January 29 when a section of their cast iron heating boiler cracked and sprayed them with hot water. Alarmed by a sharp knocking in pipes on the upper floor, the men had gone to the basement to investigate the cause. They were standing close to the boiler when the section cracked.

Interesting Points Developed Through Investigation *of the* Seams *of* Wood Pulp Digesters

By J. P. Morrison, *Assistant Chief Engineer, Boiler Division*

THE wood pulp digester explosion at Berlin, New Hampshire, late in 1930, which resulted in the death of two men, the serious injury of five people and a total loss reported to exceed $350,000 emphasized the immense amount of energy (approximately equal to 500 lbs. of T. N. T.) stored in such a vessel under usual operating conditions. It also served as a reminder of the fact that in the operation of a digester a thin brick-cement lining of unknown condition and a thin steel plate of unknown condition and material, are the only bars to death and destruction.

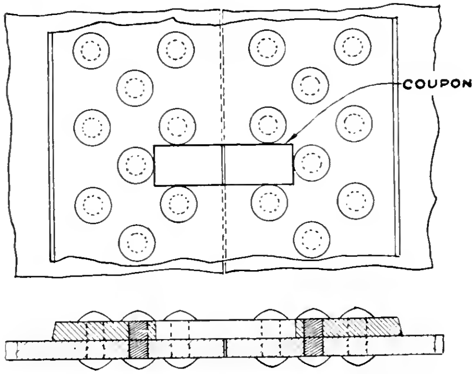


Figure 1

The Locomotive of April, 1914, carried an account of the explosion of a wood pulp digester at Grand Mere, Quebec, which occurred Dec. 22, 1912. That explosion led to an extensive investigation of the physical and chemical properties of the material in which failure took place and a careful analysis of the stresses due to the eccentric load imposed upon the seam of single butt-strap construction which was used in the manufacture of the digesters both at Grand Mere and at Berlin. Although seams of double butt-strap construction, instead of single strap seams, have been used in the fabrication of such vessels built in recent years, a considerable number of old digesters with single-strap seams remain in service, many of them insured in this Company. In view of that, and as the recent explosion in New Hampshire confirmed this Company's previous action in advising owners that age and conditions of operation might be leading to changes in the structure of the metal, particularly at the seams, this Company undertook an immediate investigation of a large number of such vessels. It will be the purpose of this article to describe briefly the manner in which that investigation was conducted and to point out several interesting conclusions resulting therefrom.

The lining of a digester for the sulphite paper pulp-making process usually consists of two courses of special acid proof brick with a silicate-cement backing to protect the steel plate from contact with the acid liquor. This brick lining, if intact, serves the purpose of protecting the shell, but if disintegration or cracking permits the liquor to reach the shell, corrosion immediately becomes active. If the break in the lining permits a circulation of liquor along the shell plate, the corrosion may impair the safety of the vessel in a short time.

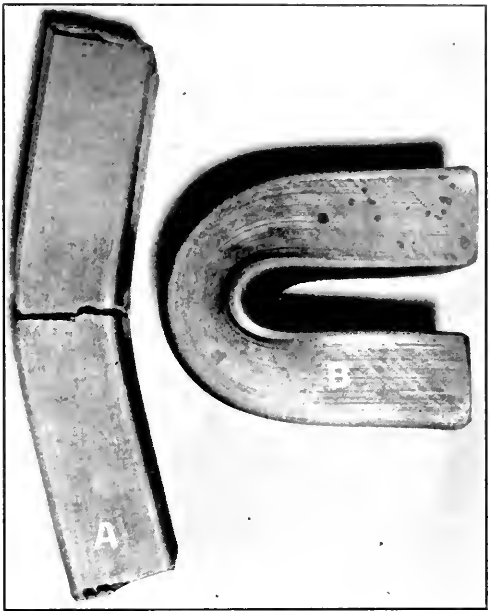


Figure 2

While serving a most useful purpose in protecting the shell from corrosion, the lining expands as the charge of wood and liquor heats and thus sets up stresses in the shell plate which may be greater than the stress due to the internal steam pressure. These stresses are further complicated by the lack of conformity to a true circle, or the slight out-of-roundness of the shell plate.

Coupons for Testing

After a vessel has exploded, the parts are available for a thorough examination. However, investigation of the material of the unexploded vessel which is under suspicion but which is to be continued in service if found to be satisfactory, involves the removal of a specimen of sufficient size for the determination of its chemical and physical properties, without materially weakening the structure. In determining the procedure for the investigation just completed, the decision to remove two test coupons from each longitudinal joint butt-strap was reached after a consideration of all the items pertinent to the problem. A coupon such as illustrated in Figure 1 was cut from the butt-strap at a point one-third the length of the strap from each girth seam, and although in theory we would expect the greatest barrelling effect to occur in the longitudinal seam midway between the girth seams, the results of this investigation have justified the plan followed.

The size of the specimens was controlled by the spacing of the rivets and they varied from 2½"x 7" to 1"x 4". Of course, in each case the specimen had a thickness equal to the thickness of the butt-strap from which it was taken. The coupon was removed by drilling or milling in preference to cutting with a torch as it was considered that the heat resulting from the use of a torch would produce a change in the structure which might affect the physical characteristics of the test piece.

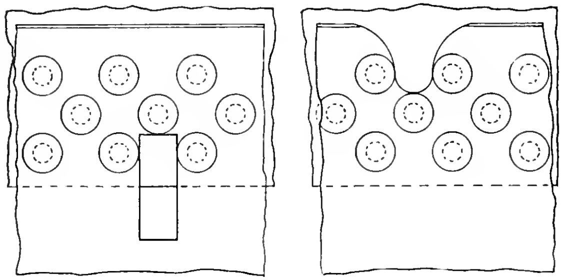


Figure 3

Tensile and Bend Tests

Coupons were planed into rectangular shape with rounded edges for the bend test, or were turned into standard .505" diameter tensile test specimens to determine the yield point and ultimate tensile strength.

A comparison of the results of many tests shows that steel plate of flange or fire box quality manufactured a number of years ago may be judged as dependable or otherwise by the bend test and, with the exception of such other tests as were needed to check the results, the bend test was relied upon unless the coupon and butt-strap from which the coupon was removed were corroded to such an extent that the removal of the strap was necessary regardless of its physical and chemical properties.

Bend tests were conducted at various institutions where proper equipment was available. A coupon was placed with its inside face upon a "V" block or similar device and, by means of a mandrel having a diameter equal to the thickness of the coupon if 1" or less and equal to twice the thickness of the coupon if over 1", pressure was applied to the surface which had formed the outside face of the strap. Thus in bending the coupon the arc of greatest curvature was imposed upon the face which, as the inside surface of the strap, had been subjected to the greatest stress as the result of the eccentric loading, the out-of-roundness, and the decrease in thickness where active corrosion had taken place.

While a bend test of new material of the grade used in digester construction requires that the bend extend through 180° of a circle it was decided to subject the coupon to a 90° bend and discard as unsatisfactory those butt-straps from which coupons failed to stand the test. In special cases where the coupon had not failed before a 90° bend was reached, the test was continued to 180° with or without the mandrel, as judged best to develop the point of special interest in that particular test.

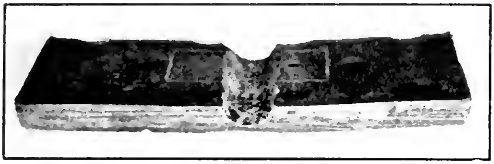


Figure 4

Test Results

Figure 2-A illustrates a coupon 1¾″ wide by 6½″ long by 1 3/16″ in thickness, which required an initial stress of 65,000 lbs. to produce distortion between 5″ centers but which snapped short when the bend had reached 15°. Figure 2-B shows a similar coupon cut from a digester built by the same manufacturer at the same time and possibly of the same grade of material, which did not develop fracture although bent to 180° over a mandrel having a diameter equal to one-half the thickness of the coupon. These two specimens illustrate the great degree of variation represented by the eight hundred specimens tested. Figure 2-A was a coupon about normal in carbon but high in phosphorus and sulphur. That condition existed in general in those coupons which failed before a 90° bend was reached. The amount of sulphur in one case was .079% and the amount of phosphorus in another case was .066% with the carbon .075%.

Some of the coupons which were bent to 180° without fracture had physical properties well within the requirements for fire box steel but were low in carbon and high in phosphorus as compared to fire box requirements.

The stresses due to the working conditions appeared to have affected the physical properties of the material to the extent of causing brittleness or fatigue corrosion near the outside surface of the coupon, while a .505″ diameter test specimen cut from the center of the coupon possessed all the physical characteristics considered essential for flange or fire box steel. It cannot be said that this condition exists in every case, for the records we have obtained of the investigation of material which failed when a digester exploded have indicated the reverse condition. That is, the center of the strap was brittle while the material near the surface of the strap was quite ductile. Segregation of the im-

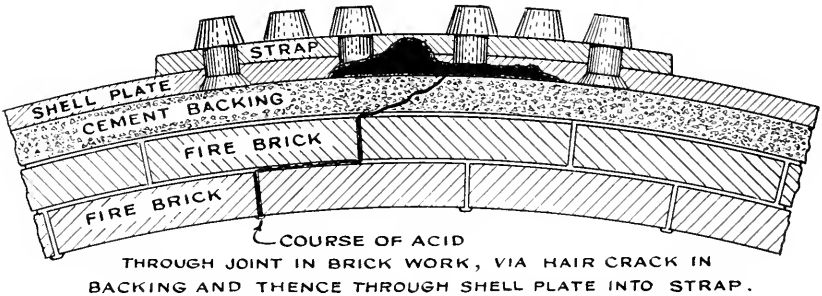


Figure 5

purities during the steel manufacturing process apparently has a determining influence on this, as tests show that there is a great variation in the chemical properties as well as in the physical properties of coupons cut from the same strap.

Quite similar tests were instituted to determine the condition of the digester joint of lap-seam construction, a design subject to lap joint crack with which the users of pressure vessels have long been familiar and which caused the use of the lap joint to be discontinued in the construction of large high-pressure boilers. The location of the coupon and the manner of notching the caulking lap to permit the examination of the under sheet for possible cracks is illustrated in Figure 3.

Effects of Corrosion

The action of the sulphite liquor upon the steel of which the digester is constructed has been referred to, and of course the break in the lining which permits the acid to reach the shell may occur at any place. However, it appears that it is most likely to take place at or near the longitudinal joint, possibly due to the change in form as the operating temperature and pressure vary. Many of the coupons were so severely weakened by corrosion that the removal of the strap was necessary. Except in special cases no attempt was made to determine the chemical or physical properties of those corroded coupons.

A section of a corroded butt strap is shown in Figure 4. The strap was of material 1 3/16″ in thickness but reduced to ¼″ where a break in the lining had permitted the acid to reach the shell. The shell plate was similarly grooved, and corroded to a less extent over a considerable area as indicated by the sketch in Figure 5.

The section photographed is from the most seriously corroded strap discovered, although breaks in the linings of several other digesters had permitted the acid to reach the shell and cause such severe corrosion that the linings had to be completely removed in order to permit a thorough examination of the inner surface of the shell plate.

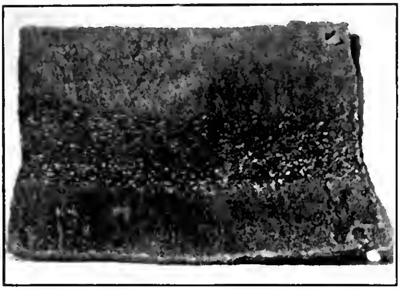


Figure 6

Tell-Tale Holes

This type of deterioration has been recognized for many years and can be detected by the use of tell-tale holes before serious damage has been done to the shell plate. The tell-tale hole is ½″ in diameter, drilled through the shell plate on 12″ centers. Those in the butt-strap should pass through the abutting edges of the shell plate and through both butt-straps where the seam is of double strap construction. The brick-cement lining, if tight, prevents leakage of the liquor, but if the lining is not tight the leakage through the tell-tale holes will not only indicate the presence of a break in the lining but also give a fairly definite idea of its location. A number of digesters have been provided with tell-tale holes on 12″ centers, while in other cases 24″ and 36″ centers have been used. Of course, the 12″ spacing is preferable, but 24″ and even 36″ spacing for tell-tale holes is better than no tell-tale holes at all. However, the slightly greater expense of placing the tell-tale holes on 12″ centers is more than justified by the increased probability of the early detection of leakage. Those tell-tale holes may be staggered longitudinally to advantage just as rivets are staggered in longitudinal seams.

Soda and sulphate digesters are unlined, for the liquor is presumed to be alkaline and thus non-corrosive. However, while this investigation was not primarily intended to include digesters of that kind, it led to the discovery of several which had been weakened to a dangerous extent as the result of corrosion at the head flanges or adjacent to forge welded seams. While the stresses due to the fabrication of the vessel made the material susceptible to the effects of fatigue corrosion, there was also a decided appearance of an acid action. A photograph of a seriously affected section of a sulphate digester is reproduced in Fig. 6.

Reconstructed Seams

The repair of the digester having a defective butt-strap presents quite a problem. A lining which has been disturbed to the extent necessary to remove the old outside butt-strap and install new double butt-straps cannot be dependably repaired, as leakage is likely to occur through the new joints. So when one strap is defective, its renewal can be accomplished most satisfactorily only by the removal of the entire lining. This increases the repair expense to an extent justified only by the reconstruction of all the longitudinal seams of the cylindrical section of the digester by using inside and outside butt-straps. The old single-strap in general had but six rows of rivets, three on each side of the abutting edges of the shell plate, and all rivets were in single shear as will be noted from Fig. 1.

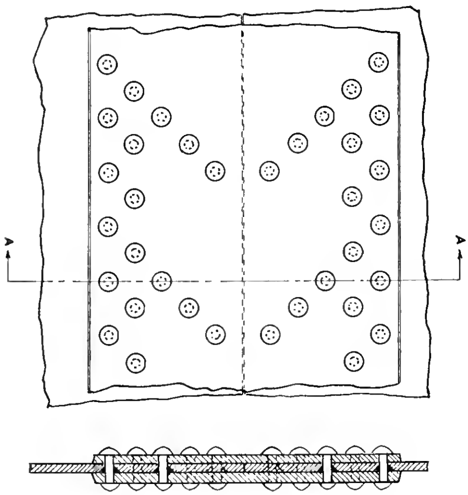


Figure 7

The reconstructed seam used more frequently in cases where this Company's investigation revealed the necessity for repairs is wider than the old seam and includes two additional rows of rivets on each side of the joint. As there is an inside and an outside butt-strap, rivets are in double shear so that it is possible to use a smaller rivet and thus produce a stronger joint. Use of the wider butt-strap has the additional advantage in each case of placing the additional rivet hole in a section of the shell plate where the metal has not been weakened either by corrosion or by stresses caused by the eccentric loading of the old seam.

Inside heads of the rivets of the old seam are driven into the countersunk holes which seem to have been necessary when sulphite digesters were lined with sheet lead, although the cement backing to the brick lining used in modern practice permits the use of button head rivets. The strength of the rivets in the two additional rows at each side of the joint is sufficient to carry the normal operating stresses with safety, so in designing the new butt-strap the old rivet holes through the shell plates are disregarded except to the extent necessary to use them to hold the butt-straps and plates firmly together near the center of the joint. The number of those rivet holes used does not exceed 30% or 35%, as shown in the illustration of the reconstructed joint, Figure 7.

Conclusions

It may be said that one important result of the tests was to emphasize the necessity of using material of flange or fire box quality, properly stamped for identification, and accompanied by a mill test report. Another conclusion established was that the single strap butt-joint as well as the lap seam joint are not dependable when used in the construction of large vessels of plate 1″ and upward in thickness. In such cases the seam should be of double butt-strap riveted construction or be welded by a process complying with "Hartford Steam Boiler" requirements.

With reference to the groove resulting from corrosion it should be noted that it decreases the strength of the plate in proportion to the amount of metal removed. In fact, a groove having a depth 10% of the thickness of the plate or even less affects quite seriously the ability of the material to withstand the bending and shock encountered in operation. The lining of a digester must be tight to prevent the liquor from reaching the shell.

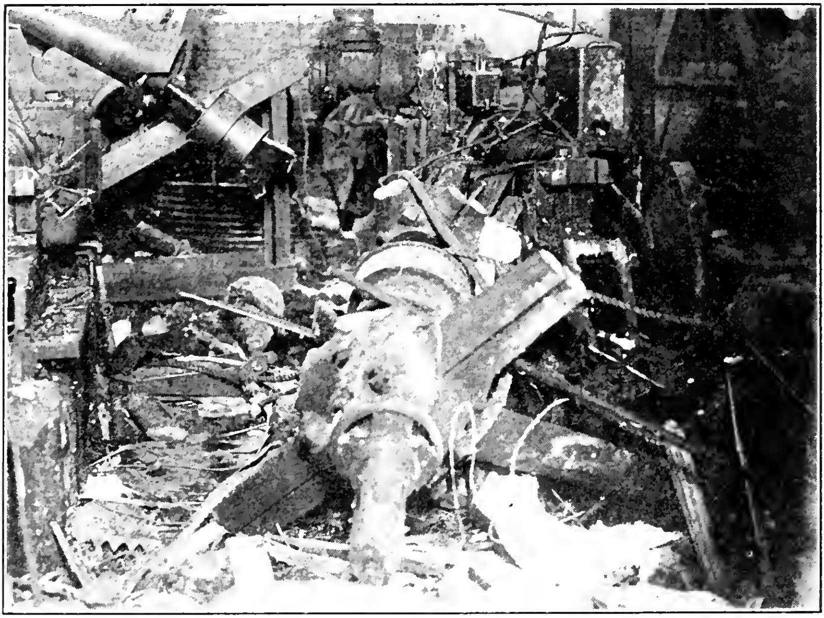
Tell-tale holes, such as described, are necessary to decrease the hazard of digester operation. If the vessel is lined, these holes should extend through the shell plate. If the vessel is unlined the holes should extend from the outer surface into the plate a distance representing the minimum plate thickness permitted when not taking into consideration the seam efficiency. And in all cases, if the holes are to be of any value, attendants must exercise care to see that they do not become obstructed.

On Burning Oil Fuel

Set the burners open wide; do not touch the valves at side; keep the pressure on the pump and up the bally steam will jump. If the smoke is black and thick open up the fans a bit. If the smoke is thick and white, to slow the fans will be quite right, for when sufficient air is given no smoke ascendeth up to Heaven. If the jets refuse to squirt, assume the cause is due to dirt. Should the flame be short and white you have combustion clear and bright, but should the flame be yellow and long combustion is entirely wrong. A wise man to his heater sees and keeps it at 10 score degrees. To have it more is not quite wise, because the oil may carbonize. A little lower has been found to give as good results all round. If the filters are kept clean no rise in pressure will be seen, but if the pump kicks up a ruction there's likely air within the suction. The pressure governs the supply, so do not keep it very high. If these instructions you will follow, you'll beat the other fellow hollow. (Author Unknown)

Flywheel Wreck Tears Engine to Pieces

THE accompanying illustration is a picture of the wreckage of a paper making machine engine after overspeed exploded both the balance wheel and the rope wheel. The engine shaft was ripped out of the bearings and, with the exception of the cylinders, the machine was completely demolished. Flying parts damaged the building, other machinery and stock in process.



The engine was of the 2-cylinder, variable-speed type, speed variation being obtained by means of a pair of adjustable-belt cone pulleys which transmitted the motion of the engine to the governor through still another belt. This latter belt supported an idler pulley on an arm so arranged that in case this belt broke the pulley would drop and cause the governor valve to close. In addition, the engine had on the flywheel as protection against overspeed a lug which was intended to move outward as speed reached a predetermined limit and strike a trigger that would close a weighted butterfly valve in the steam line.

An investigation after the accident led to the conclusion that the trouble started by breaking of the belt between the two cone pulleys. This threw the engine out of control of the governor and allowed it to speed up. Normally the overspeed trip on the flywheel should have closed the butterfly valve and shut off steam before the engine reached a bursting speed, but evidently it did not function. An attendant who was at the throttle, trying to close it, when the wheels let go, was knocked down and stunned. However, he was fortunate enough not to be caught directly in the path of the flying parts.

Seek to Explain Explosion in Compressor

INVESTIGATORS who sought to determine the cause of a recent explosion in the cylinder of an ammonia compressor after the machine had been standing idle for six weeks have not found it easy to explain the accident.

The compressor was of the 2-cylinder, vertical type. Two mechanics were adjusting the cross heads in preparation for putting it back into service. In order to move one of the crossheads to a more accessible position one of the workmen opened the discharge valve slightly while his companion applied a bar to a slot in the flywheel. Just as they started to turn the wheel there was a severe explosion that broke the cylinder head and the crank disc.

There seems to be no question but that a detonation of some explosive substance took place inside the cylinder, and it would seem probable that this substance was a mixture of ammonia gas and air. When the machine was shut down for a six-weeks period the chances are that it was pumped out. Very often a partial vacuum is obtained in compressor cylinders during this process, so that air will tend to enter through any point of leakage, such as a stuffing box. The ammonia that was admitted when the mechanic opened the discharge valve could have completed the explosive mixture.

A much harder thing to explain is how this mixture could have been ignited. The spark, if there was one, may have come either from abrasion of the piston on the cylinder wall or else from a discharge of static electricity, although it cannot be stated with any degree of assurance that the conditions necessary to bring about a spark from one of these causes actually existed. However, it is interesting at least to consider the possibility that the piston may have been separated from the other metallic parts by a film of gummy oil which functioned as a dielectric and permitted the building up of a static charge in the piston when the latter was swept over by the fine jet of gas from the partly open discharge valve. Or, as has been suggested, during the period in which the machine was idle a little ammonia left in the cylinder may conceivably have reacted with the lubricating oil to form some strange, unstable compound which required merely a shock to detonate it.

Conjectures of this nature are revived every time an accident of this kind occurs, but up to the present at least there has been no satisfactory proof that the accidents were due to either static discharges or to the setting off of some unknown ammonia-oil combination by shock. In any event it would seem to be a wise rule for operators to avoid setting in motion a compressor that has been idle for some time without first purging the cylinders of foreign gases and air.

Another recent case involving explosion of an ammonia-air mixture was not so difficult to explain. This accident came about through the rupturing of a part of a compressor when the operator started it up with the discharge valve closed. The operator immediately ran to a switch to shut down the motor, and at the moment he broke the electric circuit there was an explosion which, with the ensuing fire, caused damage estimated at $75,000. There seems to be no doubt that a spark from the switch ignited a room-full of ammonia gas and air which were present in proportions constituting an explosive mixture.

May Restore Country's Largest Water Wheel

According to the *New York Herald-Tribune* there is a move under way to restore the famous old 'Burden" water wheel at Troy, N. Y. Unused since 1898, the wheel has gradually fallen apart, but a group of electrical engineers interested in its restoration say there is enough left to make rebuilding practical.

The wheel was built nearly a century ago and was the largest in the United States. It was surpassed in size by only one other wheel in the world, the wheel on the Isle of Man. Generating 1,200 horsepower, the wheel, flooring and shafts weighed more than 225 tons. It was sixty feet in diameter and held thirty-six buckets, each of which was twenty feet wide and five feet, nine inches deep. It ran the entire plant of the Burden Iron Works which then employed 1,800 men.

The wheel operator regulated the flow of water to the wheel from Burden Pond, approximately 2,500 cubic feet a minute being available. When the supply of water became uncertain the wheel slipped into disuse and souvenir hunters have removed so many of the parts that once went to make up its mighty whole that there remains only a bare hint of its original majestic outline.

Recent Explosions of Heating Equipment

CLOSED stop valves between a hot water supply heater and the storage tank on which the relief valve was located cost a man his life on the afternoon of March 27 when the heater exploded while he was examining it to determine why it did not function properly. The accident occurred in an apartment building at Leonia, N. J.

According to newspaper reports, the heater had just been overhauled. It was thought likely that workmen closed the valves to prevent water in the tank from draining out through the heater while they had the latter open, for the valves were found closed after the explosion.

Another somewhat similar accident in an apartment building in New York City on March 18th sent several persons to the hospital for treatment. As in the case cited above, the cast iron water heater had no relief valve but was connected to a storage tank, on which there was such a valve, by means of a discharge pipe and a circulating pipe. Stop valves in these lines were found tightly closed after the accident.

Two men were injured, one so seriously that it was necessary to amputate a leg, when a cast iron hot water supply boiler exploded in the basement of an apartment house in Garden City, L. I., on February 15.

Seven persons had narrow escapes when a coal-fired steam heating boiler of the round, cast iron type exploded in a residence at West Ottawa, Illinois, lifting the floors, shaking down plaster, and tearing outer walls of the house loose from the framework. Examined after the accident, the safety valve disc was found corroded fast to its seat.

According to the owner, he went to the basement to throw more coal into the furnace about ten minutes before the blast. While there he noticed that the pressure gauge stood at 2 pounds. Whether the gauge was defective or not could not be determined, for it was crushed in the explosion. However, the extent of the damage was sufficient to prove that considerable overpressure existed at the time of the accident.

According to newspaper accounts, an explosion of a hot water tank in the main kitchen of an institution at Lawrence, Mass., early in March, injured one person and shook the building considerably. Fifty women patients were in a room directly over the kitchen at the time.

The tank was of copper and was connected to a coal-fired kitchen range. It was thought that the explosion was due to the stopping of the feed line by rust or sediment.

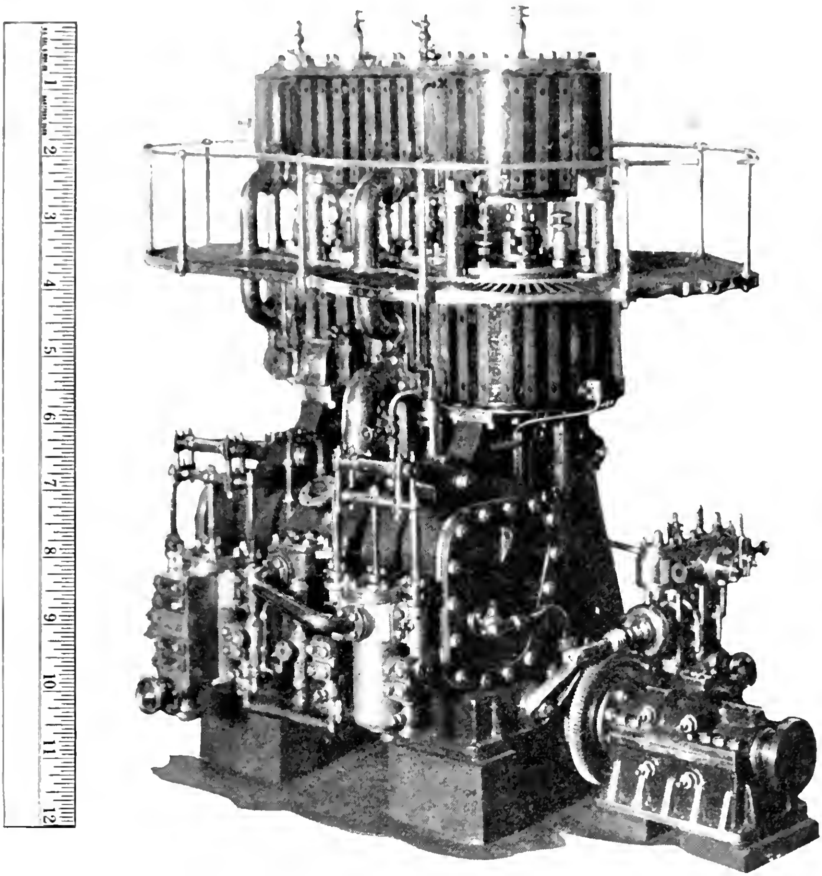
Miniature Marine Engine, Made *by* Company Inspector, Is Sought *for* Smithsonian Collection

A FEATURE that attracted much attention at the "Hartford Steam Boiler's" exhibit during the National Electric Light Association's convention at Atlantic City, June 8-12, was the miniature working model of a quadruple-expansion, disconnective type marine engine that had been designed and built in 1890 by Frank Chaese, a "Hartford Steam Boiler" inspector. On exhibition in the Company's booth, the engine was mounted on a turntable under a glass dome and, through a system of gears driven by a small electric motor, was made to revolve and operate at the same time.

A few days after the convention ended, officials of the Company were gratified to receive from the Smithsonian Institution's National Museum at Washington, D. C., a request that the model be deposited for permanent exhibition in the museum's mechanical collection, which lacks an example of the type of engine represented by Chaese's model. That collection is the largest of its kind in the country and includes manufacturing models from the works of such pioneer engine builders as Stevens, Sickles, Corliss, Porter, Hunt, Allen, Thompson, and many others. It is a merited tribute to Mr. Chaese that his little engine should be considered worthy of a place in that internationally famous collection.

The engine, as shown in the accompanying illustration, has cylinders arranged in tandem. It may be said to represent an era in marine engineering beginning about 1880, when DeLaval and Sir Charles Parsons were already experimenting with the first practical turbine. Manufacture of engines of this general type continued into the first decade of the present century and even now there are some of these engines in operation for ship propulsion. In later engines the principle of placing cylinders in tandem was done away with, but in other respects the design characteristics of marine reciprocating engines have changed but very little.

Standing about 12" high, weighing just a little more than 30 pounds, and capable of operating on steam at a pressure of 200 pounds, the model represents on a scale of ¾" to the foot a 1,000 hp. engine of the following dimensions: Diameter of high pressure cylinder 14"; first intermediate, 22"; second intermediate, 32"; low pressure, 45"; stroke, 28". The model is complete in every respect, with such details as a surface condenser, air pump, circulating pump and boiler feed pumps. Valves are of the piston type, the upper piston being slightly larger in



area than the lower one, so that when the engine is in operation the steam pressure on this excess area balances the weight of the valve, valve stem and rod attached. This tends to reduce the friction of the eccentric materially. The engine has no receivers, the valves and nozzles being of sufficient size to serve this purpose.

All the cylinders are provided, top and bottom, with relief valves of ample area, with pipes for attaching indicators, and with cylinder drain cocks. Each of these cylinders is jacketed with live steam, which enters the jacket at boiler pressure and is dripped into the condenser. In starting up the engine, the jacket valve is first opened and steam blown through into the condenser. This heats the cylinders up to the working temperature, and facilitates getting the condenser into operation. Outside of the steam jacket there is an air space, a non-conducting

(Continued on page 216)

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., July, 1931

Single copies can be obtained free by calling at any of the company's agencies.
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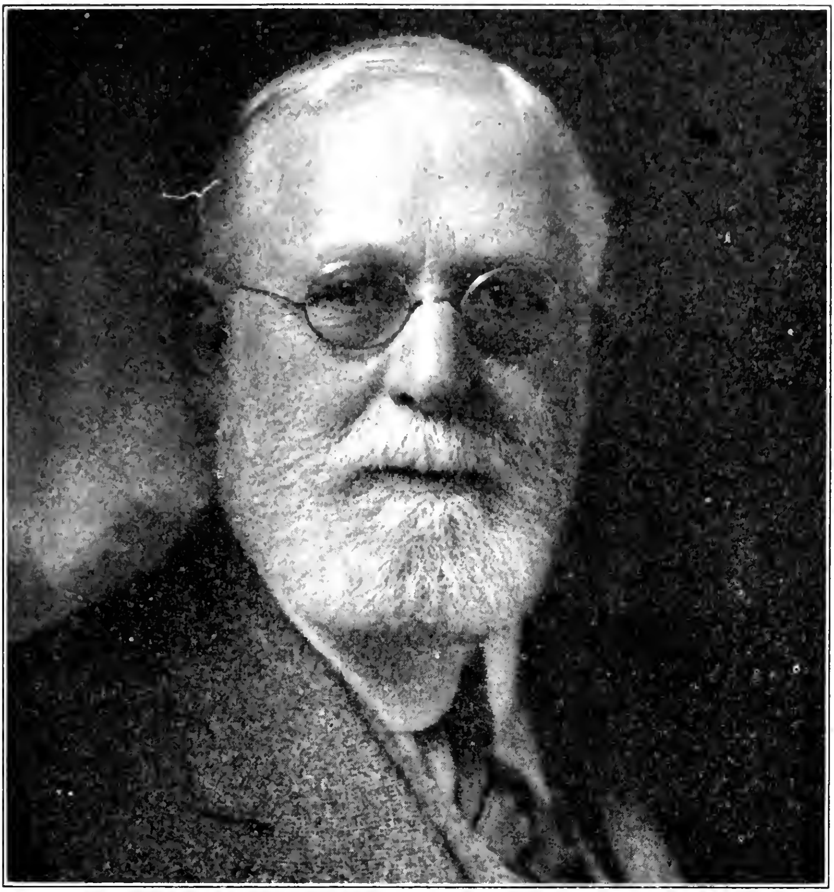
Recent bound volumes one dollar each. Earlier ones two dollars.

Charles Spafford Blake

THE death on March 31st of Mr. Charles Spafford Blake, chairman of the board of directors of this Company, came as a sad shock not only to the members of an organization that had enjoyed so many years of his loyal, devoted service, but also to many friends in insurance and engineering circles in which he had been accorded national recognition as an authority.

In the following tribute, written when the news reached the office, President William R. C. Corson expresses the Company's appreciation of the part Mr. Blake played in its progress and of the sense of loss his death brought to the officers and individual employees who had known and loved him:

"The death of Mr. Charles S. Blake, chairman of our board of directors, has not only taken from our company one who has contributed greatly to its success, but one who also has had a large influence in the general development of machinery insurance in this country. He came to us in middle life equipped with a natural aptitude in mechanical matters and by a thorough knowledge of the power machinery of those days, gained in the hard school of experience. He knew boilers and



engines thoroughly from personal contact in their construction and operation, and he had learned their frailties and the dangers to which they were exposed. He was thus especially technically fitted for a line of insurance which deals with mechanical hazards. But even to a greater degree he possessed those personal qualities of temperament and character which make for success in any line of work. Like many engineers, he thought and talked with directness and straightforward sincerity. His judgments were formed only on careful consideration. His conscientious devotion to every duty and obligation was a marked characteristic, which stimulated similar loyalty in all who worked with him and made every one in our organization his devoted follower when he became our president.

"During the 10 years of his presidency, our company's business expanded tremendously. Several new lines of machinery insurance were developed and the company's paramount position in the field was maintained in spite of growing competition. It was a period of material progress but it was a period too during which the spirit of the man at its head permeated throughout our organization, inspiring its activities and stimulating its efforts. His thought for and interest in every member was constantly in evidence and gained for him a warmth of affection seldom shown for the executive of a corporation.

"To all of our people, widely scattered throughout the country, news of Mr. Blake's death, I know, will bring that sense of personal sorrow which we, his close friends and associates in the Hartford office now feel so deeply."

* * * * *

Born in Windsor Locks, Conn., on October 25, 1860, Mr. Blake was educated in the public schools of Springfield, Massachusetts, and Jersey City, N. J., where for a time he engaged in newspaper work as a metropolitan district reporter for the United Press Association. His aptitude for things mechanical led him to abandon the journalistic field and to serve an apprenticeship at the Central Iron Works, Jersey City, a firm that built engines and boilers. Before he had reached his twenty-first birthday he was licensed as an engineer for small vessels and shortly afterward he was certified as chief engineer of ocean-going steamers. Shortly before the close of the Chile-Peruvian war he was commissioned as engineer in the Peruvian Navy and was awaiting orders when hostilities ended.

After considerable experience in marine engineering, Mr. Blake entered the boiler insurance field in 1884 as an inspector for the American Steam Boiler Insurance Company. Within three years he had become chief inspector at that company's Philadelphia office and subsequent to that was made adjuster for its Chicago agency.

Mr. Blake came with the Hartford Steam Boiler Inspection and Insurance Company on June 1, 1898, as its general agent in Hartford, and six years later he was advanced to the position of supervising general agent. In 1907 he was elected second vice president and, a year later, was made secretary. He served in that capacity until in 1916 he was made a director and at the same time elected to the presidency. He was made chairman of the board of directors on February 8, 1927.

Evidence of the confidence his competitors had in him was his annual election for 13 consecutive years as president of the Steam

Boiler and Flywheel Service and Information Bureau. At various times he was a member of the administrative council of the American Uniform Boiler Law Society, vice president of the International Association of Casualty and Surety Underwriters, president of the Insurance Institute of Hartford, and a director of the Boiler Inspection and Insurance Company of Canada. At the time of his death he was a director of the Phoenix State Bank and Trust Company of Hartford. In addition to his activities in engineering, insurance, and financial circles, Mr. Blake found time to engage in church and civic work. Expressions that appeared in the public press on the occasion of his death, and in minutes of organizations with which he was associated indicate the extent to which his sound counsel and inspiring personality will be missed.

New York Office Moved

The need of more space, due to the greatly increased business, brought about the removal on May 1 of this Company's branch office in New York City from the quarters which it had occupied for eight years at 80 Maiden Lane to a new building at 90 John Street, where it now occupies the entire seventeenth floor.

Diesel Ran With Broken Crank Pin

Recently, when the engineer of a municipal electric light plant in a mid-western city shut down his Diesel engine to look for the cause of an overheated bearing, he was surprised to find that the engine had apparently been running with a broken crank pin. From the fact that the bearing had been abnormally hot for two hours before he stopped the engine, the engineer opined that the pin had been broken for at least that length of time.

The pin was the one that drove the scavenger pump. According to the engineer the break occurred at a point some distance from the crank webs so that the connecting rod bearing acted as a sleeve that kept both parts of the shaft turning together. The facts of the accident were reported to this Company when the municipality applied for a policy to cover both of its Diesel engines.

Miniature Marine Engine, Made *by* Company Inspector, Is Sought *for* Smithsonian Collection

(Continued from Page 211)

jacket of asbestos and finally a neat wooden lagging composed of alternate strips of mahogany and white maple. The cylinders being arranged in pairs, tandemwise, and the engine being vertical, tail rods were not considered essential, as the stuffing boxes have very long sleeves.

The usual way to secure the piston of a marine engine to the rod is to make the rod slightly conical where the piston comes, and fasten the piston securely down on the tapering part by means of a jam nut. The objections to this method are that the piston cannot be adjusted after setting up the engine, and in case of accident or other emergency it cannot readily be removed. Mr. Chaese undertook to overcome these objections by fitting the piston to a collar, which is adjustable to some extent on the rod, and from which the piston may be readily removed. The pistons are fairly steam tight but two grooves are cut in each and packing rings with a diagonal slit are sprung into them.

Cranks are set at 90° and the eccentrics are at 120° with the cranks. Three of the eccentrics are keyed on, as usual; the fourth, which is used on the forward or high pressure engine in going ahead, is attached to a projection from the shaft by means of a long screw with two nuts. The lead of this eccentric may be changed by varying the position of these nuts on the thread.

The reversing gear of the engine is operated by steam. It consists of a pair of cylinders arranged as in a pump, the upper one of which is supplied with steam by means of a two-way valve, so that live steam can be admitted to either side of the piston. The lower cylinder is filled with oil and a passage runs from the upper side of its piston to the under side. In this side passage is a valve which locks the reversing gear when it is closed. A piston rod of this oil pump is attached to the lever that controls the links, and the mode of operating the gear is as follows: The valve in the oil passage is closed and steam is turned on in the upper cylinder. The oil valve is now opened quickly or slowly, depending on whether it is desired to reverse the engine quickly or slowly. In event of accident to the steam reversing gear, a small manually-operated force pump is provided. This draws oil from one end of the oil cylinder and forces it into the other end, thus shifting the links slowly in the same manner that the steam mechanism does. Passages for oil and steam are cast in the body of the reversing gear, so as to do away with piping. By the method of suspension of the link and block a sort of parallel motion is obtained, which greatly lessens the slipping of the block, and gives a quicker admission and cut-off.

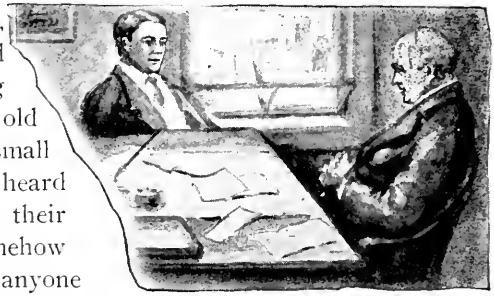
The condenser in the model has 260 sq. in. of surface and is very efficient. Water circulates through the tubes and all around the condensing space. Feed water is taken from the hot well by two pumps operated by side levers from the engine, either one of which has sufficient capacity to supply the boiler. Each pump has an air chamber and a relief valve, so that if the boiler valves are closed the feed pipes will not be ruptured. Bilge pumps are by the side of the circulating pumps, and are operated by the same side levers.

On the shaft, just back of the aft main bearing, is a large gear wheel, so arranged that it engages with a worm driven from an auxiliary engine, entirely distinct from the main engine, and which can be readily thrown in and out of gear. This device is very serviceable when it is desired to turn the main shaft slightly, so as to gain access more freely to the parts in cleaning up and repairing. This auxiliary engine is double acting and has two steam cylinders working on cranks set at right angles. It has no eccentrics, links nor connecting rods, and its valves are operated in a very simple manner by cams on the shaft. It is reversed by means of a two-way throttle valve. In addition to the two steam cylinders, it has a pair of water cylinders, so that by throwing the worm out of gear it may be used as a powerful feed pump, bilge pump, or circulating pump as necessity may require.

Neither the description given above nor the illustration shown here can convey an adequate idea of all the remarkable and ingenious details of the model. Before undertaking to build his engine, Mr. Chaese prepared an elaborate set of working drawings, giving dimensions of the more than 3,600 parts. He made the engine during odd hours in the kitchen of his home in Hartford and many of the parts were turned out on a small foot-power lathe. He made the patterns for all the castings and finished the castings in his workshop.

Chaese was born in Lescard, Cheshire, England, in 1863 and received his early education at a private school. His natural liking for mechanical things led him into the machinist's trade and by the age of 20 he had worked his way up to a position as third engineer of an ocean steamship. He followed marine engineering until in 1886 he came to this country and accepted a position in the shops of an electric light company, later entering the employ of the "Hartford Steam Boiler" as an inspector. Death cut short his career with this Company in 1892, just after he had completed the remarkable little engine herein described.

Taps From the Old Chief's Hammer



"TAKE a look at this, Chief," exclaimed Tom Preble, passing the newspaper over to the old fellow and indicating a small boxed item. "I have always heard that some golf bugs take their game very seriously, but somehow I just can't quite picture anyone swatting an opponent over the head with a club just because he happens to laugh at a bad shot."

"Tom," said the older man, smiling as he scanned the story, "if you had taken up the game—like I've been urging you to—you'd understand how a thing like that might happen. Unless a fellow is of the unusually easy-going sort it peeves him sometimes when, in spite of everything he can do, he just can't keep the ball on the fairway. No doubt this poor duffer had had just about all the kidding he could stand for one afternoon. His opponent laughed once too often and got cracked on the head for his lack of tact. Being a bum golfer myself, the victim of the assault gets no sympathy from me."

"Why, Chief," said Tom, feigning surprise, "I thought you golfers played primarily for exercise and for the sociability of going around the course with other good fellows. Do you mean to tell me that golf is such serious business that no one dares laugh when one of you makes a slip?"

"Certainly we laugh," explained the Chief, "but in golf, like in anything else, there are times to laugh and times not to laugh. The wisdom of refraining from laughing out of turn was impressed on me rather forcibly years ago and I haven't forgotten the lesson. If it hadn't been for a bit of luck I would have been made into soap grease as a penalty for laughing at the wrong fellow at the wrong time."

"Say, I've never heard that story, Chief. How did it happen?"

"Oh, it happened at an insane asylum in Missouri when I was working out of the St. Louis office. The reason I've never been very keen about telling the story is that it let me in for a lot of kidding—and still does whenever I meet up with any of the old timers. Just the same, I'll tell you about it if for no reason other than to illustrate why I'm always warning the inspectors to be careful not to get caught in a boiler and scalded.

"This asylum had five fire tube boilers, all alike, and each boiler had two outlet connections. One connection joined a header carrying steam at 100 pounds to run the engines and the other carried steam at 5 pounds for heating. The engines also exhausted into this low-pressure line.

"Of course no boiler was ever connected to both lines at once. Usually there were three boilers on the high-pressure line with the other two connected to the heating system, although the arrangement was so flexible that it was easy to keep things balanced as the power and heating loads varied.

"When I was first made responsible for the inspections at the asylum I used to insist on having one of the engineers keep conveniently near me—for two inmates worked in the boiler room and I wasn't at all keen on squeezing down into a manhole where I'd be at the mercy of one of those fellows if he should happen to run amuck. After a while, though, when I became better acquainted with the men, I wasn't so much afraid of them. As a matter of fact both of them—particularly the one they called 'John'—seemed just as normal as anyone. He was a good fireman, too. Better than a lot of others I've run across. Eventually I waived the precaution of having an engineer on hand and let John give me what help was needed.

"Everything went fine for a couple of years, until one day my sense of humor betrayed me and came within an ace of costing me my life. I remember that I arrived at the asylum about ten o'clock that morning, looked up the watch engineer and was told that I could go right ahead on Boiler No. 3. Neither John nor his helper happened to be in the boiler room just at the moment and so instead of waiting for them to come back I thought I would crawl through the fire door for a look at the underside of the fire sheet. Of course, I wouldn't have thought of going through the manhole into the boiler itself without first letting the boiler room men know, but I figured I'd get as much of the job done as possible and save the time I would have to spend waiting for John to appear.

"While I was busy in there on the grate I heard John come in, trundling his wheel barrow, so I edged over to the fire door, intending to speak to him. Just as I poked my head out of the door and opened my mouth to say 'hello', John spied me. Well sir, whether he thought I was a ghost or merely a hold-up man I'll never be able to tell you, but he let out a whoop that would have done credit to a Comanche and started on a headlong dash for the door, pushing the wheelbarrow ahead of him.

"Being an ingenious fellow, John had fashioned himself a sort of harness so that he hefted the weight of the barrow with his shoulders instead of with his arms. Well, in his rush for safety John tangled with the harness and down he went, the barrow rolling over on top of him. His frantic efforts to free himself struck me as funny and I came out of the fire door to indulge in a hearty laugh—at John's expense.

"Naturally, John didn't find the situation funny at all. I could see that my laughing had hurt his feelings and, to tell the truth, I was somewhat ashamed of myself and sorry for him. I tried to straighten things out the best I could, but it was evident that John felt pretty bad.

"Well, anyway, after I finished up under the boiler I looked John up and told him that I was ready to crawl inside, asking him to stand by to help me. I suppose I had been inside maybe fifteen minutes when suddenly I heard a hissing noise and felt a wisp of hot steam against the back of my neck. I didn't have to be told that someone was opening one of the header valves, and it came to me in a flash that John was taking that means of getting even. My lad, I want to tell you I was scared. I couldn't get to the manhole without passing directly under the opening through which the steam was coming, so I had no choice but to squeeze back into the end of the boiler—hoping that the draft of air entering the lower manhole and going diagonally across the tubes and out through the top manhole would serve to carry most of the steam away from me. I soon saw, though, that I was a goner unless someone came to my assistance, so I started pounding and yelling for all I was worth. It was sheer luck, however, rather than my yelling, that saved me. The watch engineer just happened to glance through the engine room doorway and see John on top of the boiler, monkeying with the valve. The engineer must have swarmed over those boilers at a rapid clip, but it seemed ages to me before I could jam my head up through the manhole and fill my tortured lungs with good fresh air. The steam had scalded me badly on my face, neck and hands, but the real damage was to my nervous system. It was some time before I could go out on an inspection at that asylum without shaking in my boots.

"So Tommy, my lad, that's what I mean when I say there are times to laugh and times when you shouldn't laugh. And that goes in golf, in boiler inspecting—and even at home for us married men."

Caught in the Separator

Willie: "Ma, if the baby was to eat tadpoles, would it give him a big bass voice like a frog?"
Mother: "Good gracious, no! They'd kill him."
Willie: "Well, they didn't."

The young man led for a heart,
The maid played for a diamond,
The old man came through with a club,
And the sexton used a spade.

Steve: When you get to New York you'll see the skyscrapers.
Rube: That's one of the main reasons why I'm going. I want to see them dern things work.

Flapper: I would like to try on that vieux rose frock in the window.
Saleslady: I'm sorry, that's a lampshade, but we could copy it for you.

French Maid (to inquiring friend): "Oui, madame is ill, but ze doctaire haf pronounce it something very trifling, very small."
Friend: "Oh, I am so relieved, for I was really anxious about her. What does the doctor say the trouble is?"
French Maid: "Let me think. It was something leetle. Ah, I haf it now. Ze doctair say zat madame has ze smallpox."

SAGE REASONING

This one was overheard recently by one of our men while he was inspecting boilers at a state institution where, just outside the boiler room, two negroes were at work shoveling ashes,—

Sam, straightening up and leaning on his shovel: "Lightning, suppose you knew that they was gwine take away either the sunlight or the moonlight, which one would you rather they take away?"

After a thoughtful pause during which both ceased work and Lightning scratched his woolly head, the answer came: "Well, I think I'd let 'em take the sunlight, 'cause the sun shines in daytime when it's light anyway, but the moon lights things up at night when it's dark."

ONE CAUSE OF UNEMPLOYMENT

Judge: "When you work, what work do you do?"
Prisoner: "I'm an organist."
Judge: "How can a man with such a God-given talent as yours ever be out of a job?"
Prisoner: "My monkey died."

A man walked reluctantly into a hat store.

"I just lost a bet," he said, "and I want to get a soft hat."

The salesman, selecting a hat from the shelf behind him, handed it to the prospective purchaser with the remark.

"This is the softest hat we have."

The customer gazed at it speculatively. "What I want," he said reluctantly, "is something a little more tender. I've got to eat it."—*The Office Cat.*

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1930

Capital Stock, - - $3,000,000.00

ASSETS

Cash in offices and banks		$ 501,765.85
Real Estate		326,522.00
Mortgage loans		1,044,502.72
Bonds and Stocks		17,330.488.36
Premiums in course of collection		1,213,648.12
Interest accrued		158,019.59
Other Assets		13,445.96
Total Assets		$ 20,588,392.60

LIABILITIES

Reserve for unearned premiums		$ 8,956,350.39
Reserve for losses		413,085.83
Reserve for taxes and other contingencies		910,105.27
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,308,851.11	
Surplus to Policyholders,		**$10,308,851.11**
Total Liabilities		$ 20,588,392.60

WILLIAM R. C. CORSON, President and Treasurer

Incorporated 1866 | Charter Perpetual

Department	Representatives
ATLANTA, Ga., 1103-1106 Atlanta Trust Bldg.	W. M. FRANCIS, Manager. C. R. SUMMERS, Chief Inspector.
BALTIMORE, Md., 5 South St.	JAMES P. KERRIGAN, JR., Manager. P. E. TERROY, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq. Cor. Water St.	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., 404-405 City Savings Bk. Bldg.	W. G. LINEBURGH & SON, General Agents. A. E. BONNETT, Chief Inspector.
CHICAGO, Ill., 175 West Jackson Boulevard	P. M. MURRAY, Manager. C. W. ZIMMER, Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	F. L. HOWER, Manager. W. E. GLENNON, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. PAUL GRAHAM, Manager. J. F. HUNT, Chief Inspector.
DENVER, Colo., 916-918 Gas & Electric Bldg.	J. H. CHESNUTT, Mgr. and Chief Inspector. F. G. PARKER, Ass't Chief Inspector.
DETROIT, Mich., 2401-7 First Nat'l Bank Bldg.	L. L. COATES, Manager. THOMAS P. HETU, Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. KENYON, General Agent. A. E. BONNET, Chief Inspector.
NEW ORLEANS, La., 1128 Hibernia Bank Bldg.	R. T. BURWELL, Mgr. and Chief Inspector. E. UNSWORTH, Ass't Chief Inspector.
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SAN FRANCISCO, Cal., 114 Sansome St.,	C. B. PADDOCK, Manager. L. J. REED, Chief Inspector.
SEATTLE, Wash., 707 Arctic Bldg.	E. G. WATSON, Mgr. and Chief Inspector. J. W. SMUCK, Ass't Chief Inspector.
TORONTO, Ont., Canada, Federal Bldg.	H. N. ROBERTS, President The Boiler Inspection and Insurance Company of Canada.

Vol. XXXVIII No. 8 October 1931

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Cracking of Horizonital Engine Frames Because of Disintegration of Concrete Foundations

By H. J. Vander Eb, *Ass't Chief Eng., Turbine and Engine Division*

MOST operating engineers are familiar with the extensive damage that may occur as the result of the breaking of main reciprocating parts and other moving elements on engines. For instance, it is readily understood that if the piston rod, the crosshead or the connecting rod should break, the engine frame may be so badly

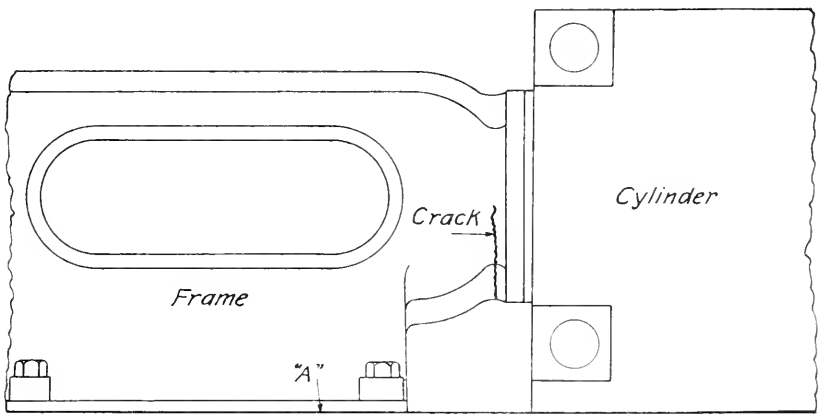


Fig. 1. Characteristic Crack Formation in Engine Frame

broken up as a consequence that nearly the whole engine would need replacing. What is generally not so well appreciated is that the stationary parts, particularly the heavy cast iron frame, may break without there first being a sudden breakdown or disturbance of the reciprocating parts.

Engine frames are almost without exception made of cast iron. Of necessity the engine designer aims to make the frame very rigid so that it will have the least possible tendency to bend or buckle under the shocks and thrusts of the reciprocating parts. The result is that the frame has a high factor of safety to withstand the ordinary longitudinal working stresses of the engine. Even under high overstress, such as may occur because of a slug of water in the cylinder, the breakage is usually elsewhere than in the frame.

Because of this, there is often considerable surprise on the part of the operating force when the strong frame structure begins to develop a crack without there ever having been any shock to the engine. The characteristic location for these cracks is in the frame neck near the cylinder as shown in Fig. 1, although they may occur also at the crank end of the guide barrel. The origin of such cracks is almost invariably to be found in the sagging of the frame when the grouting under it becomes soft locally due to oil which may be spilled over the foundation. Concrete becomes quite soft and compressible after long contact and saturation with oil.

At the time the engine is erected the frame is supported by wedges of steel or malleable iron for the purpose of leveling. After perfect level is obtained the space between the frame and the top of the foundation is filled with cement grouting. The wedges should then be removed, but this is not always done. If the wedges are left in place the result will be that the engine frame continues to be supported for some time on the wedges only. The reason for this is that, in drying and hardening, the cement grouting contracts a slight amount. However, due to the minute amount of sliding movement on the foundation, that is usually present in all horizontal engines, the wedges eventually wear down sufficiently so that the grouting will then fully support the weight of the engine. Some engine erectors prefer to leave the wedges in place but it cannot be regarded as good practice.

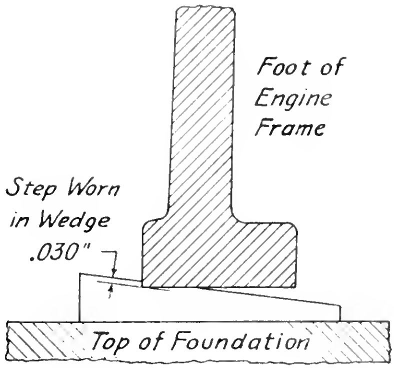


Figure 2.

The most likely place for the grouting to become soft due to oil saturation is at "A" in Fig. 1, as it is at this point that usually a small amount of oil is thrown out of the guide barrel by the crosshead at every revolution of the engine. After some years of operation under these conditions it becomes noticeable that oil is pressed out from under the frame at point "A" when the crosshead moves over that end of the guide barrel, and is sucked in again as the crosshead moves toward the crank end. When this occurs it should be clear that the engine frame is not being properly supported at point "A" because the grouting has become soft and compressed. The consequence is that the downward force acting on the guide barrel is transferred through the frame neck to the nearest support under the cylinder and this produces a bending action in the frame neck which may eventually result in a crack. After a small crack is once started it takes but a short time for it to run half way or even further around the frame neck. Leaving the leveling wedges under the frame after erection of the engine is no safeguard against the baneful effects of oil softening of the grouting since, as already mentioned, the small contact area of the wedge with the frame wears away rapidly as

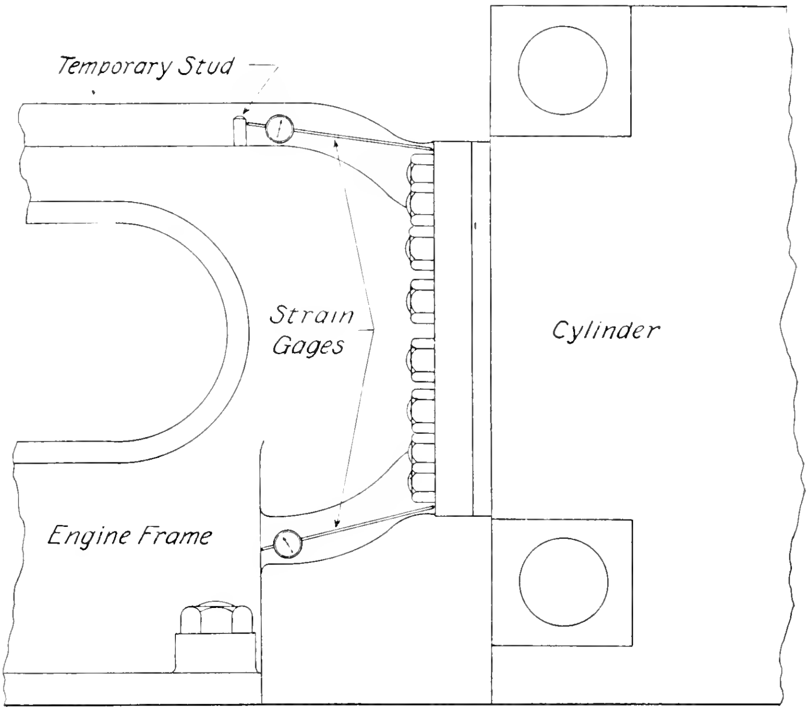


Fig. 3. Showing Application of Strain Gage.

shown in Fig. 2. In a recent case where the frame neck had cracked the wedge which was pulled from under the frame at "A" had a step worn in it of .030". This, of course, was the amount that the engine frame had sagged at that point. The vertical movement of the frame must have been a considerable proportion of this.

The vertical movement of the frame at the point where the grouting has become compressed has in a number of cases given the operators the erroneous impression that the nut on the nearest foundation bolt had worked loose. Attempts to tighten the nut under such circumstances put such a severe bending strain on the frame neck that a long crack formed in short order. Such tightening should never be undertaken without first studying the real cause of the looseness.

The telltale of oil oozing in and out from under the frame at every engine revolution may not always be visible, as it may take place on the inside of the frame and not show on the outside edge. There is, however, a more reliable method by which the existence of an appreciable

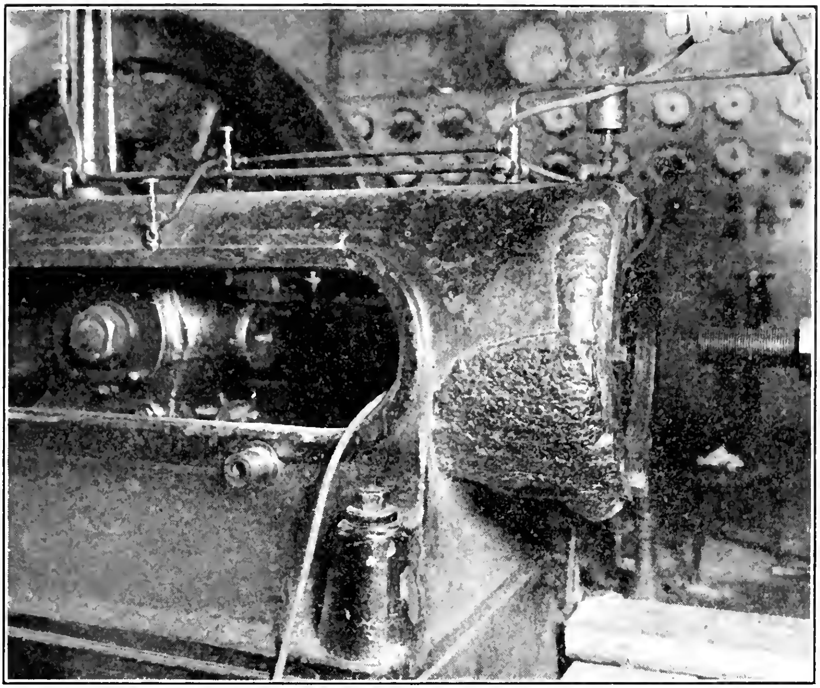


Figure 4.

bending stress in the frame neck due to sagging of the frame can be detected. This is by applying to the frame neck a simple strain gage such as is used by this Company's inspectors. The application of this strain gage is shown in Fig. 3. So long as the readings of the dial micrometer are reasonably alike at the top and the bottom of the frame while the engine is running under load there will be no trouble from cracking of the frame neck, as this indicates that there is no bending action at that point.

The normal amount of pulsating strain in the frame neck varies with different designs of engines. It usually is somewhere between .001″ and .004″. If, however, it is found that there is a considerable *difference,* of say .003″ or .004″, between the readings at the top and bottom of a frame neck which apparently has not yet developed a crack, it can then confidently be expected that such a crack will form in a short time.

After a crack has developed, it is often possible to make a reliable repair by welding or by applying a steel patch by means of tapbolts and

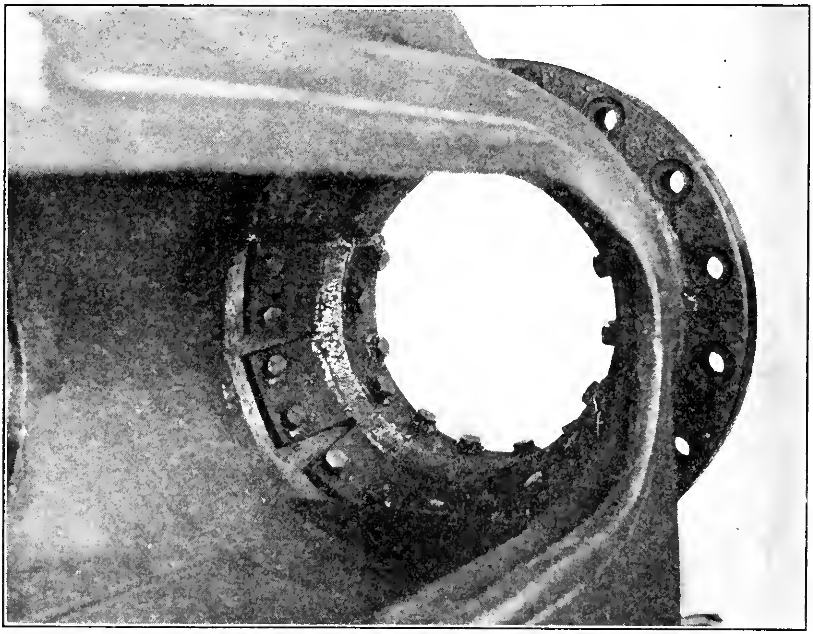


Figure 5.

thus salvage a rather costly casting. Fig. 4 show a successful repair of a cracked engine frame neck by what is known as "stud welding". Such a weld is made by "vee-ing" out the crack and screwing studs in alternate spacing in the surfaces of the "vee" groove. The studs are then fusion welded together. The shrinkage of the welding material when it cools draws the crack hard together. Fig. 5 shows a successful repair by means of a steel patch.

Whenever a repair of this kind is undertaken it is absolutely necessary of course to realign the engine and pour new grouting in order that the original overstress due to the local sagging of the frame, which caused the crack, may be eliminated. In order to do this properly and to make certain that all soft concrete is removed and replaced with new hard concrete the engine frame should be lifted off the foundation. However, as a temporary expedient to avoid a lengthy shutdown of the engine at a time when its power is badly needed, it has been found practical to chip away enough of the oil-soaked grouting without lifting the frame and by the use of double wedges, spaced fairly closely, to re-establish the proper support and alignment.

Too much emphasis cannot be placed on the warning that it is bad practice to permit lubricating oil to soak into the concrete of foundations under reciprocating engines. The most troublesome spot as regards oil spilling is as a rule under the crosshead guides. Even though the amount of lubricating oil for the crosshead and the guides is cut down to the minimum there is very likely to be a considerable accumulation of excess oil on the lower guide. This oil will tend to splash out over the foundation. Frequently the dripping of condensate from the piston rod greatly aggravates the situation by causing such an excessive amount of water and oil on the bottom guide that the crosshead beats this into an oily vapor which spreads all around the engine to do damage not only to the foundation but to other valuable property such as electric generators and motors. There should be effective drainage facilities for the space under the piston rod stuffing box to prevent any accumulations of oil and water at that point.

For high speed engines it is the practice to enclose the guides and crankpit with sheet metal to prevent the oily vapor from spreading, but in spite of this it is sometimes found that excessive leakage of oil vapor takes place through any small openings and crevices. The best remedy for this is to install a small motor-driven exhaust fan on the sheet metal casing. Some form of oil separator can be placed in the outlet from the exhaust fan and the oil thus recovered can be returned to the lubricating system, thereby effecting a distinct saving. The principal saving, however, will be the prevention of damage to the foundation which, as pointed out, can lead to serious difficulty.

That Deceiving Power Factor

A steam-driven turbo-generator at a large mill has lost caste since the recent discovery that a remarkably low unit output cost with which it had been credited for the past sixteen years was, after all, a myth.

The kilowatt hour output of the machine per pound of coal had been figured on the basis of readings of a totalizing meter which, because of a reversed potential coil, was actually reading in kilovolt-amperes instead of kilowatts. The assumption of the cost-finding department that this was kilowatts naturally gave the turbine an undeserved advantage, as the average power factor was something like 62 per cent.

Two Flywheel Accidents Cause Heavy Damage

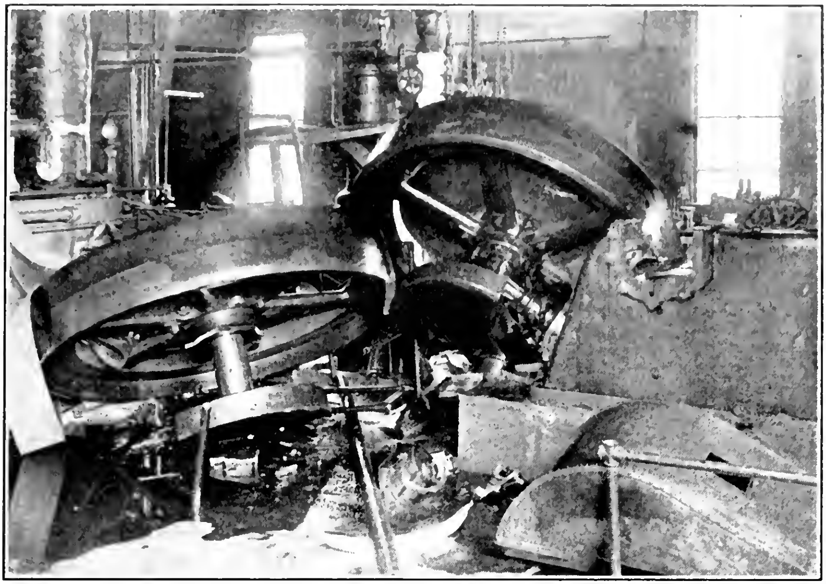
PAPER mills seem to have been let in for somewhat more than their just share of recent flywheel explosions. Since the appearance of the last issue of THE LOCOMOTIVE, in which one such accident was described, two other paper mills have been visited by the same sort of catastrophe. One of the accidents cost a man his life; both caused heavy property damage.

The accident at one plant occurred less than ten minutes before the beater engine was to have been shut down for the week-end, during which time the main belt was to have been shortened so as to eliminate a noticeable amount of slipping. From all indications the accident was caused by the breaking of this belt, but as the only man near the engine at the time was killed the exact sequence of events immediately prior to the accident is not definitely known. One large section of the 12-foot wheel was driven through the roof and landed on the ground almost 400 feet away. The building was badly damaged and, with the exception of the cylinder casting, the engine was a complete wreck. Property loss was more than $15,000.

For several days preceding the accident the belt had been slipping on the wheel and flapping up and down with the characteristic jerky load of the beater. An application of belt dressing had failed to remedy the trouble.

As the wheel was of the light "B" type, some of the investigators advanced the theory that the jerking action caused by the alternate slipping and seizing of the belt might have broken the wheel without overspeeding. However the distance through which a large fragment of the wheel traveled makes it appear certain that there was considerable overspeed involved. It takes but a very few seconds for a light-rimmed wheel such as this one to reach bursting speed after loss of the load, so the most acceptable explanation of what happened seems to be that the alternate slipping and gripping of the belt suddenly became so severe that the strain caused the belt to break. Meanwhile the engine had had an opportunity to speed up more and more, for it is likely that the extreme jerky action of the main belt at the very last caused the belt driving the governor to slip, thus slowing that mechanism down to the point where it could not effect a sufficient cutoff quickly when the belt broke and the engine started to race.

A very important contributing factor was that the receiving pulley was located in a pit which was subject to filling up with water. There was an automatic siphon for keeping the pit drained, but this siphon



It doesn't necessarily require overspeeding and a flywheel explosion to tear an engine to pieces. This recent oil engine wreck occurred as a result of fatigue failure of the crank-shaft. Noticing that the engine was running irregularly and making a lot of noise, the engineer decided to shut it down. He had already cut off the fuel supply when the shaft parted.

may have ceased functioning, with the result that water rose high enough to wet the belt.

A variable-speed paper machine engine with a 66-inch flywheel and a rated speed of 300 rpm. caused the other accident. This engine stood in the basement beneath the paper machine which it drove. That no one was killed when its wheel let go is considered remarkable, for several men were at work in the room above when parts of the wheel crashed up through the floor. The one man who was injured was passing the engine at the time of the accident. He was scalded by steam escaping from a severed main.

Attendants believed that this wheel exploded while the engine was running at normal speed. They maintained that any appreciable variation in speed would have been noticeable in the paper on the machine. However, after the accident it was found that the overspeed trip had closed the steam valve. Moreover, the governor was in the closed position. It is possible, of course, that these devices may have been actuated when the main and governor belts fell on them.

The engine was not quite as badly wrecked as was the one involved in the accident first described, but it was estimated that the loss would run between $5,000 and $8,000.

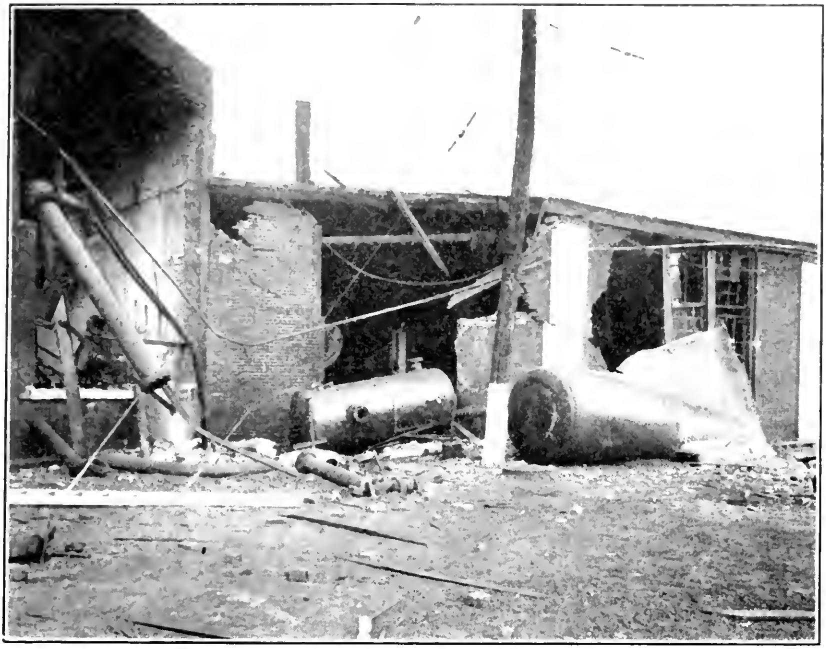
Air Receiver Explosion Caused by Oil Vapor

ACCIDENTAL ignition of lubricating oil vapor in a large air receiver at a railroad yard caused an explosion a few weeks ago that resulted in heavy property damage and injury of six persons. The tank was 66″ in diameter and 17′ 7″ long. It was of lap riveted construction and was mounted vertically outside the engine house. The explosion blew off the top head and unwrapped the upper course by tearing through the solid plate. Had the tank been inside the building the damage would undoubtedly have been much more severe, but even as it was a brick wall was hurled down and windows in houses a third of a mile away were shattered.

The compressor used for supplying air to the tank was of the two-stage type with an intercooler between stages but no after-cooler. It was driven by a 480 kv-a. constant speed motor, and to take care of fluctuations in the demand for air there were automatic devices for choking the supply of intake air and for unloading the high pressure cylinder when pressure reached 115 pounds. In addition to these safeguards against over-pressure, there were four pop valves in the discharge line from the compressor to the tank and a fifth on the tank itself. These safety valves were adequate to protect the tank against accidents resulting from any ordinary increase in air pressure but, of course, were entirely incapable of relieving the tremendous pressure instantaneously built up within the tank by a combustion explosion.

On other occasions the engineer had encountered trouble because of the discharge valve overheating. He had discovered that the machine gave warning of this by a peculiar chattering of the intake choke valve. This chattering had started and he was preparing to shut the compressor down when the blast came.

An investigation after the accident revealed that one of the steel strips in the compressor's feather-type discharge valve had broken in two and curled up. From all appearances it had been subjected to great heat, for whereas such strips are made of tempered steel, this one could easily be twisted and bent by hand. It has been demonstrated on many occasions that leaky discharge valves will cause abnormal heating of the discharge air. The assumption is that this heat is developed by recompression of hot air that leaks back from the line through the valve after the piston has completed its compression stroke and is traveling in the opposite direction. When the temperature reaches



the ignition point of the particular mixture of oil vapor and air in the line at the time, an explosion results.

The extent to which pressure may reduce the temperature necessary to ignite certain mixtures of air and vapor from the various sorts of lubricating oil would seem to be an appropriate subject of laboratory research. In any event the danger of explosions of this nature makes it advisable for every engineer having compressors under his charge to choose lubricating oil with care and to see that oil is not used in excess quantities. The temperature of the discharge air should be watched closely, for the combination of oil vapor, air, and high temperature seems to be a treacherous one.

LONG WHEELBASE

Mr. Bones: "But if you wanted a dog for the children what made you select a dachshund?"

Mr. Jones: "So that all of them could pet him at once."

Unusual Conditions Found *in the* Inspection *of* Electrical Apparatus

By K. A. Reed, *Chief Engineer, Electrical Division*

AT THE time of making a first inspection for one of our clients we found that a new wound-rotor motor was being installed to replace a similar motor, built by a different manufacturer, that had been giving trouble ever since it was installed. Naturally our inspector was very much interested in the cause of the trouble both for the purpose of rendering service to our assured and to prevent trouble from developing with the new motor similar to that experienced with the original motor. He, therefore, made a very thorough investigation of the case and discovered the cause of the trouble.

The assured said that the question of overload had been discussed with the manufacturer of the object driven by the original motor. As there were many duplicate sets in service there was no question about the motor being of sufficient capacity to handle its load.

Under certain conditions of load flashovers between the collector rings on the rotor would occur. The motor was of the totally enclosed type, used in connection with a powdered fuel installation, but the removable enclosing shields did not fit as tightly as might be desired and it was thought that possibly a slight amount of fine coal dust was getting into the motor and causing the trouble. The assured was forced to abandon this theory, however, in view of the fact that some of the flashovers occurred immediately after thoroughly cleaning the collector rings and returning the motor to service.

Due to the location of the motor, and to the fact that both the stator and rotor leads were brought out to conduit fittings, it was very difficult for our inspector to trace out the leads between the stator winding and the main switch and between the collector rings and the control equipment. Accordingly he placed a voltmeter across the collector ring brushes when the motor was operating at practically full speed. The voltage should have been near zero, but he was amazed to find line voltage between the rings.

With this information it was a very simple matter to ascertain that in running the conduits through the walls, the wires had been mixed, so that the power conductors were connected to the collector ring terminals while the control equipment was connected to the stator leads.

After the stator and rotor terminals had been connected to their proper conductors, a load test was made and the motor was found to be of ample capacity. No further difficulty has been experienced since the motor was properly connected.

Some time ago a series of failures developed in connection with a 15-cycle generator and the concern decided to have the load on the machine checked to determine whether or not overheating due to overload was causing the trouble. As the calibration curves for the portable ammeters and current transformers available were not carried below 25 cycles, it was necessary to secure from the manufacturers the percentage of error that would exist when using these instruments on a 15-cycle circuit.

The instruments were then placed in the circuit and the maximum load was placed on the generator. The load on each individual machine served by the generator had previously been checked by using the self-contained ammeter without the current transformer, and when the load reading on the output of the generator was compared with the combined loads of the individual feeders discrepancies were found to be so great as to cause the employe making the test to feel that it was unsatisfactory.

The immediate reaction of the tester was that the portable current transformer was unreliable at such a low frequency, or else there was some inherent defect in this transformer. When complete information pertaining to the test "set-up", the current transformer ratio that was used, etc., was forwarded to the engineering department of this Company for an analysis it was found that a current transformer ratio of 10 to 1 had been used in computing the results of the test instead of a ratio of 10 to 5.

After substituting the correct ratio, the load readings applying to the generator compared very nicely with the individual feeder load readings and it became necessary to look elsewhere for the cause of the trouble. This case illustrates most forcibly the absolute necessity for accurately checking all transformer ratios when testing electrical apparatus.

Hot Water Tank Explosion in Home

Six persons were injured recently in Worcester, Mass., by the explosion of a hot water supply tank in a dwelling. The lower floor of the house was wrecked, partitions being knocked down and walls loosened from the framework. So severe was the blast that it was heard a mile away and windows of houses in the neighborhood were broken.

Water Instead of Steam Drives New Engine

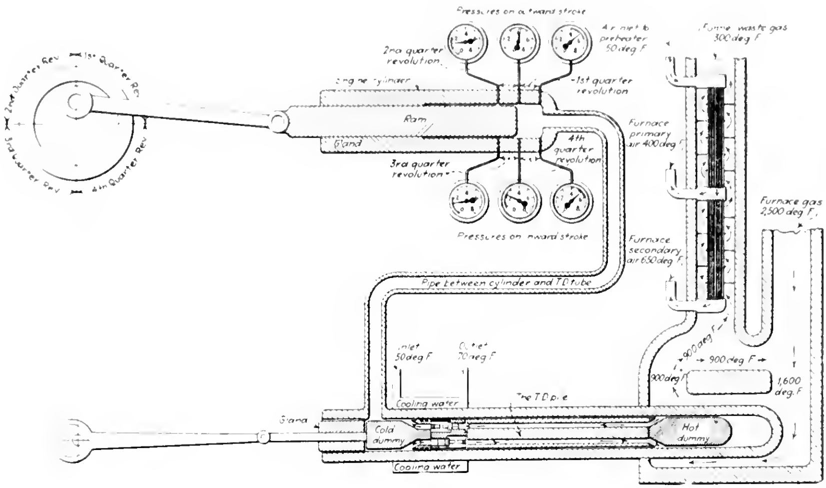
OPERATION of a reciprocating engine at 250 rpm. by means of the alternate expansion and contraction of water may strike a majority of engineers as impractical if not impossible, but that is exactly what J. F. J. Malone, an English inventor, claims to be able to do. Moreover, the efficiencies of his experimental models are said to be higher than those obtained by ordinary steam engines. Whether or not it will be possible to develop the machine to the point of making it commercially practicable remains to be seen, but so interested was the Royal Society of Arts in the possibilities of this startling new type of prime mover that it recently devoted an entire session to a discussion of the principles involved.

Malone's apparatus is shown diagrammatically in the accompanying sketch, which is here made available through the courtesy of *Power*. The working cylinder by which power is developed is at the top; at the bottom is the TD (thermodynamic) tube and TD pile by which the alternate heating and cooling of water (the working medium) is effected. This is the heart of the engine and, although it is somewhat more intricate than is here indicated, the sketch will serve in explaining the principle on which it works.

Two sets of passages traverse the TD pile from end to end, one set having a check valve that permits a flow of water only to the right; the other set having a similar check that permits water to travel only to the left. Thus it is apparent that when the pile is forced to the right, water flows through it in a left hand direction; when the pile moves to the left, water passes through it to the right.

Hot gases from a furnace enter at the chamber at the extreme right of the sketch and give up a portion of their heat to raising the temperature of the right hand end of the TD tube. Cold water flows continuously through a heat-exchanging apparatus at the left hand end of the tube, so that as water is forced first to one end of the tube and then to the other by the back and forth movement of the TD pile it is alternately expanded by absorbing heat at the right hand end and contracted by loss of heat at the cold, left hand end. This expansion increases the volume of the water in the system and creates a pressure of several tons per square inch to force the ram in the engine cylinder on its outward stroke. Conversely, the ram makes its inward stroke when the water is cooled and its volume is reduced. The pile is moved back and forth by an eccentric that is set 90° ahead of the crank. A link, not shown in the sketch, provides a means of reversing the engine and of controlling it by shortening or lengthening the stroke of the pile.

It must be understood that the sketch shown here is purely diagrammatic, the TD pile used in the actual engine being built up of a number of concentric tubes with water films of only one hundredth of an inch between them. Obviously, the crude arrangement as drawn



would not permit the rapid transfer of heat necessary for the speeds of 40 to 250 rpm. which the inventor claims for his engine.

Malone carried out extensive experiments between 1925 and 1927, building one vertical engine with 80 TD piles. In 1927 he built a small horizontal engine which to date has run well over 3,000,000 revolutions. Based on an efficiency of 27 per cent. as obtained by indicator tests conducted by three independent engineers, Malone believes that after allowing for furnace and mechanical losses an engine of 100 horsepower or over could be expected to develop 20 per cent. efficiency between fuel and shaft. His idea is that the engine will find use on locomotives where decreased fuel consumption, zero water consumption and enormous starting effort would be prime advantages.

REST AND QUIET

A lady with a discontented face entered a doctor's consulting room, and wearily sank back into a chair. "Oh, doctor, I feel so weak," she began. "What is your advice?"

"Rest, madam," replied the physician, after a slight examination.

"But haven't you any medicine you can give me? Just look at my tongue."

"Yes," said the doctor, "that needs a rest, too."—*The Outspan.*

Relief Valve in Hydro-Pneumatic System Important

THE hydro-pneumatic system of household water supply, in which there is a tank containing compressed air and water, has of late gained considerable favor in places remote from city water mains. On farms and estates, and at surburban clubs, hotels, schools, and residences, thousands of such installations of various sizes are in use. As a consequence it is not surprising to run across occasional instances of hydro-pneumatic tank explosions, for even though the apparatus is not extraordinarily hazardous, the fact that it involves the use of compressed air does bring about opportunity for accidents of considerable violence. With this in mind the user should be careful to see that the tank is well constructed, that the piping is correctly laid out, and that there is some adequate arrangement for the prevention of overpressure. In addition, the apparatus should be inspected at intervals, for tanks frequently deteriorate in service and safety valves and automatic control devices get out of order.

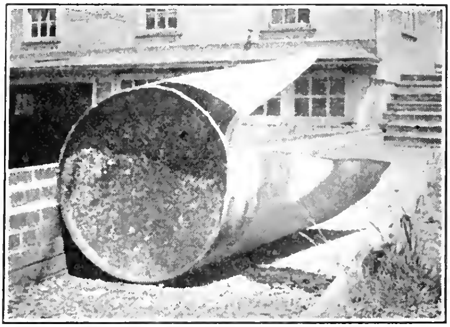


Figure 1.

There are two general classes of hydro-pneumatic systems. In one the air is trapped in the storage tank at atmospheric pressure and compressed by means of pumping water into the tank with it. In the other, both the air and the water are pumped into the tank. In either case the result is a tank in which there is water in the bottom and compressed air in the top. Because of the violence that often attends the rupture of a compressed-air container, adequate safety devices are important.

A majority of hydro-pneumatic systems are motor-driven units with some sort of an electrical relay which starts and stops the motor automatically at certain pressure limits. Figure 2 shows the damage caused recently by the explosion of a tank in such a system at a hotel. This system had no safety valve, the relay being depended on to prevent over-pressure by shutting down the pump. However, the relay failed to work and the resultant property damage was close to $5,000. Figure 1 is a view of another such tank that failed by blowing out the head and tearing along the longitudinal seam.

Automatic controls for the pump should not be depended on as the only protection against over-pressure. In all cases they should be augmented by a relief valve installed either on the tank or on a pipe freely communicating to the tank. Where the relief valve is on some

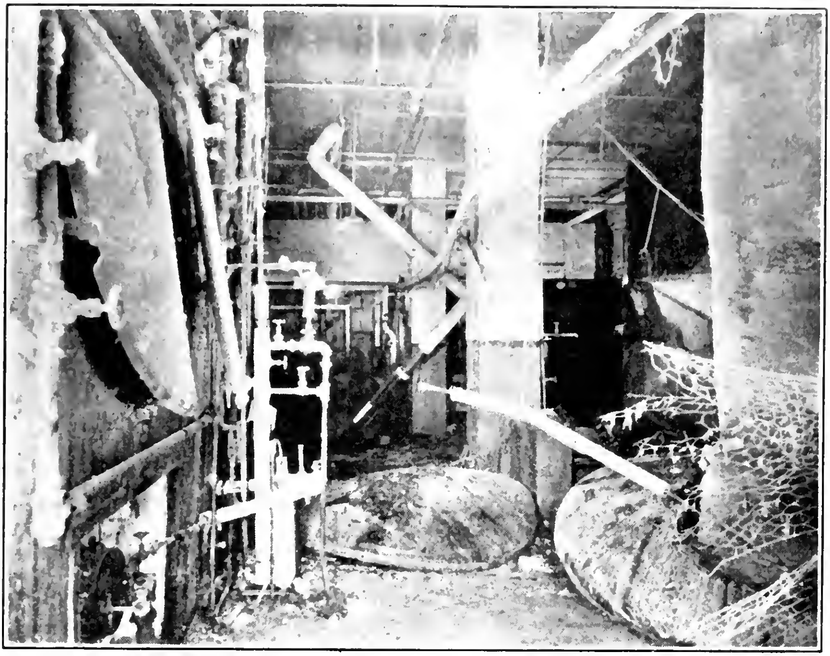


Figure 2.

part of the piping system, it is important to see that no check valve or stop valve is installed between it and the tank.

On systems in which a compressor is used to put air into the tank it is well to place the relief valve on the highest part of the tank itself so that, when the valve operates, air instead of water is discharged. The reason for this is that a safety valve above the water line is less subject to corrosion and thus less difficult to keep in operating condition. On systems that depend on trapping air in the tank and compressing it by pumping in water, this plan of having the safety valve discharge air has one practical disadvantage. Operation of the valve rids the tank of air and necessitates adding more air to the system before it can again function. For such systems the safety valve may be placed in the line leading from the pump to the tank but, as mentioned above, it should be between the tank and the next valve.

Lightning Takes Toll in Power Plants

FIVE men were burned, three of them very seriously, when lightning came in over the buses of a municipal pumping plant during an electrical storm late in the summer and caused an oil switch to explode. A somewhat unusual feature of the accident was that two strokes of lightning came into the building, one following the other within a few minutes. The first merely tripped the oil circuit breaker on the switchboard and set fire to a 300 hp. pump motor. The chief operator and his crew extinguished the fire and were preparing to start another pump when the more severe blow fell. Scarcely had they closed the oil switch than the second lightning stroke came in, exploded the switch, and engulfed the men in a sheet of blazing oil.

Evidently an extremely high pressure developed within the switch tank before the rupture occurred. Twelve 3/8″ bolts that held the cover plate down were pulled in two as the plate was blasted off. The cast iron tank was shattered into pieces no larger than a hand.

At a substation of one of the eastern utility companies lightning took an even heavier toll late in the summer when a surge came in over a high tension line and caused a flashover on the bus structure. Three men were caught in the arc, two being killed instantly and the third dying in a hospital.

The extensive damage that is often caused when lightning leaps the arresting devices and passes into electrical equipment was well demonstrated by still a third accident when, late in July, a 12,500 kv-a. central station generator was burned out. It was estimated that repairs would closely approximate $40,000.

Relief Valve Too Small, Tank Explodes

A safety valve of inadequate capacity may not prevent the explosion of a pressure vessel even though the valve is in good operating condition and set to open at a safe working pressure. This fact was demonstrated recently at the machine shop of a large mill where an air tank 30 inches in diameter and 6 ft. long blew out a head, injuring one person and causing considerable property damage. The tank was provided with a one-inch lever type safety valve to take care of a compressor of 260 cubic ft. capacity. About ten minutes before the accident the master mechanic observed that the safety valve was blowing and that the gauge pressure was 80 pounds, the point at which the valve should blow. Evidently the valve could not release air from the receiver as rapidly as the compressor supplied it, the result being an explosion.

An Optimist's Creed

(From an article by H. I. Phillips. Reprinted by permission of the New York Sun.)

I believe in the United States of America.

I believe in the American ability to beat any beatable set of circumstances and come up smiling.

I believe in the ability of the American citizen to swim upstream, hit fast ball pitching, break out of a half-nelson and have a pretty good time in the bargain.

I believe that in the long run fair weather over-balances the bad, that all "breaks" are subject to the law of averages, that the expression "Good old days" is relative and that everything comes out all right in the wash.

I believe a little optimism never hurt anybody and can be taken straight.

I believe in the capacity of the American industrial leader and in the common sense of the American workingman.

I believe that Uncle Sam is still at the old stand with a brave heart and a clear head and I do not believe he is in any danger of losing his pants, coat, vest or shirt.

I believe the United States Steel Corporation, the American Telephone and Telegraph Company, the General Electric Company and the other big industrial institutions will stay in business and that none of them is in any danger of having to take on a side line of lead pencils or apples.

I do not believe there is any danger of seeing John Pierpont Morgan, Owen D. Young, General Atterbury, Charlie Schwab or James A. Farrell throwing their jobs overboard and deciding to make a living as ferry-boat musicians.

I believe that what the country needs more than anything else is a restoration of the ducking stool for professional pessimists, squawkers, calamity howlers and confirmed grouches.

I believe the American people will continue to own and operate automobiles and that there is not a Chinaman's chance that conditions will arise which will make them decide it is a good idea to go back to the bicycle and the buggy.

I believe three square meals a day will always be the American standard, but that even if we miss one or two it won't hurt us.

I believe in common sense and natural vision as opposed to the "fidgets" and the use of smoked glasses when anything goes wrong.

I believe that much of the world depression is "done by mirrors."

I believe the worst is over and that it never was as bad as it was advertised.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION
George H. Prall, *Editor*

HARTFORD, CONN., October, 1931
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.

Welding Now Coming to the Fore

IN VIEW of the many failures of improperly welded pressure vessels in the past and the lack of any practical method by which the field inspector could determine even approximately the strength or soundness of a weld, The Hartford Steam Boiler Inspection and Insurance Company has been very reluctant to issue insurance on such risks. The wisdom of this attitude has been proven time after time when investigations of exploded vessels have revealed welded seams in which there was a most alarming lack of fusion and penetration. In such cases it was sometimes difficult to understand why failure had not taken place sooner.

The refusal, up to now, of the A. S. M. E. Code Committee and practically all the state and municipal inspection departments to recognize or permit the use of welding where structural strength depended on the weld, has sometimes been misconstrued to mean that these agencies considered a satisfactory weld impossible of attainment. Such was far from true, however, as the welding of some manufacturers has for years been up to a high standard. The trouble has been the great lack of uniformity in the kinds of welding turned out by the large number of shops doing that work, and the consequent lack of dependence that could be placed in welding in general.

Although this hesitance on the part of authoritative agencies to sanction welding for pressure vessels has been somewhat of an undeserved penalty for those manufacturers who could do good work, it effectively restricted the widespread use of vessels of absolutely unknown strength and safety. Furthermore, it served as at least one of the main incentives leading up to an intensive investigation of all factors influencing the character of welded joints. In brief, it helped stimulate a successful effort to put welding on a basis where it is no longer regarded as a doubtful method of construction if made according to recognized standards.

The Hartford Steam Boiler Company several years ago set up its own standards by codifying rules for both the characteristics of welds and the methods of testing, so as to assure with reasonable certainty the integrity of the work. The Company also established a list of approved shops which, after undergoing careful investigation, demonstrated their ability consistently to meet these standards. Vessels built by these approved shops have been taken for insurance without hesitation. However, the recent issuing of fusion welding specifications by the A. S. M. E. Boiler Code Committee constitutes authoritative recognition of this form of construction. With these specifications serving as a generally accepted standard there is in sight a new era in which fusion welding will play an ever-increasing part in the construction of pressure vessels.

Diesel Engines Establish Two Records

Within recent weeks the Diesel engine has established two significant records. On Memorial Day a Diesel-powered automobile completed the 500 mile race at Indianapolis without stopping once for fuel or tires. Although its speed of 86.17 miles an hour was not fast enough to win the race, the car's showing was considered remarkable in that the engine had not been designed especially for a racing automobile. It was of the type intended for stationary and marine installations. Thirty-one gallons of fuel oil, costing $1.75, carried the car through the race.

At Jacksonville Beach, Florida, during the first week of June, an airplane powered with a Diesel established a world's record for continuous flight without refuelling. The plane remained aloft 84 hours and 33 minutes.

First Steam-Driven Warship Built *for* United States Navy During War *of* 1812

A SALUTE from whistles and sirens of a thousand craft heralded the famous war frigate *Constitution* when, late in August, she trailed slowly up through New York Harbor behind a modern naval mine layer. Known by school children the country over for her victorious engagements in the War of 1812, this rejuvenated old relic of the past inspired thoughts of a time when towering spars and billowing canvas carried the navies of the world into action and steam on the high seas was still very much in its infancy.

So much concerning the *Constitution* and her exploits has been printed in newspapers and periodicals during recent months that little remains to be told. But now that interest in naval history has been revived by the *Constitution's* voyage, we wonder how many of our readers know that had the war which made her famous been continued another year the United States would have sent against the enemy a steam-propelled warship, the first steam war vessel in the world.

There is an interesting account of this vessel in an old volume by Rear Admiral George H. Preble, entitled "History of Steam Navigation". The following facts have been taken therefrom:

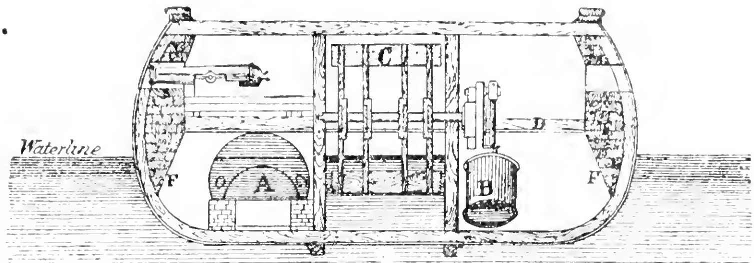
Near the end of 1813 Robert Fulton exhibited to the President of the United States the drawing of a proposed war steamer or floating battery, named the *Delomogos*. Fulton contemplated that in addition to armament on deck she should have four submarine guns, two suspended at each bow and capable of firing a hundred pound ball into an enemy ship ten or twelve feet below her water line. According to the drawings his vessel would have also an engine for throwing an immense column of hot water upon the decks or through the ports of an adversary. The estimated cost of his ship was $325,000, which was about the cost of a first-class sailing frigate.

Fulton's project was favorably received, and in March of 1814 Congress passed a law authorizing the President to arrange for the construction of such a vessel, "for the defense of the waters of the United States." The responsibility was turned over to a committee of five gentlemen appointed by William Jones, then Secretary of the Navy, and this committee chose Fulton as engineer. The enemy's blockade of the coast, then in effect, enhanced the price of timber and rendered the importation of copper, lead, and iron difficult, but although these obstacles increased the expense they did not retard the speed of construction. On June 20 the keels were laid at the ship-yard of Adam and

Noah Brown in New York City and on October 29 the hull was launched.

On the 21st of November the *Fulton*, for such she was eventually named, was towed to the works of Mr. Fulton on the North River where the work of installing her machinery was started.

The dimensions of the first war steamer were: Length, 150 feet; beam, 56 feet; depth from deck to keel, 20 feet: water-wheel, 16 feet



Transverse section of the first steam warship, showing: A, the boiler; B, the engine; C, the water wheel; F-F, the wooden side "armor". This cut is a reproduction of an old wood-cut appearing in "Steam Navy of the United States".

in diameter; length of bucket, 14 feet; dip, 4 feet; engine, 48-inch cylinder, 5-foot stroke. No clear description of the boiler is given, but apparently it was of the flueless type, 22 feet long and 8 feet in diameter. With a tonnage of 2,475, the Fulton exceeded by several hundred tons the largest steamer built previous to her launching.

The commissioners appointed to examine the Fulton said in their report:

"She is a structure resting on two boats, keels separated from end to end by a canal fifteen feet wide and sixty-six feet long. One boat contains the caldrons of copper to prepare her steam. The vast cylinder of iron, with its piston, levers and wheels occupies a part of its fellow; the great water wheel revolves in the space between them; the main or gun deck supporting her armament is protected by a bulwark four feet ten inches thick, of solid timber. This is pierced by thirty port-holes, to enable as many 32-pounders to fire red hot balls. Her upper or spar deck, upon which several thousand men might parade, is encompassed by a bulwark which affords safe quarters. She is rigged with two short masts, each of which supports a large lateen sail and yards. She has two bowsprits and jibs and four rudders, two at each extremity of the boat, so that she can be steered with either end foremost. Her machinery is calculated for the addition of an engine which will discharge an immense column of water, which it is intended to throw upon the decks and all through the ports of an enemy. If, in addition to all this, we suppose her to be furnished, according to Mr. Fulton's intention, with 100-pound columbiads, two suspended from each bow, so as to discharge a ball of that size into an enemy's ship ten or twelve feet below the water-line, it must be allowed that she has the appearance at least of being the most formidable engine of warfare that human ingenuity has contrived."

Such is a correct description of this sea-monster of 1814 but, as might have been expected, exaggerated and fabulous accounts of her got into circulation abroad. Among others was the following story that appeared in a Scotch newspaper of which the editor explained he had "taken great care to procure full and accurate information.":

"Her length on deck," he wrote, "is three hundred feet; thickness of sides thirteen feet of alternate oak plank and cork wood; carries 44 guns, four of which are 100 pounders; and further to annoy an enemy attempting to board can discharge 100 gallons of boiling water in a minute, and by a mechanism brandishes three hundred cutlasses with the utmost regularity over the gunwales; works also an equal number of heavy iron pikes of great length, darting them from her sides with prodigious force, and withdrawing them every quarter of a minute."

This description by the highly imaginative Scotch editor was certainly not of a kind to foster peace of mind on the part of the British Admiralty. Whether the prospect of running afoul of the steam behemoth had anything to do with the decision to suspend hostilities we know not; but the fact remains that peace was declared before the *Fulton* could get into action.

Because of an exhausted treasury and the sudden death of Mr. Fulton, the fitting out of the ship was not completed until June, 1815, when on a trial trip she demonstrated ability to go against the wind, to stem the tide, and to navigate safely among other vessels riding at anchor. Shortly thereafter she was taken out to sea beyond Sandy Hook for a more thorough test of her behavior in rough weather and to see what effect the firing of her guns would have on hull and machinery. From all accounts she emerged from this test with flying colors. Her performance more than equalled Fulton's expectations, and it exceeded what he had promised the government—namely, that she would be propelled by steam at the rate of from three to four miles an hour.

In congratulating the government and the nation, the commissioners who supervised her construction had this to say: "Honorable alike to its author and patrons, it constitutes an era in warfare and the arts. The arrival of peace indeed has disappointed the expectations of conducting her to battle. That best and conclusive act of showing her superiority in combat has not been in the powers of the commissioners to make.

"If a continuance of tranquillity should be our lot, and this steam-vessel of war be not required for public defense, the nation may rejoice in the fact we have ascertained as of incalculably greater value than the expenditures, and that if the present structure should perish, we have the information, never to perish, how, in any future emergency, others may be built."

After her acceptance tests the *Fulton* was taken to the navy yard at Brooklyn and moored on the flats. She served as a receiving ship until, on June 4th, 1829, she was destroyed by the accidental explosion of her powder magazine.

Safeguarding Against Photographic Spying*

FROM many quarters in the German industries there has been complaint that the technical departments at present are practically wide open to industrial spying. This is mainly attributable to the fact that the majority of industrial spies are sent from countries which, at present, are again counted as best customers. It is, therefore, impossible or at least not tactful to object openly when for instance "secret" photographing is resorted to by means of a small camera with the lens pointing to the object through a small hole in the vest pocket.

There is a very simple means for readily nullifying this clever trick of spying. In large industries it is pretty well known which the desired views are and when they are taken. One does not become greatly exercised about the matter and makes no demand for the films, but proceeds along the following lines. Photographic plates are sensitive as well to other rays as they are to light rays. If, therefore, the plates are exposed even for a short period to strongly penetrating radium rays or to Röntgen rays it is impossible, no matter how ingeniously the developing is done, to produce a picture of even the slightest value. The way this is worked out is by unobtrusively guiding the visiting commission, which is suspected of violating its welcome, past a certain apparatus which is not recognized nor even visible. The entire line of beautiful photographic impressions is thereby obliterated.

* Translated from an article in *Der Maschinen Schaden.*

Taps From the Old Chief's Hammer

"PSHAW," growled the Old Chief as he hung up the telephone receiver and turned to Tom Preble, "I know it's a fact that home wouldn't be worth living in if it weren't for the women folks, but why do they insist on worrying themselves continually over a fellow's welfare? That was my daughter reminding me that I'd forgotten to bring my dyspepsia tablets this morning. She and her mother have memories that are altogether too perfect, if you should ask me."

"So you don't think a perfect memory is all it's cracked up to be?" asked Tom, amused at the old fellow's good-natured rebellion.

"I think," said the Chief, "that there's such a thing as having so perfect a memory that it's a nuisance to other people. My idea of a good, satisfactory memory, by the way, is one that can retain the important things without cluttering itself up with the unimportant details."

"That sounds like a fair rule to follow," was Tom's retort, "but where are you going to draw the line as to what's important and what's not?"

"Look here, young fellow," laughed the Chief, "you're trying to get this conversation into the realm of psychology or philosophy or something. Well, I'm not going to argue with you on that basis, but I can cite two examples to illustrate my point, if that'll satisfy you."

"Go ahead," urged Tom, who sensed that the old man was in the mood for spinning a yarn.

"Well," commenced the other, drawing out a desk drawer for a foot rest and settling back into his chair, "I have in mind a case where a fireman's failure to remember a very important detail came near getting me into a lot of trouble."

Pausing long enough to tamp down the tobacco in his pipe and get it well lighted, the old fellow continued: "I had been ordered to make an internal inspection of one of the horizontal tubular boilers at a large planing mill, but when I arrived at the plant that morning I found that the boiler still contained about two inches of water. While I was getting into my work clothes the fireman opened the blow-off valve, so by the time I was ready to crawl inside the water had drained out. However, the bottom of the boiler was still wet and as I wanted to crawl in under the tubes I asked the fireman to get me a plank to lie on. At the same time I asked him to be sure to close the blow-off valve if he hadn't already done so. Of course I should have seen to it personally that the blow-off valve was closed, but under the circumstances I thought he could be depended on for that.

"Well, he brought me the plank and inside I went. I had worked my way almost to the other end when suddenly I heard a rumbling gurgle in the blow-off connection that made gooseflesh stand out all over me. It was evident that another boiler was being blown down into the same manifold with which my boiler was connected and that the blow-off valve of the boiler I was in hadn't been closed. It was equally apparent that there was going to be a tight race between yours truly and the hot water, so I started to worm my way backward as fast as I could go. By the time I reach the manhole and shoved my feet out. there was water covering the bottom of the shell. Ordinarily, I would have slipped out without any trouble, but in my extreme haste my clothes somehow wadded up around my waist and there I hung. The more I struggled, the tighter I seemed to stick—and all the time the water was rising higher and higher. Finally, to keep from being cooked, I had to support myself by hooking my fingers around the lower row of tubes. Of course it seemed longer than it really was before I managed to kick loose and tumble out onto the floor, but even at that the boiler had filled up enough so that the plank floated on a level with the lower edge of the manhole.

"That," exclaimed the old fellow, pausing to relight his pipe, "is what I'd call an example of a poor memory for an important detail. The fireman admitted afterward that he made a mental note to close that blow-off valve as soon as he had brought me the plank. But something else crowded it out of his mind, and when the time came to blow down the other boiler he went ahead without a thought of what might happen to me."

"What about the other example you were going to cite?" asked Tom, when the old man had finished.

"I was just trying to think of one," explained the Chief, thoughtfully contemplating the bowl of his pipe.

"Well, Tom," he said at last, "This one doesn't illustrate exactly what I mean by saying that some folks worry too much over remembering unimportant matters, but it will express the idea in a general way—and on top of that it's a good story.

"I was just leaving a hotel in Witchita one morning when the clerk called me back and handed me a telegram directing me to high-ball for a little town about fifty miles down the line. The wire indicated that there had been a boiler explosion. I was to do what I could toward finding out the cause and helping the plant get things straightened out. Well, I caught a train within a few minutes and when I reached the plant along about ten o'clock I found the boiler house scattered all over the landscape, two men in the hospital, and a crew of employees digging under the wreckage in an effort to locate the body of the fireman. Of course, I pitched in and helped in every way I could, but as the afternoon wore on without our finding any trace of the poor fellow, we finally came to the conclusion that he must have been blown to atoms. Someone suggested that the widow ought to be notified but that was a job nobody seemed to hanker after. Finally the superintendent suggested that maybe I'd consent to break the news, so he and I went off, leaving the other men at their apparently hopeless task of finding the remains.

"Ahem, Mrs. Kennedy," I said after the superintendent had introduced us, "no doubt you've heard about the accident we had at the plant this morning . . ."

" 'Yes,' she said, 'Mike, poor man, was telling me about it.'

"You can imagine our surprise. We had taken it for granted that Mike was winging his way among the angels just about then yet here was his supposed widow intimating that he had paused long enough to break the news to her. We were about to inquire where she had seen Mike when who should appear in the doorway but Mike himself. He furnished the explanation without any further questioning on our part.

"It seems that Mike had the good fortune to be out by the coal pile when the boiler let go. Instead of being crushed under tons of debris he had merely been hurled off his feet. However, he was scared half to death, so home he ran as fast as his legs would carry him and went right to bed.

"Naturally we were somewhat embarrassed in view of our purpose in coming out there and the way matters had turned out, so we mumbled something about being glad that Mike wasn't hurt and started to leave. Just as we got to the gate Mike called after us.

" 'Oh Mr. Robinson,' he said, leaning over the porch rail, 'you fellows didn't happen to find my pipe while you were working around the boiler house, did you? I distinctly remember putting it on the window sill just before I went out to the coal pile.' "

Caught in the Separator

THIS HECTIC AGE

The mountaineer was driving a single hog to Atlanta when a man overtook him on the highway.

In reply to questions the mountaineer said that he could get $2.00 more for the hog in Atlanta than at the county seat, and that it took him two days to go to Atlanta and two days more to return home.

"Man, you get only $2.00 more for the hog in Atlanta and it takes all that time?"

"Time," said the mountaineer, "what's time to a hog?"

She (as they motored by the church): "Aren't those chimes beautiful? Such exquisite harmony."

He: "You'll have to speak louder, dear. Those bells are making such an infernal racket that I can't hear a word."

PRACTICE MAKES PERFECT

At the recent Early Settlers' Picnic Mrs. Upson won the ladies' rolling pin throwing contest by hurling a pin 75 feet.

Mr. Upson won the 100-yard dash.—*Carpenter—He Prints.*

DOG-GONE!

A man bought some sausages and asked his landlady to cook them for his breakfast.

"How'll I cook them?" she asked.

"Fry 'em like fish," replied the lodger.

The next morning, when the landlady served them, she remarked: "I hope you'll enjoy your breakfast, sir; but there's not much in these things when they're cleaned out."—*Ferguson Cross Section.*

OH! DOCTOR!

"Here's something queer," said the dentist, who had been drilling and drilling into a tooth. "You said this tooth had never been filled, but I find flakes of gold on the point of my drill."

"I knew it," moaned the patient. "You've struck my back collar button."

COULDN'T TELL A LIE

"You seem to have plenty of intelligence for a man in your position," sneered a barrister, cross-examining a witness.

"If I wasn't on oath I'd return the compliment," replied the witness.—*The Airway.*

At a concert in Detroit, quarters were decidedly cramped and Madame Ernestine Schumann-Heink, the soloist, had to make her entrance from the rear, down through the orchestra with its maze of music stands. All went well till she came to the orchestra where her familiarly large proportions began knocking over music racks.

"Go sideways, Madame," hissed Conductor Gabrilowitsch in an excited stage whisper.

Ernestine wrinkled her brow, gave a puzzled look from right to left, and called back to the conductor in a hoarse whisper, "Mein Gott, I have no sideways!"

—*The Cockle Bur.*

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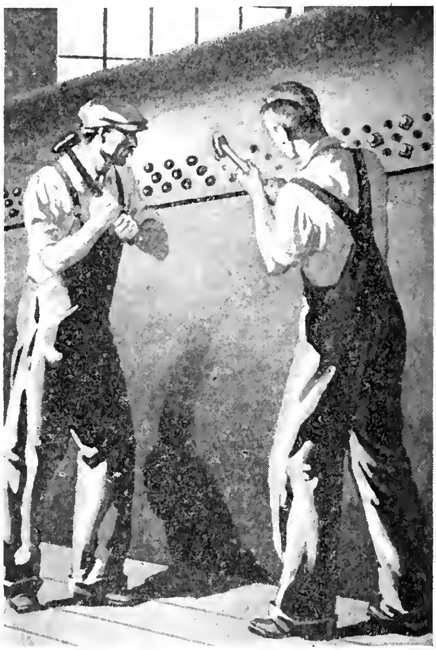

TOO MANY RIVETS

IN the early days, boiler makers frequently put in so many rivets that the holes weakened the plates. Sometimes they did not use enough rivets. Little was known about the proper method of calculating riveted joints so that all parts of the seam would be of equal strength. Explosions resulted. ¶Studies by "Hartford Steam Boiler" engineers early developed standards of boiler construction which came to be designated as *Hartford Standards* and were accepted as the boiler designers' guide. Many of them were used in the boiler construction codes established by State laws. ¶As welding is now taking the place of riveting in many pressure vessels, "Hartford Steam Boiler" is making similar studies in this increasingly important field. ¶Such studies and the vigilance of four hundred Master Inspectors have given Industry its confidence in the "Hartford Steam Boiler".

The Locomotive

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The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
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Company

Please show to your Engineer

Two Serious Power Boiler Furnace Explosions

THE engineer of a large modern laundry in Hollywood, California, was severely injured on October 28 when a fuel explosion in the furnace of a gas-fired power boiler wrecked the setting and blew out a brick building wall. He was not only burned about the head and hands by the sheet of flame that swept through the boiler room, but was hurled twenty feet through a window.

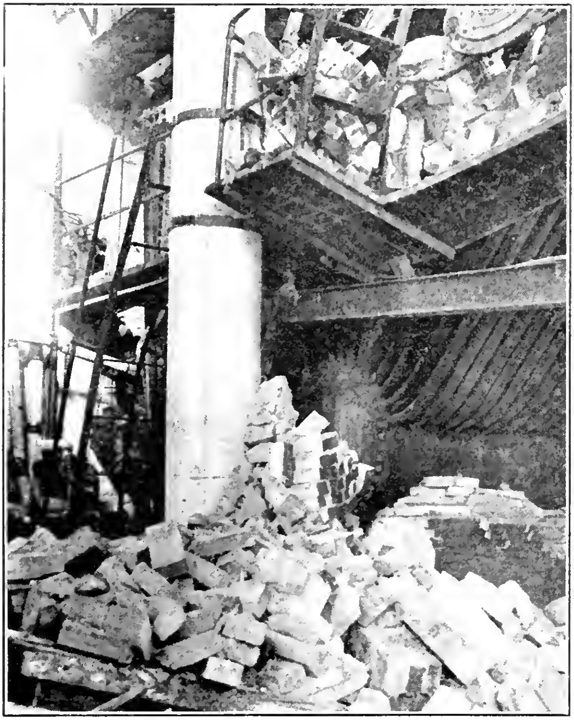


Figure 1

The steel columns supporting the boiler and the 18″ steel girders between these columns were so badly bent and twisted that an entire new supporting structure had to be installed. Deflection of the support caused the boiler to drop about three inches, breaking the blow-off pipe, the safety valve "Y", and several smaller pipe connections. A companion boiler also was badly damaged, as the explosion ripped open the breeching and carried away the safety valve. It took thirty-six hours to place the spare boiler in operating condition. Figure 1 shows some of the property damage, which was estimated at $6,000.

According to the engineer, he closed the fuel control valve at the boiler as well as the valve at the meter outside the building when shutting the boiler down the night before. In some way gas leaked through these valves during the night and filled the furnace and gas passages. The explosion took place when he attempted to light the pilot.

A still more serious furnace explosion occurred in California in

July when the engineer of a paper products plant in Los Angeles lost his life. As in the case just described, the breeching was destroyed and the brickwork of the setting knocked down. Caught under the brick wall as it fell, the engineer was crushed. As is indicated by the illustration shown in Figure 2, the property damage was considerable. An estimate placed the plant's financial loss at $10,000.

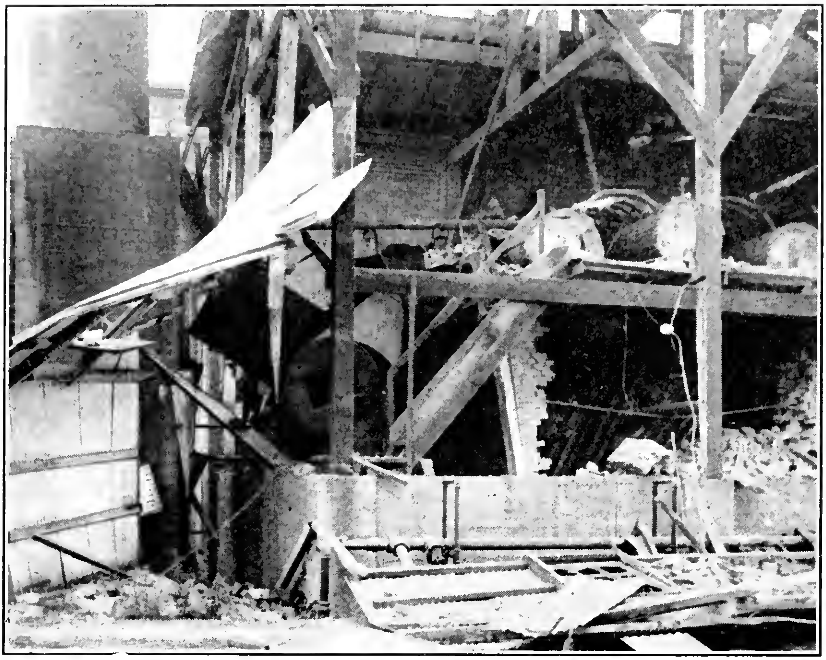


Figure 2

It was thought that perhaps the accident was caused by the engineer permitting the gas pilot to flow too long before igniting it, but as the victim was alone in the boiler room at the time this supposition could not be checked. It seems more probable, however, that there may have been a leak in the gas or oil lines that resulted in the furnace filling up with combustible vapor, as in the case previously described.

To minimize the danger at the time of lighting the pilot on either gas- or oil-fired furnaces, the operator should take particular pains to see that the damper is open. Before approaching the furnace with a torch he should make sure that the furnace and combustion passages have been well ventilated. With oil-fired furnaces he should see that there is no accumulation of oil that may have leaked into the combustion chamber. Tips and nozzles of oil burners should be looked over to see that they are clean and securely connected to the oil lines, and with installations where there is an arrangement for preheating the oil, this temperature should be right before the burner is lighted.

Recently, when asked to issue insurance on an oil-fired heating boiler in a theatre, the company found that the boiler had sustained several furnace explosions. An inspector reported that because of the presence of a deep stage between the boiler and the stack, the smoke flue had been installed with a deep dip so as to pass below the lowest point of the stage foundation. Thus right at the boiler there was a high pocket in this flue that permitted the accumulation of combustible gases. Such an installation, which, fortunately, is unusual, is admirably arranged to produce furnace explosions not only because of the pocket where gas can collect but because the depression in the flue prevents the stack from creating a draft sufficient to serve the furnace. In this particular case it was impracticable to relocate the flue so that it would pass in a horizontal plane from the boiler to the stack, but the danger was minimized by the installation of a small motor-driven induced draft fan.

Another Accidental Electrocution

A boiler room employe recently lost his life at a plant in Philadelphia when an 110-volt lighting circuit accidentally grounded through his body. Carrying a water hose in one hand and an extension cord in the other, the man had just started to enter the combustion space of the boiler he was to clean when the ground occurred. There have been so many similar accidents, in some of which defective or lightly insulated extension cords have been involved, that we feel justified in publishing again this oft-repeated warning: A person whose clothes are damp from perspiration and who is in contact with the metal of a boiler makes a path of low resistance for any electrical current with which he may come in contact. Under such conditions a voltage even as low as 110 may prove fatal. Obviously only extension cords heavily insulated should be used for boiler room work, and great care should be taken to see that fittings are kept in order.

A man went into a shop to buy a fountain pen. The young saleswoman gave him one to try, and he covered several sheets of paper with the words "Tempus fugit."

The saleswoman offered him another pen, saying, "Perhaps you'd like this one better, Mr. Fugit." —*Tid-Bits.*

Boiler in Illicit Distillery Explodes, Kills 2

THE boiler of what was purported to be the largest bootleg whisky plant ever discovered in Southern New Jersey exploded shortly before daylight on December 2, killing two men instantly and, like a huge projectile, passing through and demolishing a wing of a nearby farm house in which several persons narrowly escaped injury.

Investigators had no difficulty in agreeing on the cause of the accident. A large steel heating boiler of the firebox type, intended for a pressure of not more than 15 pounds, had been used to furnish steam for two stills at a pressure of from 60 to 80 pounds per square inch. At the time of the accident the pressure may have been even greater, for although the boiler had a steam gage on which pressures up to 200 pounds could be read, there was not a sign of a safety valve. It seemed evident that the persons responsible for the installation had little knowledge of boilers.

Even though its speed must have been checked when it encountered the house, the boiler traveled 500 feet before coming to rest. The shell was found intact, but the furnace sheet and front head had been torn out completely, stripping the staybolt threads.

The distilling plant had two very large stills. One was rated at 15,000 gallons capacity and the other at 10,000 gallons. Federal prohibition officers estimated the plant cost between $50,000 and $75,000. The stills were in a barn, concealed behind a wall of hay, but the boiler was in a shed some distance away. Apparently the victims were in the boiler shed at the time of the blast. One was blown fifty feet, and the other was hurled into a field 200 feet away.

As is shown in the illustration, the boiler tore a hole 20 by 25 feet in the upper story of one wing of the T-shaped farm house. It passed directly over the bed in which a farm hand was asleep, miraculously sparing his life but taking with it a pair of trousers in which he had secreted a roll of money representing his savings. These trousers, with the money still in the pocket, were found later hanging to the topmost limb of a tree some distance from the house.

After passing through the wing shown in the photograph, the boiler sliced away the wall of the second-story hallway adjacent to rooms in the other wing in which six children were sleeping. They were hurled from their beds but were not seriously injured.

An Explosion Easily Accounted For

Two significant factors figured in the explosion of a small digester that recently came to our attention. The vessel was built with a disc head, the edge of the saucer-like disc being welded to the edge of the shell in such a way that the strain caused by breathing of the head was made to concentrate at the weld. To make matters worse the vessel had no safety valve to guard against a pressure greater than that for which it was intended. Full dependence was placed on the effectiveness of a reducing valve which, moreover, was provided with a by-pass for use when starting the cook.

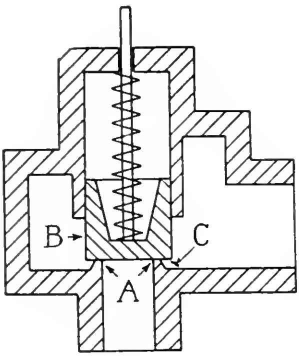
The explosion occurred when this by-pass was accidentally left open too long. However, in the absence of a safety valve, the accident might have come about with the by-pass closed, for reducing valves have often been known to get out of order.

List of 1930 Boiler Accidents

For many years the Company has maintained a tabular record of the boiler accidents occurring in the United States, collected from the Company's files, from the newspapers and other sources. In recent years that information has been published annually in pamphlet form. A few copies of the pamphlet containing 1930 explosions are now available for distribution, on application, to persons who are interested in such data.

Back Pressure Opens Safety Valve on Idle Boiler

TWO men were at work some time ago in front of the open tube cleanout doors of an idle horizontal water tube boiler when suddenly the safety valve on a companion boiler popped and, much to the men's surprise, a cloud of steam was discharged from the empty boiler into their faces. They were puzzled, for the stop valve and blow-off valve were tightly closed and they could think of no way in which steam could have entered the empty boiler.



When an inspector next visited the plant they told him of the occurrence and he undertook to find the explanation. The boiler was one of several used to heat a large store building and the safety valves on all boilers were piped to a common line that ran a long distance before opening to the atmosphere. From the unusual length and layout of this line the inspector reasoned that friction would build up an appreciable amount of back pressure while a safety valve was popping, and it occurred to him that there might be something about the safety valve on the boiler in question that caused it to open when pressure was applied to it from the discharge side.

On examining the valve the inspector found that it was of the type shown *diagrammatically* in the sketch. Plunger "B" had no exposed area on which back pressure would act downward to help the spring hold the valve closed. However, it extended a considerable distance beyond the seat "A" so that there was an area "C" on which back pressure could act upward, thus tending to open the valve. For this particular valve the overlapping area was considerably larger than the area exposed to boiler pressure, so a back pressure even less than the rated popping pressure of the valve was sufficient to lift the plunger.

The discharge line was not only long but it had a sharp bend in it. Probably what happened was the safety valves on two boilers popped simultaneously and caused a momentary back pressure that was enough to raise the plunger of the safety valve on the idle boiler.

When a safety valve discharge line is reasonably short, straight, and of an area at least equal to the combined discharge areas of the valves connected into it, there should be very little or no back pressure. With such an installation there would seem to be very little possibility of any type of safety valve opening under back pressure unless, of course, the discharge line should become stopped up in some way. The incident is cited merely to call attention to the importance of having safety valve discharge lines so arranged that they offer as little resistance as possible to the outflowing steam.

Overspeed Cracks in Thin-Rim Cast Iron Pulleys

By H. J. Vander Eb, *Ass't Chief Eng., Turbine and Engine Division*

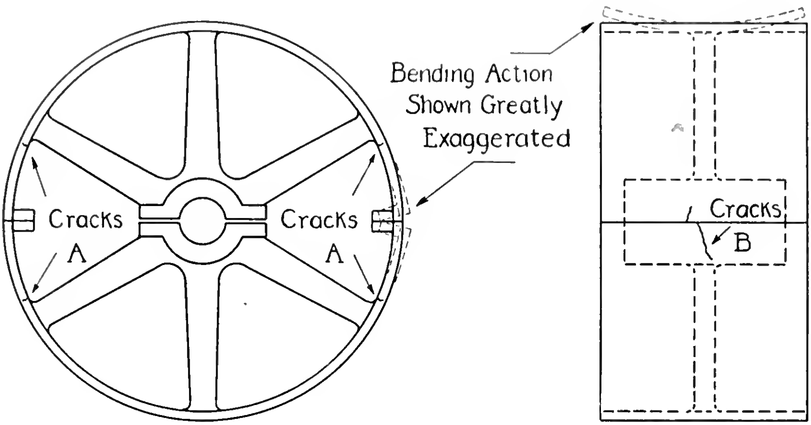
THE approximate formula $V^2/10$, in which V is peripheral speed in feet per second, is generally accepted as expressing with sufficient accuracy the pounds-per-square-inch fibre stress set up in a revolving hoop as a result of centrifugal force. For a hoop of cast iron, for which the breaking strength in tension is conventionally assumed to be 18,000 pounds per square inch, the bursting speed would theoretically be reached at a speed: $V^2/10 = 18{,}000$, or $V = 424$ feet per second (25,440 feet per minute).

Some years ago, by means of a series of tests in which small cast iron wheels of various types were run to destruction by overspeed, it was established that a solid wheel of fairly thick rim and a sufficient number of spokes follows very closely this formula for the hoop. So for such wheels the formula $V^2/10$ is used to determine stresses and allowable speeds.

During the same tests it was discovered that wheels of the design shown here in the sketch and commonly referred to as Type "B" wheels, have only about one-quarter the strength of solid wheels, so in calculating the bursting speed of such a wheel made of cast iron the formula becomes $V^2/10 = 18{,}000/4$ and $V = 212$ feet per second or 12,720 feet per minute. Based on this calculation, in which the rim joint efficiency of a "B" wheel is assumed to be 25 per cent., most authorities have agreed that the maximum safe speed of such wheels is 5,000 feet per minute at the periphery.

However, as the bending resistance of the rim is a major factor in the efficiency of the rim joint, there is some inaccuracy in the assumption of 25 per cent. efficiency when a "B" wheel with thick rim and ample reinforcing flanges is considered. Such a thick-rim wheel would undoubtedly show a somewhat higher bursting speed than a light-rim wheel if both were tested to destruction. Conversely, our experience has shown many times that in thin-rim "B" wheels the development of cracks can be confidently expected when the operating speed is above 5,000 feet per minute. In certain weak constructions cracks have developed at speeds even lower.

There was recently a very interesting confirmation of this well-known weakness of thin-rim "B" type pulleys in a paper mill where there were seven such pulleys of 53″ diameter, 30″ face, and having a single set of six arms. The owners ran these pulleys for a time at 5,900 feet per minute, later speeding them up to 6,800 feet per minute.



There was no difficulty in finding cracks in every one of them immediately thereafter as shown here in the sketch.

The characteristic cracks to be looked for in "B" pulleys are the ones marked "A" at the juncture of the rim and the arms adjacent to the rim joint. The cracks at "B" were undoubtedly due to the fact that the face of the pulley was rather wide for a single set of arms. Apparently the excessive peripheral speed bent the rim as indicated by the dotted lines in the sketch, and the alternating pressure of the belt caused a weaving of the rim surface which resulted in the cracking.

Index to Volume 38 Now Available

The title page and index for Volume 38 of The Locomotive, covering the years 1930 and 1931, is now available and may be obtained by those of our readers who have been sufficiently interested in the little magazine to preserve the issues for reference. Requests should be mailed to this office.

Whenever I see this ill-assorted conglomeration of hopeful youth (a class of incoming college freshmen), they call to my mind the young lady who said to her physician, "How soon will I know anything, after I come out of the anesthetic?"

"Well," replied the doctor, "that's expecting a great deal from an anesthetic."

—*Albert Edward Wiggam* in *Marks of an Educated Man.*

Several Recent Explosions of Heating Equipment

TWENTY-FOUR guests at a Halloween party in Sidney, Ohio, had narrow escapes from injury when a cast iron heating boiler exploded a few minutes after they had left the home of their hosts, causing damage to the house and furnishings estimated at $22,000. The boiler stood directly beneath the living room in which the guests had been seated. Figure 1 shows the room as it appeared after the blast. A nursemaid and a baby who were asleep on the second floor were not injured, although ensuing fire threatened to block their escape from the building.

Figure 1

In Johnstown, Pa., a four-year-old girl was fatally scalded on November 7 when a section of a cast iron boiler burst and showered her with steam and hot water while she was at play in the basement of her home.

A cast iron boiler explosion on October 26 under a sales room in Cleveland, Ohio, came near resulting seriously for the proprietor. The telephone had rung and he was walking toward it when the heavy boiler top came up through the floor, hit the ceiling, and crashed down on the 'phone. The boiler was of the round, vertical type, equipped with a safety valve of ample capacity and in good working order. It was thought that the casting may have been either weak or cracked and that failure occurred at a pressure less than 15 pounds.

Early in December, Alabama street in Indianapolis, Ind., was the scene of two heating equipment explosions on consecutive days. Both accidents occurred in apartment houses and in one, which resulted in

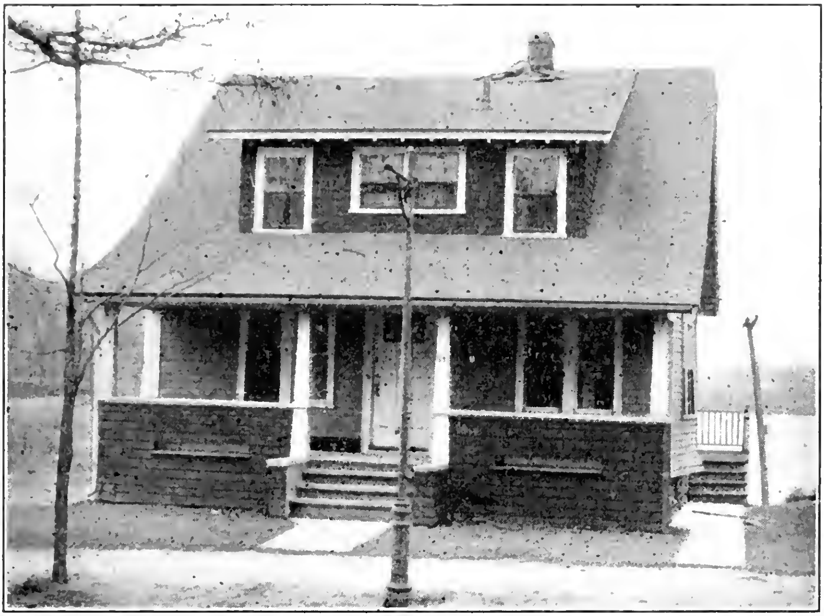


Figure 2

the death of the janitor and the injury of two other men, the janitor was thought to have been working on the boiler when it let go, hurling people from their beds in the apartments and badly wrecking the lower floor of the building. A day after this accident a hot water supply tank exploded in the basement of another apartment house in the same street, tearing a large hole in the floor of the suite directly above it. A woman who was in the apartment suffered from shock. It was reported that there had been repair work done on the tank a few days before the accident.

Just before daylight on the morning of December 30, persons living in a residential neighborhood in Camden, N. J., were rudely awakened as an exploding hot water tank wrecked the interior of an expensive home. The concussion was so severe that the occupants of a neighboring house were thrown from their beds. In the house in which the explosion occurred walls were cracked, floors were bulged, and the windows as well as doors were torn from their fastenings. Property damage was estimated at $7,500.

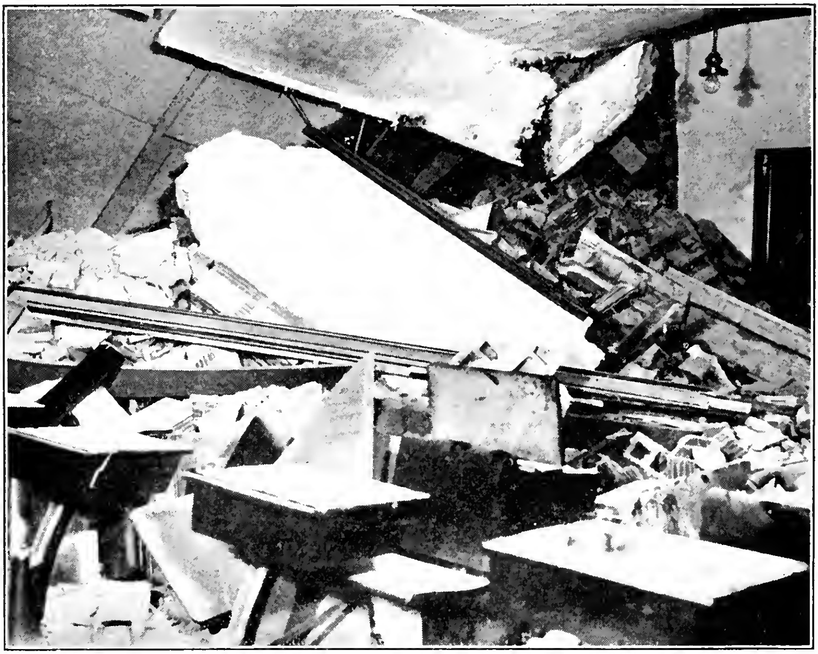


Figure 3

Another recent explosion occurred on New Year's Day at a residence in Worcester, Mass., where a hot water supply tank shot up through two floors to the roof. Figure 2 shows the hole in the roof where the tank struck, as well as a bulged side wall, but it does not give an adequate idea of the damage to the framework and interior. As in the case previously described, the lower floor of the house was wrecked. Furniture was tumbled about, plaster was shaken down, gas pipes and electric light fixtures were broken, and radiators were wrenched from their fastenings. Because heavy floor beams were broken and the whole framework was seriously impaired, the owner was of the opinion that the house would have to be virtually rebuilt.

The tenants were not at home when the accident occurred. It appeared that some one had accidentally left the gas coil heater burning.

Figure 3 is a view of a room of the McKinley school in Willobee, Ohio, where the explosion of a hot water tank during the Christmas recess caused property damage estimated at $15,000. Only one man, an electrician, was in the building at the time. He was fortunate in escaping injury as he was working in a narrow space between the roof and the ceiling of the room here shown. He was obliged to dig his way out after the explosion hurled debris over the trap-door exit. Had the explosion occurred a few hours later many lives would have been endangered, for that evening the school team was to have played a basketball game in the building.

The tank was of lap-welded construction, about 30 inches in diameter and four feet in length. It was protected by a safety valve supposedly set to relieve at a pressure of 60 pounds per square inch. Failure occurred by the blowing out of the minus head which tore through the base of a 90-foot brick smokestack and brought it down. The tank itself was driven endwise through a wall, the shock being sufficient to collapse the roof and damage one class room, the assembly hall, and the cafeteria.

When examined after the accident, the safety valve was found to have had its spring screwed down so far that the coils were nearly squeezed together. Under test, the valve dripped slightly at a pressure of 135 pounds and opened as wide as the compressed spring would permit at 145 pounds.

The closing of the inlet and outlet valves of a cast iron water heater on which there was no relief valve caused the heater to explode on December 31 and kill the superintendent of an apartment house in Brooklyn. Apparently the water heating system depended for protection against overpressure on the fact that a rise in pressure would back water out into the main through the feed line connected to the tank. When the heater was segregated from the tank by closing of the stop valves it was deprived of this protection. Like a tightly stoppered bottle of water placed over a fire, it burst as soon as the pressure within it became greater than it could withstand.

To the best of our knowledge, there was no boiler insurance in effect on any of the accidents here described.

The Importance of Testing Transformer Oil

By K. A. Reed, *Chief Eng., Electrical Division*

IN order to perform its functions properly and safely, a transformer of the oil-filled type must be filled with transformer oil that is in proper condition. As the condition of the oil is subject to variation in service, it is necessary that this oil be given proper maintenance attention.

There are three very important functions performed by transformer oil:

1. By circulating through the oil passages in the windings, it serves as a cooling medium and transmits the heat that develops in the coils and core away from those parts to the cooling surfaces of the tank and radiators.
2. It serves as an insulating medium.
3. It acts as a preservative agent for the insulation and tends to prevent the entrance of atmospheric moisture into the windings.

Samples of the oil in the transformer should be tested periodically, perhaps once a year in the smaller sizes and every six months in the medium sizes. For larger transformers it is customary to make the test approximately once a month. The oil should break down at not less than 22,000 volts across a standard A.I.E.E. gap, which consists of one-inch discs spaced one-tenth of an inch apart. Higher breakdown values are desirable, of course, and it is not uncommon to find samples that will withstand 32,000 or 34,000 volts before breaking down.

Transformer oil must be free from acid, alkali, or free sulphur. Acidity tests should be made once in a while, depending on local conditions; and an examination to determine whether the oil is sludging should also be made occasionally.

The dielectric strength of transformer oil is seriously affected by moisture, and cases have arisen where one part of moisture in 10,000 parts of oil has reduced the dielectric strength 50 per cent. Sludging, which is more prevalent in transformers that have been operated at very high temperatures, or in transformers where the oil is very old, retards circulation and prevents proper dissipation of heat from the core and coils. Acid, alkali and sulphur are detrimental to the insulation and may even damage the cooling coils or the tank.

Cases have come to our attention where the oil in important power transformers had not been tested in more than three years and sludging developed to such a degree that, with no change in load, the transformers started to heat up excessively. On dismantling the apparatus it was found that the oil passages were practically closed and a coating of sludge had collected on the interior of the tanks. The condition of the oil was such that, of course, replacement was necessary.

In general oil samples should be taken from the top and from the bottom of each transformer, the bottom sample being the more important, as moisture accumulates in the bottom of the tank. Usually the bottom sample can be obtained from the drain valve. When this procedure is followed, a sufficient quantity of oil (perhaps several gallons when the drain valve is quite large) should be drained off in order to insure that all moisture that has accumulated in the bonnet or other parts of the valve has been removed before the sample is taken. If there is no drain valve or opening in the bottom of the tank, the sample may be taken with a "thief", a device so arranged that it may be lowered into the tank from the top and filled with oil at any level desired. Samples must be placed in absolutely dry containers and, if there is to be any delay in testing, the covers of the containers should be sealed with paraffin, sealing wax or some other suitable material.

Local power companies are usually in a position to test transformer oil samples for their customers, and the concern using transformers should have this test made periodically, just as it would have any other maintenance work done. An important point to remember is that transformer tanks should be kept full of oil.

Unusual Condition Found by an Inspector

A Company inspector recently discovered an unusual case of trouble when, while examining the taped joints between the cables and terminals of a turbo-generator, he found that he could push his finger through the taping on one of the leads.

After cutting away the taping, he saw that the joint had been very poorly soldered when it was made. The poor joint had heated sufficiently to melt the solder holding the cable in the lug and destroy the inner tape, leaving the outer layers as a mere shell that kept the solder from running out on the floor. Had the condition not been discovered, the generator would have been badly damaged.

One man was killed and another injured on November 21, when the cylinder head of a 300 horsepower Diesel engine exploded at a gasoline plant in Oklahoma. The men had noticed something unusual in the engine's behavior and were trying to shut down the machine when the accident occurred, killing one of them instantly and crushing the thigh of the other.

Two Explosions from Ineffective Safety Valves

A SAFETY valve in which the spring had been screwed down so far that the coils were tightly compressed led recently to a boiler explosion that caused considerable damage at a laundry in a mid-western city. It is supposed that someone screwed the valve down in order to apply a hydrostatic test to the boiler, and then forgot to

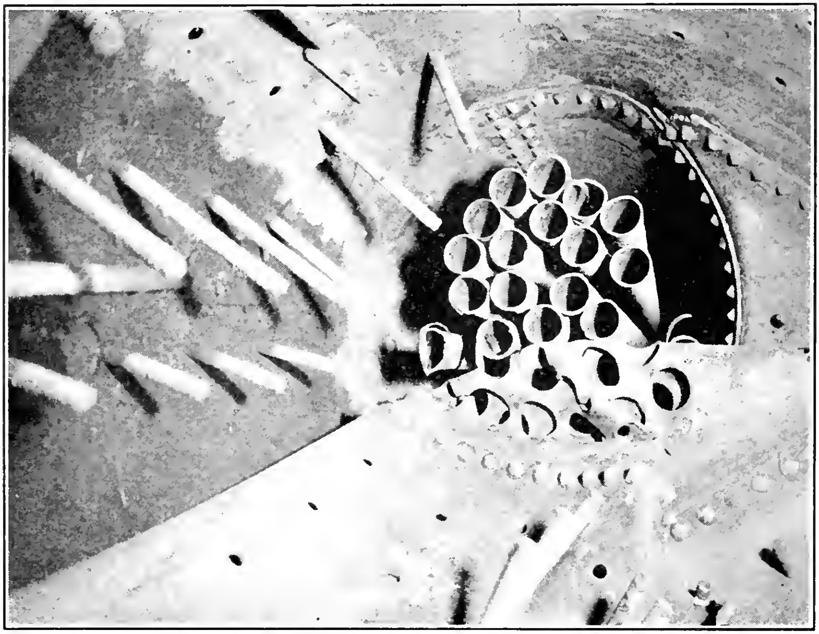


Figure 1

reset the valve before again placing the vessel in service.

An examination made after the accident disclosed no excessive corrosion or old cracks; in fact, the vessel appeared to have been in good condition and entirely suitable for the approved working pressure of fifty pounds. There seems to be no question but that the accident would not have occurred had the safety valve been able to function.

The boiler was of the locomotive type. As is shown in Figure 1, which is a view taken with the camera pointed in through the firebox door, the crown sheet dropped and the tube sheet pulled away from the tubes. Although no one was in the boiler room at the time, the blast injured one man and showered débris on five other persons who happened to be in another part of the building. The front of the building was blown out and a store next door was considerably damaged.

A safety valve in which the spring had not been screwed down but which in another way had been made just as ineffective as the one mentioned above, figured in still another laundry explosion that occurred a few weeks ago in Texas. In this case the safety valve had been installed with a stop valve between it and the boiler. The owner intended,

Figure 2

of course, that this valve should be kept open. In some way it became closed with the result that the locomotive-type boiler dropped its crown sheet, tore in two at the throat sheet, and traveled abruptly up the main street of the town. The barrel, shown in Figure 2, shot forward 300 feet to cut down two gasoline pumps in front of a filling station. The firebox end was hurled backward against a telephone pole. Nothing was left of the boiler house.

After the accident it was found that the safety valve spring had corroded almost in two. Thus weakened, the spring probably allowed the valve to leak at a pressure somewhat less than the 85 pounds at which it was set. The supposition is that in order to lessen the annoyance someone closed the stop valve which, although it should never have been there, offered a convenient way of stopping the leak.

Even though we can think of no good reason why anyone would want to place a valve of any sort between a safety valve and the boiler, and every agency interested in boiler safety has repeatedly warned against the attending danger, this Company's inspectors now and then find installations with that fault when examining boilers offered for insurance. One such case was reported a few weeks ago.

Coal as Raw Material for Chemical Manufacture

SCIENCE is just beginning to reveal coal as destined to become the foundation for vast industrial chemical operations. Its first use was as fuel. Of the 600,000,000 tons produced yearly in the United States, five-sixth is still used raw.

Far from being a simple substance, coal is a complex mixture of chemical compounds, largely hydrocarbons, together with such impurities as ash, moisture, and sulphur. Very little carbon as such exists in coal. This complex nature makes it easier to understand the transformations that occur when coal is distilled in coke ovens, such distillation being historically the second important step in the utilization of coal.

When distilled, coal yields coke, an essential raw material in blast furnace operations and in production of water-gas; coal gas or coke oven gas, valuable as a fuel and as a source of hydrogen for the synthesis of ammonia; ammonia, recovered as a water solution or combined with sulphuric acid to form sulphate of ammonia, the second most important nitrogenous fertilizer; benzol, raw material for various organic syntheses, also a motor fuel of valuable anti-knock properties; and coal tars, well known as raw material for synthetic organic chemical manufacture. About 15% of the United States coal production is distilled, mostly in by-product coke ovens of efficient design.

There are under development uses for coal certain to be of vast importance to civilization, since they will assure indefinitely certain essential commodities, the chief being gasoline and lubricating oils, heretofore obtained solely from petroleum. Coal is destined to be the most important raw material ever available to chemical industry.

Starting with coal, proceeding thence to water-gas (largely hydrogen and carbon monoxide), we have a material that is the immediate starting point in the synthesis of ammonia, of alcohols, and of motor fuels. Under suitable conditions of heat and pressure we can combine the hydrogen derived from water-gas with coal itself, thus obtaining synthetic gasoline and other hydrocarbon oils comparable in utility with the present products from petroleum.

Use of coal as a raw material for chemical manufacture is the direct result of research, principally in Germany and to lesser extent in France, Great Britain, and the United States. The initial coal hydrogenation studies specifically should be credited to the Kaiser Wilhelm Institute for Coal Research in Mulheim-Ruhr, Germany. In these laboratories was conceived the idea of adding hydrogen molecules to the solid hydrocarbons of coal, thus obtaining liquid hydrocarbons similar to the fractions of petroleum. Hydrogen is combined with the powdered coal at elevated temperatures and at a pressure of several hundred atmospheres. The inherent mechanical problems are extremely difficult. The coal is introduced into the pressure or reaction chamber in the form of paste, made by incorporating the powdered coal with some of the heavy oil produced in the reaction. This paste is actually pumped into the system and in similar manner the ash and heavy oils resulting from the reaction are removed.

Separation of this crude oil into its constituents is accomplished in the same manner as in the treatment of petroleum.

This process of hydrogenating coal has not yet been exploited generally because of the present surplus of petroleum in nearly all parts of the world. However, the Interessen Gemeinschaft Farbenindustrie (commonly known as the German Dye Trust) has expended millions of dollars on the process, which is now in production on a large factory scale.

Little imagination is required to forecast the economic and political significance of coal hydrogenation. Countries that do not possess adequate supplies of petroleum and gas, as for example, Germany, will be enabled to become self-sufficient in motor fuels and oils. Most important of all, however, future generations in all countries need not fear that the possible eventual decline of petroleum resources will cause difficulties and inconvenience. Relative to petroleum, coal appears to exist in virtually inexhaustible quantities widely distributed, and therefore is the logical economic basis of all fuel supplies whether solid, liquid, or gaseous. These new and large possibilities for the utilization of coal have come about with comparative suddenness and are attributable directly and entirely to the vision and genius of the research chemist. (Reprinted from *Research Narratives*)

"Are you folks saving anything?"
"Well, not exactly, but we've quit spending money we haven't got."—*Pathfinder.*

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., January, 1932

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Subscription price 50 cents per year when mailed from this office.
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Lon James Reed

OFFICERS and Home Office employes of the Company were greatly saddened on the eve of the holidays by word of the death of Lon J. Reed, chief inspector of the San Francisco department. Mr. Reed had apparently been in good health until he was stricken suddenly with appendicitis. Death occurred early on the morning of December 22 after an emergency operation.

Born in San Francisco on January 3, 1872, Mr. Reed was educated in the schools of that city. After a term of shop work during which he gained experience with both railroad and marine power equipment, he took to the sea, eventually obtaining a chief engineer's license for vessels of any gross tonnage and serving for years as chief engineer on the various vessels of the Pacific Coast Steamship Company. During the Spanish-American War his vessel and its crew were requisitioned for the transportation of troops to the Philippines.

Mr. Reed came with the Hartford Steam Boiler Company in 1909 as an inspector in the San Francisco department. In June, 1918, his Country needed his services and he was given a leave of absence to

enlist in the Navy. As junior lieutenant he made several trips to France in the engine room of the S. S. Alloway and later, as senior lieutenant, he was stationed in New York in charge of the motive equipment of the steamships under the jurisdiction of the Navy at that port.

Three years after his return to this Company in 1919 he was advanced to the position of assistant chief inspector of the San Francisco department, and in 1927 he was made chief inspector. In that capacity his thorough knowledge of engineering matters and his keen sense of loyalty to his Company and its clients earned the respect and admiration of all who knew him.

Directing Inspector L. E. Grundell has been placed temporarily in charge of the inspection department at San Francisco.

Chief Inspector Thomas B. Hetu, of the Detroit department, has been appointed to membership on the Board of Boiler Rules of the Department of Labor and Industry, State of Michigan.

See Great Possibilities for Straight-Through Boiler

ONE of the important results looked for in the experiments now being conducted in this country with super-pressure boilers, is a determination of the extent to which it may be commercially practicable to take advantage of the better thermal efficiency that theoretically should come with the use of higher pressures. The idea that increasing the steam pressure is a means of raising the overall thermal efficiency of a plant has been pretty generally accepted, but engineers have found that with the ordinary types of boilers the higher the pressures go the greater becomes the cost of construction, and at the same time the smaller become the increments of efficiency.

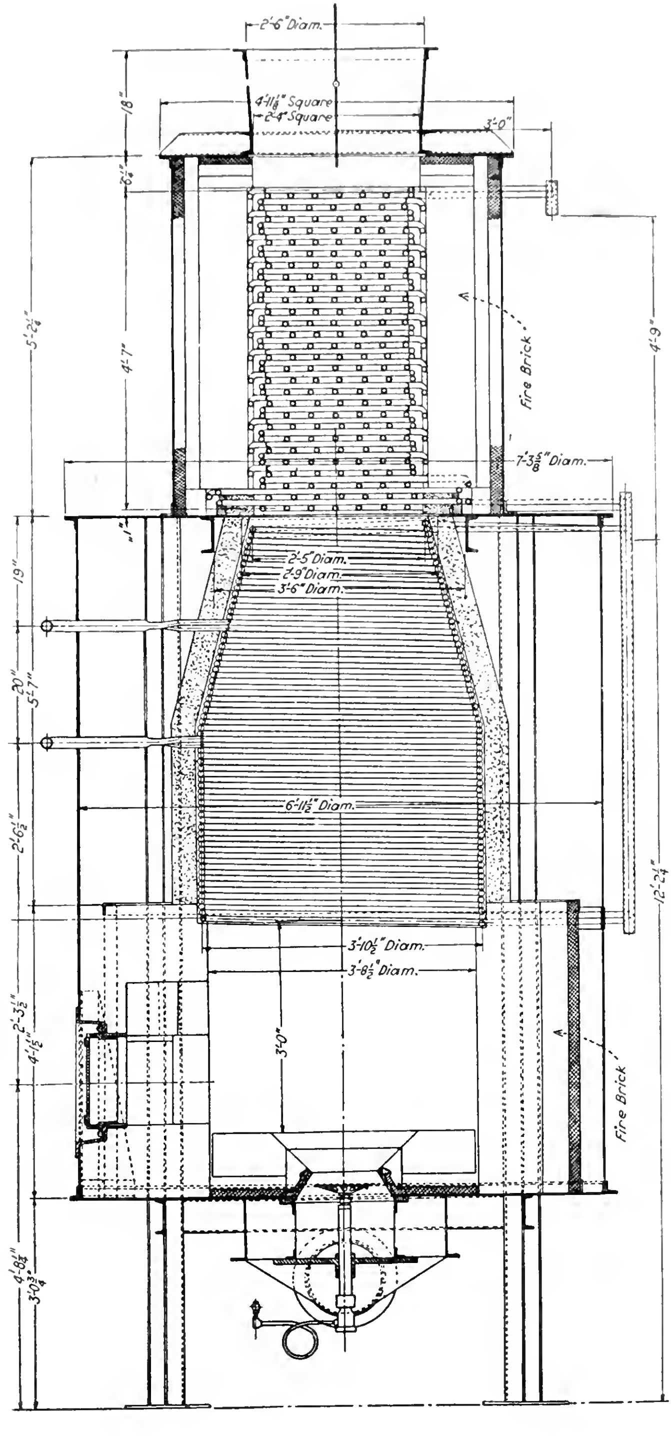
It may be that there is some pressure beyond which it will not pay to go. Experience has shown that as pressures increase, the extra cost of using the orthodox type of standard pressure equipment merely by increasing the thickness of its various parts cuts deeply into the thermal saving that high pressure brings. Therefore, one of the important problems seems to be the designing and building of apparatus for the production and use of high pressure steam at a minimum increase of cost over that of standard pressure apparatus.

At pressures below 3,200 pounds per square inch (the critical point, at which water and steam have the same density) the release of steam from water is attended by violent boiling. To minimize this disturbance in the ordinary type of boiler so that a great deal of entrained water will not be carried out with the steam, it is necessary that the boiler have a sufficient disengagement surface. Usually this is provided for by means of a steam drum or some equivalent arrangement; and when boilers are built for very high pressures the cost of fabricating these large-diameter parts becomes considerable.

In order to avoid the use of such parts which are not only expensive but which hold a tremendous store of energy that would do great damage in case of a failure, there has been developed what is termed the straight-through flash type forced-feed boiler. It consists in the main of a series of coils of small tubing into which water is pumped, and out of which steam emerges at almost any desired pressure and degree of superheat.

At the recent annual meeting of the A.S.M.E. in New York, reports were presented on two such boilers, one of which is in experimental operation at the Babcock & Wilcox Company plant in Bayonne, N. J., and the other at the engineering experiment station of Purdue University. These boilers are very much alike, although the Purdue unit has but two straight-through circuits, whereas the other has seven.

As may be seen from the illustration, which shows the general form



2'-6" Diam.
4'-11⅛" Square
2'-4" Square
3'-0"
18"
6¼"
5'-2¼"
4'-7"
Fire Brick
4'-9"
7'-3⅝" Diam.
1"
19"
2'-5" Diam.
2'-9" Diam.
3'-6" Diam.
20"
5'-7"
6'-11½" Diam.
2'-6½"
12'-2¼"
3'-10½" Diam.
3'-8½" Diam.
2'-3½"
4'-1½"
3'-0"
Fire Brick
4'-8¾"
3'-0¾"

of the unit at Purdue, the boiler is vertical and is made up of an economizer section above a furnace surrounded by wall tubes in the form of helical coils.

To quote from the report submitted at the A.S.M.E. meeting: "This steam generator is a further development of the Calumet-type unit in that the steaming economizer, or convection element, is continued through the evaporating and superheating sections. There is no steam drum, and the water that enters the unit passes through a continuous coil and leaves it as superheated steam. It can be operated at any pressure between 1,000 and 3,500 pounds per square inch at the outlet, although in the lower pressure ranges the friction loss is excessive by reason of the small tubes used. No throttle valves or other regulating devices are installed between the boiler feed pump and the steam generator outlet. By varying the ratio of fuel to water at any load, the final quality of the steam may be changed from saturated to superheated steam at a maximum temperature of about 830 deg. F., this being limited by the tube material. The unit is constructed of 1 in. O.D. by ½ in. I.D. seamless-steel tubing (A.S.M.E. 1927 Code boiler steel). All joints are gas-welded, using a butt type of weld.

"The feedwater is delivered to the top of the convection section, where it is divided into two parallel circuits each 521 ft. in length, and flows downward countercurrent to the gas flow . . . The water which leaves the two parallel circuits at the bottom of the convection section is carried to the bottom of the furnace coils by a single downcomer or equalizer which is made of double extra-heavy 1½ in. seamless-steel tubing. The lower furnace-coil section consists of two parallel circuits wound in the form of a cylindrical helix and discharging at the upper end into a common tube or equalizer. The middle and upper furnace-wall sections consist of two parallel circuits wound in the form of a conical helix, with another equalizer connection between the sections.

"The steam generator is fired by a single mechanical oil burner placed underneath the cylindrical furnace, the gases flowing upward in a single pass to the stack . . . Feedwater is supplied by a triplex pump driven by a direct-current variable-speed motor."

No attempt can be made in an article as brief as this one to describe the intricate and sensitive regulating devices used in conjunction with this boiler, or the apparatus by which its thermal performance is being checked. However, it is important to note that for any boiler of this type, where the water that enters passes directly through to emerge at the other end as steam, there must be regulating devices that keep the rate of feed and heat supply in close synchronism with the steam demand. Obviously, if the demand increases, the feed pump and the oil burner must keep step. Should the feed pump deliver less water than is necessary to make up the amount withdrawn as steam the tubes would soon be damaged by overheating.

It is too soon to make any prediction as to what may come out of these experiments, but it is possible that added light on the question of high pressure economy, and further development of this type of high pressure generator may in time bring about radical changes in the art of power generation.

Small Turbines Also Need Periodic Inspections

IT is just as important that the small, auxiliary turbine be inspected internally at regular intervals as it is that the large, main power unit be given this necessary attention. A recent accident to a turbine driving a condenser circulating pump brought this forcibly to attention.

The plant where the accident occurred made a practice of having its main units inspected regularly and kept in the best possible condition. When it was found at one inspection that sediment had not only collected on the buckets but had also fouled the quick-closing valves on two of the units so they could not operate properly, the management immediately had the sediment scraped out and took steps to correct the condition of the steam. However, the probability that sediment had collected also on the buckets of the auxiliary turbine was overlooked, with the result that the overload on the thrust bearing, together with poor oil, finally resulted in so much wear that the rotor moved lengthwise and damaged the buckets. A whole new wheel was necessary.

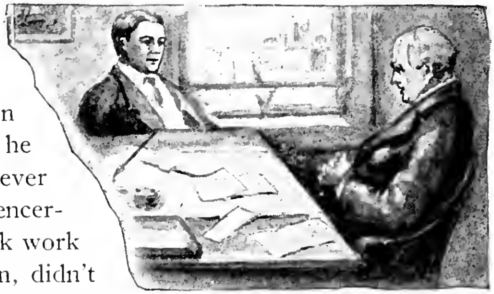
Auxiliary turbines frequently receive a poorer quality of steam because of their usual location below the main units and at the bottom end of the steam piping. In addition, there is a strong temptation for operators to give less care and attention to the proper lubrication and other operating details of these machines when they are more or less hidden away in the basement or boiler room. As a result, failures of buckets, speed control mechanisms, bearings and thrust bearings are more likely to occur and to result in serious damage than in the case of large units that are being given constant attention.

THE SILVER LINING

Anyway, you don't have to wait at grade crossings, as you did in the summer of 1929, for a freight train 178 cars long to pass.

Franklin P. Adams in *New York Herald Tribune.*

Taps From the Old Chief's Hammer



"SAY, Tom," exclaimed the Old Chief, glancing up from a note that had been placed on his desk before he arrived at the office, "who ever it was you sent up to the Spencertown Woolen Mill made quick work of getting things going again, didn't he? The trouble with the generator couldn't have been nearly as serious as the manager thought when he 'phoned me yesterday."

"It turned out to be merely a broken field coil connection, Chief," explained the old man's assistant, "but Bronson claims that even at that it was just plain good luck that he was able to put things in shape for the mill to start this morning. However, I think it was due more to ingenuity on his part than to luck."

"What happened?" asked the Chief.

"Well, after you notified me I got in touch with Bronson and had him drive over to Spencertown right away, telling him that if it was at all possible the generator had to be in shape to run at seven o'clock this morning and for him to stay on the job until repairs were completed. He reached the plant about noon, he says, and saw right away what the trouble was. One of the strap connections between the field coils had snapped, the two broken ends being so short that it was impossible to make repairs by lapping and soldering them together. The logical way of fixing the break was to solder in a strip of heavy copper. However, the plant didn't have an electrician of its own and as it was Sunday there wasn't one to be found anywhere in the village. Under the circumstances, Bronson offered to supervise the work if the engineer would dig up a blow torch, a soldering iron, and some strap copper.

"Of course, it wouldn't have taken any time at all just to sweat on a strap and tape the connection but, believe it or not, when they came to look for a suitable piece of copper there wasn't a bit to be found anywhere. The village plumber couldn't help them out either.

"The engineer had just about concluded that the only recourse was a thirty-five mile trip to Talbott, with the chance even then of not being able to find the proprietor of the eletrical supply store, when Bronson spied a discarded automobile engine on a junk pile and immediately thought of a way out of the difficulty. The cylinder head was removed and the copper gasket salvaged. Half an hour later the generator had been repaired and tested, and Bronson was ready for the trip home."

"That was good work," exclaimed the old man. "I'll have to speak to Bronson about that."

"By the way," said Preble, "in the old days, with towns large enough to have supply stores few and far between, you must have frequently been up against the necessity of making emergency repairs so as to keep things running. How about it?"

"Oh, yes," smiled the Chief. "You know," he continued after a thoughtful pause, "an inspector isn't supposed to actually make repairs. I don't say that he won't lend a hand now and then in an emergency, but his job is merely to tell what should be done and suggest a way of doing it. I have in mind an incident of years ago where one of my men, on going out to an emergency case which the assured had reported as a boiler explosion, found that corrosion in the form of pitting had eaten a hole about the size of a lead pencil through the wall of a 4-inch tube. He discovered, too, that quite a number of tubes were similarly affected to less extent, which bore out a suggestion he had made at a previous inspection to the effect that the boiler would soon be in need of retubing.

"This particular plant was a cold storage warehouse located in a small town. As it was near the end of the summer the cold storage rooms were filled with perishable fruits and vegetables, so it was important to keep the plant in operation if that were at all possible. An inquiry of the local repair man revealed that he didn't have any 4″ by 20′ tubes on hand and wasn't at all certain that he could get them right quick from his material supply dealer. It was evident under the circumstances that some sort of temporary repair was in order, so at the inspector's suggestion a hard-wood block 12 inches in length was shaped to fit snugly into the tube. The boiler was then filled with water and the block was driven into the tube until it was centered lengthwise over the pit hole. Placed in service with that block in place, the boiler operated satisfactorily for about sixty days, at which time weather conditions permitted shutting it down for retubing.

"Pshaw, Tom," laughed the old man, tapping out his pipe and reaching for a can of tobacco, "don't get me started spinning yarns this morning. If you do I'll be telling you about the Sunday I had to recommend the use of a piece of a shoe sole to rebabbit the crank pin bearing of a draft fan engine."

"Go ahead. Let's hear it," urged the younger man.

"Oh, it didn't amount to anything, except the bearing burned out and the boilers wouldn't handle the load without forced draft. We couldn't find enough babbitt anywhere around, so I showed them how to shape up a piece of sole leather, anchor it in place by driving pegs through the leather into the anchor holes, and make a repair that filled the bill until a permanent job could be done.

"Don't get the idea, though, Tom, that even in those days we ever condoned makeshift repairs upon which safety depended. However, whenever it has been a matter of figuring out a way of keeping a plant in operation until permanent repairs could be made, I've always been a strong believer in the inspector using his resourcefulness."

Another Oxide of Carbon

CARBON dioxide, CO_2, the product of the complete combustion of carbon, is an inert gas which has long been familiar to mankind in the foam of beer, the sparkle of champagne, and as the driving force of the soda siphon. More recently in its solidified form of "Dry Ice" it has extended its range of usefulness.

Carbon monoxide, CO, which results from incomplete combustion of carbon, serves us well as a major constituent of ordinary illuminating gas and serves us badly in the exhaust gases of motor vehicles, which it renders highly poisonous by its habit of combining with the red coloring matter of the blood, which thereupon loses its power of uniting with oxygen in the lungs.

Familiar as both of these oxides of carbon are to everyone, we now have to reckon with a third, the suboxide of carbon, C_3O_2, with which only a few chemists have as yet even a speaking acquaintance.

The suboxide is a gas at ordinary temperatures, but is easily condensed to a liquid boiling at 7 degrees Centigrade and to a solid which melts at about 110 degrees below zero, centigrade. It has an unbearable odor, like mustard oil; its dilute vapor brings copious tears. In greater concentration it attacks the whole respiratory system with suffocating effect. It burns in air to CO_2, and with water it forms malonic acid. With ammonia, aniline, and many other chemicals it units to form a variety of compounds. Heated, it polymerizes to a dark red solid. Like many other laboratory curiosities it may one day find its place in industry.

These oxides of carbon afford a striking illustration of the extraordinary difference in properties which compounds of the same two elements exhibit as the proportions of the two constituents vary. We have another example in the case of water, H_2O, and hydrogen peroxide, H_2O_2. *(Industrial Bulletin of Arthur D. Little, Inc.)*

Caught in the Separator

The pedestrian was dodging about indecisively to the bewilderment of a motorist, who finally stopped entirely and asked, "Would it be requiring too much of you to ask you to outline your plans?" *Adapted from New Yorker.*

"Good cook is offered splendid view from kitchen window of main thoroughfare with constant arrests, small accidents, ambulance calls, and other interesting incidents at all hours of the day and evening."

—Ad. in an English paper, quoted in *The Literary Digest.*

In a small town in the South, there was a lad who had the reputation of not being very bright. People there had fun with him several times a day by placing a dime and a nickel on the open palm of his hand, and telling him to take his pick of the two. In each case the lad would pick the nickel, and then the crowd would laugh and guffaw.

A kind-hearted woman asked him one day, "Don't you know the difference between a dime and a nickel? Don't you know the dime, though smaller, is worth more?"

"Sure, I know it," he answered, "but they wouldn't try me out on it any more if I ever took the dime." —*Christian Science Monitor.*

WHAT TO DO!

It's a queer world. Remain silent and others suspect that you are ignorant; talk, and you remove all doubt of it. —*The Baptist.*

The get-rich-quick schemes that offer you a return of 25 per cent on your money never undertake to explain what will happen to the other 75 per cent.

—*Arkansas Gazette.*

That girl *must* be twenty-five. She's stuck to the same story all the years I've known her. —*Pathfinder.*

Lord Dawson, of Penn, relates this in the *Atlantic:*

A farm laborer in England had been out of work for many months and had been living on the dole. He remarked to his physician one day:

"Doctor, do you know I had an offer of work some days ago which would have given me five shillings more a week than I am getting from the dole, but after giving it thorough reflection I preferred to remain independent."

—*Boston Transcript.*

Safe driving at a moderate speed requires nothing but self-control and a strong rear bumper. —*Dubuque American Tribune.*

"Oh, Bob, did father seem pleased when you told him of the $500 you had saved?"

"I think so—he borrowed it." —*Pathfinder.*

The quitting whistle had blown when Murphy shouted, "Has anyone seen me vest?"

"Sure, Murphy," said Pat, "and ye've got it on!"

"Right and I have," replied Murphy, gazing solemnly at his bosom, "and it's a good thing ye seen it, or I'd have gone home without it." —*Capper's Farmer.*

The Hartford Steam Boiler Inspection and Insurance Company

56 Prospect Street
HARTFORD, CONN.

ABSTRACT OF STATEMENT, DECEMBER 31, 1930

Capital Stock, - - $3,000,000.00

ASSETS

Cash in offices and banks		$ 501,765.85
Real Estate		326,522.00
Mortgage Loans		1,044,502.72
Bonds and Stocks		17,330,488.36
Premiums in course of collection		1,213,648.12
Interest accrued		158,019.59
Other Assets		13,445.96
Total Assets		$ 20,588,392.60

LIABILITIES

Reserve for unearned premiums		$ 8,956,350.39
Reserve for losses		413,085.83
Reserve for taxes and other contingencies		910,105.27
Capital Stock	$3,000,000.00	
Surplus over all liabilities	7,308,851.11	
Surplus to Policyholders,		**$10,308,851.11**
Total		$ 20,588,392.60

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Incorporated 1866 — Charter Perpetual

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Vol. XXXIX No. 2 April 1932

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Three Explosions Caused by Lap Seam Cracks

THE most dangerous defect to which old boilers with longitudinal lap seams are subject—grooving and cracking of the seam—caused three explosions within a few weeks of each other early this year. Five men lost their lives and three were injured. To the best of our knowledge, no boiler insurance was carried in any of these cases.

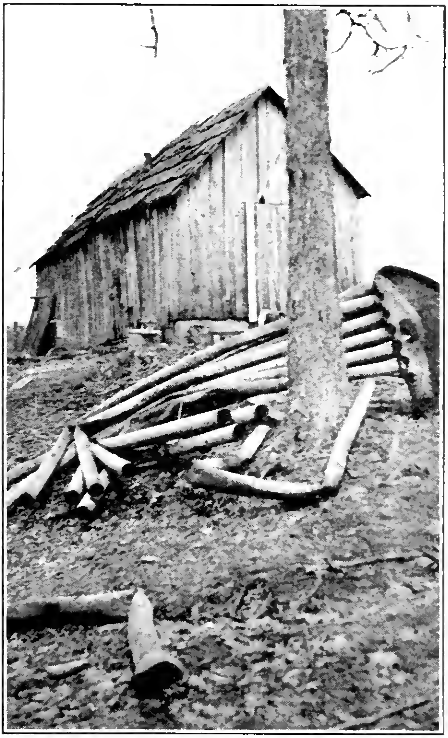


Figure 1

At one plant, a sawmill in a Southern state, a horizontal tubular boiler 36 inches in diameter and 12 feet long failed at the longitudinal seam of the front course on the morning of March 10. This sheet tore away from the front head and second course, crashing into and demolishing a mill building. The two other courses, together with the rear head, sailed like a rocket over another building and came to rest in a copse of wood 900 feet from the starting point. With the tubes still attached to it, the front head was driven against a tree with such terrific force that some of the tubes were bent almost double, as shown in Figure 1. Had the tree not been there, these parts of the boiler would have plunged into the residence of one of the mill workmen. One tube did break away and pass completely through the house, but fortunately it did not strike any of the several women and children who were there.

The grooving along the seam that failed was so deep that an inspector who examined the plate after the accident was inclined to believe that the explosion occurred at the ordinary working pressure of the boiler. The fireman had brought the pressure up and was in the act of rolling the engine off center, preparatory to starting the mill for the day's run, when the accident took place. Three men were killed instantly and three others were seriously injured, one critically. Destruction of the mill was complete.

A boiler of the locomotive firebox type figured in another recent explosion at a sawmill in the South. The mill had been working at a new location only two days when, while workmen were preparing to start operations on the morning of January 12, the boiler blew up and

Figure 2

killed two men who were firing it. Failure took place along the inside lap of the course nearest the firebox, and was caused by a groove along the inside lap so deep that at some points only a thin film of sound metal remained.

This explosion was extremely violent, destroying the mill building completely, as is evident from the view shown in Figure 2.

The fortunate fact that only one man was on the premises is probably the reason that no one was killed or injured when, on January 11, a 48″ locomotive-type boiler let go at a plant in Maine. He was out of range of the force of the blast and suffered only the effects of being thrown heavily to the floor.

Previous to the accident there had been no indication that a defect existed in the boiler. Two weeks before, attendants had removed manhole covers and given the vessel a thorough washing-out. The safety valve was set to blow at 95 pounds, this pressure having been reached on many occasions without signs of leakage.

The initial break occurred along the outside surface of the inside sheet forming the double riveted lap-seam of the front course, shown in Figure 3. After this sheet tore loose it sailed over several plant buildings and came down through the roof of a two-story warehouse 400 feet away. The reaction of escaping steam caused the main portion of the boiler to jump backward about 20 feet to strike the main plant

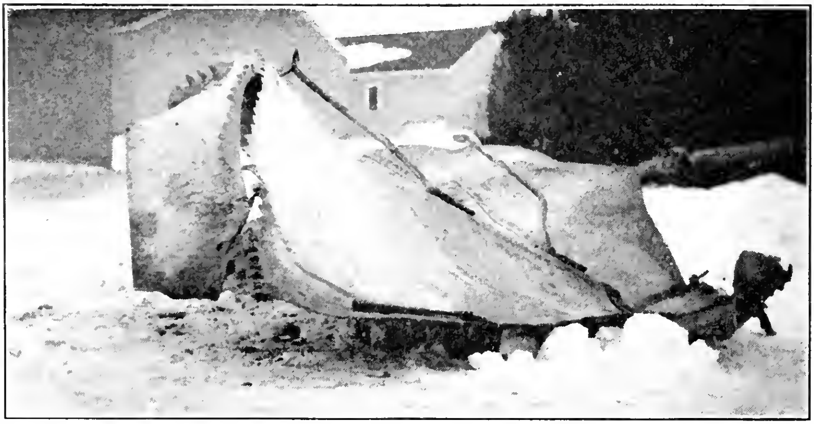


Figure 3

building. The impact was sufficient to move the entire building 15 inches on its concrete piers. Property damage was estimated at $4,000.

The plate was judged to have been 9/32″ thick originally, and uniform corrosion with some slight pitting had reduced this to 7/32″ in some places. There was also a well-defined crack. The edges of the crack were rough and showed signs of considerable exposure. The sound metal remaining at the crack varied from 1/16″ to not over 1/8″ in thickness.

This boiler was of the locomotive, wet-bottom type, 48″ in diameter and 17′ long. It had been bought two years before from a sawmill and was probably about 15 or 20 years old.

A boiler room employe of a cotton oil mill in Greenville, Texas, lost his life recently while helping to clean a boiler. According to a newspaper report, it was evidently a case of electrocution. The man was using an extension cord from a 110-volt lighting circuit. A similar case was reported in our last issue.

Causes *of* Furnace Explosions, *and* Methods Recommended *for* Reducing Their Frequency

By E. R. Fish, *Chief Engineer, Boiler Division*

INQUIRIES received since the appearance of the last issue of The Locomotive have indicated considerable interest in the subject of power boiler furnace explosions. In presenting a discussion of this hazard and of the conditions conducive to it, we do so with the thought that it may be of value to many of our readers in plants where either oil, gas, or coal, either coarse or pulverized, is used as fuel.

Combustible gases cannot burn without a supply of air. A deficiency of oxygen produces smoke and partly burned gases. An excess gives complete combustion providing there is thorough mixing of the air and gas, but too great an excess is inefficient in that it wastes heat up the chimney.

Mixed in the proper proportion with air, combustible gas will be burned completely to incombustible gas. When there is a considerable excess of air an "explosive mixture" may be formed. This burns almost instantly when ignited, and such an occurrence is termed a "combustion explosion" or "detonation," which in reality is only very rapid burning. The volume of gas is thereby so greatly and quickly increased that it creates a pressure, the intensity of which depends on the quantity of gas and the size of the space in which the explosion occurs. When an explosion takes place, gases are forced out of every opening in the furnace, and if these openings are not of sufficient area to relieve the pressure promptly, the result may be the blowing down of the brick setting or disruption of the breeching.

Such explosions frequently blow open fire doors, causing personal injuries and property damage. The A. S. M. E. Boiler Code requires that fire doors of certain types of boilers be positively latched, which minimizes the danger of their being blown open.

For the purpose of relieving the pressure promptly the settings of many boilers are provided with special explosion doors that are unfastened but so designed that they stay shut until opened by a slight increase of pressure within the combustion chamber. These should be so arranged that if they operate no injuries or damage will result. Unfortunately, however, they are rarely of sufficient size or design to function as they should.

Gas and Oil Fuel—Explosions when gas or oil is used as fuel differ somewhat from those occurring with the use of solid fuels. When gas is used, be it natural or one of the several varities of artificial gas, it is introduced through a specially designed burner into the combustion chamber. Usually some air is blown in with it, the additional or secondary air necessary to complete combustion being admitted elsewhere than around the burner. The entering gas must be ignited immediately or trouble is likely to ensue, so it is important that the igniting devices be effective and dependable. Failure to ignite promptly provides the interval in which an explosive mixture may form.

Using a gas valve that leaks or inadvertently leaving the valve partly open when the boiler is not in use are other sources of danger, for either of these will result in the furnace filling up with an explosive mixture requiring only a spark to set it off.

Furnace explosions are not quite as likely to occur with oil fuel as they are with gas, but leaking oil that can accumulate on the bottom of the combustion chamber when the boiler is idle will give off gases that can easily form an explosive mixture. These gases are freed quickly when the furnace is warm but, even when it is cold, gases will be liberated from the oil after the latter has been exposed to the atmosphere for a certain length of time.

Prompt ignition of the oil when lighting the fire is not quite so essential as with gas, but it is very desirable. Explosions are not likely if ignition is delayed only slightly, but even so a temporary bad furnace condition is produced until the sprayed oil is burned away.

Pulverized Fuel—Pulverized or powered fuel is used principally in the larger installations but may be adapted to relatively small furnaces or boilers, say down to about 250 horsepower. Through costly experiences large plants have learned the need of careful and capable supervision in order to avoid furnace explosions and to keep the installation operating economically. As a consequence the operating and maintenance crews are carefully chosen and thoroughly instructed. Smaller plants are usually not quite so well manned and, as would be expected, explosions occur more frequently in these plants than in the larger ones.

When intended for use as powdered fuel, coal is reduced to such fineness that about 85 per cent. will pass through a 200 mesh screen. The result is an exceedingly fine powder that easily remains in suspension in the atmosphere, settling very slowly. It is well known that combustible material, when suspended in appreciable quantities in air, forms an explosive mixture quite similar to combustible gases. It is this characteristic that gives rise to the need for extreme care in handling plants that burn this fuel.

There are two systems of using pulverized fuel—the direct or unit system, and the indirect or storage system.

The direct system consists of one or more pulverizers with the accompanying fans located immediately adjacent to the furnace or boiler they serve. The raw coal supply is brought by means of conveyors from the crusher to the pulverizing unit. From there the fine coal is blown into the furnace by the primary air which provides a portion of the air required for combustion, the quantity of which varies in the several systems. The secondary air, or the air required in excess of the primary air, is supplied through separate openings in the furnace, or possibly through ports forming part of the burner arrangement.

An indirect system consists of a central drying and pulverizing plant with storage bins located away from the boilers. Distribution of the fine fuel to the several furnaces is accomplished through conveying pipes, usually with air as the transporting medium.

In compiling information on the handling of this fuel, we recently asked six manufacturers of pulverizing equipment for their explanations of why furnace explosions occur, and how to avoid them. The following comments are taken from their answers so that the advices are not ours alone but those of concerns directly engaged in the design and installation of powdered coal apparatus. Although appearing in quotation marks so that they may be distinguished from the author's own expression, the following excerpts are not literal quotations. However, in making some few changes for the sake of conciseness, the original meaning has not been disturbed.

"At least 95% of the furnace explosions in powdered-coal-fired boilers have occurred while starting fires. Most of these were caused by an insufficient ignition flame. In the earlier days of the art it was common practice to use oil-soaked rags for torches and to accept an occasional puff or flareback as a matter of course. In practically all of the earlier installations the storage or indirect system was used. In starting, only one of the several burners was lighted, so that only a comparatively small amount of coal was blown into the furnace and the explosions that often resulted from lighting were of a minor nature. In direct fired systems a larger quantity of coal is used in starting, and unless ignition is properly obtained a serious explosion may occur. The best safeguard against explosion is an amply adequate ignition flame. Oil torches of the self-sustaining type, having air supplied with the oil, should be used. Such torches cannot be smothered by the air and powdered coal mixture. If ignition is not obtained almost immediately —within 10 to 20 seconds after introducing the coal—the coal supply should be shut off, the furnace cleared of dust by increasing the draft, and a new attempt at lighting made with different adjustments of air, coal and draft.

"Furnace explosions may occur also when, during operation, the fires are extinguished and the feeders and burners continue in operation. The coal may then reignite from hot brickwork and a serious explosion occur. The cause of the fire going out may be in the feeds or in the draft. When the fire goes out due to an interruption in the coal feed, care should be taken to see that the feeding is not resumed except under control of the operator. The fire must be relighted by using a torch, and the coal feed and draft adjustment must be the same as when lighting a cold furnace. Watchfulness on the part of the operator is necessary to prevent explosions that would result from temporary interruptions of coal feed."

"There are two types of explosions that occur in furnaces. One is a true explosion, sufficiently violent to be so termed. The other may be more correctly called a 'puff,' and the degree of intensity of the latter may vary between pressures of two inches up to six or eight inches of water. Considering the 'puff' type first, causes will usually be found in fuel feed interruptions or wide fluctuations in the supply of coal, the result of which is a deficiency of coal followed immediately by a surplus.

"Puffs are most frequently found in connection with direct or unit firing and especially when starting a unit-fired boiler. In the latter case they are due to unstable ignition because of incorrect relations of primary and secondary air and coal quantities. If ignition fails or becomes unduly retarded, a large amount of pulverized coal is introduced into the furnace but not burned. If there is ample air in the furnace and ignition suddenly becomes active, the entire mass of coal becomes ignited at once, resulting in increased pressure which is known as a puff. During the operation the same thing can happen, particularly in the case of single mill firing, if the feed to the mill is interrupted to such an extent that the fire goes out or becomes very unstable. Under such conditions an immediate increase of the fuel supply, if ignited by what is left of the flame in the furnace, would produce a similar sudden increase in pressure. Furnaces with refractory walls are less subject to explosion, as the incandescent refractories serve as a stabilizer of the ignition."

"Another true type of explosion is due to the accumulation of gas in the furnace or setting. In the case of a water-cooled-wall furnace with a refractory bottom ash pit, if the supply of coal to the mill is interrupted so that the fire goes out and then a supply of coal is started at a fairly high rate of feed, the coal may not be ignited when

(Continued on Page 55)

Hot Water Heating System Boilers Explode

THE first two recent accidents to heating equipment about to be described involved boilers used for heating buildings by means of the hot water system. Particular mention is made of this because it is by no means unusual to find owners of such heating systems of the opinion that their boilers are not of the exploding kind.

Figure 1

The proprietor of a candy shop in Audubon, N. J., was serving a customer a cup of hot chocolate on the afternoon of March 9 when the hot water system heating boiler exploded and hurled both men through a window into the street. Fortunately, the plate glass preceded them by a fraction of a second, so they escaped with minor bruises and cuts. Figure 1 shows the rear of the store. The back wall of concrete blocks was hurled down, and the side wall was tilted outward so as to be in danger of collapse. A newspaper account stated that the property damage amounted to about $5,000.

Reports indicate that the system was installed without either an expansion tank or a relief valve. Coke was being used as fuel, and as the day was cold and windy it was suspected that the vigorous firing necessary to meet these conditions was too much for the boiler.

Figure 2 shows what was left of the firepot section of a hot water heating boiler that exploded on March 11 in the basement of a pumping plant in Haverhill, Mass. This, too, was a closed system, but one having an air-tight expansion tank and a differential relief valve. The top and third sections of the boiler crashed upward through the first floor, forcing a 12″ x 6″ beam out of its anchorage in the brickwork, and raising the whole first floor up about three inches. Other parts of the boiler caused considerable damage to the plant switchboard, bending

Figure 2

switch handles, breaking a slate panel, and piercing an iron grill protecting the oil switch. The steel-trussed roof of the building was also raised by the concussion. One of the trusses pulled the brick side-wall about four inches out of perpendicular at the resting place of the truss.

During the morning the attendant noticed that the return pipes and about one-third the height of the radiators were cold. He supposed that the system was air-bound, so he tried the pet cocks on the radiators and drew a small amount of water from the system before admitting sufficient makeup water to bring the gauge up to the normal pressure of about 8 pounds. He noted then that the thermometer on the boiler read 140°F. Twenty minutes after he had thrown on a little coal and left the building the explosion occurred.

Neither the relief valve nor the expansion tank was damaged by the explosion. When tested, the valve worked freely at 25 pounds. The cause of the accident could not be positively determined. In view of the fact that boiler had been used previously at another location—and possibly under conditions that may have affected the strength of the castings—failure might have occurred under normal operating conditions. If the water had been brought to the boiling temperature corre-

Figure 3

sponding to eight pounds pressure there would have been sufficient energy stored in the boiler to account for the damage done by its failure. If such was the case the safety valve, set to blow at 25 pounds, would not have had any opportunity to act.

The last of several employes of a garage in Peoria, Illinois, had just left the locker room shown in Figure 3, on the morning of January 18, when a small cast iron boiler used for supplying hot water, exploded, smashed furniture, knocked out windows and doors, and raised the ceiling. The men had just changed to their work clothes, preparatory to beginning the day's work. Had the explosion occurred while they were in the room it is probable that some at least would have been seriously injured. This heater was not equipped with any means for relieving overpressure, nor was there a device for temperature control.

In Figure 4 is shown the wreckage of a welded steel hot water supply boiler that exploded January 28, in a building at Yakima, Washington. This boiler was connected to a welded hot water supply tank and neither boiler nor tank was equipped with a relief valve. The day

Figure 4

before the accident the water was shut off from the main in the street. The following morning the engineer fired up the boiler and the explosion occurred three-quarters of an hour later, causing property damage estimated at $2,000.

Another accident from a similar cause occurred in a store at Long Beach, California, on January 14. In this case the apparatus involved was a hot water supply tank heated by a gas coil. The system had been out of use for some time and when starting it up someone evidently forgot to open a valve in the line from the tank to the water main. The tank had no relief valve, depending on free communication with the outside water main for relief of overpressure. With a closed valve cutting off this means of relief, the tank wrecked the store and damaged apartments above it. The property loss was estimated at $3,000.

The occupant of a residence in Clinton, Iowa, felt that he escaped death by seconds on the morning of March 21 when, as he was walking down the cellar stairs to tend the furnace, the latter exploded and tore a hole in the floor above it. He had been down in the basement to open the drafts about fifteen minutes before, and was going again to check the fire.

Hydro-Pneumatic Tank Explodes in Garage

PATRONS and employes of a car washing laundry in a North Carolina city were fortunate to escape serious injury on December 9 when a hydro-pneumatic tank blew out its lower head, soared upward and came down through the roof of an auto show room 100 feet away. Luckily the show room was unoccupied at the time, for the heavy vessel brought down plaster and splintered timbers as it crashed on the concrete floor.

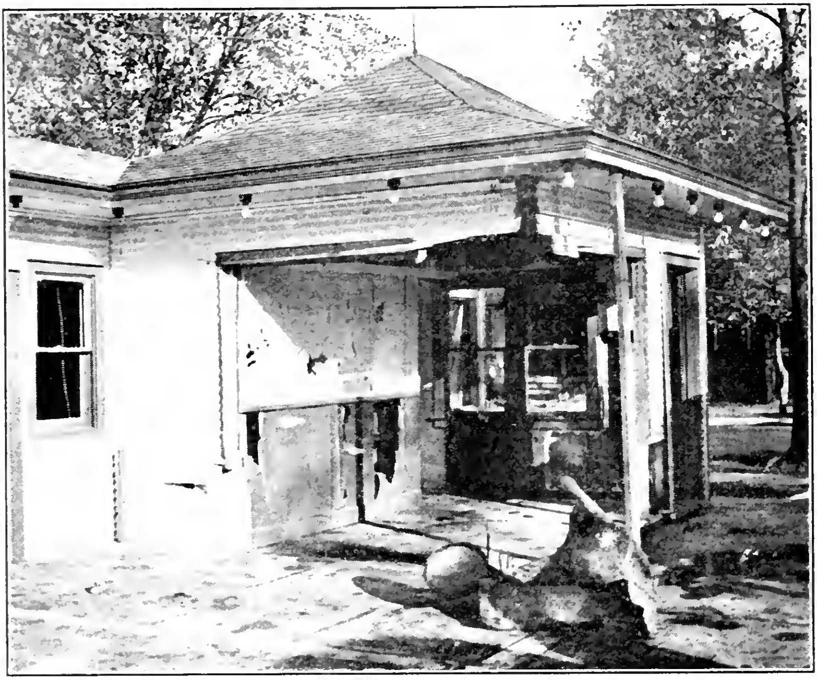
The tank was of the kind commonly found in car washing garages for furnishing water under pressure. Although this particular tank was used under a pressure of 150 pounds, it is interesting to note that it was made of tank steel, only ⅛″ thick. It stood 6′ 4″ high and was 30″ in diameter. The longitudinal seam was lap riveted with fusion welding on the outside, evidently to make it air tight. Heads were of quarter-inch material, the top one being convex and the bottom one concave. In fastening them in, the ends of the shell plate had been crimped over slightly and a thin strip of fusion welding applied between these ends and the heads.

Installed in 1925, the tank was in operation for several years under 150 pounds pressure. A few months ago the unloader on the compressor became out of order and prevented the pressure from rising above 90 pounds. According to attendants, the pressure gauge registered 80 pounds just before the explosion took place.

The lower, concave head reversed its dish when the explosion occurred, tore away from the shell at the weld, and remained behind while the vessel, propelled by the reaction of escaping air, rose like a rocket. Of the several persons who were standing near the tank only one was knocked down and injured.

These hydro-pneumatic tanks, of which thousands are in use, contain enough energy to do tremendous damage in case of an explosion. Needless to say, the prospective purchaser should be careful to select a vessel of approved design and construction. The need for care is even more important where welding instead of riveting is used, for it is next to impossible to tell by looking at a welded seam whether it is sound or not.

The compressed air equipment of garages and service stations con-



tributes its full share of accidents. In addition to the case just described, there was recently an explosion of a compressed air tank in an Indiana city that tore down two walls of a filling station. The damaged building and tank are shown in the accompanying illustration, which is from a photograph taken after the wreckage had been cleared away. In this case the accident was evidently not caused by any structural weakness of the tank. According to reports, someone screwed down the spring of the safety valve so that it permitted overpressure to develop.

Oldest Three-Phase Plant To Go

"Projected abandonment this year of the Mill Creek No. 1 hydro station of the Southern California Edison Company, marks the passing of an historic installation, the oldest in the company's system. Built in 1893, it is the first generating plant designed for three-phase operation. A steam-engine-generator was added in 1896 to supplement the water wheel at low-water periods, and the station was rebuilt in 1899 and again altered in 1905 and 1920. It is now planned to replace the plant with a full automatic hydro unit in a small concrete building."—*Power.*

Wondered Whether Huge Blast Would Jar Earth

IN VARIOUS cities throughout the country scientists waited attentively at their seismographs one afternoon a few weeks ago. Two hundred and twenty tons of dynamite were to be set off at a limestone quarry near Manistique, Michigan, and they were curious to find out how much of an effect the largest single controlled charge of explosives that man has ever dealt with would have on the rigid structure of the earth. *Time,* in a recent issue, told the story as follows:

"At the vast deserted quarries of Inland Lime and Stone Company, eight miles from Manistique, a small group of men—Army and Navy observers, men from the Bureau of Mines and the Coast and Geodetic Survey, quarrymen, photographers—huddled under a line of steel freight cars. No other humans should have been within a mile of them. The occasion was dangerous. The military men said that during a heavy explosion it was best to stand on one's toes with the mouth open. The concussion then had less effect on the ears. Others opined that it was just as well to lie stretched on one's stomach.

"As 3 P. M. (Central Standard Time) approached, the men under the steel cars became attentive. Attentive also to what was going to happen at the quarries were scientists tending earthquake recorders at Madison, Wisconsin, Ann Arbor, East Lansing, St. Louis, Buffalo, New York City, Washington. Chronometers of everyone interested were set to check with a radioed time signal from the Naval Observatory at Washington.

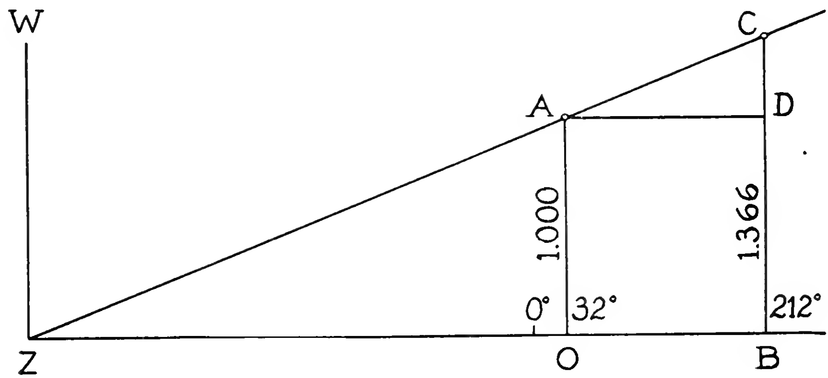
"At 3 P. M., Lieutenant Edwin J. Brown of the Coast and Geodetic Survey grasped the switch of an electrical device under his freight-car shelter. From the device ran seven miles of wire, which dipped into a mile-long line of steel cases buried in the limestone quarries. There were 5,000 steel cartridges. They contained altogether 220 tons of dynamite.

"For the quarrymen the blast would churn up 1,125,000 tons of limestone, sufficient to supply the blast furnaces of Inland Steel Company (which controls the stone company) one year. For seismologists the blast would show how much of an effect a 220-ton jolt had on the 6.6×10^{21} -ton earth. The knowledge would give them something precise by which to measure the forces underlying all earthquakes.

"At 3:02 P. M. the Naval Observatory signaled 'Go.' Lieutenant Brown pulled his switch. A strip of rocky earth a mile long by 200 feet wide heaved up slowly, settled with roar and dust. At the distant earthquake observatories, the seismographs registered faint squiggles. Thus man knew that he had shaken the earth, made it quiver, trifling though that quiver was."

Measuring Heat With the Absolute Scale

COLD is defined as the absence of heat, and of course there are many degrees of coldness. Objects to which we commonly refer as being cold actually contain some heat, so as absolute zero is far below the zero on our Fahrenheit thermometer, it is evident that even though most "cold" things with which we are familiar, such as a cake of ice or the coils of a refrigerating machine, may be relatively



frigid in comparison with other objects which we regard as being warm or hot, they really have stored in them quite an amount of heat.

Absolute zero is the point where no heat exists. It is also the point where molecular activity stops, where metals lose their resistance to the flow of electricity through them, and where a perfect gas would have no volume. Physicists have succeeded in producing temperatures so close to absolute zero that it can no longer be looked on as merely a theoretically calculated point 460 degrees below the zero on our Fahrenheit thermometer, but even before means were found for obtaining extreme cold the point was fixed mathematically from the laws governing the expansion and contraction of a perfect gas. As this calculation is very interesting and simple, it is given here for the benefit of those of us who may never have encountered it.

If a perfect gas be held under constant pressure, its volume will decrease at a uniform rate as its temperature is lowered. The converse is also true; its volume will increase uniformly as its temperature is raised. From experiments it was found that one cubic foot of gas at 32°F would expand under constant pressure to 1.366 feet as its temperature was raised 180 degrees to 212°F. In the illustration, the part of the diagram from OA toward the right represents this experimental data. As the expansion and contraction of a perfect gas is assumed to proceed at a uniform rate—which means that equal changes in temperature at any points on the temperature scale would produce the same changes in volume—the line CA may be extended until it cuts the line OB, and Z will be the point where the volume of gas theoretically shrinks to nothing—the point defined as absolute zero.

It is apparent that the triangle ZOA is exactly proportionate to triangle ADC, so ZO:OA::AD:DC and ZO:180::1.000:0.366, from which ZO (the number of degrees between absolute zero and 32 on the Fahrenheit thermometer) can be obtained as 492. By subtracting 32 from 492 we find that absolute zero is 460 degrees below the zero of our Fahrenheit thermometer.

Readings above zero on the Fahrenheit thermometer may be translated to absolute temperature by adding 460 to them; readings below zero may be similarly changed by subtracting them from 460.

The need for calculating absolute temperature values arises so seldom in engineering work that for most of us the matter has only an academic interest. In our work the upper range of the Fahrenheit thermometer scale serves most purposes.

Erosion Causes Failure of Tallow Tank

Erosion of the shell plate of a tallow tank at a packing plant in Pennsylvania caused an explosion on February 17 that injured two men and damaged property to the extent of about $2,000. The tank was operated at a steam pressure of 100 pounds to the square inch. When it ruptured it wrecked the interior of the building and soared out through the roof. A part weighing 150 pounds was thrown 534 feet from the scene of the accident.

The shell of the vessel was made from quarter-inch plate. At the point of rupture erosion had thinned it until only .028 of an inch of metal remained.

It is understood that the tank was not insured.

Cast Iron Feed Water Heater Bursts

The explosion of a cast iron feed water heater at a power house in Missouri on January 17 not only demolished the heater itself but caused property damage in excess of $2,000. It was suspected that the accident was caused by the accidental closing of a stop valve between the heater and a back-pressure valve.

Bootleg Plant Boilers Causing Trouble

SINCE the appearance of our last issue, in which there was an account of the explosion of a boiler used in connection with an illicit distillery in New Jersey, we have received newspaper clippings indicating that in recent months Maryland has had what might be termed a mild epidemic of "still" boiler blasts. In view of the fact that boilers for such use are frequently installed and operated by men who are more expert in whisky-making than in boiler work, and that for obvious reasons they are not given the benefit of either state or insurance company inspections, the occurrence of these accidents is not at all surprising.

An attendant was killed in January by the explosion of a vertical fire tube boiler within the city limits of Baltimore. The boiler was blown from a barn, in which the still was set up, on to a public road. State inspectors, who investigated the accident, reported that the explosion was the result of low water.

A few days after the accident just described, there was a similar accident at Elkridge in which three men were seriously injured, and in another part of the state a boiler that had been stolen from a road contractor put an abrupt end to a whisky-making venture by soaring skyward.

Find New Way to Pulverize Ores

THE principle used in the process of preparing breakfast foods by shooting steamed rice, wheat, or oats from guns has been applied to the treatment of metallic ores by R. S. Dean, chief engineer of the metallurgical division of the U. S. Bureau of Mines, and John Gross, metallurgist of the Bureau. A description of their process was presented at a meeting of the American Institute of Mining and Metallurgical Engineers in New York. Says a report from *Science Service:*

"Preliminary investigations have disclosed that their method requires little expense and labor, and they believe that it may work something of a revolution in mining.

"Zinc and iron ores have been successfully shattered. The pores and crevices of the ores are first impregnated with water, then the ore is heated under pressure until the water turns to steam. When the pressure is suddenly released, the lumps of ore tear apart under the force of the expanding steam just as small grains of wheat are blown into large puffy particles.

"The Bureau is planning experiments on a larger scale, it was said. Fuel expense of treating ore in this fashion has been estimated to be only five cents per ton of ore treated, when the cost of coal is two dollars per ton. The process means the salvaging of materials formerly discarded, Mr. Dean said."

Heat Vaporizes Heavy Oil, Explodes Tank

Three men, two of them city firemen, were killed at Knoxville, Tennessee, on March 9 by the explosion of oil vapor in a large storage tank. The accident occurred under unusual circumstances. Workmen who had been ordered to empty the tank found that the cold weather had thickened the oil so much that it would not flow, so they built a fire under the tank. This fire got beyond their control, forcing them the call on the city fire department for assistance. The firemen had just arrived when oil vapor inside the tank became ignited, hurling the 16,000-gallon receptacle endwise from its concrete saddle and sending the head crashing through the side of a nearby sheet-metal building. The victims were struck by the head.

Think Electric Spark Ignited Benzine Vapor

The two proprietors of a hat cleaning establishment in Memphis were recently injured seriously by what newspaper accounts termed a "mystery blast." One of them had just thrown the switch of an electrically-driven hat moulder when there occurred an explosion that wrecked the place and burned them severely.

Usually there are considerable quantities of such fluids as benzine or gasoline used in cleaning hats, so it seems probable that instead of being of mysterious origin the explosion may have been the violent detonation of a room full of combustible vapor, ignited by a spark from the switch.

There have been several cases in which ammonia fumes have been exploded in this way, the hazard being sufficiently serious to warrant the utmost care when electrical equipment of the kind that can spark is operated in rooms where combustible fumes can accumulate.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., April, 1932

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.

Company at Home in Its New Building

This issue goes to press too soon after the completion of the Company's new home office building to permit a detailed description of its appointments and furnishings. We plan to run that in the July issue, together with photographs of both exterior and interior. However, we are proud to be able to inform those friends who know and are interested in us that even a week in the new building has been sufficient to demonstrate how completely the architects succeeded in their effort to produce a plant that would meet in every detail the needs peculiar to this business.

The personnel and equipment were moved into the new building over the week-end of April 23, and at the formal opening on April 29 hundreds of policyholders and other friends visited and inspected it. Features that drew many favorable comments were the efficient layout of the engineering department and a display of inspecting instruments and defective boiler and machine parts arranged to acquaint the layman with the nature of the Company's work.

James L. Thomson Added to the Directorate

Since the last issue of THE LOCOMOTIVE the directors of the Company have welcomed Mr. James L. Thomson to membership on the Board. Mr. Thomson was elected by the stockholders at their annual meeting on February 9, 1932.

Educated at Andover Academy and at Yale University, from which he graduated with the class of 1896, Mr. Thomson has for years been prominent in financial and industrial circles of Hartford. From 1914 until his retirement in June, 1928, he was senior partner of the firm of Thomson-Fenn and Company, investment brokers. In addition to his membership on the board of directors of the Hartford Steam Boiler Inspection and Insurance Company, he is at present a director of the Bankers Trust Company, the Hartford Fire Insurance Company, and the Hartford Accident and Indemnity Company; vice president and director of the Terry Steam Turbine Company; managing director of the Hartford Hospital; and chairman of the executive committee of the Hartford Community Chest.

Filling the vacancy that had existed on the Board since the death of Chairman Charles S. Blake on March 31, 1931, Mr. Thomson's election brings to the organization a man of exceptional experience and talent.

Instead of finding gold, worth about $22 an ounce, near Great Bear Lake, a Canadian mining company discovered a deposit of pitchblende, the ore from which radium is derived. As radium is valued at something like $1,800,000 an ounce at present prices the company can afford to overlook the disappointment at not finding what it sought.

The pitchblende deposit is so situated that the only means for transporting the ore to the outside world is the airplane. This difficulty will be overcome, according to reports, by the erection of an ore-crushing and refining plant right at the mine.

L. E. Grundell Appointed Chief Inspector

In announcing the appointment of Leonard E. Grundell as chief inspector of the San Francisco branch office, to fill the vacancy caused by the death of Chief Inspector Lon J. Reed, the Company feels itself fortunate in having readily available a man so well qualified to take over the important duties of that post. Mr. Grundell's appointment was effective May 1.

A native of California, the new Chief Inspector was graduated from the engineering courses of St. Mary's College, Oakland, California, in 1908. For several years he engaged in municipal engineering for the city of Tacoma and Pierce County, Washington. Then, as plant superintendent and engineer, he was for seven years in charge of the building and maintenance of a shipyard at Tacoma. Following that he was associated with the Hart Construction Company while that organization participated in the building of Longview, Washington, for the Longbell Lumber Company.

Mr. Grundell entered the employ of the Hartford Steam Boiler Inspection and Insurance Company on March 17, 1925, as an inspector in its San Francisco department. On January 1, 1930, he was made a directing inspector, in which capacity he has been in charge of the inspection work of that department since the death of Mr. Reed.

Veteran Inspector Passes Away

Old friends of the Company in New England as well as veteran employes throughout the country will be saddened to learn of the death of Oscar L. Holt. Mr. Holt passed away in his 84th year on April 15th at the Masonic Home at Wallingford, Conn.

For many years an inspector in the Company's Boston department, Mr. Holt possessed personal characteristics that drew to him many warm friends. His long experience had given him so thorough a knowledge of the construction and operation of power equipment that his associates and engineers of plants to which his work took him placed the utmost reliance on his judgment.

Born at Hampton, Conn., on November 27, 1848, Mr. Holt came to Hartford as a young man and served an apprenticeship with a firm specializing in the repair of boilers and engines. In January, 1887, he joined the "Hartford Steam Boiler" as an inspector in Hartford. Shortly thereafter he was transferred to Boston and in time was appointed resident inspector for the Providence territory. Some years ago, when advancing age made it difficult for him to carry on active inspecting work, he was detailed to work in the Boston office where he served loyally and well until his retirement in 1927.

Causes *of* Furnace Explosions, *and* Methods Recommended *for* Reducing Their Frequency

(Continued from Page 40)

it enters the furnace. Some of it may settle down on the incandescent bottom of the ash pit. Then the volatile gases from this coal will be distilled off and diffused through the furnace. If an attempt is made to ignite the fuel by means of a torch or if self-ignition occurs from the tongues of flame from the coal deposited in the ash pit, a violent explosion will result. If the gas has passed up into the boiler setting proper, the greater effect of the explosion may be found in the upper part of the setting and it may be sufficiently violent to blow the roof off the boiler or destroy the breeching. Violent explosions frequently have fatal results to those who are starting the furnace. This kind is more likely to take place when starting a fire after an all night shut-down and is more prevalent with the unit-fired installations.

"As an example, take a unit fired pulverizing mill using preheated air for mill drying, as is now quite usual, and shut it down at the end of the day's run. It is usual to scavenge the mill with the primary air. If this air is at a high temperature it may heat such coal as is not swept out of the mill to a temperature sufficient to start spontaneous combustion. Then, if the remaining coal in the mill slowly gasifies during the night the mill and burner piping will be filled with gas in the morning, and there may even be a considerable amount of gas passed into the furnace. When the mill is started in the morning the first thing done is to supply air to the smoldering coal and start it into flame which will, of course, immediately ignite the gas in the mill and piping. The ignition will be carried over into the furnace with a violent explosion as the result. Ventilation of the mill to clear the gas from it before starting is the proper procedure. And, when scavenging the mill before shutdown, cold air should be used in order that the coal may not be raised to a temperature at which ignition could take place. In indirect or storage systems the same things can happen, but the probability is more remote. In this system explosions are more likely to occur in the conveying piping and collector but do not ordinarily affect the furnace. With the indirect system, puffs in the furnace may occur if the forced draft fan should fail and if within a few minutes thereafter a full supply of primary air should be fed. This would give the condition of an excess of coal in the furnace and low combustion rates followed by quick ignition of the coal due to the increased volume of air."

One of the letters ends up as follows: "There is absolutely no danger if there is a flame of any kind in the furnace or high enough temperature in the furnace. There is not even a puff or the least indication of pressure if there is a flame close to the pulverized coal burner. There should be absolutely no fear of danger if, when starting, the operator first sees that his stack damper is open and then provides a kindling flame before he starts the pulverizing and if, when the coal flame does not form almost immediately, he shuts down to make sure that his kindling flame is still burning."

To sum up briefly, the following precautions should be observed:

Never turn any fuel into the furnace unless there is a torch flame in such a position that immediate ignition will result.

If ignition does not result within 15 or 20 seconds, stop the feed and fully ventilate the furnace.

When starting up either after a temporary interruption of ignition or after an all-night shutdown, see that the damper is wide open and everything thoroughly ventilated before attempting to start the mill or ignite any new supply of coal.

Be sure that the igniting flame or torch cannot be blown out by the sudden opening of the feed valve.

Since the first of the year there have been two powdered fuel explosions reported to us, one of which was insured and one of which was not. We quote from the reports of these:

"The burner had been giving trouble and the mill was stopped to clean the carbon out of the burner tube. Some dust had accumulated in the pipes and the burner was started without placing a flame in front of the burner to ignite the dust. This resulted in an explosion which damaged the setting considerably."

Another report reads as follows: "Just about 4 P. M. this boiler was being made ready to place in service, and the fire had been carried along about thirty minutes during which time the boiler pressure rose to above 75 pounds. At this time the fire was lost for a minute or so and then was reignited, causing the explosion. Unit pulverizers were used with preheated air controller at the fan of the pulverizer. The boiler room foreman's opinion is that the fireman turned on too much primary air, blowing his fuel past the pilot light, which they claim was never out, and of course the furnace lining was not hot enough, at this time, to ignite the fuel. The general opinion is that the foreman, who was a new man on the job, returned to the boiler and, finding the fire out, checked the primary air and thereby caused an accumulated deposit of fuel to ignite."

Furnace explosions occur also when solid fuels are used. Usually any such explosions are the results of banked fires which act as gas producers. In banking a fire to keep it alive over some considerable period of time, a quantity of fresh coal is heaped over live coals and practically all air is excluded by closing the fire and ash pit doors and the flue dampers. The volatile gases are driven off but the temperature is not sufficient to ignite them. Later on the glowing mass will probably form carbon monoxide (CO) which is combustible. Both the volatile gases and the CO will form explosive mixtures with the right amounts of air, a condition easily brought about when fires are banked.

Natural and artificial gases, the gases emanating from oil and volatile gases from coal, are all lighter than air and hence tend to rise. Carbon monoxide gas is heavier than air and hence tends to settle. It is important therefore to avoid pockets in the gas passages where either the light or heavy gases can accumulate and form explosive mixtures. All of them are readily moved by draft currents.

If there is any possibility of unburned gas being present when a fire is started, the gas passages should be thoroughly purged by opening the damper and allowing a flow of air to pass through. This should be done also before a banked fire is broken up or a gas or oil fire ignited. As far as possible, the pockets above mentioned should be avoided or so arranged that they are either in the gas flow or else ventilated by small openings.

Although furnace explosions do not ordinarily cause damage anywhere near as extensive as a boiler explosion causes, they frequently result in much inconvenience and, unfortunately, many serious personal injuries and even deaths. A little forethought and common sense precaution will render them less likely to occur. Furnace explosion losses can now be covered in boiler insurance policies.

Taps From the Old Chief's Hammer

"SAY, Chief," declared Tom Preble, entering the old fellow's inner sanctum to find him enjoying his after-luncheon cigar, "they tell me that the portable boiler found by the police when they raided that bootleg plant the other day was stolen about six months ago from a contractor in Evansville. You'd hardly think it possible that they could make away with a thing as bulky as a boiler, would you?"

"Oh, I don't know," drawled the old man, leisurely examining the white ash on his cigar before flicking it off into the waste basket. "I don't know as I'd say that was so difficult."

"Well," insisted the younger man, "at least you'll admit it was quite a trick to spirit away a heavy boiler without leaving at least some clue by which the owner could trace it down."

"It was quite a trick, all right," the Chief agreed, "but what would you say of a fellow who shipped home a whole refrigerating plant, set it up and kept it running for ten years before it was located?"

"Who did that?" asked Tom, his tone indicating that he had his doubts that any such thing had ever taken place.

"Sit down over there if you want to hear the story," said the old man, discarding the cigar butt and loading his pipe.

"I heard this yarn about twenty years ago. It came to me second-hand from a representative of the company that made the refrigerating machine.

"Look here." The Chief brushed aside a pile of papers and pointed to a spot on a map under the glass desk top. "That's Lake Okeechobee, which the folks down in Florida claim is the largest lake entirely within the boundaries of the U. S. A. Well, Okeechobee is well known to tourists nowadays, but thirty years ago the lower part of Florida was pretty sparsely populated, and from all accounts Lake Okeechobee was entirely surrounded by the Everglades. The only entrance to it was by way of the Caloosahatchee River which emptied into the Gulf of Mexico at San Carlos Bay.

"Well, along about that time the refrigerating machine company received an inquiry from a man in Tampa who said he wanted to buy a complete ten-ton refrigerating outfit which he himself would erect. After some correspondence the order was received, accompanied by a check for ten per cent. of the purchase price. The agreement called for an equal payment when the equipment was delivered on the dock at Tampa and deferred payments thereafter until the bill was entirely liquidated. The purchaser had given a Tampa bank as his financial reference, and as inquiry there revealed that he had a substantial balance the manufacturer had no hesitancy about filling the order.

"In due course the shipment arrived at the dock and was turned over to the purchaser on his payment of the sight draft for the second payment of ten per cent. of the purchase price, attached to the bill of lading. Up to this point everything had gone off according to Hoyle, but when the bill for the third installment was mailed out sixty days later it was returned by the post office as undeliverable, and the manufacturer saw that something had gone wrong. A letter to the bank where the purchaser had had his account brought the information that the amount deposited had all been withdrawn and that the client had left no address other than the one in Tampa to which the company had sent the bill.

"Well, that was a puzzler, and the big question was—'Where was the equipment?' The company sent out a man who searched high and low for miles in all directions, but he couldn't find a trace of it. Neither could he find anyone who knew where any new refrigerating plant had been set up recently. So the search was finally abandoned and the company decided that there was nothing it could do but bid good-bye to the 80 per cent. still due on the bill.

"This is what had happened. As soon as the purchaser took possession of the equipment he had loaded it on several shallow draft scows and towed it down the coast to San Carlos Bay, just below Fort Myers. From there he towed it up the Caloosahatchee River to Lake Okeechobee, the total distance being about 170 miles. There, in a spot then almost entirely cut off from the outside world, he set up the plant and put it to work furnishing ice for his fishery. The ice was used to preserve the fish while they were being towed down for sale at Fort Myers. Aside from these trips down the river the fishing colony had very little contact with the west coast towns.

"It wasn't until ten years had passed and a road of some sort had been cut through to the lake, that a casual vacationer penetrated the Everglades and came upon the industry thriving in the wilderness. He was so impressed at finding a complete refrigerating plant operating in such an out-of-the-way place that the next time he met a friend of his who was connected with the refrigerating machine company he told him about it. The latter thought it was quite a compliment to his company to have one of its plants operating so far from civilization, so he reported the case to his home office. However, the home office records contained no reference to a plant ever having been sold for installation at that point, and it occurred to someone that this might be the long-lost shipment. Of course, the subsequent investigation proved that this was the case."

"Did they go after the owner of the fishery?" broke in Preble.

"No, they didn't," explained the old man. "As a matter of fact he hadn't stolen the stuff, if that's what you have in mind. He had merely deferred paying the balance due on it. When they visited him he told them frankly that their machine had certainly been a profitable investment for him, and that he was now prepared to pay whatever he still owed on it, plus interest, if they'd figure out the amount. And he did."

Stresses Importance of Keeping Bolts Tight

In describing an accident that badly wrecked an air compressor, our English contemporary *Vulcan* calls attention to the importance of frequent checkups by the operating staff of such things as connecting rod bolts and other parts that can gradually work loose in service.

"The air compressor in question was of a rather unusual type, being in its original form a vis-à-vis machine, with a gas-engine cylinder at one end and an air-compressor cylinder at the other, with the crank shaft situated between the two.

"A year or so ago, however, the engine cylinder piston was disconnected, and the air compressor driven by ropes from an electric motor on to the flywheel. The machine functioned satisfactorily after the change-over until the date of the breakdown when suddenly, and without warning, as the result of the connecting-rod bolt nuts becoming detached, the compressor piston was released, causing it to fracture, together with the cylinder liner, the connecting rod, the balance weights, bed plate and other details.

"To complete the sequence of events it may be mentioned that some of the flying debris fractured a water service pipe, and deflected the stream of water into the heart of the electric motor, which was seriously damaged by this treatment.

"The case serves once again to emphasize the advice that has been so repeatedly given in the pages of *Vulcan,* viz.: 'Try the nuts with a spanner at both ends of the connecting rod before starting up.' "

Caught in the Separator

"Well doctor, how am I?"
"Very well. Your legs are still a bit swollen, but that doesn't disturb me."
"Sure, doctor, if your legs were swollen, it wouldn't disturb me either."—*Pages Gaies.*

Mrs. Higgins had just paid the last installment on the perambulator.
Shop Assistant: "Thank you, madam. How is the baby getting on now?"
Mrs. Higgins: "Oh, he's all right. He's getting married next week.—*Kingston Standard.*

"What's the idea of the Greens having French lessons?"
"They've adopted a French baby, and want to understand what it says when it begins to talk."—*Sheffield Weekly Telegraph.*

There's a terrible surplus of wheat in this country, but it could be worse. It could be spinach.—*Life.*

People say that they often find it difficult to tell the difference between weeds and young plants. The sure way, of course, is to pull them all out. If they come up again they're weeds.—*Montreal Star.*

The ideal marriage is when a man finds a beautiful girl and a good housewife, says a philosopher. We thought that was bigamy.—*Life.*

A political platform is just like the one on the back of a street car—not meant to stand on, just to get in on.—*Journal of Education.*

The reason the voters are so patient with Congress is because they don't know what to do either.—*Literary Digest.*

A mother had just been telling her small son some of the "facts of life" and when she finished she said, "Now, son, are there any questions you would like to ask? Anything at all, don't be afraid."
After a little heavy thinking, he replied, "Well, yes, there *is* something I've been wanting to know for a long time." Her heart failed her as she asked him what it was.
"Mother, just *how* do they make bricks?"—*Parents' Magazine.*

After a young lawyer had talked nearly five hours to a jury that felt like lynching him, his opponent in the case, a grizzled old veteran of the legal cockpit, rose, smiled sweetly at the judge and jury, and said:
"Your Honor, I will follow the example of my young friend who has just concluded, and will submit the case without argument."—*Montreal Star.*

The auctioneer held up a hand for silence. "Gentlemen," he said, "I wish to announce that yesterday a certain gentleman had the misfortune to lose his wallet containing $1,000. A reward of $250 will be given to anyone returning the same."
After a short silence, a gentleman with a plaid tam-o'-shanter was heard to murmur: "Twa hoonderd an' feefty-five."—*Christian Observer.*

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1931

Capital Stock, - - $3,000,000.00

ASSETS

Cash on hand and in bank		$ 901,554.83
Premiums in course of collection (since October 1, 1931)		1,177,597.98
Interest accrued on mortgage loans		27,546.67
Interest accrued on bonds		124,122.94
Loaned on bonds and mortgages		986,760.15
Real estate		462,799.10
Agents' ledger balances		10,742.54
Miscellaneous assets		2,014.13
		$3,693,138.34
Bonds and Stocks:		
Book value	$15,576,111.24	
Convention value over book value	790,997.40	
Total value as fixed by The National Convention of Insurance Commissioners	$16,367,108.64	
Deduction to adjust security holdings to true value as of December 31, 1931, as required by Connecticut Insurance Dept.	1,147,046.25	
		15,220,062.39
TOTAL ASSETS		$18,913,200.73

LIABILITIES

Premium reserve		$ 8,609,354.91
Losses unadjusted		329,660.26
Commissions and brokerage		235,519.60
Other liabilities (taxes accrued, etc.)		611,642.21
Special depreciation reserve		2,000,000.00
Capital stock	$ 3,000,000.00	
Surplus over all liabilities	4,127,023.75	
Surplus to Policyholders,		**$7,127,023.75**
TOTAL LIABILITIES		$18,913,200.73

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Incorporated 1866 | Charter Perpetual

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NEW YORK, N. Y., . . . 90 John Street . . .	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
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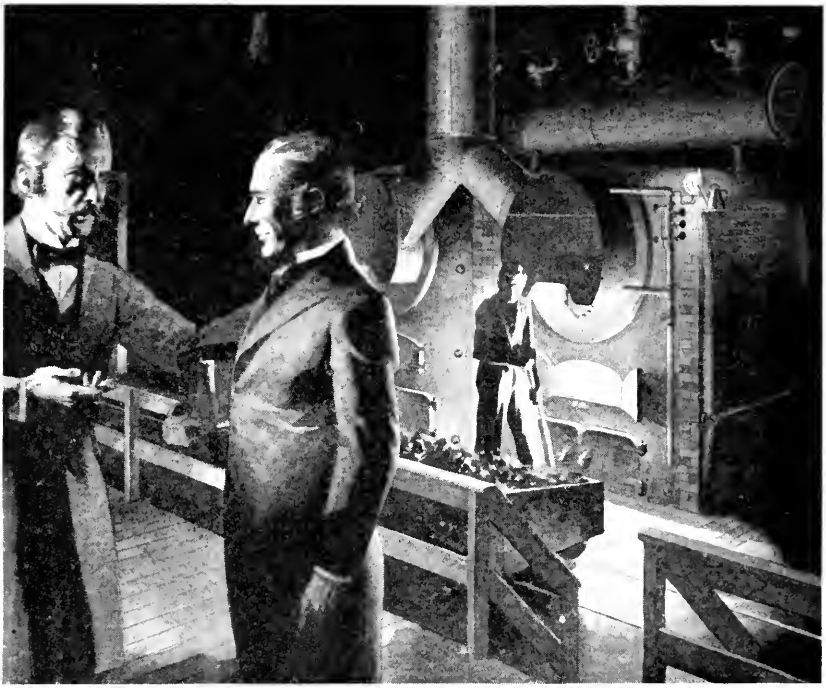
TORONTO, Ont., Canada . Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.



"You do our worrying" *said* Stanley *in 1867-1932*

IN 1867 The Stanley Works took advantage of a new idea—that many boiler accidents could be prevented by proper inspection, and that boilers so inspected could then be insured. They took out a policy in the first company to write such insurance. Their boilers were inspected by "the first safety man," the original "Hartford Steam Boiler" inspector.

All these years "Hartford Steam Boiler" inspectors have examined periodically the power boilers of The Stanley Works—one of the great manufacturers of Hardware, Tools, and Steel, whose trade name "Stanley" is known throughout the world.

To huge mills like those of Stanley, to the plant that launders your clothes, to the apartment house you live in, and to the factory that made your motor car, go "Hartford Steam Boiler" inspectors who "do the worrying" about the safety of boilers, turbines, engines, motors and other power equipment. Their inspections and the company's reputation for stability over 66 years have earned the confidence and respect of industrial executives and engineers.

Vol. XXXIX No. 3. JULY 1932

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

"Hartford Steam Boiler" and Fusion Welding

By W. D. Halsey, *Ass't Chief Engineer, Boiler Division*

FUSION-WELDED vessels, when properly made, possess many advantages over riveted vessels. The most striking of these is their relative freedom from leakage. They can be constructed with less weight of metal than is required in riveted vessels to fulfill the same purpose, and can be fashioned in rather complicated shapes with greater ease.

These advantages have been recognized for a long time, but fusion-welding was slow in gaining the confidence of users of pressure vessels, governmental regulatory boards, and boiler insurers. Safety could not be sacrificed in the interest of a slight saving in construction cost, and such attempts as were made to apply fusion-welding to pressure vessels were hampered and discouraged by their frequent and disastrous explosions.

Riveting maintained its popularity for many years because of its general dependability. It was recognized that a riveted vessel could be ruined by improper methods of fabrication, but the pitfalls were so well known and proper practices for riveted construction had been so standardized, that engineers had confidence in its trustworthiness.

The use of the electric arc and the oxy-acetylene process of fusion-welding received great impetus during the World War, and following the war there was a strong urge on the part of many to give greater recognition to fusion-welded vessels. The Hartford Steam Boiler Inspection and Insurance Company kept in close touch with the experience that was being obtained, but for several years the record of accidents which it compiled convinced it that the time had not then arrived when fusion-welding could be recognized as a sufficiently reliable method of construction.

There can be no doubt that the attitude then taken by the "Hartford Steam Boiler," the other insurance companies, and the Code Committee of the A. S. M. E. was of benefit to the welding industry. Had these agencies accepted fusion-welding when it was in a very immature stage of development, the economies it promised might have tempted its immediate general use on vessels for which it was at that time quite unsuited. In all likelihood there would have been a still larger number of serious accidents, which would have caused a great set-back to the use of welding. Although at the time it may have seemed reactionary to some, the insistent stand of the insurance companies and others in the interest of safety was undoubtedly a factor in bringing about the

FIGURE 1—*A building wrecked when the welded head seam of an ammonia generator failed injuring a man and causing $15,000 property damage. An illustration of the kind of accident that for years postponed acceptance of welding as reliable for pressure vessel construction.*

more intensive study of the fundamental principles of the art of welding and the means whereby it was developed as a method of construction as reasonably safe as riveting.

The prime need was to find methods that would give uniformly dependable results. Several of the leading manufacturers courageously accepted the challenge. Great strides were made by some, and "Hartford Steam Boiler" engineers were not slow then in acknowledging that their development had brought fusion-welding to a point where it merited more recognition. The manufacturers who had made the progress were given an opportunity to prove that they had developed processes yielding sound fusion-welds with acceptable physical characteristics, and their vessels were declared acceptable for insurance.

However, having thus accepted the product of a few makers as insurable, the Company saw that in fairness to all manufacturers, as well as for the protection of prospective purchasers of vessels, some well-defined standard of welding would have to be codified, and tests would have to be devised whereby it could be determined whether or not a manufacturer was meeting the standard. The Company, therefore, undertook the responsibility for an investigation which afforded it the opportunity of pioneering in a new field just as it had pioneered years before in establishing the standards for riveting.

In the opinion of the "Hartford Steam Boiler" engineers there are three physical properties that every weld must possess if it is to be considered safe. These properties are sufficient tensile strength, ductility, and soundness, and the means for determining these properties as developed or adopted by the Company are recognized as fully adequate for the purpose.

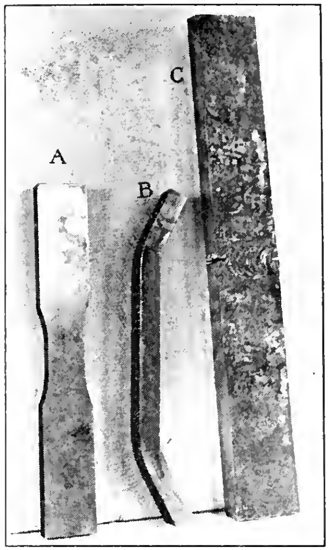


FIGURE 2 — *The Company's standard test coupons: (A) Tensile Test; (B) Free Bend Test for Ductility; (C) Nick Break Test for Soundness.*

Fusion welds have sometimes been judged by their exterior appearance. It is possible to make some rating of a weld in this manner, but it is utterly impossible thus to determine its full value. In fact, the Company's engineers have seen some welds of very fine external appearance which on examination proved to be entirely untrustworthy. Consequently, the Company felt that if good work was to be assured, the problem would have to be attacked at its source—in the shop where the welding is done.

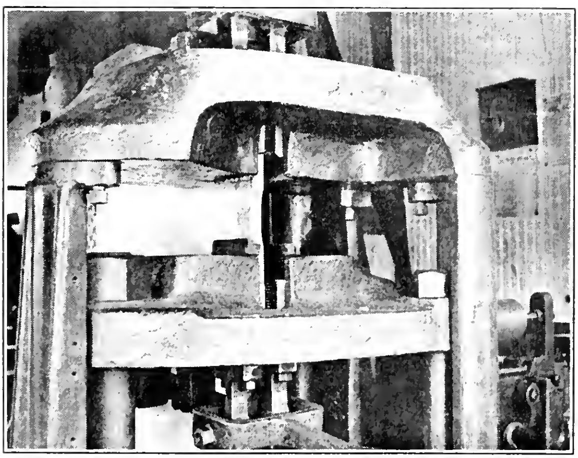


FIGURE 3—*Start of the Tensile Test, showing coupon in the testing machine.*

Early in the preliminary studies, it was decided that successful fusion-welding depended on two major items: first the development of a process which would give the required results, and second the training of the individual welders to follow this process. Obviously, the most experienced welder cannot obtain satisfactory results if he does not have the proper materials to work with, and conversely, an inexperienced and untrained operator will not obtain satisfactory results even with the best of material and equipment.

The Company's investigation resulted in establishing the following procedure: When a manufacturer desires to obtain its approval for his fusion-welding, he is required first to furnish a written statement outlining his process in detail. He must then fabricate a number of welds in accordance with the specifications which he has submitted, and these sample welds are subjected to the special method of testing adopted by this Company. If the welds pass the tests successfully, the manufacturer is placed upon the "Hartford Approved List," a copy of which may be obtained on application at any of the Company's branch offices. This means that he has demonstrated to us that he has a process whereby fusion welds can be made which will meet this Company's requirements. However, before building fusion-welded vessels which will be acceptable to the Company he is required to show that all welders who work on the vessels have, by specified qualification tests, proven their ability to obtain the desired results. Furthermore, he must arrange for inspection by a representative of this Company during the time the vessels are being fabricated. By this means the Company satisfies itself that its requirements for construction have been met, and is thus in a position to certify to the purchaser that the vessel will be satisfactory to "Hartford Steam Boiler" for insurance.

FIGURE 4—*Start of the Free Bend Test for Ductility.*

In making investigations of manufacturers who have sought the Company's approval it has frequently occurred that the first tests were not successful, and it has then been necessary for the manufacturer to give further study to the problem of developing a process which could consistently produce results meeting the requirements. In fact, this has happened in the case of several manufacturers who felt that because they had long used fusion-welding as a process of manufacture they would have no difficulty in meeting the requirements. They discovered, after subjecting their work to the Company's standard tests, that it fell far short of what they had expected. "Hartford Steam Boiler's" cooperation with them in improving their methods, which resulted in acceptable work, has brought the Company many expressions of appreciation.

In the course of its investigations the Company arranged with a large number of manufacturers to send to Hartford sample welds in a wide range of plate thicknesses. Some of these welds were in plates 2½″ thick and the investigation involved the handling of material totalling a weight of 6½ tons. These samples were tested at the expense of considerable time and money. The results convinced the Company not only that its method of testing was adequate for the purpose, but that a weld made by an untrained and inexperienced welder could not meet the requirements of the tests.

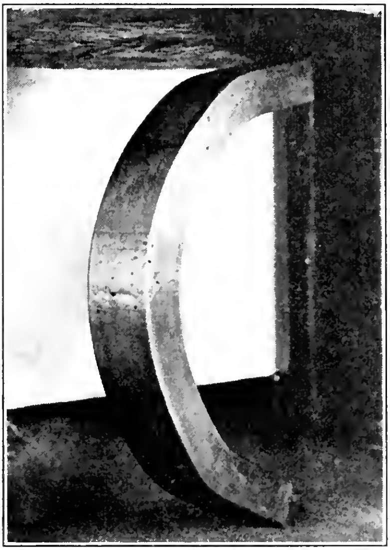


FIGURE 5—*End of the Free Bend Test, showing the stretching to which the metal in the weld has been subjected.*

When the Company started its study of welding, the old standard tensile test was practically the only one that was being used to any great extent. That form of tensile test specimen was not considered entirely satisfactory, so the Company set about to develop a form of tensile test specimen which its engineers felt would be more adequate for the purpose. (See Figure 2, A.)

The question of how to test the ductility of a welded joint presented a difficult problem. However, at about that time the Union Carbide and Carbon Research Laboratories had developed what is known as the "Free Bend Test for Ductility". The Company felt that this was an acceptable method for measuring that quality, and, therefore, adopted it as one of the standard tests.

The determination of soundness presented the most difficult problem of all, and for this the Company finally developed what is now known as the "Nick Break Test".

A more detailed description of these three tests is given in succeeding paragraphs.

Prior to the development of the special type of tensile test coupon, the specimens generally used had been the standard 8″ gauge length as commonly used for the testing of steel plate, the weld being located at the middle of the 8″ length. The reinforcement at the weld, or the added thickness commonly placed at that point, was usually not removed. It had been common experience in testing specimens of this sort, even when the weld was known to be of inferior quality, to have the failure take place at some distance from the weld. This gave a test of the strength of the plate, but did not tell anything conclusive about the strength of the welded joint. The Company considered that for such tests its special tensile specimen should be used. (Figure 2, A.) It will be noted that the reinforcement of the weld is removed and the specimen reduced in width over a length sufficient to take in only the weld and a short section of the plate on either side of the weld. In this way the failure under tensile stress is forced to take place within the weld metal or at its boundaries, thus giving the tensile strength of the joint.

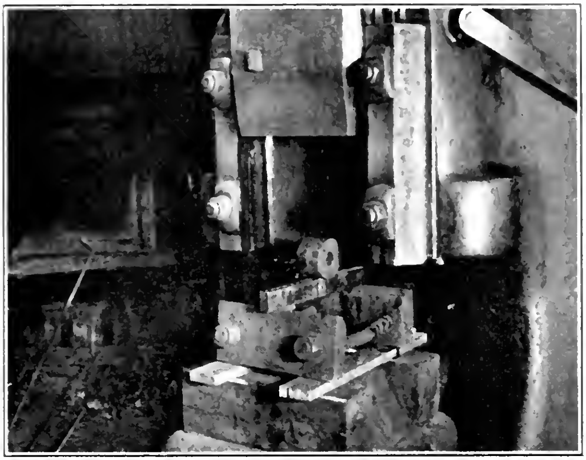


FIGURE 6—*Coupon in place for Nick Break Test.*

In measuring ductility a difficult problem is presented. If the failure in the tensile test specimen would always take place within the weld metal, the ductility could be measured in the conventional manner between two points located on the weld metal. But as the failure does not always occur so that this measurement can be properly made, this means of testing ductility is not practicable. It has been suggested that ductility be obtained by drilling holes in the welds so as to force failure to take place within the weld metal, and then measuring the elongation of these holes. This, however, is not a satisfactory method, as the stretching of the holes varies to a very considerable degree, being influenced by the proportion which the size of the holes bears to the metal remaining between them.

The present accepted method of testing for ductility of the weld metal consists of measuring the stretch on one surface of the welded joint, and is known as the "free bend test". In Figure 4 is shown a specimen prepared for test. Two center punch marks or scribed lines are made on the surface of the weld slightly inside of the juncture of the weld metal with the base or parent metal. The distance between the two lines is measured and recorded and the specimen is then bent as shown in Figure 5, the maximum bending being forced to take

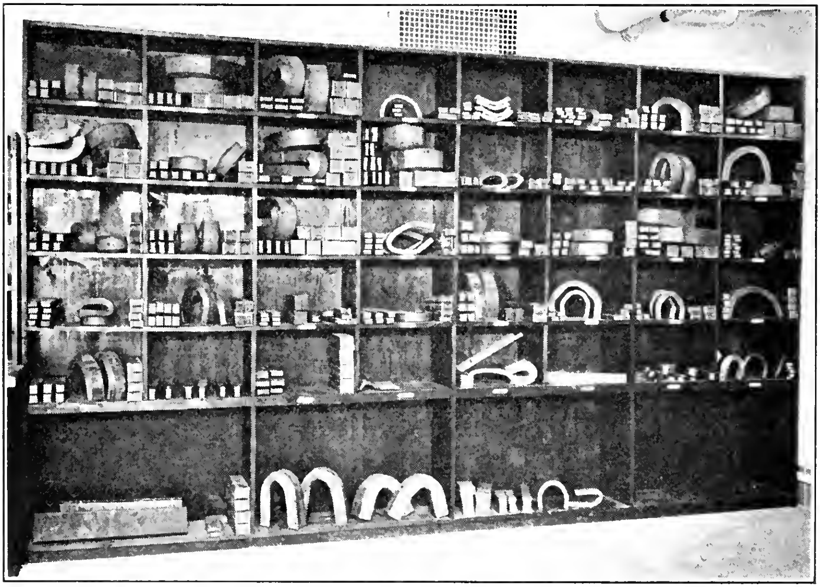


FIGURE 7—*Coupons tested and filed as a record. Part of the 6½ tons of metal submitted by manufacturers for investigation. These samples are on display at the Home Office.*

place at the weld. When failure takes place in the surface of the specimen in the weld, the test is stopped, and by means of a flexible steel scale the distance between the two reference marks is again measured. the ductility of the weld is recorded as the percentage of increase of the distance between the two reference marks.

The "Nick Break Test" is for determining the soundness of a weld. It consists of making notches or saw cuts in a specimen as shown in Figure 2, C, and of breaking the specimen by one sudden quick blow, preferably under a hammer or other heavy falling weight. This test snaps the weld apart and enables one to see the character of the weld metal. It discloses how thoroughly the weld had penetrated from one side of the plate to the other, whether there are any oxide or slag inclusions, what degree of porosity may exist, and gives some idea of the crystalline structure of the weld metal.

At the very outset of this Company's work in fusion-welding it was found that although the highest type of welding should be required for a boiler drum or for a heavy-walled unfired pressure vessel operating at high temperatures or pressures, it would not be necessary to require as high a standard of construction in the fabrication of vessels for the storage of cold water. Vessels for containing various substances such as ammonia, steam, or water at moderate pressures and temperatures, would require a class of welding lying somewhere between the two extremes mentioned. With these things in mind the "Hartford Steam Boiler" divided vessels into several general classes and established standards of welding for each. Within the recent past the Company has been gratified to have the Boiler Code Committee of The American Society of Mechanical Engineers adopt essentially those provisions as to classes of fusion-welded vessels and also to set up a code for welding which agrees so closely with the standard the Company had itself devised that the Company has now adopted the A. S M. E. Code requirements for Fusion Welding as its recommended standard for construction.

FIGURE 8—*A modern welder at work.*

The A. S. M. E. Code establishes three classes of fusion-welded, unfired pressure vessels in addition to fusion-welded drums for power boilers. The most severe requirements of the A. S. M. E. Code are those for power boiler drums, because power boiler drums are subjected to the most severe service and are potentially the most dangerous class of pressure containers. A Class I Unfired Pressure Vessel is not restricted as to pressure, temperature or kind of service and the requirements which must be met are practically the same as those for a fusion-welded power boiler drum.

A Class II vessel is limited to service where the pressure does not exceed 400 lbs. per square inch, and the temperature does not exceed 300 degrees F. if the vessel contains a liquid, or 700 degrees F. if the vessel contains a gas. The maximum plate thickness of which Class II vessels can be constructed is 1½", and they may not, under the restrictions of the Code, be used for the storage of deadly gases or liquids.

Class III vessels are limited to those used for the storage of gases or liquids at pressures not exceeding 200 lbs. per square inch or temperatures not exceeding 250 degrees F. except that the températures must not, in any event, exceed the boiling temperature of the liquid at atmospheric pressure. This limits such vessels, when used for the storage of hot water, to a temperature of 212 degrees F. Vessels of this class cannot be built of plate exceeding ⅝" in thickness and, like Class II vessels, are not to be used for the storage of deadly gases or liquids.

It is now generally recognized that if a welder has been properly trained and has demonstrated his ability to obtain acceptable test results in the tensile, free-bend and nick-break specimens, his work may be considered reliable. In fact, it is felt that the employment of such qualified welders is all that is necessary to assure a safe vessel for Class II or Class III service. However, for Class I Unfired Pressure Vessels or for fusion-welded power boiler drums, for which the service is such that the hazard is extreme, it is essential to go even further. Therefore, this Company now requires, as does the A. S. M. E. Code, that the principal seams of all Class I fusion-welded vessels or power boiler drums be examined by the use of the X-ray at the plant of the manufacturer if such vessels or drums are to be stamped "H. S. B."

As the foremost engineering organization engaged in rendering shop inspection service to manufacturers of boilers and pressure vessels, the Hartford Steam Boiler Inspection and Insurance Company has recognized that it must specially equip and train its Inspectors for that service. Now, to meet the inspection requirements of this new form of construction the Company has trained many of its inspectors in courses it devloped for them in both oxy-acetylene and electric arc welding. This training has been conducted both by the engineers of the Company and by manufacturing and research organizations which have given long and careful study to the fundamental principles of fusion-welding, the methods to be followed to obtain safe and sound welds, and the dangerous practices to be avoided. These training courses have even gone so far as to include the highly specialized examination of fusion welds by the X-ray.

The Company feels that reliable fusion-welded vessels can now be constructed, and such vessels, when built by one of the manufacturers on the "Hartford Approved List*" in accordance with its requirements for construction and shop inspection, are acceptable for insurance.

Explosion Causes 6 Deaths, $63,000 Property Loss

IN addition to property damage estimated at $63,000., the explosion of a rotary rag digester on May 12 at a pulp and paper mill in Ohio cost the lives of six men. It is understood that the concern carried insurance on the vessel but that the policy limit was only $20,000., thus showing the extent to which a plant may be out of pocket when its policy is written with a limit too low for proper protection against a catastrophic loss.

This digester was a cylindrical vessel, supported horizontally by a 9″ hollow cast-iron shaft with which it revolved. It was used to process a charge that consisted ordinarily of about 3,500 pounds of scrap rags or jute, 2,000 gallons of water, and from 400 to 650 pounds of caustic soda or slacked lime. Evidently the vessel was quite old. The plates were of wrought iron, considerably laminated. However, the investigators were inclined to the belief that the initial failure occurred in the shaft rather than in the plate, and that this breaking of the supporting shaft tore the plate by permitting the heavily-loaded vessel to sag.

Earlier in the day twelve women employees had been in the plant, but had been told that there would be no work for them at that time. Had they been at work at their accustomed place on the second floor of the building in which the explosion occurred (see illustration) there is little doubt but that some if not all would have been killed or injured.

The following information is based on the official report filed with the Ohio Industrial Commission:

The vessel was approximately 20′ 10″ from edge to edge of head flanges. It was made of eight courses of wrought iron, three sheets to a course, assembled with single-riveted lap joints both longitudinally and circumferentially. Through the cast-iron heads, 1⅞″ thick, passed the cast-iron shaft, the outer ends of which were machined to form

* In issuing this "Approved List" there is no implication that manufacturers not on it may not be doing good welding.

journals on which the vessel rotated. The digester was purchased second-hand in 1910, and although information as to its history prior to that time is lacking, it is reasonable to assume that a vessel of such construction would be from 40 to 50 years old.

Steam from a header carrying a pressure of 96 pounds per square inch was fed to the digester through a line containing a reducing valve,

a safety valve and a check valve. For some time the reducing valve had been set at 60 pounds, but two days prior to the accident it was regulated to cut the pressure to 40 pounds, as the lower pressure was better suited to the product in course of manufacture. The purpose of the check valve was to prevent any pressure generated in the digester by chemical reaction from backing out the contents and thus fouling either the safety valve or the reducing valve.

The explosion blew the vessel into four pieces, exclusive of the heads and shaft. The seam at the west head failed by cracking through the plate at the head rivets, while the corresponding seam at the other head failed by shearing and tearing the plate. Signs of old cracking, that may or may not have extended entirely through the plate, were observed at the east head. It was evident that the cracking was proceeding from the outside of the plate inwardly, and that the laminations in the metal were tending to arrest it.

Although the investigators took cognizance of the fact that the explosion might have been caused by overpressure either from the steam main or from chemical reaction within the vessel, the nature of the failure at the head seams led them to feel that a more probable cause was the breaking of the cast-iron shaft. With that in mind, they concluded their report with the following hypothetical analysis of what took place:

"Some shock or irregularity in operation stressed the central shaft to the point of failure at its weakest point, which is believed to be at (a) blow hole approximately 49″ from the east head, or (at) the drilled holes 7″ from the east head. This shock might have been easily caused by a foreign object falling between the driving pinion and the gear mounted on the west head of the vessel. It will be remembered that a section of this gear was broken out and, while it might easily have been broken out due to the violence of the explosion, it could also have been broken out in the manner suggested. With the failure of the shaft, stress on the head seams would be immediately and tremendously increased. This would also be true of all the girth seams, but the head seams would receive the greater stress.

"The west head would be forced to sustain, in addition to the load of the vessel and its contents, the unsupported weight of almost 20′ of cast-iron shaft. Considering the weakened condition of the metal due to fatigue and the presence of the cracking in the east head seam, it would be reasonable to say that the initial failure was at one of these seams."

Separator Explosion Causes Heavy Damage

A PAPER mill in Michigan was operating at capacity during the early morning hours of February 12 when the main steam header in the engine room exploded with terrific violence, crippled the power supply, and brought plant operations to a complete stop. It is thought that the accident was caused by failure of the cast iron head of a steam separator under the tremendous impact of water carried over from the boilers. Hundreds of feet of piping were broken, bent, and jarred out of line; expensive electrical and measuring apparatus on a nearby switchboard and elsewhere about the room was ruined; holes were blown in the roof and floor; and dirt sprayed thick over walls and machinery.

An engineer and an oiler were in the engine room when the explosion occurred, the oiler being about ten feet from the separator. He was burned about the face and hands, and his eyes were filled with dirt.

The engineer, who had been on the point of leaving through a door at the far end of the room, rushed back to his assistance.

According to these men there was no warning in the form of vibration or other unusual sounds. They said the explosion came as a flash that was followed immediately by a roar like that of a cannon. Had the oiler been standing but a few feet nearer the wall, he would have been crushed beneath a 500-gallon oil distributing tank as it fell.

The destructive effects of the explosion were so far-reaching that production of paper was entirely stopped for one whole day, and approximately sixty-five per cent. prevented for eight days. Fortunately for the plant, it was insured against loss because of stoppage of production as well as against the loss represented by the property directly damaged by the accident. It was paid $20,502.34, of which $9,121.17 was for direct property damage and $11,381.17 for Use and Occupancy.

Naturally the plant officials were desirous, even though they had Use and Occupancy insurance, of seeing production reestablished as quickly as possible, so as to permit the shipment of orders for which customers were pressing them. "Hartford Steam Boiler" representatives went on the job immediately, lending their technical aid until things were back in shape and running smoothly. Partial production was arranged for just as soon as the wreckage had been cleared away, by bringing in outside current, feeding a paper machine live steam through a temporary line from the boiler room header, and setting up a portable air compressor to operate a boxboard press.

The real task, however, was to obtain parts and erect quickly a new supply line from the boiler header to the engine room distribution header; to erect a new distribution header with branch lines to the engines; to install a 500-foot rope drive; repair or replace various pieces of electrical equipment; and to check over machinery for possible damage that would prevent its functioning when the plant was again ready to resume operations. It was particularly feared that the turbine bearings had been wiped or scored while the machine coasted to a stop without sufficient pressure on its lubricating oil line, so while the other work was under way this machine was dismantled and inspected.

That the plant was ready for capacity operation by the morning of February 20 was an eloquent testimonial to the cooperation of the firms supplying the parts, to the manner in which shipments were scheduled and expedited, and to the technical planning that coordinated the work of the crews making the repairs.

Think Clogged Line Caused Air Tank Blast

The recent explosion of an air tank in a garage in Pennsylvania indicates the importance of having the system free from an accumulation of dirt, oil, or any other substance tending to clog the lines. The tank which burst was a storage vessel for compressed air used to run a small elevator. Prior to the accident the elevator refused to operate. It is thought that the air outlet from tank to elevator was clogged, but evidently the mechanic supposed the air pressure was low, for he set the compressor running by hand, not waiting for the automatic starter controlled by pressure in the tank to take effect. The forcing in of additional compressed air apparently created a pressure inside the tank greater than it could withstand. The resulting explosion smashed plate glass windows at least fifty feet from where the air tank stood at the rear of the building. The shell sailed off its base, along the under surface of the roof, and landed between a brick wall and one of the cars parked in the garage. Little damage was done except to tanks and windows, and no one was injured although an employee standing only six feet away was splashed with oil when the accident occurred.

Some Violent Heating Equipment Accidents

SOME recent and disastrous accidents, both to heating and to hot water supply systems, indicate the importance of their being installed with adequate automatic safety devices for relieving excess pressure and for accurately regulating the fuel supply. The presence of such devices, however, is only half the story. To be sure that they operate correctly, they should be checked carefully and regularly by someone trained to recognize their tricks and their peculiarities.

Hurled across the boiler room by the concussion when a round steel heating boiler exploded in the basement of a garage and tire and battery shop, one man was so badly injured that he died a few minutes after a police ambulance had rushed him to a hospital. He had just entered the room when the explosion occurred, according to the boiler room attendant who, himself, escaped injury by the narrowest of margins. The blast broke water pipes, cracked the concrete floor above the boiler, shattered windows, and so choked the basement with steam that attendants several times were forced back from the entrance to the boiler room before they were able to reach the injured man.

All seams of the boiler were welded. As can be seen in the illustration, the inner shell tore away from the base ring around practically two-thirds of its circumference. The safety valve was not found, so it is a matter of conjecture whether the initial cause of the inner shell's collapse was failure of the welded seam or overpressure within the boiler.

The explosion of a forty gallon copper hot water supply tank in a fine residence caused nearly $5,000.00 damage to the house and furnishings. Five members of the family and the maid, who were asleep in the upper rooms, fortunately escaped injury, although the rear wall of the house was torn away, one wall of a sunparlor at the front of the house blown down, and plaster and debris from falling partitions scattered all over the first floor.

Evidently the gas-fired coil heater had not been turned off when the family retired. It is thought that the system lacked adequate relief equipment, for pressure accumulated inside the tank, increasing until at last the copper shell tore apart. Bottom head and base were driven through the kitchen floor into the basement; shell and upper head shot up into the ceiling, hit a steel beam, and were deflected out through the side of the house, taking window frames along too. Had its course not been turned from straight upward, injury might have struck those asleep upstairs.

Trouble with the thermostatic regulation of gas-flow in relation to water temperature, and failure of the relief valve to function at a reasonable pressure, probably were responsible for the violent explosion of a steel hot water supply tank in an undertaking establishment. The tank was of the storage type, with an integral heating unit below it. All seams were fusion welded, the longitudinal seam a lap joint, fillet-welded on the outside only. The heads, both of plus design, also were fillet welded.

During the week prior to the accident, the thermostatic control, supposed to regulate the flow of gas according to the temperature of the water, had not been working properly. The proprietor noticed that occasionally the flame was unusually high and the water unusually hot. After an unsuccessful attempt to regulate the thermostat, he shut off the burner and called the local gas company. Adjustments were made, but the trouble must have persisted, for two days later the tank exploded. Although every seam was torn apart, it is thought that overpressure, resulting from the non-functioning of safety devices, was to blame, rather than possible weakness of the welds, which seemed to be of good quality.

The boiler room was closed off from the rest of the basement by an eight inch concrete wall on three sides, the elevator shaft forming the fourth. The three walls were completely demolished and one side of the elevator shaft blown in. Part of the enclosure surrounding a pipe organ was destroyed and the organ badly damaged. The force of the blast broke windows, set doors out of line, and moved the sectional cast iron heating boiler sideways about ten inches, cracking its base and breaking down piping. The total extent of property damage was estimated at $4,000.00.

Did Not Know Seriousness of Lap Seam Crack

LAP seam cracks in the shells of horizontal tubular boilers and other types of fire tube boilers are an old story. That, if undiscovered, they may result in disastrous explosions, also is an old story. An accident of this type which occurred some time ago, killing one man and injuring seven others, tells the story with variations for besides illustrating the danger of lap seam cracks it illustrates also the danger of making improper repairs when defects are discovered.

The boiler was located at a saw mill, and was of the horizontal return tubular type, two courses, forty-four inches in diameter by thirteen feet long, with double riveted lap seam longitudinal joints, and designed to carry one hundred pounds pressure. The explosion occurred when the shell plate failed along the longitudinal seam of the back course, where a lap seam crack had developed. This crack had been noticed some time before, and an attempt to repair it had been made by welding along the outer surface of the shell for about fifteen inches, probably all of the crack visible from the outside. An examination of the plate after the explosion, however, showed an old crack extending about forty inches along the inner surface.

In addition to this defect, two of the four diagonal braces to the upper segment of the back head were broken, showing old breaks of long standing, another brace was partially broken, and nine rivets in the front head under the tubes had been wasted off flush with the front head flange.

It is said that the safety valve worked at one hundred twenty-five pounds and that the gauge showed one hundred fifteen pounds just before the explosion occurred. The boiler in such weakened condition, of course, was not fit to operate even at the pressure approved for it when built. Had the serious nature of the crack been discovered and explained to the owner, and the boiler removed from service, one man's life would have been saved and seven others spared their injuries.

Small Tanks Overstressed by Air Pressure

Danger's hiding places are unexpected. A few weeks ago, a woman whose house stood close by a filling station took advantage of the station's service to fill the air pressure tank attached to her oil cooking stove. As the kitchen was only a few feet from the tank she ran the air hose used for pumping up tires into the room and attached it to the kitchen tank, which suddenly burst. A large piece struck her in the face, inflicting fatal injuries.

A somewhat similar accident, the explosion of a small tank used for spraying gasoline, injured a father and his son, the father seriously. According to the report of an attendant at a nearby filling station, they had pumped up air pressure in the tank, evidently exceeding the strength of the container.

Home-made Device Causes Furnace Explosion

An attempt to economize on their coal bill cost the lives of an entire family, a man and his wife, and their two small children. The man, who was an automobile mechanic, conceived the idea of utilizing for fuel the crankcase drainings obtainable at the garage where he worked. In the attic of his house he installed a storage tank for the drainings, piping it to the top of a stove of the ordinary "parlor" variety, in which coal was burned. A hand regulating valve controlled the amount of oil fed, and the slow dripping of the oil upon the fire gave a hot flame with reduced coal consumption. On the night of the accident, which happened late in March, the family had gone to bed, apparently after putting a fresh charge of coal into the stove. Probably the oil continued to drip on the banked fire, which was giving enough heat to vaporize it without causing combustion. As soon as the temperature was sufficient to ignite the gases, or an open flame was discharged from the coal bed, the oil vapor burned almost instantaneously, causing an explosion immediately followed by a fierce blaze which burned out the interior of the house and trapped the occupants before any attempt to rescue them could be made.

Miniature Boiler Explodes, Kills Operator

Early one evening in April, two employes of a redecorating company were working in a residence, removing paper from the walls of one of the rooms, when without warning death struck down one of them. In order to loosen the paper, they were using a steam pan, passing it over the walls. A hose connected the pan with a little three-gallon closed vessel containing the water and steam, and fixed directly above the gasoline-fired burners. The man who escaped was standing on a scaffold suspended between two ladders, and holding the pan. According to his story, the force of the blast darkened the room, shattered windows, hurled him off the scaffold.

Small though the exploded vessel was, it tore apart with tremendous violence. A hole was blown in the ceiling and in the floor, all windows in the room were broken, pictures on the walls of the house next door thrown down, and the jar felt a block away.

The Locomotive

THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., July, 1932

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.

New Home Office Suited to Company's Needs

ANNOUNCEMENT of the opening of the Company's new home office building was made in our last issue, but the building had then been completed so recently that satisfactory interior and exterior views were not available. For that reason it seemed better to hold over for this issue a description of the details in which we know our friends will be interested.

The building is of three stories and is in the shape of an "L" reversed. Above a granite base it is made of a warm, gray Indiana limestone. Exterior doors and windows are framed in aluminum, and between windows of the second and third stories spandrels of that material carry in relief a gear wheel and engine governor, suggestive of the nature of the Company's business.

Although the new plant is not a large one, as modern buildings go, in some respects it is unusual. Before the architect drew plans, an extensive study was made by office layout specialists to determine the most efficient arrangement of departments, equipment, and personnel. The building was designed around the resulting layout, so that it is fitted precisely to the purpose for which it is intended—namely the efficient

General View—*Showing the results obtained by the architect in using a modern classic design to produce a building of striking simplicity and beauty. In relief on each of the spandrels between the upper rows of windows are intertwined a gear and a governor, suggestive of the Company's business.*

conduct of the many details peculiar to the business of engineering insurance and inspection.

Sound-proofing in all open work spaces, and conditioned air through the building contribute greatly to comfort and, of course, to efficiency. Vaults on each floor protect records against the hazard of fire, although that hazard is slight in that scarcely a wagon-load of wood was used in the entire building.

The front wing of the first floor is given over to the quarters of officers, a reception room, and the directors' room. In the other wing are offices and work spaces for the personnel having charge of the Company's business in the Hartford territory. The engineering department as well as the underwriting staff is on the second floor, and on the third are the quarters of the legal, claim, and advertising departments, an assembly hall, nurse's room, kitchenette, and separate club rooms for the young ladies and men. Private offices, some permanently built-in and others formed by steel partitions, are provided on all floors for those having work that does not permit of the distractions unavoidable in open work spaces. On the ground floor is a laboratory where meters, boiler materials and all manner of safety devices may be tested and

FRONT ENTRANCE—*In the grill over the doors is the Company seal, with its replica of the old locomotive "Comet". Doors and frames are of aluminum, as are the railings leading out to the stone posts.*

PRESIDENT'S OFFICE—*Natural wood paneling and a corner fireplace give this room a comfortable, homelike appearance.*

DIRECTORS' ROOM—*Of the early Colonial type. Furniture was taken from the corresponding room in the old building.*

OPEN WORK SPACES—*The features most noticeable in the open work spaces, two of which are shown here, are the orderliness and the even distribution of light. These photographs were taken at night without illumination other than that coming from the ceiling fixtures.*

GIRLS' CLUB ROOM — *For relaxation during the lunch hour and for evening gatherings of employes. A similarly appropriate room is provided for the men.*

inspected, and where samples of boiler feed water may be analyzed.

Designed in all details so as to afford the greatest ease and efficiency in the conduct of the Company's specialized business, this modern building should substantially increase the effectiveness of "Hartford Steam Boiler" service to assured. Such was the intention when the building was planned, so we feel that our friends will be interested in this brief description and in the accompanying photographs from which the appearance of the new home may be visualized.

Using Steam at Temperature of 860° F.

Two points of distinction are claimed for a new boiler and turbo-generator recently placed in operation at the Burlington station of Public Service Corporation of New Jersey. The arrangement is said to be the first in this country to employ steam at the high pressure of 730 pounds per square inch and temperature of 860 degrees F; the 18,000 kilowatt turbine is the first of its size in the country to operate at 3,600 rpm., most large turbines having a rotor speed of 1,800.

The new boiler has a greater capacity than the combined output of ten older boilers in the plant. Those boilers are now held in reserve while steam from the new boiler is used at reduced pressure to operate the turbines they once served.

Wouldn't Take "No" for an Answer

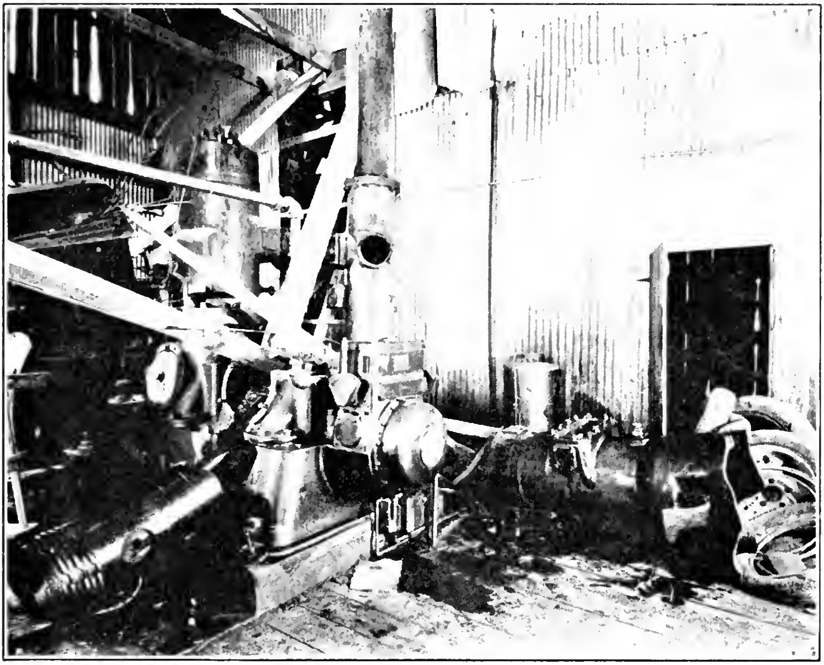
Many a story has been told about Yankee ingenuity, but none that beats the true account of how a resourceful New Englander continued to obtain dividends from a corporation years after it was defunct. The story appeared in the *Railroad Gazette* during 1887:

"The only stockholder that ever got a dividend out of the old Farmington (Conn.) Canal has just died. The president of the canal company told him that there was no dividend, and no prospect of any, and jestingly advised him to go home and mow the towpath for a dividend. Mr. Munson (the stockholder) did so, taking a 20 per cent. dividend in hay from the eight miles of towpath, and went on doing this with perfect complacency thereafter."

Judge: "Guilty or not guilty?"
Sam: "Not guilty, suh."
Judge: "Ever been arrested before?"
Sam: "No, suh, Ah never speeded befo'."—*Christian Science Monitor.*

Diesel Wrecked During Starting Operation

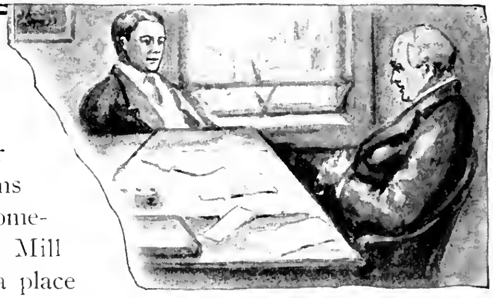
THE operator in a plant in Florida was in the act of starting his Diesel engine on the morning of January 25 when something went wrong with the starting-air mechanism. The resultant explosion tore the cylinder from the crankcase, allowing the piston to fall down and break a large piece out of the engine bed. At the time this



happened, the operator was standing at the starting-air lever, shown in the foreground of the illustration, so it is evident that he was fortunate in escaping serious injury. The plant was not so fortunate, as there was no engine insurance to cover the heavy property loss.

According to accounts of the accident, the mechanism for admitting starting-air in some way became disarranged, so that the cylinder contained air at a pressure of 125 pounds per square inch while the piston was on its upward stroke. As the piston proceeded upward, the air was compressed until it either reached a pressure sufficient to rupture the cylinder or else caused pre-ignition of fuel that may have entered the cylinder during a previous false start. The view of the engine here shown clearly indicates the completeness of the wreck.

Taps From the Old Chief's Hammer



"BY THE WAY," declared Tom Preble as he was about to leave the boss's office after laying a sheaf of report forms on the desk, "I ran across something at the Salmon Creek Mill that ought to be worthy of a place in the book."

"What sort of a thing?" inquired the old fellow, expelling a cloud of smoke that he had drawn from a particularly wicked-looking briar.

"I guess the fellow who installed it intended it as a strainer," was the explanation, "but I'll be darned if it wasn't a new one on me."

"Come on, what's the story?" urged the old man, replacing his pipe and settling back comfortably to listen.

"Well," said Preble, "several days ago we received an order to insure the mill's four horizontal tubular boilers, and I had expected that McAlear would be able to make the first inspection yesterday, when the boilers were to have been closed down for the week-end. However, I had to send him off early on another detail and as none of the other inspectors was available, I decided to do the job myself.

"It seems that up until about six years ago the mill had only two boilers, 48-inch affairs. At that time they added an engine and put in a 72-inch boiler to give them the extra steam. From what I was told yesterday by the engineer, the addition of the large boiler still seemed to leave them somewhat short of what they wanted, and they were continually having to force the two old boilers to keep up pressure. About three months ago they decided that they had had enough of that, so they put in another 72-inch H. T. That ended the trouble as far as the shortage of steam was concerned.

"In telling me about the boilers the engineer kept referring to No. 3 as the easiest steamer of the group. That was the older of the 72-inchers, you understand. According to his way of stating it, the fireman merely had to wave his scoop at that baby to make her safety valve pop. He seemed so determined to have me understand that there was a super-boiler that I decided to find out what the difference was between it and No. 4, a newer one of exactly the same size but without a dome.

"Bearing in mind the advice you once gave me about taking a sharp look at the steam outlet of any boiler that had gained a reputation of being an unusually easy steamer, I crawled into No. 3, reached up into the dome, and played the beam of my flashlight into the steam pipe. There was the villain—in the shape of what was evidently a piece of metal with holes for steam to pass through.

"Calling for the engineer to go with me, I then climbed up on top of No. 3 for an outside view of the steam outlet and there, sandwiched with two gaskets between companion flanges in the pipe, was a piece of thin metal. I asked the engineer about it, but as he had not been with the company at the time the boiler was installed, he had no idea as to the reason for the thing. As a matter of fact, he was as insistent on investigating it as I was, and sent for tools to break the joint so we could have a look.

"So we took the joint apart, and there between the flanges of that 4½-inch flow pipe was a 16-gauge steel diaphragm in which someone had drilled sixteen half-inch holes. Even some of those holes extended out between the flanges so far that they were half closed. All the steam that left the boiler had to pass through those perforations, which I figured had a combined area of not more than a fifth of the area of the pipe. Moreover, that diaphragm, strainer, or whatever you'd call it, was actually dished upward, as if to indicate that the pressure in that particular boiler had frequently been somewhat higher than the pressure in the header. How much, I have no way of knowing, but I should guess it was quite considerable, judging from the way the diaphragm was bent."

"That *is* a strange one," mused the Old Chief as Preble finished. "Now and then I have been obliged to point out a choked dry pipe to an engineer who had what he supposed was an unusually easy steamer in his battery, but I don't think I've ever encountered a strainer in a flow pipe quite like that. What did the engineer have to say?"

"Plenty," laughed the younger man. "But what he said had to do with the fellow who installed the device and it won't bear repeating here. However, we think, now that the steam can get out of No. 3 boiler, he'll be able to shut down the two older boilers and hold them as spares. It ought to make a noticeable difference in the coal bill, too."

"Were you one of the many fooling with the stock market?"
"Not me, I was serious; the market did the fooling."—*Stray Bits.*

One Thing That Handicapped Early Engineers

COULD James Watt come back to earth for a glimpse of the smooth-running, efficient equipment to be found in even the least up-to-date of our present-day power plants, it is safe to say that in assigning credit for the great advance since his time he would give a generous share to those who developed machine-tools.

The building of an engine 150 years ago was a problem. In fact, for boring Watt's first cylinder the only device available consisted of a boring bar supported at only one end and carrying a boring cutter of the same size as the bore of the cylinder. Even a rough degree of accuracy was not possible with such a tool, and it was not until a Mr. Wilkinson came to Watt's assistance by designing a boring machine which supported the bar at both ends that a fairly accurate cylinder was produced. Of this early machine-tool builder Watt's partner, Boulton, wrote: "Mr. Wilkerson has bored us several cylinders almost without error. That of 50 inches diameter which we have put up at Tipton does not err the thickness of an old shilling in any part."

Boulton considered Wilkinson's feat of boring a cylinder within a tolerance of one thirty-second of an inch a remarkable thing. It was. But we would not have advanced far beyond the limits of Watt's crude engines had not succeeding Wilkinsons found means for reducing tolerances to as little as a thousandth of an inch and, in some cases, a ten-thousandth.

Coal Dust and Oil Mixed as Ship Fuel

A combination of fuel oil and coal dust for firing boilers is being tried out on the Cunard liner *Scythia*. With the crude oil is used coal pulverized so fine that the mixture runs freely through the jets under the boilers.

The present experiment with colloidal or "coal loaded" fuels calls to mind similar tests made in 1919 by the late L. W. Bates, a consulting engineer. It was reported at that time that the test showed that an efficient and economical substitute had been found for oil and coal as steamship fuel, but shortly thereafter fuel oil became so cheap that no general use of "coal loaded" oil was undertaken.

"You must give up staying out late at night," said the doctor.
"You think the night air is bad for me, doctor?"
"No," said the doctor," "it isn't that. It's the excitement after getting home that harms you."—*Line-ings.*

Caught in the Separator

The country has the five-cent cigar it was shouting for, and to make the picture harmonious now gets the old three-cent postage-stamp.—*Albany Knickerbocker Press.*

Apparently those Navy officials who have ruled that ensigns can't marry until two years after they've graduated discount the value of practical fighting experience.—*Ohio State Journal.*

"Sir, my wife said I was to ask for a raise."
"Good. I'll ask my wife if I may give you one."—*Gente Nostra (Rome).*

Salesman (wiping the perspiration from his brow): "I'm afraid, madam, we've shown you all our stock of linoleums; but we could get more from our factory."
Customer: "Well, perhaps you had better! You see, I want something of a neater pattern and quite small. Just a little square for my birdcage."—*Bio-Chemic Review.*

Beware of Hasty Conclusions

Recently a father and son were at a gathering and both had married the second time, the son having remarried sometime before the father. During a general conversation, the son was asked how long he had been married and he replied that he had been married a year longer than his father.—*California Safety News.*

"That was a close call, old man. Don't you know you always ought to give a woman driver half the road?"
"I always try to, as soon as I find out which half she wants."—*Woman's World.*

"It is very hard to drive a bargain," said the fellow who had bought an old flivver for $10.00.—Princeton *Tiger.*

General Pershing says American citizens are slovenly and that the country is governed by cheap politicians. The sentiment is entirely proper but, General, is "cheap" exactly the word?—*Indianapolis Star.*

Sign in a Texas restaurant—"If the steak is too tough for you, get out. This is no place for weaklings."—Boston *Transcript.*

Law and order, says a reformer, is the need of the day. Personally, we could get along with fewer laws if we could get a few more orders.—*Southern Lumberman.*

Let other navies tag their ships with such awe-inspiring cognomens as *Dauntless, Scorpion,* and *Terror.* The United States Navy simply christens its newest cruiser *Chicago* and lets it go at that.—Chicago *Daily News.*

A golf professional, hired by a big department store to give golf lessons, was approached by two women. "Do you wish to learn to play golf, madam?" he asked one.
"Oh, no," she said, "it's my friend who wants to learn. I learned yesterday."—Montreal *Star.*

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1931

Capital Stock, - - $3,000,000.00

ASSETS

Cash on hand and in bank		$ 901,554.83
Premiums in course of collection (since October 1, 1931)		1,177,597.98
Interest accrued on mortgage loans		27,546.67
Interest accrued on bonds		124,122.94
Loaned on bonds and mortgages		986,760.15
Real estate		462,799.10
Agents' ledger balances		10,742.54
Miscellaneous assets		2,014.13
		$3,693,138.34
Bonds and Stocks:		
Book value	$15,576,111.24	
Convention value over book value	790,997.40	
Total value as fixed by The National Convention of Insurance Commissioners	$16,367,108.64	
Deduction to adjust security holdings to true value as of December 31, 1931, as required by Connecticut Insurance Dept.	1,147,046.25	
		15,220,062.39
TOTAL ASSETS		$18,913,200.73

LIABILITIES

Premium reserve		$ 8,609,354.91
Losses unadjusted		329,660.26
Commissions and brokerage		235,519.60
Other liabilities (taxes accrued, etc.)		611,642.21
Special depreciation reserve		2,000,000.00
Capital stock	$ 3,000,000.00	
Surplus over all liabilities	4,127,023.75	

Surplus to Policyholders, - - - - - $7,127,023.75

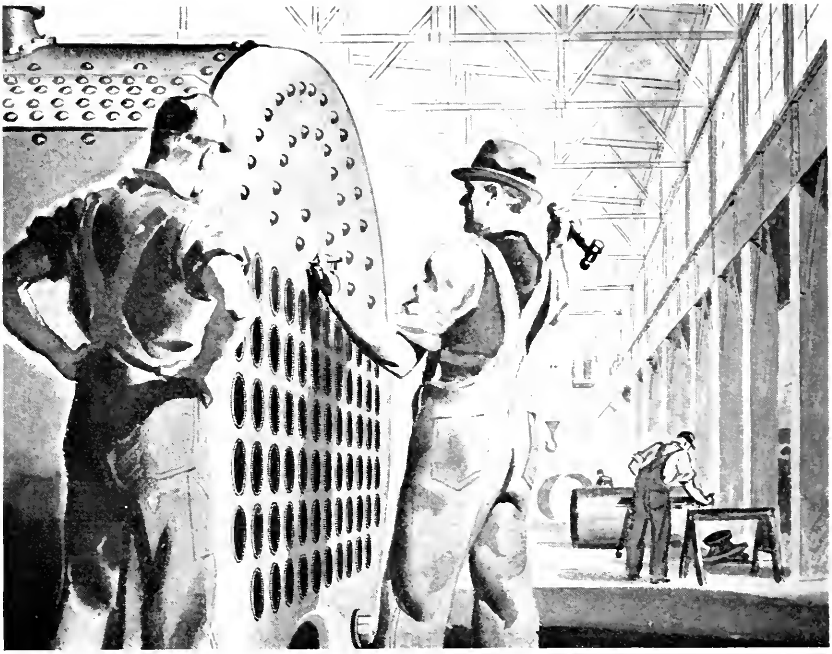
$18,913,200.73

WILLIAM R. C. CORSON, President and Treasurer

BOARD OF DIRECTORS

Incorporated 1866 — Charter Perpetual

Department	Representatives
ATLANTA, Ga., Citizens & So. Nat. Bk. Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 5 South St.	James P. Kerrigan, Jr., Manager. P. E. Terroy, Chief Inspector.
BOSTON, Mass., 4 Liberty Sq. Cor. Water St.	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., City Savings Bk. Bldg.	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 175 West Jackson Boulevard	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio, First National Bank Bldg.	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, Leader Bldg.	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER, Colo., Gas & Electric Bldg.	J. H. Chesnutt, Mgr. and Chief Inspector. F. G. Parker, Ass't Chief Inspector.
DETROIT, Mich., First Nat'l Bank Bldg.	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., 56 Prospect St.	F. H. Kenyon, Manager. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Bldg.	R. T. Burwell, Mgr. and Chief Inspector E. Unsworth, Ass't Chief Inspector.
NEW YORK, N. Y., 90 John Street	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut St.	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., Arrott Bldg.	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth St.	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., 114 Sansome St.	C. B. Paddock, Manager. L. E. Grundell, Chief Inspector.
SEATTLE, Wash., Arctic Bldg.	E. G. Watson, Mgr. and Chief Inspector. J. W. Smuck, Ass't Chief Inspector.
TORONTO, Ont., Canada, Federal Bldg.	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.



The New Boiler

gets its "STERLING MARK"

WITH hammer and stamp the inspector strikes into the steel of the finished boiler the letters "HSB". This, the Hartford Steam Boiler Inspection and Insurance Company's brand, is placed on about ninety percent of all the power plant boilers manufactured in the United States. It is considered the "Sterling Mark".

It means that a 'Hartford Steam Boiler' inspector stationed in the maker's shop has watched the construction of the boiler. He has checked design, materials and workmanship; has examined seams and rivets, plates and tubes. Only on a boiler built to established standards does he place that stamp.

Purchasers of boilers commonly look for this mark. Many of them in their specifications demand Hartford shop inspection. This acceptance, in other countries as well as our own, of the 'Hartford Steam Boiler' brand has been established by this company's research and experience over sixty-six years.

Shop inspections are, however, but a small part of the service which 'Hartford Steam Boiler' renders American industry. Its primary business is Engineering Insurance; and about half of all such insurance written in the United State is placed with this company. This includes the insurance not only of power and heating boilers but of engines, turbines, electrical and other power machinery.

Vol. XXXIX No. 4 October 1932

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

72 Lives Lost as Boiler Bursts on Harbor Boat

ONE of the most disastrous marine accidents in years occurred in New York Harbor on September 9th when a boiler explosion aboard the steamer "Observation" cost the lives of seventy-two men. The boat was loaded at the time with workmen on their way to a construction job on Riker's Island, and many of the seventy-two victims were killed outright by the terrific force of the blast. One was hurled from the boat against a sixth-story window of a power house building, and three others landed on shore five hundred feet from the sinking vessel. Parts of the boat were thrown long distances, a heavy spar piercing the driver's cab of a motor truck which the occupant had fortunately left just a moment before.

The boiler was of the three-leg marine type. It had been installed new in 1908, and although at some time a six-inch crack in a water leg had been repaired by welding, an inspection by representatives of the U. S. Steamboat Inspection Service in April revealed no evidence of leakage or serious wastage. Part of that inspection consisted of applying a hydrostatic test at 225 lbs.

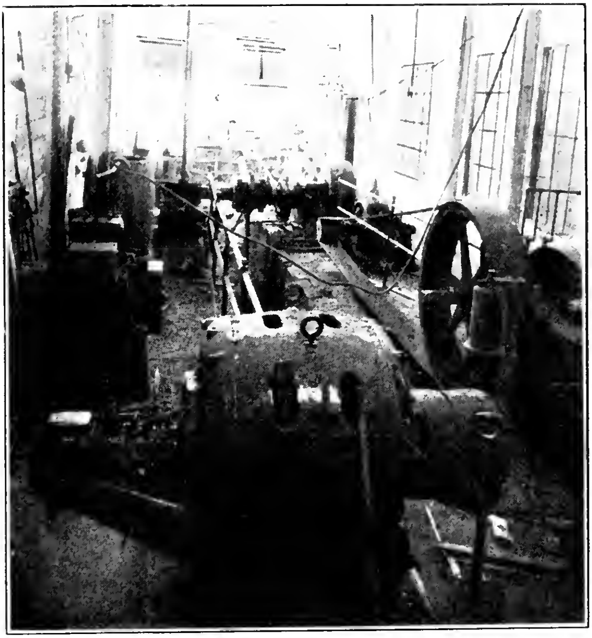
From the fact that the safety valve relieved at 145 lbs., when recovered and tested after the accident, it seems probable that the boiler exploded at a pressure not greater than the 150 lbs., for which it was considered safe. Just what caused the rupture may never be known, however, as the boiler itself remains imbedded somewhere in the muddy bottom of the river in spite of long efforts on the part of a salvage crew to locate it by grappling and dredging.

The "Observation" was for years used on regularly scheduled sight-seeing trips around Manhattan Island, and her trim, white super-structure was a familiar sight to the thousands of commuters who crossed by ferry from Jersey City. However, she was taken from that run several years ago and had since knocked about the harbor on such occasional assignments as her owners could find. For some time prior to the explosion, she had been carrying workmen to and from a new city penitentiary under construction on an island in the harbor.

After an investigation at which testimony was given concerning the condition in which the boiler had been maintained, the Grand Jury on September 30th returned an indictment for second degree manslaughter against the captain and part owner who had survived the accident.

Severe Accidents to Engines

OF SEVERAL engine accidents that have recently come to our attention, two would seem to be of particular interest from the operating engineer's standpoint. The first involved a property loss of about $7,000 from the bursting of a 30 ft. flywheel on a Corliss type engine, and the other killed three men when a cylinder head was knocked out. The wreckage caused by the fly-wheel explosion, which occurred in August at a planing mill, is shown in the illustration. It was reported that spokes were cracked in the governor belt pulley and that when this pulley failed over-speed resulted because one of the safety cams was missing and the other was out of adjustment.



Few details of the other accident are available, but it would seem that the three victims were scalded when trapped in a corner of the engine room by steam escaping from the broken cylinder head, and that the mishap was caused by some breaking or crushing of the connecting rod brasses that allowed the piston to over-travel far enough to strike the cylinder head a shattering blow.

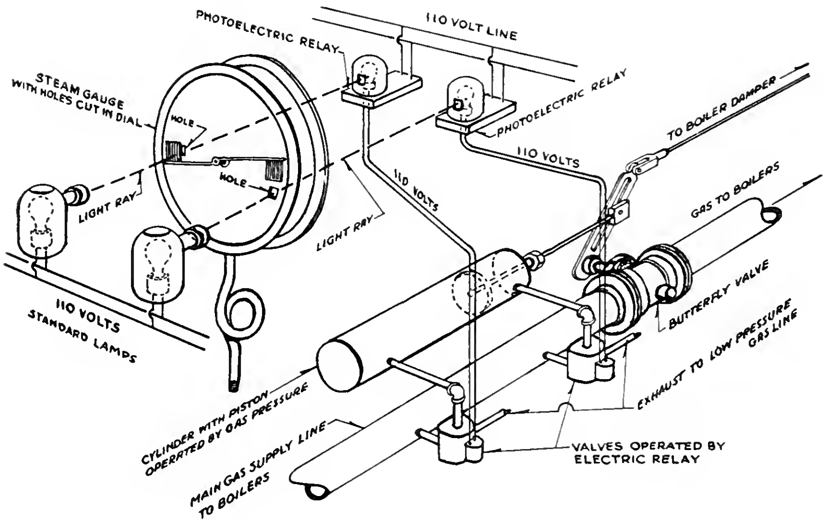
Newspaper reports stated that because of the steam it was impossible for rescuers to reach the men for half an hour.

Oil-Treating Tank Blows Out Head

One person was killed and six were severely burned when a tank containing hot oil at 50 lbs. pressure burst at an oil treating plant in Texas. The tank was 6 ft. in diameter and 20 ft. long. Although girth and the longitudinal seams were welded, the break did not occur in the weld but in the solid shell plate very close to the head seam.

A New Use for the Electric "Eye"

TO THE plant engineer of the Godchaux Sugar Refinery, Reserve, La., goes credit for the ingenious pressure-control apparatus illustrated diagrammatically in the accompanying sketch. A small hole is cut in the steam gauge dial at the pressure for which regulation is desired. A similar hole is cut on the other side of the dial but not



quite opposite the first one. The regular gauge hand is replaced by a long hand with metal flags large enough to cover the holes.

As steam pressure increases, the right hand flag moves down in front of the hole, thus interrupting the beam of light to the photoelectric cell. This causes the relay to energize the coil of the relay valve on the gas line and open the valve. Gas under pressure enters the cylinder from the main and moves the piston, which in turn partly closes the butterfly valve in the line to the burners.

As the fuel supply decreases, steam pressure drops. When the pressure reaches a predetermined low limit, the flag on the left covers its corresponding hole in the steam gauge and its photo-electric relay opens the butterfly valve in the gas line. More fuel enters the burners and pressure again increases. This device is said to regulate pressure within a limit of three pounds. The butterfly is so adjusted that gas cannot be turned completely off, and a by-pass is provided around the valve for use in case it is desired to cut the regulator out of service.

Caring for Windings of Electrical Machines

EXPERIENCE has demonstrated time and again that in general the life of the windings of an electrical machine depends largely on the attention given their insulation. It has been demonstrated, too, that many months and even years in some cases, may be added to the life of the windings of generators and motors by giving the insulation proper attention at periodic intervals and by cleaning and revarnishing windings when necessary.

Many operating and maintenance engineers have found, by experience, that it is a profitable investment to select an opportune time in the operating schedule for removal of electrical apparatus from service long enough to clean the windings thoroughly with carbon tetrachloride, gasoline, or some other proper solvent in order to remove all accumulations of oil and other foreign matter, and then to treat the insulation with a high grade of air-drying insulating varnish. Routine maintenance should be carried on in accordance with an established schedule, and the frequency of such unusual maintenance work as that just mentioned naturally depends on the kind of service in which the object is used and on the operating conditions surrounding it. Care should be taken not to varnish the windings too frequently and they should not be coated too heavily, because such practice tends to fill up the ventilating spaces and to retard the dissipation of heat from the coils.

Motors installed in "seasonal" plants such as ice plants, cotton gins, oil mills, rice fields, and similar places, require more than the usual attention to obtain the best operating performance. Motors used in this class of service are subjected to extended periods of idleness during which the insulation absorbs moisture due to exposure to atmospheric conditions and other causes. Attention just prior to their idle season is very necessary if the best results are to be obtained.

Just as soon as seasonal operations are over and the motors are discontinued from service, the windings should be gone over carefully, cleaned and given any other attention that may be required. After this work is done, each motor should be covered with a canvas or other suitable covering so as to reduce the exposure to atmospheric dampness and prevent an accumulation of dust and dirt. Such procedure not only eliminates the exposure of these "moisture catching" substances, but tends to prevent the foreign matter from being packed into the ventilating ducts and passages between the coil ends where it will interfere with a free circulation of cooling air.

In cases where unusually bad moisture conditions exist, it would be advisable for the operator to consider the use of a space or strip heater, or a lamp bank, near the base of the machine, to keep the windings from absorbing moisture during the idle period.

A few days prior to placing seasonal motors in service, the windings should be given an insulation resistance test to determine whether or not drying out is necessary. A lamp bank or other heating devices, such as space heaters or strip heaters, can be very advantageously used if drying is necessary. Such devices should be installed at the bases of the objects and each machine should be covered with a tarpaulin or boxed in with a small opening at the top for the escape of the moisture that is driven out of the coils.

In cases where electric current is not available to supply the energy for heat, an oil- or gas-fired unit can be used, provided the necessary precautions are taken against fire. Heating units, installed for the purpose of drying out windings should, of course, be placed in such a way that maximum benefit will be obtained from the heat, but not in a manner that will expose the insulation to overheating as a result of the proximity of the drying unit. Insulation resistance tests should be made in the course of the drying process to ascertain when a safe value has been reached.

As a general thing, distribution transformers receive very little, if any attention after they are installed. This is true particularly of those that are mounted on poles. It is advisable that the oil of such transformers be examined at least once a year to ascertain its condition, especially with respect to sludging. If there is then any evidence of irregular conditions, the tanks should be drained and the oil filtered or renewed. Before refilling the tanks, the transformer core should be carefully washed with fresh transformer oil to remove from the oil passages any sludge or other foreign matter that would interfere with the circulation of oil and its attendant dissipation of heat. Caring for distribution transformers in this manner will add to their active period of usefulness and tend to prevent interruptions at critical times.

Recent Explosions of Air Tanks

OVERPRESSURE was not a factor in the recent explosion of an air tank in a Milwaukee laundry. The tank was used in conjunction with a motor-driven air compressor and had as protective devices not only a safety valve set to relieve at 80 lbs. but also a motor cut-out adjusted to function automatically at a pressure of 5 lbs. under that limit. As both devices were in good order, it seemed that the explosion must have occurred at a pressure not greater than that for which the vessel was intended to operate.

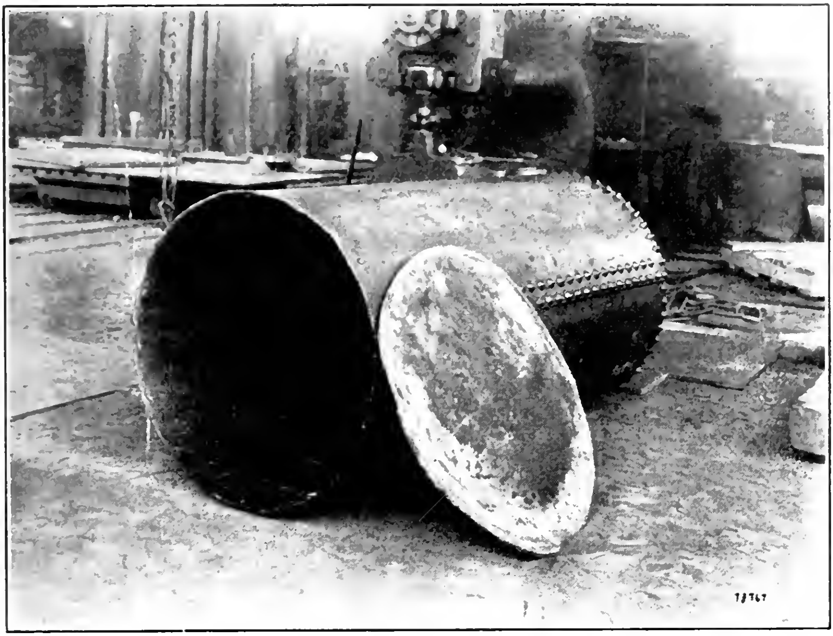


Figure 1

The tank was 36" in diameter, 6 ft. long, and was made of 1/4" plate with double riveted lap joints. Its lower head, however, had at some time been replaced with a shallow, skirtless head fastened in place by welding. The explosion occurred when the weld material sheared and permitted the saucer-like disc to tear loose around its entire circumference. Figure 1 shows the flatness of the head and the manner in which failure took place.

An air tank of about the same length as the one just described, but somewhat smaller in diameter, exploded last month in the top story of a garage in New Orleans. Its lower head broke several heavy joists while passing through the floor below and damaged an automobile there. The tank itself crashed up through the roof.

Air was pumped into this tank by a motor-driven compressor. The owner was of the opinion that the safety valve stuck, thus permitting the compressor to build up an excess pressure. However, from an examination of the welded joint that failed, it appeared more probable that defective welding was the cause, for around at least a third of its circumference the head had scarcely been joined to the shell plate.

Some people apparently do not consider hazardous the tank used

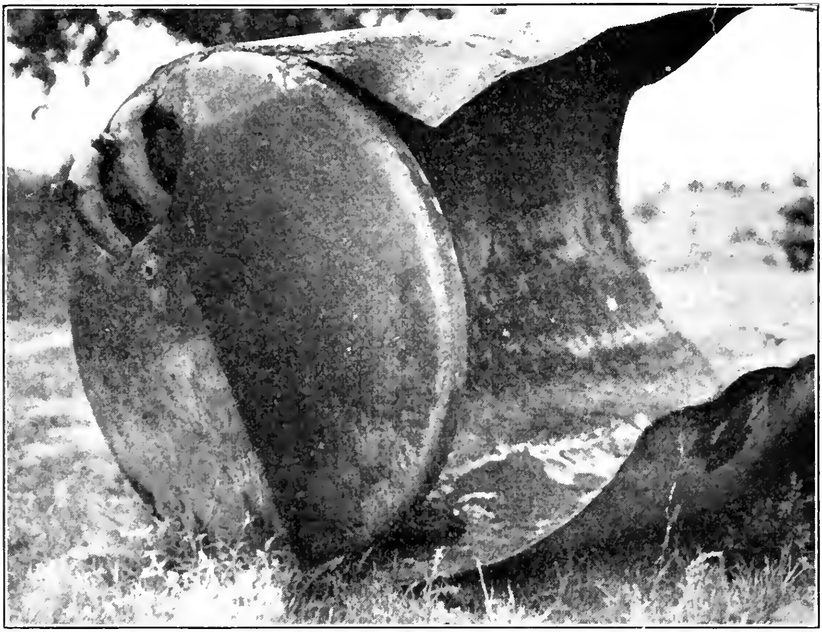


Figure 2

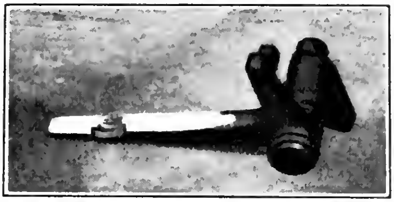
in the hydro-pneumatic system of water supply. They overlook the fact that, although the tank is partly filled with cold water, the compressed air in the remaining space renders the container as dangerous as any air receiver.

At a greenhouse in Maumee, Ohio, the water supply system was of the kind in which pressure is created by trapping air in a tank and pumping water in with it. The tank was 14 in. in diameter and 24 ft. long, and was made up of three courses of 1/4" plate with butt welded longitudinal and girth seams. A gasoline engine drove the water pump and there was neither a relief valve nor any automatic arrangement for shutting down the engine when the required pressure had been reached. Prevention of overpressure depended on the operator stopping the engine when sufficient pressure showed on the gage.

As could so easily happen with this arrangement, there came a day a few weeks ago when the pressure became excessive. The resulting explosion tore the tank apart at each of the two girth seams, at the longitudinal seam of each course, and at both head seams. In Figure 2 may be seen one course to which the head is still partly attached. No one was injured.

Three Small Turbines Go to Pieces

THE explosion of a small auxiliary steam turbine results in less damage to surrounding property than is caused by the breakup of a large turbine of the prime mover class, but such an accident can entirely destroy the value of the installation. Numerous cases have resulted in the injury and death of attendants. Three such accidents to small units occurred within recent weeks.



In taking one of the main turbine units off the line, power house attendants had just opened the hand vacuum breaker when the 104 hp. auxiliary turbine driving the condenser pump overspeeded and went to pieces. Fortunately it did not injure anyone or damage other equipment to any great extent, but the turbine wrecked itself so completely that the only parts that could be salvaged were the bed plate, gear case, and low speed gear.

This turbine had an emergency trip mechanism actuated by a plunger which, recessed in the shaft and held in place by a spring, was so arranged that when the speed of the machine increased, centrifugal force threw the plunger out far enough for it to strike a knockoff lever. This knockoff lever unlatched a spring which, acting through a suitable linkage, caused the control valve to close.

Although the machine was used infrequently, it was customary for attendants to test the overspeed device weekly whenever the turbine was in operation, and to unlatch the knockoff lever by hand at intervals during the idle period. Examined after the accident, the control valve was found free from any deposit of sediment that would have prevented its closing; and there was no evidence of the stem having stuck in the guide bushings. Hence it was felt that the fault probably lay somewhere in the overspeed trip mechanism.

As may be seen in the illustration, the knockoff lever was considerably worn at the point of contact with the plunger. This wear may have taken place during the weekly tests and possibly it so reduced the distance through which the plunger could move the lever that the lever would not unfasten the latch. This supposition was further supported by the fact that the latch blocks seemed to have had a contact surface somewhat wider than is the usual practice for similar installations, and thus would require considerable movement to snap them apart.

The second of the three accidents above referred to involved a 40 hp. turbine used to drive a centrifugal pump. As no one was near-by when the accident occurred, it is not definitely known whether the wreck was the result of overspeed or whether it had its origin in the breaking of the shaft. It was suspected that the latter was the case, however, as the machine was of a type having the turbine wheel overhung a considerable distance from the single bearing that supported it. As several other machines of the same type have given trouble because of bearing failure, and consequent shaft breakage, it seems entirely possible that the same condition may have been the cause of the accident which wrecked this turbine completely.

The third recent small turbine accident was to a machine that had once been used to run a draft fan but which, after a period of disuse, had been reconditioned for the purpose of driving a d. c. generator. It was being tested out at no load when it disrupted. Flying parts injured several men, one so seriously that he died.

Ammonia Compressor Explosions

An engineer's inadvertent failure to open discharge valves when starting a steam-driven ammonia compressor was thought to have caused an ammonia cylinder to burst a few weeks ago in the plant of a concern manufacturing photographic supplies.

The accident ruptured several ammonia lines, and pieces of the shattered cylinder casting damaged the engine room roof considerably.

A man who happened to be standing near the engine room doorway was blown out of the building and across the street. He suffered from bruises and shock but was not seriously injured. Two women who were overcome by ammonia fumes were treated at a hospital.

Fortunately, this accident was not accompanied by fire, as is sometimes the case when ammonia fumes mix with air to form a combustible mixture. An accident of that sort occurred in New Jersey early in October. When a compressor cylinder head blew out at an ice plant, ensuing fire raised the total property loss to $75,000. The owner of the plant escaped injury, although he was standing within a few feet of a wall through which the cylinder head crashed.

Salesman (showing customer some sports stockings): "Just the thing for you. Worth double the money. Latest pattern, fast colors, holeproof, won't shrink, and it's a good yarn."

Customer (politely): "Very well told, too."

How Riveted Boiler Seams Can and Do Deteriorate

By J. P. Morrison, *Asst. Chief Eng., Boiler Division*

THE riveted boiler seam became a problem early in the development of industries involving power produced by steam, and difficulties of one kind or another have followed in wake of each new seam design. Improvements in men, methods, materials and machinery have resulted in a decrease in those minor difficulties attributable to materials and workmanship, but, in keeping pace with the demands for higher pressures and higher rates of evaporation brought about by the demand for decreased capital investment and increased fuel economy, boiler design and operation have become complicated. Likewise, the problem of preventing seam defects and of discovering defects which do develop has become quite intricate.

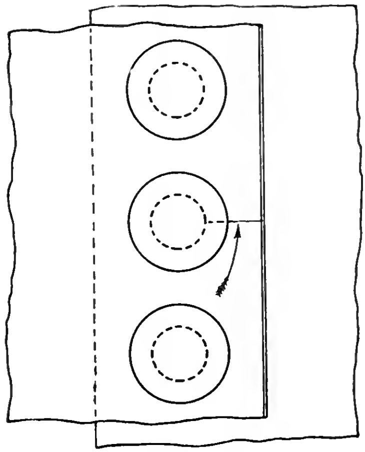


Figure 1

Fire Cracks

The defect illustrated in Figure 1, which develops between the rivet hole and the caulked edge of the plate, has become universally known as a "fire crack". It first became a source of trouble in railway locomotive operation, a class of service that involves high fire box temperatures and high rates of heat absorption by those surfaces exposed directly to the radiant heat. This condition resulted in temperature differentials, and expansion and contraction stresses that were beyond the endurance limit afforded by the material and workmanship obtainable at the time steel was coming into a common use in boiler construction.

Old time stationary and portable boilers of the locomotive type and the various forms of fire tube boilers having external furnaces using wood or coal fuel were hand fired and operated at 100 lbs. pressure or less. The rate of evaporation was low as compared with that in the railway locomotive boiler of that time, and with the load carried by similar equipment today. In fact it was not unusual for the purchaser of a 100 hp. engine to install a boiler of 150 hp., commercial rating, so that there would be a surplus of boiler capacity. As a result, the boiler furnace temperatures were low and where the feed water was of average quality there was little or no detrimental effect upon the fire box and shell plate seams exposed to the heat of combustion.

However, as industries improved their methods of production and the smaller central electrical generating stations increased their output, boiler loads, rates of evaporation, pressures and plate thicknesses increased until the furnace and shell seams, where two thicknesses and a row of rivets were exposed to the new operating conditions, could no longer transmit the heat from the furnace to the water with sufficient rapidity to maintain a comparatively uniform temperature throughout the plate thickness. Under these conditions there were frequent cases in which the outer sheet of the lap seam exposed to the heat attained a considerably higher temperature than that reached by the inner sheet in contact with the water, and trouble started.

In this connection, it may be noted that a temperature differential of 100 degrees, encountered under normal conditions, may be doubled if a small amount of scale or oil has coated the interior surface of a ½″ shell plate forming a lap seam. The tendency of the outer and hotter plate to expand is opposed by the inner plate and by the rivets holding the two plates together. When the outer plate contracts as the temperature decreases, the rivets and inner plate cause longitudinal tension stresses which in time produce fire cracks. The use of metal lacking proper ductility, or poor workmanship in construction, such as punched or drifted rivet holes, hastens this development.

Fire cracks in girth seams became so common 25 or 30 years ago that in an effort to overcome them there was developed a horizontal tubular boiler constructed of only two plates, each plate forming a semicircle without circumferential seams between the head seams, but with longitudinal seams of the lap joint type extending the full length of the boiler. Later, another boiler of somewhat similar construction was tried, this one having one fire or bottom sheet but with two or three sheets forming the upper half of the shell. However, the lack of the stiffening influence of the girth seam as well as the stresses that developed in the longitudinal seams, whether of the lap joint or of the butt joint types, resulted in several failures, some of which were reported in old issues of THE LOCOMOTIVE.

The fire crack, which had been a most common trouble maker in those districts where the available feed waters were of poor quality, was frequently accompanied by overheating and bulging of the plates exposed to furnace temperatures, and the construction intended to avoid the girth seam fire cracks complicated, in many cases, the work of making repairs when repeated overheating led to the necessity of applying patches. The logical solution of the trouble, which at first appeared to depend upon the elimination of the mid-shell girth seam in the construction of boilers having shell plates exposed to furnace heat, later was found to rest upon limiting the thickness of the shell plate so that the combined thickness of the two plates at the girth seam would not be sufficient to cause an undesirably high temperature in the outer sheet. As a consequence, for a number of years the specifications prepared by The Hartford Steam Boiler Inspection and Insurance Company for boilers of the horizontal tubular type have called for shell plate thicknesses not exceeding 9/16″; and the A.S.M.E. Boiler Code carries a limit of ⅝″ for the thickness of the plate at the seam. If the shell plate thickness of an A.S.M.E. Code horizontal tubular boiler exceeds ⅝″ it must be reduced at the girth seam to 9/16″, thus reducing the total thickness of both sheets at that point to 1⅛″.

The fire crack necessitates repair of some description, and is annoying if it results in leakage. However, as it is not due to or affected by steam pressure, it is not ordinarily a source of danger, unless continued leakage results in corrosion to an extent sufficient to weaken the structure. The problem of repair is a small one or a large one, depending upon the extent of the defect and the conditions which have contributed to its formation.

Lap Seam Cracks

Steam boiler engineers recognized some of the inherent weaknesses of the lap seam longitudinal joints a great many years ago. In fact, as early as 1875 The Locomotive printed accounts of boiler explosions due to lap seam failures, and in 1890 published a special article on the stresses developing in single riveted lap joints. Following several disastrous explosions of boilers having double or triple riveted longitudinal seams of the lap joint type, it published in 1907 an article that explained in detail the stresses which must exist as a result of the eccentric loading of the seam, and urged the use of boilers of butt strap construction. In all ways, the Company has long discouraged the use of longitudinal seams of lap joint construction; and since 1891 boiler specifications prepared by it have required the use of butt strap seams.

However, a mistaken idea of production economy led to the manufacture of thousands of boilers of the fire tube and water tube type with lap joint longitudinal seams before public sentiment and legal restriction prevented. Many of those boilers have since been retired from service and the working pressure of others has been reduced to 15 lbs., but in spite of the fact that the A.S.M.E. Boiler Code provides for a reduction of pressure to 50 lbs. on each boiler of that type and does not sanction a pressure greater than 15 lbs. on a new lap seam boiler over 36″ in diameter, many lap seam boilers still remain in high pressure service.

The lap seam crack is found in the overstressed material of one of the sheets where it is hidden by the lap of the other sheet forming the seam. Even at the start the shallow fissure in the surface of the plate may extend the length of the entire course or the length of the entire seam, its depth nearly uniform from end to end. However, the crack grows progressively deeper into the plate along its entire length, so

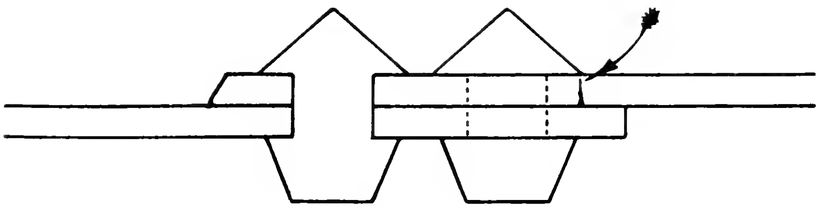


Figure 2

that when the fracture finally pierces the plate at one point, making its presence known by leakage there, the sheet may be on the verge of being torn asunder by steam pressure from girth seam to girth seam. In fact, such failure has occurred in many cases simultaneously with the first appearance of leakage, so that no advance warning of the disastrous accident was given.

A lap seam crack, as it develops in the inner surface of the outer plate of the seam is illustrated by the line sketch, Figure 2, which is reproduced from THE LOCOMOTIVE of January 1907. A similar crack is shown in Figures Nos. 3 and 4 which are photographs of plates removed from a boiler in which one of our inspectors found a lap seam crack extending from the middle girth seam to the head seam. The discovery of this crack was accompanied by a similar finding in a duplicate boiler built of the same material by the same manufacturer and installed at the same time. The two boilers were operated in connection with the same header and at the same pressure, so that in every respect the material, design, construction and operation of the boilers were as nearly alike as could be. The lack of proper curvature at the seam, which can be noted in Figure 3, was increased by rough handling, but it was partly due to improper construction methods and partly to operating stresses which exceeded the yield point of the weakened seam and permitted permanent deflection to take place. The path of the lap seam crack did not lead through the rivet holes but was comparatively close to the rivet heads and along the line of greatest bending stress due to eccentric loading of the lap seam.

The V notch in the caulking edge of the plate, shown in Figure 4, was made before the plate was removed, to afford our inspector an opportunity to examine the outer surface of the inner sheet of the seam. Similar notches were made in the edge of the inner plate, but the upper row of tubes was located so close to the seam that a thorough examination was impossible. However, there was sufficient indication of cracking

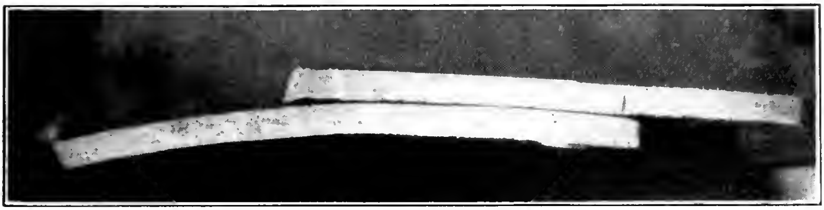


Figure 3

to justify further investigation. The one-half inch diameter hole, visible below the marker pasted on the plate, was drilled into the outer surface of the plate opposite the location where it was thought a crack was developing. The drill did not reach a depth equal to one-quarter the thickness of the plate before the crack was visible across the bottom of the drill hole, as may be judged from the depth of the crack as shown by Figure 3. Owing to the limited range of the telltale holes the exploration slot is preferred and has been used to great advantage since full detail of the method was published in The Locomotive of October 1914.

Figure No. 5 is of a section of a lap seam removed from a boiler which was retired from service recently as the result of a discovery of a lap seam crack by one of our inspectors. The boiler was used to furnish steam for prime movers and for process work in a steam laundry where 20 girls were employed in the flat work ironing department adjoining the boiler room. The V notches cut to permit examination of the hidden surface in which the crack was discovered were enlarged after the section of plate was removed from the boiler. The seam shown in the photograph has its normal appearance near the right hand end where the inside lap covers the crack, which, however, can be traced along a line near the edge of the rivet heads where the notches have been cut. The crack did not extend into any of the rivet holes.

We have chosen these two of several illustrations of seam cracks in boilers of lap joint construction, not only to emphasize the need of complete cooperation with our inspector, when an investigation of this kind is necessary, but also to repeat the old warning that a boiler of lap seam construction is a source of *hidden* danger which increases year by year with each change in pressure and temperature. The opinion expressed freely some years ago that the usefulness of a lap seam boiler should be limited to 10 years as a reasonable safety requirement was probably too conservative for the average case, but we do subscribe to

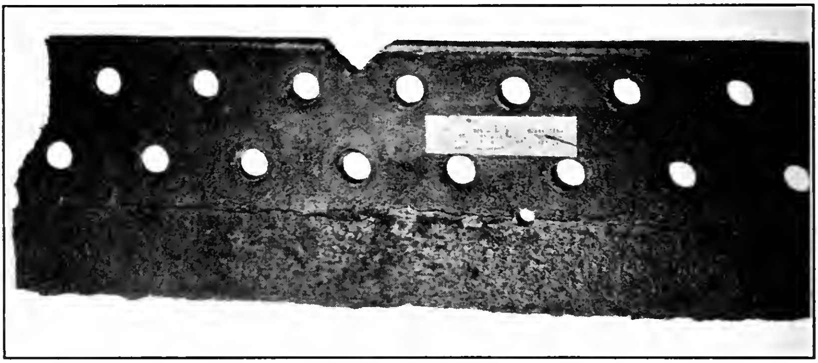


Figure 4

the belief that after 20 years of service at a pressure of 100 lbs., or more, the lap seam boiler constructed according to practices which were standard at that time is likely to have developed defects affecting its safety to such an extent that a reduction in stresses by reducing the working pressure is justified, and this should be done promptly.

The effects of a long time load and of age hardening or dispersion hardening of stressed steel due to the decomposition of supersaturated solid solutions at relatively low temperatures are receiving increased attention, particularly in the consideration of the need for stress relieving, at elevated temperatures, of welded seams. There is no doubt that age hardening takes place at room temperature and is accelerated at temperatures of 400 to 470 degrees Fahrenheit, which are quite common in the sheets of steam boilers. As the plate weakens, the rate of "decay" increases so much after a certain condition is reached that a lap seam crack may develop so rapidly that detection is impossible and advance warning of failure is lacking. The longitudinal seam of a boiler of lap joint construction should be slotted as a matter of precaution, and to afford the inspector a better opportunity of making a thorough examination.

The hydrostatic test is looked upon by some as a means for definitely determining the safety of steam boilers. It is, however, a short time load not accompanied by temperature stresses, and unless the pressure applied is greatly in excess of normal working pressure, the test is of no real value other than to assist in the location of leakage of known or at least suspected existence. A lap seam crack may have weakened the seam throughout its entire length to such an extent

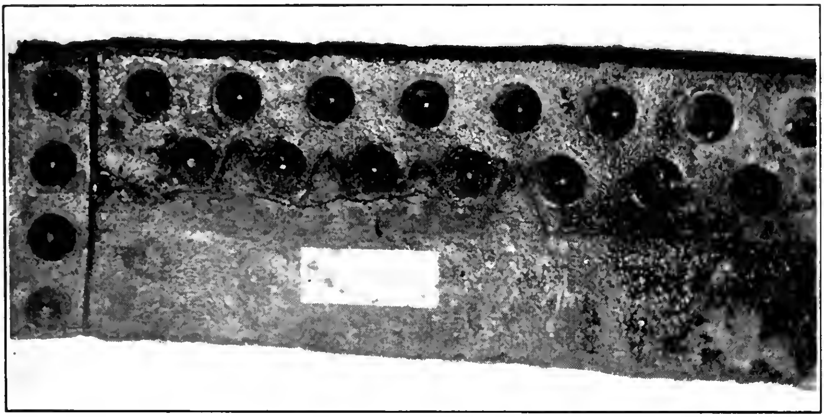


Figure 5

that a hydrostatic test at 1½ times the maximum working pressure may cause overstresses in the remaining material without giving evidence of the existing weakness. This overstress may not be of sufficient magnitude to produce immediate failure but it may lead to failure shortly after the boiler is placed in service under pressure and temperature stresses.

Caustic Embrittlement

There is no doubt that some of the boiler explosions attributed to lap seam cracks have been due to other causes which were not understood a few years ago. The same may be said of some girth seam failures. This conclusion is based on events subsequent to those earlier explosions rather than on the results of investigations of those accidents, for in a multitude of cases the explosion of a boiler, which was uninsured and was operated without legal restriction, left the owner in financial distress. Confronted with the problem of rebuilding his factory and reestablishing his trade, to say nothing of the claims for personal injury and death, he was usually not in a position to conduct or finance an investigation into the causes which contributed to the failure.

However, as exploded boilers of lap seam construction were replaced with butt-strapped boilers of an entirely different type, material and make, and those in turn gave trouble and were replaced by other boilers which in turn followed in the same footsteps, so to speak, it became obvious that some factor other than design and material was having an influence. Operating conditions became a source of inquiry, for within reasonable limits those conditions had remained constant while the design, construction and manufacturers of the boilers and materials had changed. Eventually, after distressing failures of a similar nature had developed in boilers of large industries and institutions where those interested had the means and desire to make investigation, extensive research pointed to the feed water as the probable source of trouble. This resulted in the development of the caustic embrittlement theory now quite generally accepted.

The feed waters used in the boilers examined during these early investigations were all from deep wells and were referred to locally as "free stone" waters, because the absence of lime caused them to lather freely with a small amount of soap of standard quality. In their lack of hardness they resembled rain water, although they did contain a considerable amount of sodium carbonate.

As a result of those investigations, many of the locations (principally in the middle west and far west) where this soft well water occurs, were plotted. Concerns using such water for boiler purposes should understand the difficulty which may be encountered. New areas are being discovered from time to time, principally as a result of boiler failures, and to those locations plotted in Bulletin 216 of the Experimental Station of the University of Illinois, we would now add an area in the vicinity of the junction of the Mississippi River with the Arkansas-Louisiana boundary line and extending for 50 miles or more from each bank of the river. Another recently developed area of sodium carbonate water is in the Medical Lake district in the eastern part of the State of Washington. Water from spring fed lakes has been used there for boilers, and explosions and minor seam difficulties have been occurring since 1896. Quite recently a distressed condition of a butt strap seam due to caustic embrittlement was discovered in that region in time to avoid what might have been a violent explosion.

A comparison of the details of Figure 4 with those of Figure 6 will enable the layman without the aid of special optical instruments to distinguish one of the principal differences in the general characteristics of the lap seam crack and the defect resulting from the use of feed water of high alkalinity. The lap seam crack, as has been explained, starts in the surface of the plate, and its depth increases more or less uniformly throughout the length of the course until the plate is pierced, possibly the entire distance from girth seam to girth seam. The fracture may pass through a rivet hole but more frequently is near the line of the edge of the rivet heads. On the other hand, caustic embrit-

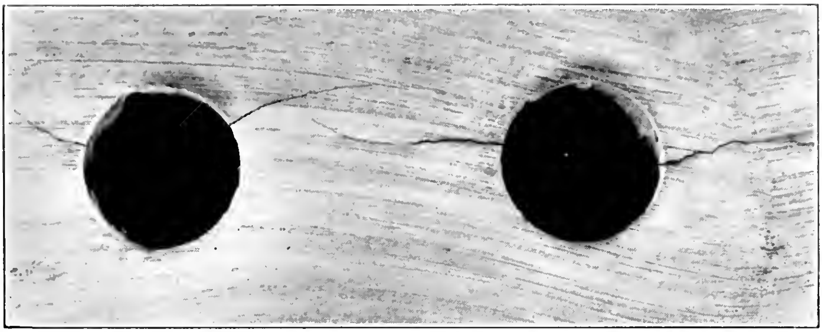


Figure 6

tlement defects, whether found in the lap seam or butt strap seam of a steam boiler, reach out in several directions from each of several rivet holes. As in the case of the lap seam crack, there is no serious weakening of the vessel at the start, but the long-continued and progressive deterioration of the cement binding together the microscopic steel crystals may, over a period of time, extend the weakened condition so far into the plate that steam pressure can then cause a sudden and violent explosion.

The first appearance of caustic embrittlement distress is usually along the line of rivet holes next to the caulking edge, while the lap seam crack in general develops near the line of rivet holes farthest from the caulking edge.

The University of Illinois Experimental Engineering Station in Bulletins Nos. 98, 155, 177 and 216, deals with caustic embrittlement and outlines in technical terms the cause and effect. Those publications should be available for study in any city library; but a thorough understanding of the theory requires some knowledge of chemistry and metal-

(Continued on Page 119)

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., October, 1932

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.

President Corson 25 Years With Company

Warm greetings from employes in many parts of the country came to President William R. C. Corson on Friday, October 7, as reminders that the day marked the twenty-fifth anniversary of his entering the Company's service. And at noon he was the honored guest at a luncheon arranged as a surprise to him. Officers, home office department heads, and veteran employes were there to bear witness to the part he has had in the Company's development, and to participate in the presentation of the gold medallion worn by all who have been twenty-five years with the organization. Bouquets from various groups graced the table, and Mr. Corson was given two bound volumes containing records showing loyal support by employes in all departments.

Mr. Corson came to the Company in 1907, in the mechanical engineering department. In February, 1909, he was elected assistant secretary and on November 20, 1916, he became secretary. On October 25, 1921, the directors made him vice president and treasurer from which he was advanced on February 8, 1927 to his present joint post of president and treasurer.

Keeping Boiler Auxiliaries In Repair

A FEW WEEKS ago some very extensive damage occurred in a plant containing ten large water tube boilers. As a result of low water in eight of the ten boilers, several tubes ruptured, a few pulled out of the drums, and many others were so badly distorted that it was necessary to replace them. As the other two boilers were not in service at the time, the mishap shut the plant down. Fortunately, it did not cause any damage to persons, or property other than to the boilers themselves.

The apparent cause for the low water was the accumulation of sediment which, coming over with wet steam, clogged up strainers in the steam pipes and very seriously reduced the flow of steam to the feed pumps.

The plant had three turbine-driven centrifugal feed pumps, two of which were in constant service. When attendants noticed the lowering water line and slowing of the pumps, they made strenuous efforts to get more water into the boilers, but even after they started the third pump the water level continued to fall. The damage occurred before other protective steps could be taken.

Low water is a rather frequent source of trouble, but to have so many boilers involved at one time in exactly the same way is quite unusual. This case may well serve as a text for calling the attention of plant engineers to the possibility of the failure of the feed supply, and the need for seeing that pumps are always kept in prime condition and fully serviceable. It also serves to emphasize the necessity of giving careful attention to all other equipment and auxiliaries on which the proper and safe operation of a boiler plant depends.

Fifty Years Ago—Fifty Years Hence

FIFTY years ago on September 4, Thomas A. Edison started the engine of his Pearl Street generating station in New York City to commence the first commercial distribution of electric current in the country. To most of us that half century appears as a long time, but to the older engineers who remember the event and who have since witnessed first-hand the many developments in power equipment, the fifty years must now seem a remarkably short period for the accomplishment of so much.

With the growth of the electric utility industry came mechanical and electrical developments demanded by a rapidly expanding market for current. Edison's small engines and cumbersome dynamos gave way very soon to larger installations. Within seven years, cross-compound horizontal engines, each driving two belted dynamos, were being installed in a Brooklyn station. Then, to conserve floor space, designers finally brought out engine-generators with vertical cylinders.

In size, these old vertical power plant engines were truly awe-inspiring. They represented what was then the peak development in engine building, and there was no one that did not feel a thrill when, for the first time, he was privileged to see one of them in operation.

However, the giant engine's day came to an end. It was crowded out of its place in the utility power house by the turbo-generator, the grandsire of the tremendous fellows that now provide in a single unit more capacity than was combined in a whole battery of the engines of thirty years ago.

Mindful of these things, we cannot help wondering what the source and method of distributing power will be a half-century hence. We have no reason to think that the limit of invention has been reached.

How Riveted Boiler Seams Can and Do Deteriorate

(*Continued from Page 115*)

lurgy. The issues of The Locomotive of October 1928 and October 1929 carried articles dealing with the subject, but more recent developments justify repeating here some of the information in those publications.

Stripped of technicalities, the difficulty may be stated briefly as being due to a concentration of sodium hydroxide in capillary spaces between the sheets forming the boiler seams. The effect of the sodium hydroxide concentration upon the stressed steel has been described as a chemical and as an electrochemical action. With this the layman is not interested primarily. It is sufficient to understand that the material which cements the grains of steel together is gradually weakened or destroyed. Difficulty of this kind is not confined to steam boilers but is encountered in the operation of caustic evaporators, caustic kiers and devulcanizers. Nickel tubes are now frequently used in the construction of vessels of that kind in an effort to overcome the trouble.

Inside caulking is sometimes used as a means of preventing the concentration of sodium hydroxide within the boiler joints, but inside caulking is of value only when the seams and rivets are not caulked at the outside surface of the plate. If outside caulking is necessary to secure tightness of the seam, the inside caulking is not tight and a concentration may build up between the sheets.

Laboratory as well as plant experiments indicate that a concentration of sodium hydroxide within the boiler joints is prevented by the use of feed water containing a substance which will seal the capillary openings so that the solution can not enter. Sodium sulphate in the form of Glauber salts and various other chemicals have been used as inhibitants but the determination of which chemical to use and how much of it to use for a particular feed water should be left to the judgment of the chemical engineer experienced with boiler feed water analysis and fully acquainted with recent developments in that work. A definite ratio of sodium sulphate-sodium carbonate alkalinity has been worked out as necessary for each range of pressure, and the chemist should prescribe with these ratios in mind.

The chemical engineer should be in close contact with the boiler plant and supervise the treatment by frequent analysis of the boiler water. A daily test of the boiler water is preferable. A hardness test with standard soap solution is not sufficient. The condition of the water supply and, therefore, the alkalinity of the boiler water may change seasonally, so that water which may be harmless at one season of the year may be dangerous to use at another. Likewise a treatment suitable at one season may be injurious at other seasons.

The concentration acting upon the grain binder of the steel starts minute fissures in the highly stressed material around the rivet holes. The defect develops and extends in the general direction of an adjacent rivet hole. It may meet and merge with a similar defect or it may run practically parallel with a similar defect extending in the opposite direction. If two of the lines extend in a more or less parallel path between two rivet holes a piece of the plate is sometimes entirely surrounded and forms what has been termed an "island".

In its early stages a caustic embrittlement defect is not visible to the naked eye. Its outline can not be detected until magnified sometimes as much as 100 diameters. As the condition progresses, the development of the fissure lines from each rivet hole may lead to formation of a visible defect extending practically the length of the seam.

A boiler which has been operated under conditions suitable to the production of caustic embrittlement may become infected and continue the development of the "disease" even after the objectionable feed water conditions have been corrected. Hence, the fact that the feed water is satisfactory at the time persistent leakage or a dislodged rivet is detected is not conclusive proof that caustic embrittlement has not developed.

The boiler using untreated well water or spring lake water which forms comparatively little scale, or the boiler using treated water which prevents the formation of scale, may be looked upon with suspicion, and a dependable method should be used for determining whether or not the boiler water has the proper sulphate-carbonate alkalinity ratio. Manufacturers of feed water treating equipment and preparations should be in a position to advise the owner of the boiler regarding the chemicals used, and to guarantee by analysis of the boiler water weekly, or more frequently, that the sulphate-carbonate alkalinity ratio recommended in the A.S.M.E. Boiler Code is being maintained. A copy of the latest analysis should be available for examination by the boiler inspector at the time of each inspection visit.

This procedure is intended to prevent damage to the boilers by the use of injurious chemicals and it also has the advantage of protecting the manufacturer of the feed water treating process from blame in case his treatment is used in a boiler plant where previous feed water conditions have initiated the development of caustic embrittlement.

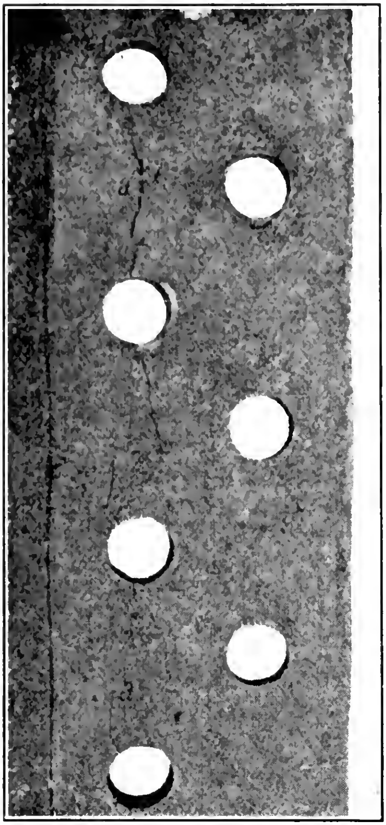


Figure 7A

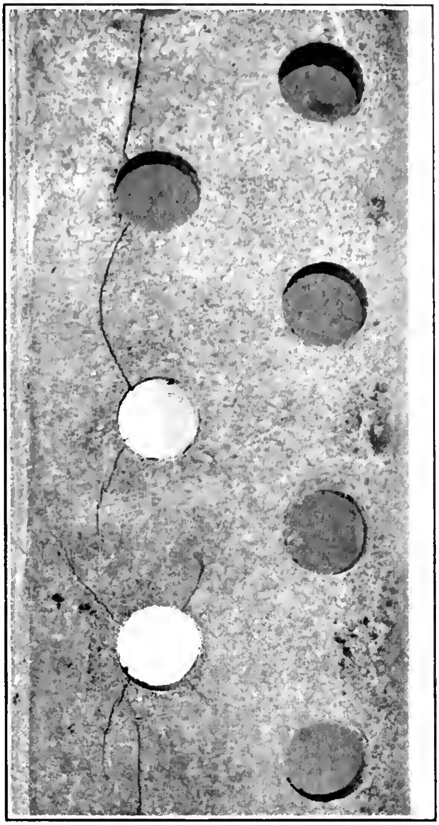


Figure 7B

Caustic embrittlement defects are not confined to any particular seam of a boiler. Girth seams, longitudinal seams, lap seams and butt strap seams all have been found affected in very much the same way, so in case of persistent leaking, or in case a rivet head has become dislodged, or if one may be broken by a sharp twisting blow of a light hammer, sufficient rivets should be removed to afford an opportunity to examine the plate at the wall of the rivet holes with the aid of a Hartford Magniscope, a magnifying instrument developed by this Company especially for the purpose.

In the light of what has been learned in recent years, it now seems probable that some of the boiler accidents which were in the past attributed to defective material and workmanship, temperature stresses, or mysterious causes, were actually the result of caustic decay, particularly those cases known to have been operated under feed water conditions that now are recognized as dangerous. In the issue of July 27, 1907 of the Journal of the German Engineers' Association there appeared an article by Mr. C. Sulzer, a mechanical engineer of high standing in his profession. The article dealt with crack formations resulting from heat stresses which occurred in a boiler of unquestionable material and workmanship, although the design and operation were not fully in accordance with American practice current at that time. No mention was made in the article of the characteristics of boiler water. An illustration of the defective seam is reproduced in Figure 7a, while Figure 7b illustrates a defective double riveted head flange seam removed quite recently from a water tube boiler in which heat stresses were negligible. We diagnosed this one as a case of caustic embrittlement because of the unmistakably intercrystalline nature of the minute fissures and the high alkalinity of the untreated feed water drawn from a deep well. The seams are quite similar and the failures are strikingly so, although one occurred in Germany and the other in Texas. Undoubtedly the German failure also was due to caustic embrittlement, although not so recognized at that time.

The importance of complete cooperation between the owner and the inspector is best emphasized by reference to one or two of the large number of caustic embrittlement cases that we have encountered. Following an inspection of a boiler in which the inspector suspected that caustic embrittlement was developing, our chemist analyzed the feed water and reported: "The continued use of this water may also, under certain conditions, cause embrittlement of the shell plate along the seams." Within six years of that analysis four boilers were removed from the plant because of caustic distress at the butt strap longitudinal seam.

In 1924 two inspectors visited a plant where treated feed water was used. The examination of a piece of broken feed pipe led to an inquiry concerning the base exchange treatment of water drawn from the Mississippi river, and the probability of caustic embrittlement was discussed. Within two years of that inspection unmistakable signs of the development of caustic embrittlement were discovered and in 1928 a boiler had to be removed because of weakness which developed in the longitudinal seam. Approximately two years later a second boiler was removed from this plant, due to the same condition.

These experiences may be duplicated in any plant using deep well water of high alkalinity or where feed water treatment, boiler compounds, scale solvents or boiler preparations are used without proper supervision.

Taps From the Old Chief's Hammer

"BUT what about those recommendations?" pursued the plant manager, as he and the Old Chief left the boiler room and set out across the yard for the office. "It looks to me like you fellows are crowding us more than is really necessary, particularly on that engine," he added. "As the engineer told us just a moment ago, he has even seen governor stops tied up when they were bothersome and kept shutting the engine down. I'm rather inclined to agree with him that such a safety device is so seldom called on to act that there's very little danger in running without it."

"My old boss used to say that the danger of an engine wreck is a bit like the danger of getting struck at a branch line railroad crossing," replied the Chief, seating himself beside the manager's desk and selecting a cigar from a box proffered to him. "The train may not run oftener than once a week, but that trip can be one too many if the train and you happen to reach the crossing at the same time. Our recommendations with respect to that engine are for your own good, young man, as are the other recommendations on the things we found wrong in the boiler room."

"Now, be frank with me, Chief," urged the other good-naturedly. "No doubt your inspectors find a great many dangerous things that they feel should be changed in the various plants they visit, and now and then they must run into a manager like myself who has to be convinced that the inconvenience of immediately making the recommended changes is justified by the hazard. For all I know you may even have to refuse a risk in extreme cases. What happens then? Does the engine ever run away, and does the boiler ever blow up because of the faults you folks recommended fixing? Come on, now, tell me of a case."

Asked to visit the plant for a conference on a proposed new boiler layout, the Old Chief had concluded the business in hand and had been on the point of departure when the manager chose to bring up for discussion several specific recommendations embodied in the last inspection report. The Chief knew Johnson well enough to guess that his complaint held more of the spirit of banter than of real earnestness. But, as all the Chief's friends would testify, the old fellow had a marked propensity for spinning stories, and it required no repetition of Johnson's direct challenge to start him off on one.

"Well," said the Chief, after a moment's reflection, "I don't know as I enjoy these 'I-told-you-so' stories as well as I do some others, but as long as you've asked for it, here goes.

"Along about five years ago our office received an order to write insurance for a rather good sized paper mill. I sent Inspector Murphy out to make the initial inspection to see if the equipment was in such condition that we could approve it for acceptance, and although he found the boilers to be all right he wouldn't pass two paper making machines, each of which contained some fifty-odd cast iron steam rolls. It seems that these rolls drew live steam from the boiler header through an old type reducing valve, and Murphy discovered that the plant attendants were in the habit of manipulating the weights on these valves to vary the pressure to suit their notion. To make matters worse, the machines had weight-and-lever type safety valves which the men found easy to adjust in accordance with the particular pressure for which they had the reducing valve set. Moreover, the steam gages were out of order and were so badly worn that their setting could not be corrected.

"Under these conditions there was nothing we could do except to withhold insurance until safety and reducing valves of proper design were installed, and the steam gages either repaired or replaced. But right at that particular time the plant was in process of being remodeled. A new boiler house was being built and the old engine was to be replaced with a bleeder turbine. The manager felt that if the old equipment could be made to hold together a little while longer the new valves could be installed more handily while the piping was being changed over to the new power installation. As a consequence, we were notified that our recommendations would not be carried out until later and that we were to leave the paper machines out of the policy for the time being.

"Some three months later Murphy was called back to the plant to witness a hydrostatic test on one of the new boilers and, remembering his inspection of the paper machines, he passed through the mill on his way out. He noticed that nothing had been done, and that the usual bunch of scrap weights was hanging from the reducing valves and the safety valves. While he was talking to the attendant the safety valves on some of the boilers blew, indicating that pressure on the header was 125 lbs. and, as near as Murphy could judge, that same pressure was on the cast iron machine rolls.

"Making some remark to the effect that the attendant had more than an average amount of nerve to stay around the machine under existing conditions, Murphy left the fellow, and was walking out across the yard toward the mill office, where he was to change his clothes, when he heard the sound of an explosion, immediately followed by two others. He turned and ran back to the mill room, but live steam drove him away from the door. So he ran around to the boiler house and had the fireman close the stop valve.

"As soon as the steam had cleared enough to permit their entrance, Murphy and several other men groped their way in between the two paper machines. They found the attendant lying on the floor, right at the spot where Murphy had been talking with him just a few minutes earlier. Parts of a fractured roll had evidently struck him, knocking him unconscious, and the scalding steam had done the rest."

"Phew!" said Johnson as the Chief ended the story. "What are you trying to do? Make a fellow nervous?"

"Well," laughed the old fellow, reaching for his hat, "don't blame me if you can't get to sleep tonight. You invited it."

ASHES OF VICTORY

With bowed shoulders Homer Smith entered his house. His dragging feet scuffed their way through the front hall and into the kitchen where his wife was preparing the evening meal.

The smile faded from Mrs. Smith's face as she noted the wobegone appearance of her better half.

"Homer!" she cried.

Slumping into a chair, Homer Smith stared straight ahead with dead eyes.

"Tell me, darling," pleaded his wife.

She came over to Homer and lifted his chin in her hand. Homer Smith moistened his lips with his tongue.

"The worst," he said dismally, "has happened."

"No!" cried Mrs. Smith aghast.

"Yes," said Homer. "This afternoon just before quitting time the boss called me in and gave me the business."—*Judge.*

"Did you go to your lodge meeting last night, Rastus?"

"No, suh; we dun have to postpone it, account de Grand All-Powerful Invincible Supreme Unconquerable Potentate dun got beat up by his wife."

GOT HIS MAN

"Sacred to the memory of Major Brush, Royal Artillery, who was killed by the accidental discharge of a pistol by his orderly, April 14, 1831. Well done, good and faithful servant."—*Epitaph in an English churchyard, according to the New York American.*

A Scottish landowner was complaining of the weather to a tenant.

"Aye," said the tenant, "ye're richt. Only three fine days this month; an' two o' them snappit up by the Sawbath."—*Christian Register.*

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1931

Capital Stock, - - $3,000,000.00

ASSETS

Cash on hand and in bank		$ 901,554.83
Premiums in course of collection (since October 1, 1931)		1,177,597.98
Interest accrued on mortgage loans		27,546.67
Interest accrued on bonds		124,122.94
Loaned on bonds and mortgages		986,760.15
Real estate		462,799.10
Agents' ledger balances		10,742.54
Miscellaneous assets		2,014.13
		$3,693,138.34
Bonds and Stocks:		
Book value	$15,576,111.24	
Convention value over book value	790,997.40	
Total value as fixed by The National Convention of Insurance Commissioners	$16,367,108.64	
Deduction to adjust security holdings to true value as of December 31, 1931, as required by Connecticut Insurance Dept.	1,147,046.25	
		15,220,062.39
TOTAL ASSETS		$18,913,200.73

LIABILITIES

Premium reserve		$ 8,609,354.91
Losses unadjusted		329,660.26
Commissions and brokerage		235,519.60
Other liabilities (taxes accrued, etc.)		611,642.21
Special depreciation reserve		2,000,000.00
Capital stock	$ 3,000,000.00	
Surplus over all liabilities	4,127,023.75	
Surplus to Policyholders,		**$7,127,023.75**
		$18,913,200.73

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Incorporated 1866 — Charter Perpetual

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The Night When 14 Boilers Quit

"Call Hartford Steam Boiler! Do whatever they tell you!"

All 14 vertical boilers of a steel mill's battery had suddenly and almost simultaneously developed tube trouble of an unusual sort. Steam pressure dropped. Blowers and water pumps stopped. Circulation of water would have to be restored quickly, or blast furnace tuyeres and cooling plates would burn out.

The boilers' combustion passages had recently been rearranged for greater efficiency—and this wholesale failure baffled the night superintendent. Although the boilers were not insured in this Company, "Get the Hartford Steam Boiler!" was the chief engineer's response to the superintendent's call.

From Cleveland the 'Hartford Steam Boiler' chief inspector telephoned directions to borrow local fire engines to circulate water while he was on his way. Once at the plant, he was able very soon to determine what had caused the trouble. He appraised the extent of the damage and indicated which boilers could be quickly and safely repaired so as to restore steam pressure for the pumps. Then, from his diagnosis he recommended a change, costing but a few dollars, that would prevent recurrence of the difficulty.

The Hartford Steam Boiler Inspection and Insurance Company's ability to serve, whether in emergencies or during regular inspections, is based on the accumulated experience of 66 years' specializing in this one line. Its aid is always available without cost to plants insured by the Company, and is one of the added values of 'Hartford Steam Boiler' protection.

Vol. XXXIX No. 5 January 1933

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Three Examples of Furnace Explosion

THREE general classes of furnace gas explosions are illustrated by recent power boiler accidents, of which two occurred in San Francisco, California, where natural gas is in general use as fuel, and the other at a plant in Detroit, Michigan, that was using pulverized coal. One accident resulted from a mistake on the part of an attendant, another was attributed to failure of automatic control devices, while in the third the fault seemed to lie in a pilot which failed to provide ignition until so much fuel had entered the combustion passages that ignition took place with explosive violence. In each case there was considerable property damage.

It was customary at a plant using a Scotch Marine boiler to turn the gas pilot light down as much as possible during the night. One of the watchman's duties was to see that this pilot did not go out. Evidently he did not understand the correct procedure for re-lighting an extinguished pilot, for one night when he found that it was out he undertook to kindle it without first venting the furnace chamber. Gas which had accumulated from the unlit pilot burner exploded with sufficient violence to tear up the brick arch on the combustion chamber and throw down a section of the stack.

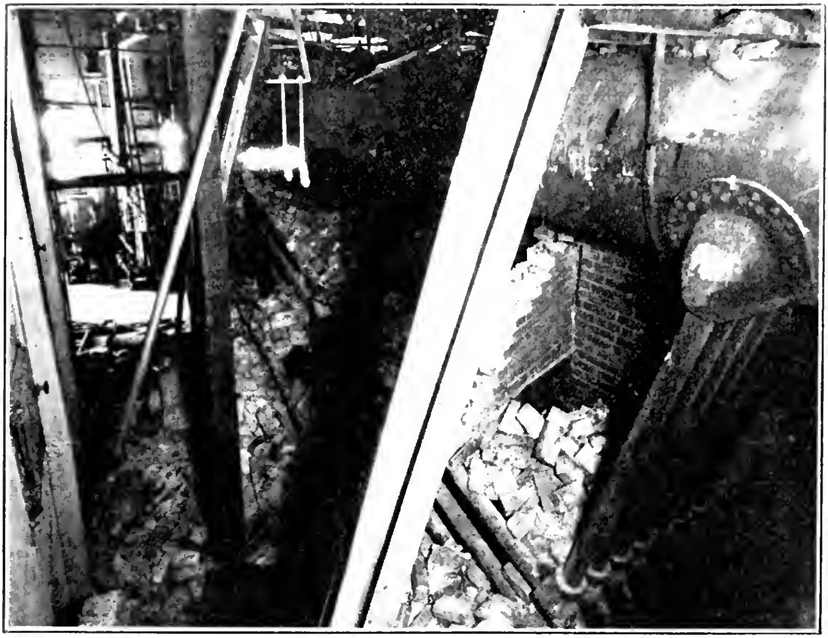
At the other plant where gas fuel was used, the burners under a battery of water tube boilers were controlled by regulators that were intended to maintain a uniform steam pressure. Some failure of the control apparatus was thought to have led to the accumulation of unburned gas in the combustion chamber and gas passages, and to the explosion that knocked down the entire side wall of one boiler setting and damaged the settings of other boilers in the battery. The illustration shows the wreckage.

The third accident occurred on Sunday, December 4, to a large water tube boiler of the 4-drum, bent-tube type. The steam demand over the week-end was confined to the small amount used for heating, and the fireman's method of handling this light load was to shut down the pulverizer when steam pressure reached 150 pounds, starting it up again when pressure had dropped to about 30 pounds. He had boosted the pressure twice and was starting up for the third time when the explosion occurred.

Such an accident might conceivably have been caused by failure to have the damper open, but the fireman stated emphatically that this was not the case. He pointed out that the damper was open and the pilots lit, but that there seemed to him to be a lapse of five or six minutes between the time he started the pulverizer and the ignition of the fuel.

The plant engineer explained that there was usually a time lag of two or three minutes before the fuel ignited with that particular burner.

The burner was of rectangular shape, 6″ deep and 70″ wide. Ignition was provided by two gas pilots, one placed at each end of the burner in such a way that no part of the flame was directly in front of the nozzle opening. From the fact that delayed ignition had been a common occurrence with this arrangement, it was easy to believe that on the occasion just described a great deal of fuel blew past the pilot lights and some of it reached the upper part of the setting before it was touched off. The brickwork covering the overhead circulators between the center and rear drums was completely blown out, as was the brickwork covering the tubes running from the front drum to the square header at the top front of the setting. One sidewall was knocked down.



TRANSPORTING COAL DUST IN PIPE LINES

At some German power plants pulverized coal is being transported in pneumatic pipe lines for great distances. For distances shorter than 450 yards the material is ordinarily drawn through the pipe by vacuum, but for longer hauls, up to 2,000 yards, air pressure is employed. It is recognized that the intimate mixture of air and dust introduces an explosion hazard, especially with high volatile and easily ignited coals. For such fuels an inert gas such as flue gas is sometimes used instead of air.

Turbine is Damaged as Oil Escapes from System

THE WRONGFUL use of a valve that was not intended to be opened while the turbine was running, and the misunderstanding of directions passed along by one watch engineer to his successor as they changed shifts, recently led to the damaging of a 6.500 kva machine at a large paper mill in the west. Unaware that his predecessor had slightly opened the drain valve on the oil reservoir in order to get rid of a layer of water, the second engineer shut down the return pump between the filter and the reservoir and thus unwittingly permitted the entire supply of oil to run out of the system and into the filter tank. The results were burned out bearings, rubbed blade ends, broken lashing wire, and other more or less serious items that usually follow when a turbine spindle loses its nice alignment.

The train of circumstances that led to the accident started at the auxiliary oil pump turbine. This turbine had no leak-off drain for its steam sealing gland, and as this gland was directly above the oil reservoir cover in which there was a 5/8″ cup-like hole, some water entered the tank and caused the oil to emulsify.

Whenever the oil emulsified to the point where filtering was necessary, it was customary to start a pump which picked up oil from the filter tank and carried it up to the oil reservoir where, as the level rose, the overflow drained back through the filter and into the filter tank. Filtering had been going on for several hours when the watch engineer noted that there was a layer of water in the bottom of the reservoir. To get rid of this he partly opened the drain valve on the line between the reservoir and the filter and adjusted the speed of the return pump so that oil was being replaced in the reservoir as rapidly as it was being drained out. As the oil had not cleared up to his satisfaction when his trick ended, he told the operator of the next shift that the oil would require more filtering. He failed, however, to make clear to his successor that the drain valve was partly open, and when the engineer shut down the return pump during the night the oil reservoir soon drained empty.

NEW USES FOR ANTHRACITE

In seeking new outlets for their products, miners of hard coal have been exploring the possibility of using anthracite as electrode carbon. It is reported, too, that anthracite fines have been found superior to sand in water-softening beds.

THE EXTREME IN LOW ROTATIVE SPEED

A timing motor that will revolve only twice a day has been developed by research engineers of the Westinghouse Electric and Manufacturing Company. That is by no means the slowest speed obtainable, however, as by using the same principle of design the speed could be brought down to one revolution or less per year.

Water Circulating Systems for Diesel Engines

By H. J. Vander Eb, Ass't Chief Engineer,
Turbine and Engine Division

A GOOD water circulating system and the prevention of scale in the engine jackets are major factors in the successful operation of a Diesel or semi-Diesel plant. This can scarcely be overemphasized, for neglect of these important details invariably results in frequent, forced shutdowns and untimely replacement of parts. To obtain the normal length of useful life of cylinder heads, pistons and cylinder liners, an ample supply of pure, cool water is essential. Unless the metal walls of the parts exposed to combustion temperature are continuously cooled by an active flow of water they become overheated and will break down. The lower the temperature at which such parts are operated, the better the expectancy of a reasonably long life. Moreover the gain in efficiency to be had by intentionally maintaining a high temperature of water for the cylinders and cylinder heads is very small, and the savings to be obtained thereby do not compare with the cost of frequent part replacement.

While it is desirable to keep the cylinders and cylinder heads at a low temperature, this should not be effected by the use of very cold water, even though a saving in water could thus be made. It is inadvisable to use water of a temperature lower than 50° F. In other words, the problem is principally one of a sufficient flow rather than of low temperature at the inlet. A large quantity of water should be circulated through the jacket so that a violent turbulence is maintained everywhere in the water spaces to keep the temperatures of all the parts uniformly low and prevent steam pockets. Any appreciable interruption of the flow of cooling water while a Diesel engine is in operation, or the accumulation of scale in the water jackets, or an insufficient flow of cooling water will quickly cause dangerous overheating and consequent distortion and cracking of the casting. It may cause seizing of the pistons in the cylinders.

There are many Diesel and semi-Diesel installations where, for reasons of mistaken economy, the water circulation system is not much better than a makeshift or where, due to the absence of a badly needed water treating system, the cylinder jackets collect scale at a rapid rate. In such plants the cracked heads, seized pistons, and scored cylinders represent a burdensome expense.

The circulating system best adapted for any given installation of Diesel or semi-Diesel engine depends upon the quality and the quantity of the available water. Both of these factors vary greatly in different

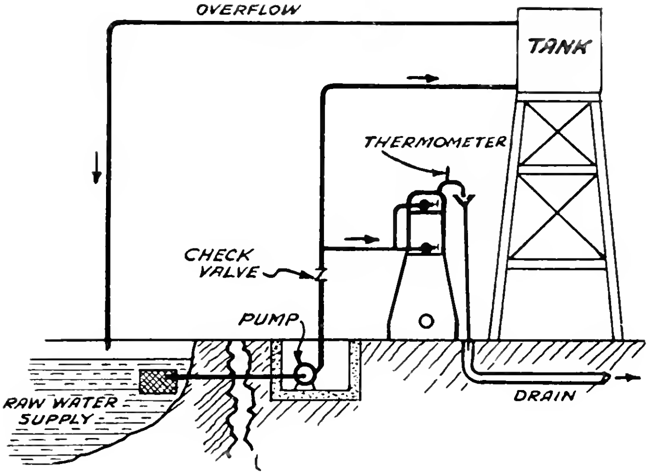


Figure 1

USING RAW WATER IN CYLINDER JACKETS WHERE WATER SUPPLY IS PLENTIFUL AND OF GOOD QUALITY.

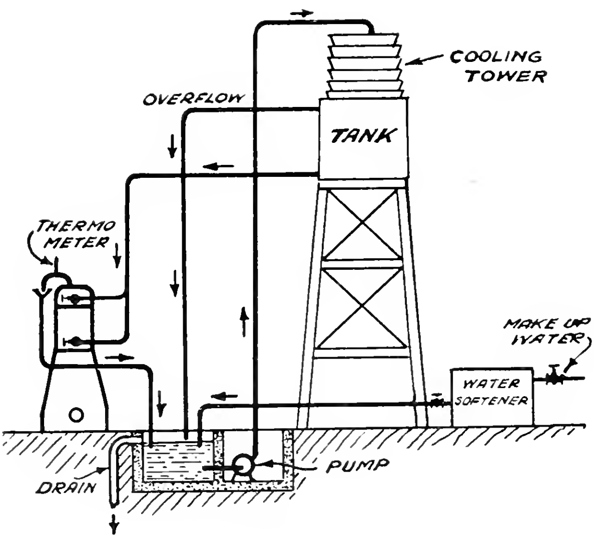


Figure 2

OPEN SYSTEM OF COOLING WHERE WATER SUPPLY IS LIMITED.

localities. Consequently, a circulating system which is satisfactory for one plant may be entirely unsuitable and inadequate for another. The sketches accompanying this article are intended to give a general idea of what is recommended good practice for circulating systems under different conditions of quality and available quantity of water.

Obviously, if an ample source of soft water is available at low cost, the circulating system can be made very simple by letting the discharge run to waste. An outline of such a system is shown in Figure 1. Water that is entirely free from scale forming matter is rarely available, but in quite a few districts the quality of the water is reasonably good, so that the rate of scale formation is slow and the character of the scale is such that it can be easily removed. This system (Figure 1) may still be used under those conditions without undue hazard of overheating, provided the scale is not permitted to build up to an appreciable thickness before removal and provided, furthermore, that the rate of water flow through the jackets is such that the temperature of the discharge is held down to about 100° F. To produce this result in Diesel and semi-Diesel engines the rate of flow, in general, should be from twenty to thirty gallons per horsepower hour when the engine is under full load. For the larger size engines, with cylinders 16″ or more in diameter, a somewhat smaller quantity of water per horsepower hour is sufficient. The necessary amount of cooling water varies in direct proportion to the load for any engine, but, in any case, it is desirable that the temperature difference between inlet and outlet of the cylinder jacket do not exceed 20° F, and that the maximum outlet temperature do not exceed 120-130° F.

The system shown in Figure 2 is used largely in localities where the water supply is so limited that the cooling system must be one in which the water can be constantly recirculated. In this system the cooling is done by means of a cooling tower and it involves considerable evaporation. This may amount in a day to as much as 5% of the total water in the system, so that if hard make-up water were to be used, the water in the system would gradually become more and more charged with scale-forming impurities, making it necessary frequently to drain and refill the system. Where only hard make-up water is available, it is essential therefore to use a water softener in order to avoid the risk of undue scaling of the jackets. Of course, if the make-up water is reasonably pure, the softener may be unnecessary in this "open" system, but such water is rarely available.

The "closed" type system, shown in Figure 3, which is self-explanatory, is the best for conditions where there is a plentiful supply of raw water of such poor quality that it may be less expensive to operate an

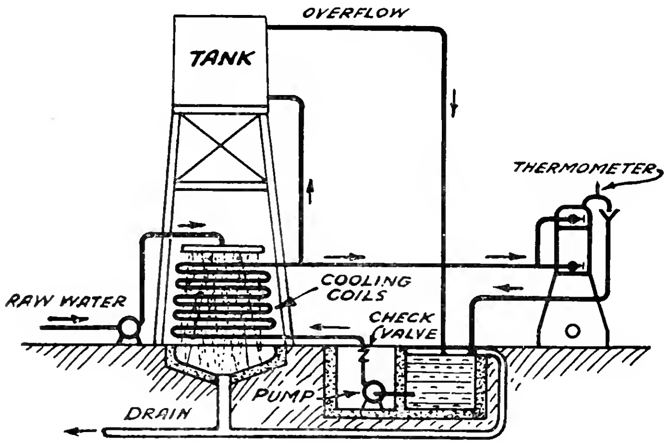


Figure 3

CLOSED SYSTEM OF COOLING WITH PLENTIFUL SUPPLY OF RAW WATER OF POOR QUALITY.

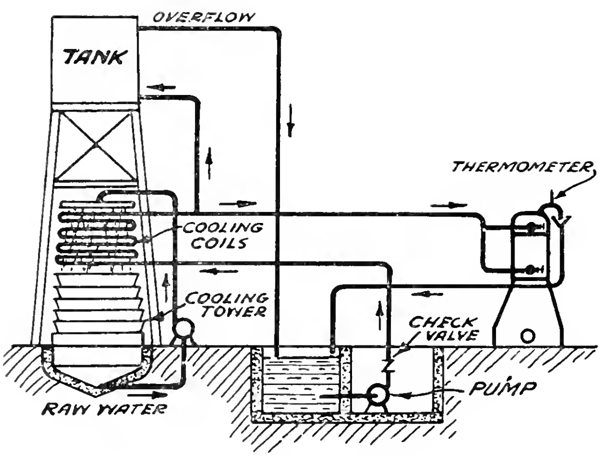


Figure 4

CLOSED SYSTEM OF COOLING WITH LIMITED WATER SUPPLY.

extra circulating pump than to treat the water chemically. The amount of evaporation from this system is very small so that the maintaining of the proper quantity of water in the system can be done by adding rain water or pure water from any other source.

The system shown in Figure 4 is the most desirable system where the amount of available water is extremely limited and is of such poor quality that it is totally unsuited for engine cooling. It will be noted that this is also a "closed" system and rain water or treated water is used in the coils. The raw water sprayed over the outside of the coils is cooled by means of a cooling tower and is constantly recirculated.

It will be observed that there is an overhead storage tank in each of these systems. This tank should be large enough to hold a sufficient supply of water to continue circulation for about thirty minutes after the engine is shut down. It is intended also as an emergency supply in case the water circulating pump should fail, so it should be full of water at all times, and should be equipped with a float attached to a gauge board in order that the water level in the tank can be observed conveniently. It is a simple matter to connect up the float with an electric alarm device which will give the operator notice in case the water level in the tank begins to drop.

The overhead tank should be placed high enough to obtain sufficient water pressure for the desired rate of flow through the system. In general the elevation should be such that the bottom of the tank is not less than fifteen feet above the top of the engine cylinder heads.

PROPOSES USING DIESEL IN NEW POWER HOOKUP

What is today known as the Buechi system consists in utilizing the exhaust gases of a Diesel engine to drive a turbine, which in turn compresses air for purposes of scavenging and super-charging the engine. Buechi now proposes to turn the system around. He would make the engine simply a generator of high-pressure, high-velocity gases. These gases would drive a turbine to produce the useful power, while the power generated by the Diesel would go to drive the compressor. It is reasoned that the efficiency of this arrangement would be somewhat lower than that of a conventional turbo-charged Diesel engine, but that its flexibility would be very great, as the speed of operation and power output of the exhaust-driven turbine could be varied within wide limits. The system is suggested for use in the operation of locomotives and other machinery in which wide variations of speed are required without speed transmissions.

1932 POWER INSTALLATIONS AVOIDED REHEATING

According to the 1932 Progress Report of the A. S. M. E. Power Division, there was a marked layoff during the year in the effort to increase steam pressure to the level of 1,200 to 1,400 pounds with the necessary reheat. Instead, the tendency was to use pressures as high as possible without reheat, and the report states that pressures of the order of 1,000 pounds and temperatures of 1,000° F without reheat are in sight.

Another Example of Air-Water Tank Hazard

TWO workmen on an estate in Lattingtown, Long Island, were severely injured on November 1 when they were caught in a pump house that was virtually demolished by the explosion of a hydro-pneumatic tank beneath it. The tank was used to supply water to the various buildings on the estate, pressure being obtained by forcing compressed air into the tank with the water.

The explosion ripped the roof from the building, hurled the two men twenty feet, and scattered the pumping machinery over a wide area. It was stated that the estate superintendent tried unsuccessfully to shut down the pump motor after he found that the automatic cut-off was not working, and that he attributed the explosion to failure of the safety valve to open when the pump built pressure up to the danger point.

The superintendent first suspected trouble when he saw smoke issuing from the windows of the pump house. He found the smoke coming from the motor, which was evidently overheated. An attempt to pull the switch resulted in his receiving a shock that hurled him several feet, so he telephoned for electricians. The latter had scarcely entered the pump house when the tank let go, and they were carried aloft by a muddy geyser that swept everything before it. Neither man had regained consciousness by the time an ambulance arrived, and it was feared that they had sustained internal injuries.

Many thousands of these hydro-pneumatic water supply systems are in use on estates, farms, and at hotels and clubs where no city water is available, and they have come to be used extensively in car washing garages. Numerous cases that come to our attention indicate that they are the source of frequent explosions, a fact that is not at all surprising when it is considered that apparently many persons fail to realize that a tank filled partly with water and partly with compressed air is more closely akin to the very hazardous air tank than it is to the ordinary tank for the storage of water.

WHY NOT AARON?

The circus was doing badly and funds sank lower and lower. At last the cashier pinned up a notice announcing that in future salaries would be paid as funds permitted, and that artists would be paid in the alphabetical order of names.

Next day Zero, the strong man, called on the cashier.

"I have come," he said, "to tell you that I have changed my name."

"Oh!" replied the cashier. "And what are you going to call yourself now?"

"Achilles."—*Tid-Bits.*

NO LATHER IN IT

Barber—"Haven't I shaved you before, sir?"

Customer—"No, I got that scar in France."—*Christian Science Monitor.*

Engine Wrecks Caused by Failures at Crank

PROGRESSIVE cracking of the crank pin at a point inside the disc recently caused an expensive accident to a tandem-compound Corliss engine in a Mississippi cotton mill. The break permitted the reciprocating parts to strike and drive out the rear heads of both low and high pressure cylinders, as well as to break crosshead slippers and

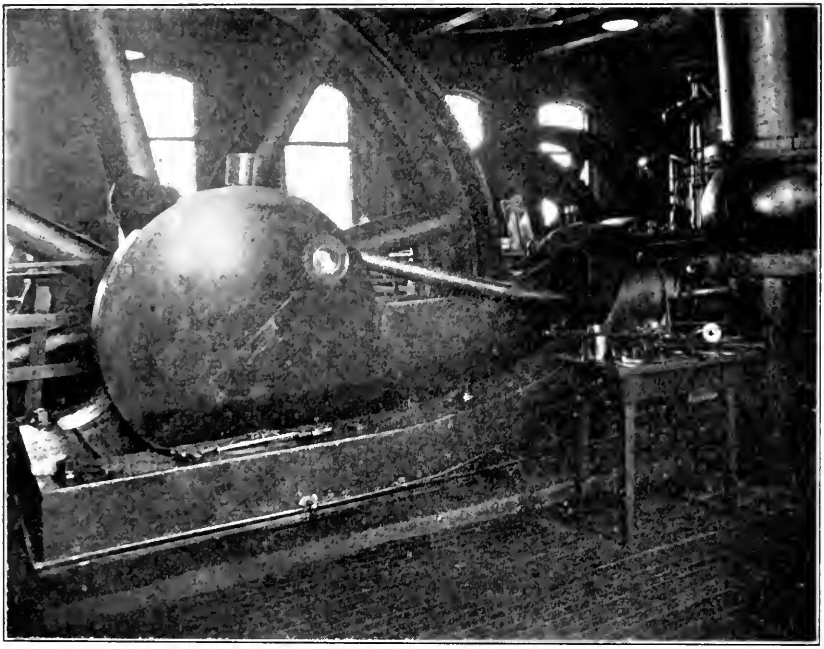


Figure 1

adjusting studs. The shock was severe enough to crack the body of the throttle valve.

Several hours before the accident the engine developed a slight knock and the shift engineer discovered that the crankpin was warm. When he tried using heavier oil the knock seemed to disappear, but it recommenced with greater severity at 4 o'clock in the morning. At that time the engine was shut down and the chief engineer called to the plant.

After the two men had gone over the crosshead and crankpin, and checked adjustments by rocking the engine, they started the engine and took an indicator card to see whether the trouble had been caused by the eccentric slipping. They had just finished taking the card when the accident occurred. As is apparent in Figure 1, the pin broke off below the surface of the disc where the crack could not have been seen even with the crank removed. The darker part of the fracture shows the extent to which the crack had gradually worked into the pin. The bright part is the area of sound metal that failed at the time of the accident.

In Figure 2 is shown the head end of a Corliss type engine that was

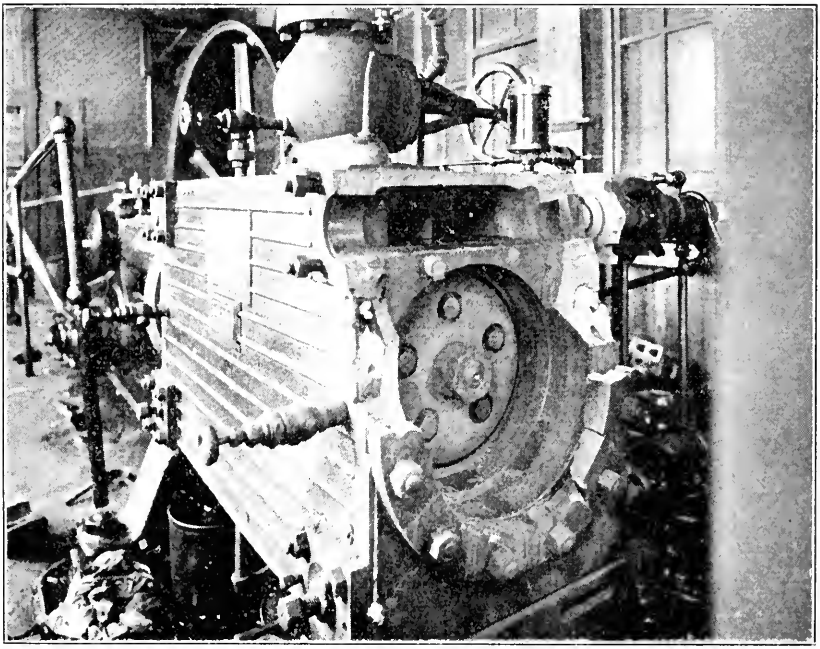


Figure 2

wrecked in October at a mill in Gloversville, New York, as the result of the breaking of the connecting rod strap. Cast adrift by the failure of the strap, the heavy reciprocating parts rammed the piston against the cylinder head, knocking off the end of the cylinder. The shock of the impact broke the crosshead shoes and bent the connecting rod.

WASTED RACKET

"Pat," said the manager of the factory, "I want you to report to me at 6 o'clock tomorrow morning. Here's an alarm clock."

The next morning arrived. Pat was met by a frowning manager.

"Well, what was the matter? Didn't the alarm clock go off?"

"Oh, yes, sorr, it went off all right, but the trouble was that it went off while I was asleep."—*Answers.*

Stays of Unusual Shape Prove Weak

CONGRATULATIONS were in order among a group of eight young women employees of a Texas laundry on August 3rd. They had been away from their work table but a few minutes during the noon recess when it was demolished by the explosion of a cast iron steam chest on a flat work ironer. The force of the blast was such that the top of the chest and a 1,500 lb. roll were hurled to the ceiling before landing at the spot where the women had been working. The lower part of the chest drove downward to sever all manifold piping.

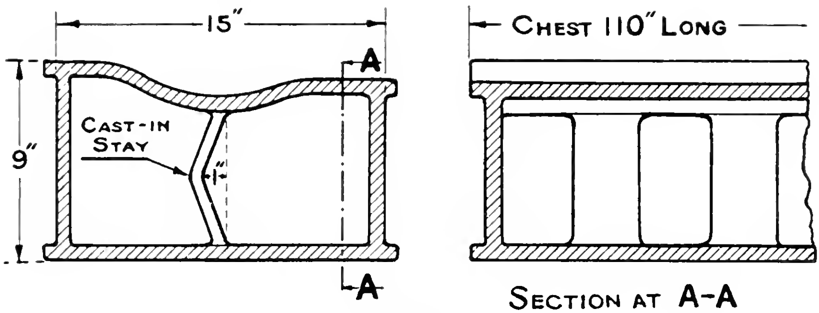


Figure 1

Steam for this ironer and several others in the plant was furnished by boilers on which safety valves were set to blow at 150 lbs. Between the main header and the ironers there was a regulator adjusted to reduce pressure on the steam chests to 90 lbs., and on each machine was a safety valve set to relieve at 105 lbs.

The essential details of the exploded steam chest are shown in the accompanying sketch, Figure 1. It will be noted as a rather unusual feature that the stays cast integral with the chest for the purpose of stiffening the flat upper and lower surfaces are bent, instead of being straight as would normally be expected. Seven of these stays had been broken and another cracked, so that the chest had been greatly weakened before the explosion. The remaining stays parted when the chest disrupted, presumably under a pressure of about 95 lbs. per square inch.

It is thought that the bent stays permitted the chest to "breathe", thus causing a bending tendency in them. The movement may have been small, but as the brittleness of cast iron renders it unsuited to withstand repeated bending stresses even of small magnitude, the condition is thought to have led to the breaking of one stay after another until the chest gradually became so weakened that it gave way.

As other chests in the machine contained stays of the same bent shape, each was subjected not only to a visual inspection but also to a hydrostatic test during which deflection readings were made at several points to determine whether or not stays had broken. No broken stays were found.

The explosion caused property damage exceeding $700. It was only

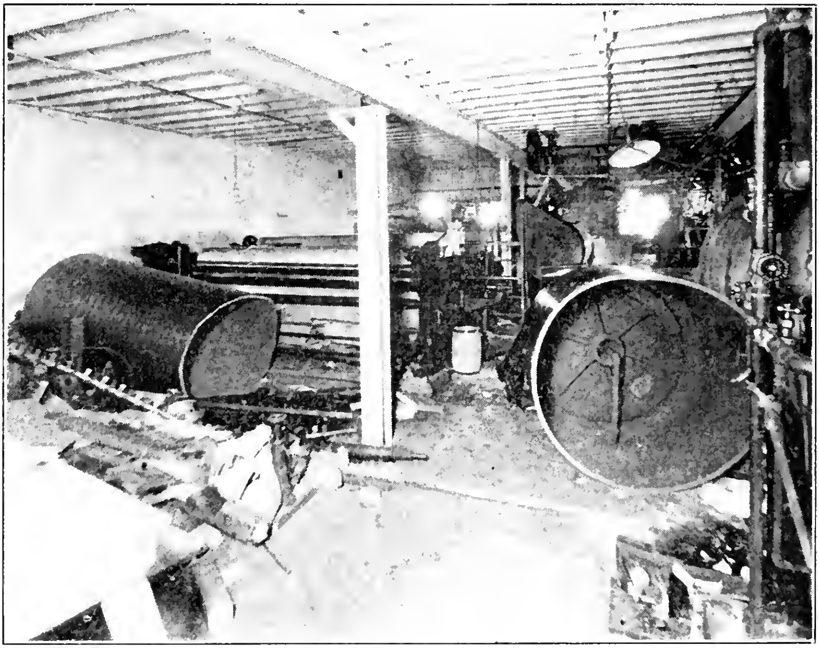


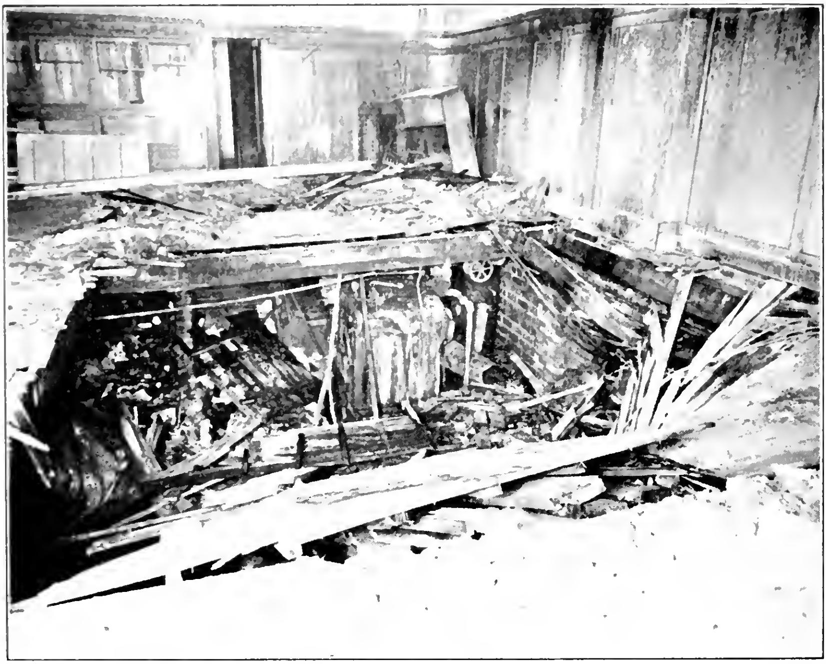
Figure 2

by the greatest of good fortune that there were no personal injuries or deaths, for had the accident occurred a few minutes earlier many would have been at work within range of the flying wreckage.

At a laundry in Detroit, the mangle shown in figure 2 was being warmed up after a shut down for the Thanksgiving holidays when the 4′ x 10′ drying cylinder exploded and caused property damage estimated at $3,000.00. This accident was thought to have been the result of stresses set up in the cast iron by unequal expansion, for the fact that the damage was not extensive, except to the machine, indicated that the cause was not excessive pressure.

Steam Heating Boilers in Violent Explosions

THE account we have received of the heating boiler explosion pictured below, indicates that the safety valve was either inoperative or else it was not large enough to relieve pressure that increased rapidly when an attendant closed the stop valves in both the steam and return lines. This accident occurred on December 2 at the



showroom of a large automobile agency, and although several automobiles on the showroom floor were badly damaged—two of them falling into the hole shown in the picture—only one person was injured. That happened to be a passerby who stopped to look at the display of cars and was cut by pieces blown from the plate glass window.

Two coal fired cast iron sectional boilers comprise the batttery used for heating the showroom. During extremely cold weather both boilers are used at a pressure of from five to ten pounds, but at the time of the accident the weather was unusually mild and only one boiler was in use.

Because of the warmth, the agency manager had instructed the boiler operator to fire less vigorously, so it seems not unlikely that the operator closed the stop valves with the idea of making the building more comfortable by temporarily shutting off the supply of steam.

The boiler was hurled about twelve feet from its setting and driven through a stout brick fire wall. The damage was estimated at $10,000.00. As far as is known, there was no boiler insurance in effect.

The heating plant in the parish house of a church in Nanticoke, Pennsylvania, had been giving trouble for some time. According to the pastor, it would not keep the building warm. From his description of the difficulty, investigators of the boiler explosion which occurred there on November 19 were led to believe that the accident was caused by some fault that prevented the free return of the condensate to the boiler. As the latter appears to have been overheated, their supposition was that the condensate was held back in the system and that, eventually rushing into the boiler, it caused overheated sections to crack.

The explosion blew out doors and windows in the basement and broke a hole six feet square in the parlor floor above.

We cite below a few of the explosions that occurred during a week in December to heating boilers in buildings other than residences. The information has come to us in the form of newspaper clippings, only, and we do not know whether or not there was any insurance in effect. However, they were not insured in the "Hartford Steam Boiler", and it is probable that the owners had no such protection.

The explosion of a heating boiler on December 11 at a theatre in Oak Park, California, occurred with such severity that it shook loose from its hangings the large entrance covering over the sidewalk in front of the building.

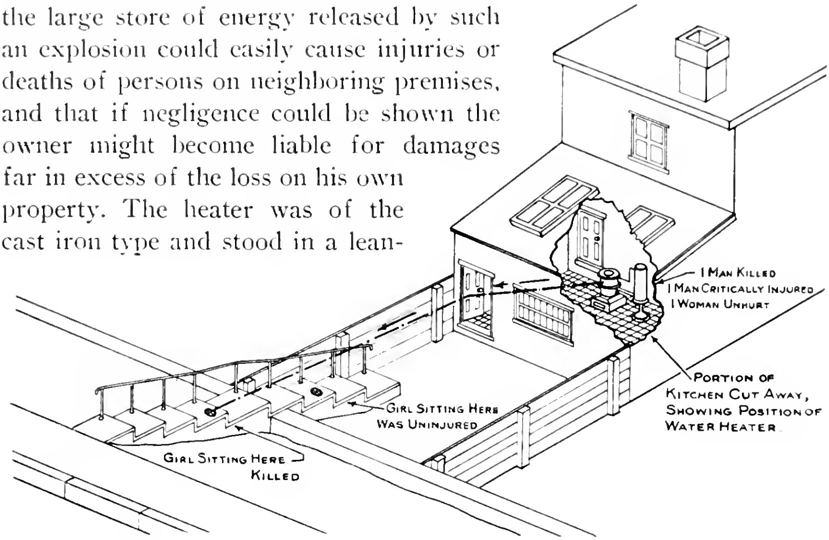
At Onancock, Virginia, a piece of iron blown from a heating boiler in the high school narrowly missed striking a man. The classroom above the boiler was badly damaged. This accident occurred on December 12.

A heating boiler in the garage and office of a Philadelphia motor sales organization exploded on December 17 and, according to the newspaper account, "terrified thousands of persons in the busy neighborhood". The building was shaken and goods stored in the basement were damaged.

Until a temporary heating boiler could be installed, it was necessary for a printing plant in Battle Creek, Michigan, to shut down after an explosion of its boiler on December 12.

Water Heater Explosions Claim Several Lives

THE fatal explosion of a water heater in a residence at Conshohocken, Penna., early in October differed very little in essential detail from the many accidents to similar equipment that are constantly coming to our attention. However, in killing a young girl who was some distance from the boiler, it brought up a point that most home owners do not appreciate, namely, that the large store of energy released by such an explosion could easily cause injuries or deaths of persons on neighboring premises, and that if negligence could be shown the owner might become liable for damages far in excess of the loss on his own property. The heater was of the cast iron type and stood in a lean-



to kitchen at the rear of the home. Of the three persons who were in the room when the explosion occurred, one man was fatally injured, and another was injured so badly that for a time his condition was critical. One of two small girls playing in the back yard, as shown in the sketch, was struck in the head by a fifteen pound piece of iron. She died at the hospital within a few hours.

Municipal authorities attributed the accident to stoppage of pipes by corrosion and sediment. In the absence of a safety valve this blocking of the circulation could have permitted overpressure that could not be relieved by the backing out of hot water into the city mains.

Another accident to a water heater of about the same type occurred on November 4 at a garage in Denver, Colorado. In this case the heater was being used to furnish hot water for washing cars, and was so installed that there was no means for relieving overpressure. There was no relief valve, and a check valve in the feed line effectively prevented the relief that might have been obtained through direct communication with the city water main.

This accident occurred during the noon hour when no water was being drawn from the system. All indications pointed to overpressure as the cause. The exploding heater injured a garage workman seriously and wrecked the interior of the room in which it was located, shattering itself into pieces no larger than a man's hand.

In Philadelphia, on the night of November 14, a two year old child was killed by the explosion of a small cast iron water heater. Three other persons were so injured that hospital treatment was given them.

Departures from the Orthodox

TWO interesting applications of the two-cycle opposed-piston type of Diesel engine have recently been described in the technical press. One engine uses reciprocating motion directly to drive an air compressor, and the other translates lineal into rotary motion without the aid of the crank mechanism that for so long has been the stand-by for that purpose.

The air compressor is coming into general use in Europe, according to J. Gould Coutant, who describes it in *Power* as "a new type of free-piston oil-engine air-compressor without connecting rods, cranks, valves, spark plugs, or fly wheels. Its moving parts are in perfect balance. The inventor is the Marquis de Pescara, with headquarters in Paris:

"Referring to the cross-sectional drawing (Figure 1), operation is as follows: The two opposed free pistons slide in and out in synchronism, insured by a lever pivoted at its center and connected by side rods to the two pistons. These rods do not normally transmit any power; their work is merely to absorb the slight incidental variations in the operation of the pistons and keep them in step. The oil pump, however, is operated by this mechanism.

"In effect, the pistons are entirely free of mechanical connections and act as engine pistons on the inner ends and as compressors on the outer ends. All power is produced in space C, according to the Diesel two-stroke cycle. Fuel oil is injected at B in proportion to load.

"A coil spring (not shown) is cranked up for starting. The two pistons are driven together by the action of this spring. At the proper point explosion takes place and forces them out. This outward movement compresses the air in the annular spaces D.

"During the first stages of compression, part of the air is by-passed through the plate valve G and acts as scavenging air, passing through H into combustion space C and out through the exhaust. As the stroke continues, the by-pass port is closed and the air pressure builds up for delivery to the receiver K, from which it passes to the outside application.

"Compressed air locked in space J by the secondary fixed piston E acts as a cushion to insure return of the piston A, regardless of the load on the compressor ends. All of these actions, of course, take place simultaneously at both ends of the machine, which is symmetrical in all respects except for the location of the scavenging and exhaust ports."

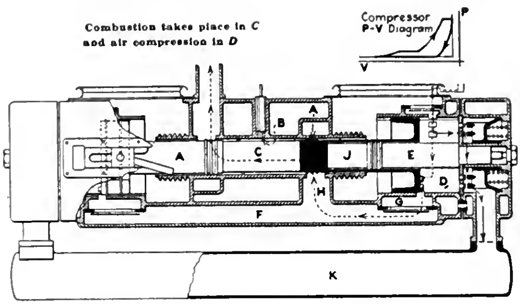


Figure 1

The engine that obtains rotary motion without the crank was described in *Diesel Power* by T. L. Sherman, chief designing engineer for the makers, the Mitchell-Crankless Engine Company. It makes use of a mechanism which, shown in Figure 2, consists of two plate-like slant members attached to a shaft having its axis parallel to the motion of the reciprocating unit. The straight-line piston reciprocating unit presses against the plate through slipper pads, the resultant force being a torque that causes the shaft to rotate.

Engines of this type, says Mr. Sherman, can be constructed for ordinary land and marine purposes at 20 lbs. per brake horsepower, utilizing ferrous materials only. For aircraft purposes the weight can be brought down to less than 2 lbs. Engines can be constructed at any specific weight within this range according to the field it is desired to serve. An aircraft engine of 350 horsepower at 1750 rpm. with a centrifugal type blower, can be constructed within a diameter of 20 in. and an overall length of 48 in., with an estimated weight under 600 lbs.

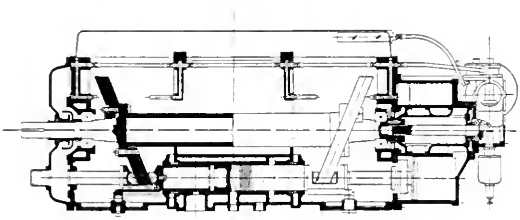


Figure 2

According to George Bernard Shaw, the substitution of Roosevelt for Hoover won't make any difference to anybody. G. B. S. has never been in the postmaster business.—*Norfolk Virginian-Pilot.*

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., January, 1933

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.

Former Editor Taken by Death

LETTERS that come now and then to the present editor of THE LOCOMOTIVE indicate that there are still many among its readers who remember its former editor, Allan D. Risteen, Ph.D., and will regret to learn of his death in Hartford on December 30, 1932, after a year of failing health.

Dr. Risteen was born in Amesbury, Massachusetts, August 15, 1866. He was graduated from Worcester Polytechnic Institute in 1885 with the degree of bachelor of science in civil engineering. Later he studied advanced courses in languages and physical science at Dartmouth College and, after pursuing studies in mathematical physics at Yale University, was honored by Yale with the degree of doctor of philosophy.

After leaving Worcester Tech. Dr. Risteen was with the United States coast and geodetic survey, and for a time was editor of *Power*. He came with the Hartford Steam Boiler Inspection and Insurance Company in 1889 to become assistant editor of THE LOCOMOTIVE and then its editor. Thereafter he gained a national reputation as a safety engineer, and his writings and lectures brought wide comment. During that period, he prepared a book of conversion tables that is still in use for comparing metric units with other standards of measurement. It was during that period, too, that he was an assistant editor of the *Encyclopedia Americana* in charge of topics relating to chemistry. He was an expert mathematician, particularly in the use of the calculus, by means of which he derived formulas which he published in THE LOCOMOTIVE as guides in the calculating of stresses in pressure vessels.

Dr. Risteen went to the Travelers Insurance Company in 1912 as director of technical research, a post that he held until the time of his death. While with that company his technical writings continued on such subjects as advanced mathematics, civil engineering, astronomy and the promotion of safety in industrial plants. Although best known for his work in the literature of engineering, he was also a skilful author of original fiction, and many of his stories were published in magazines.

Oldest Agent Is Active at 94

Unless some reader submits a better claim, the distinction of being the oldest "Hartford Steam Boiler" agent goes to Mr. John M. Bostwick who, at the age of 94 years, is our vigorous and active representative at Port Washington, Wisconsin.

The length of Mr. Bostwick's career is not its only interesting feature. More remarkable in some respects is the fact that during the period in which he was building a substantial insurance agency, he was able to find the time and energy to become a successful leader in other industrial enterprises of his city. At present he owns the Wisconsin Chair Company, a concern that in turn owns and operates the National School Equipment Company, and he is president and treasurer of the New York Recording Laboratories, manufacturers of phonograph records.

To Mr. Bostwick we extend greeetings from the "Hartford Steam Boiler" and its associated agents and brokers. For him we wish a continuation of good health and vigor.

A Friendship of Long Standing

Among the things most gratifying to a company that has been in business for two-thirds of a century are the many loyal friendships that accrue to it. In that respect our organization has been most fortunate, so we were indeed pleased recently to learn that there is in active service an engineer whose contact with us started fifty-four years ago and who, in all that time, has had no boiler in his charge that was not protected by our company's inspection and insurance.

It was in 1879 that Mr. James O. Montz first became acquainted with us. He was then employed at a plant at Terre Haute, Indiana. In recent years he has lived at Kansas City, Kansas, where he now operates the boilers and engine for the Chicago and Great Western Elevator.

It is a source of satisfaction to learn that this old friend feels that the suggestions of "Hartford Steam Boiler" inspectors have resulted in worth-while economies in the plants where he has had charge, and that on at least one occasion an inspector's discovery of a dangerous condition probably saved his life.

It's Important to Drain the Line

Picked up by incoming steam and whisked along at express train speed, the water that has accumulated in an idle steam line can strike an elbow or a "tee" with blasting force. Two such accidents came to our attention recently, and we mention them here as reminders of the advisability of draining steam pipes before turning steam into them.

An attendant at St. Marie's Hospital in Walla Walla, Washington, lost his life as the result of a steam pipe rupture on October 22. He was opening a valve to an 8″ main when water hammer shattered a "tee". Struck by a piece of metal and rendered unconscious, he could not escape from the scalding steam and water.

A similar accident occurred at a laundry in the Bronx section of New York City on December 27. In this case it was an elbow that gave way. Fortunately none of the 200 girl workers were injured, although the explosion hurled across the street a shattered pane of plate glass.

A Diesel engine of 21,000 b.h.p., said to be the largest in the world, is being built in Copenhagen for installation in a power plant there.

"Outage"—a New Form of Insurance

THE loss caused by a boiler explosion or machine breakdown in a manufacturing plant can sometimes run far in excess of the cost of repairing the damaged property. If an accident of this sort occurs in a plant entirely dependent on its own generated power, or if the physical damage from such an accident is so extensive that plant production is brought to a standstill, the owners face a situation that may be ruinous. They must meet such continuing expenses as salaries, rents, interest, taxes and the many other items of overhead which do not diminish as plant income shrinks but which call for a continued outlay of cash.

The basic boiler or machinery insurance policy agrees to indemnify the owner of the boiler or machine, up to the stated policy limit, for the loss on the property directly damaged by the accident. At one time it was the only policy available, there being no means whereby the owner could secure protection against other than the direct damage part of the loss an accident would cause. Later the Use and Occupancy form was devised to go with boiler and machinery direct damage insurance policies, and today power users and business enterprises in general avail themselves of it. To establish an indirect loss of the kind it covers, the accident must result in a restriction of plant output.

However, this Company's experience in writing Use and Occupancy insurance has revealed that there are some businesses to which Use and Occupancy insurance can not properly be applied. These businesses are of such a nature that although an accident to a boiler, process vessel or power machine would greatly increase expenses by deranging production schedules or procedure and by creating other conditions resulting in intangible losses, it would not lessen the plant's capacity to produce its manufactured articles. In order that these businesses, too, may have the means of securing coverage for their indirect losses, a new form of protection called **Outage** insurance has been designed and is now available. It is not intended to take the place of Use and Occupancy. Its specific purpose is to take care of circumstances under which the explosion of boilers or pressure vessels, or the breakdown of machinery would result in a loss which would not be reflected directly in a reduction of business.

Described briefly, **Outage** insurance provides for the payment of a specified amount of money for each working hour that the insured object has been rendered incapable of performing its functions because of an accident to it of the kind described for the direct damage insurance. The coverage is added to a direct damage policy form by an endorsement that specifies for each object the amount to be paid for each hour of its total "outage", and also the total amount for which the Company may thus be liable for such an accident to that object. These amounts are agreed upon at the time the policy is written, and are based on the assured's estimate of the loss he would sustain because of inability to use the vessel or machine.

The assured does not have to sustain a definite or provable financial loss to collect under this policy. From the time the accident occurs, until the object is again able to perform its functions or until the Company has substituted some other means of performing these functions, the Assured will be paid as agreed for each working hour during which he would have used the object had there been no accident. Partial "outage" is paid for on a pro rata basis. "Outage" payable with respect to one boiler or machine is not affected or limited by "outage" payable with respect to any other boilers or machines that may have suffered explosion or breakdown and be out of use at the same time, the amounts collectible being cumulative.

To show the type of risk for which **Outage** insurance was particularly created we give the following typical applications:

When a manufacturing process is such that supplies of partly finished raw material are stored between stages in the process, an accident to one piece of equipment may not necessarily cause a reduction of plant output. Nevertheless, the plant sustains a loss because of the upset routine, and greater cost of operation. This increased cost of operation may result from having to do the machine's work by hand as in the case of the breakdown of a crane or conveyor motor, or from the necessity of using less efficient engines in place of damaged turbines, or because of the greater cost of purchasing outside power to substitute for power produced on the premises.

It is frequently necessary to rent and install a substitute motor (for elevators, conveyors, looms, cranes, dredges, shovels and many other installations) while repairs are being made to a motor that has broken down.

A store is obliged, sometimes, to employ cash girls as "runners" when the motor of its cash carrier system fails.

When pumping engines or motors of irrigation projects break down, the loss is not usually measurable in production, but occurs in the form of penalties, expenses for substituting temporary apparatus or for purchasing power from an outside source. Sometimes there is the possible reduction of retarding of the crops because of inability to irrigate.

Failure of boilers in a business place might necessitate the hiring of substitute equipment; failure of heating boilers in a school could cause the school district to hire other buildings or to lose the financial aid that in many states is paid to local schools on the basis of days attendance.

Public utilities produce power most economically when using their efficient base load turbo-generators. Breakdown of one of these often makes it necessary either to substitute less efficient base load apparatus, or to start up a stand-by station. Such expedients mean increases in cost of producing power.

This new form of insurance provides the more appropriate means whereby many businesses may now secure protection against serious indirect losses which heretofore they have paid from their own resources. It is expected to meet a need that has long been felt.

Make *Sure* the Vessel Is Empty

Caught in cramped quarters beneath a feed water softener which they were cleaning at a factory in the middle west, two power plant employees were recently scalded so badly that one died and the other was not expected to live. The softener was in the form of a vertical 72″ cylinder that ended at the bottom in a cone to the apex of which a drain valve was attached by means of a pair of bolted flanges. The men had opened this valve and, after hammering the vessel and running a wire up into it, thought that all fluid contents had been removed. However, when they unbolted the flanged connection, soft sediment that was clinging to the surface of the cone let go and started to slide down through the opening. The two men who were badly scalded managed to hold the flanged joints together long enough for three companions to reach a point of safety, but they soon collapsed as the hot mud flowed out on them.

At the risk of becoming tiresome, we must again issue the oft repeated warning against the danger of opening boilers or any other pressure vessels before making sure they are empty. A recent issue of *Vulcan* described two fatal scalding accidents caused by the premature removal of boiler manhole covers.

Accuracy Takes on a New Meaning

To the best of our knowledge, no one has ever settled the question as to how many million angels could dance on the head of a pin. But an equally difficult feat of measurement has been made possible through the development by General Electric of a vacuum tube which responds to an electric current of one quintillionth (1-1,000,000,000,000,000,000) of an ampere.

It is claimed that this tube will measure the flow of six electrons per second. If anyone is in doubt as to how small a quantity that is, he has but to note "that if these (six electrons) are considered as that many drops of water, then the number of electrons flowing in one minute through a 50 watt incandescent lamp equals the number of drops in the enormous volume of water going over Niagara Falls in a whole century! In view of that it is not hard to understand why the new tube has been declared the most sensitive measuring device of all time.

Claim T. N. T.'s Bad Name Undeserved

T. N. T., in the movies and in the daily press, has become symbolic of all that is powerful and hazardous, dangerous and uncertain, of all that must be handled with circumspection if the direst of consequences are to be avoided. But its evil reputation is not entirely deserved, declares the *Technology Review*. It is powerful, to be sure, but it is not unreliable, and it is not so tremendously powerful when all things are considered. The explosion of a pound of T. N. T. liberates an amount of energy of the same order of magnitude as that which is produced by a pound of sugar used as food in the human body, the magazine observes.

T. N. T. is one of the safest of the high explosives, and for military purposes is the most important. In appearance it is a buff colored crystalline powder resembling brown sugar. If a bottle containing T. N. T. should be dropped upon a concrete floor, the bottle would be broken but the T. N. T. would not explode. Loaded in a tin canister it is not exploded by the impact of a high power rifle bullet. Tetryl, the high explosive which is universally preferred for boosters, is exploded under the same conditions, but it is not explosive by the impact of a rifle bullet if it is loaded in a pasteboard carton. Cyclonite is exploded even in a pasteboard box. Thus the reputation which T. N. T. has earned as the most treacherous of explosives is scarcely deserved.

SIZING UP THE CROPS

"How did you find things down on the farm this summer? Crops good I hope."

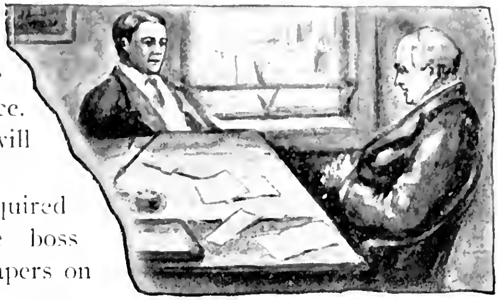
"Well, father did fairly well on his barbecue, but he just about broke even on his gasoline and oil."—*Hudson Star*.

LOOK OUT FOR THE BIG BOSS

Mr. Bigmitt—"You're a henpecked little shrimp!"

Mr. Peewee—""I'll bet you wouldn't dare say that in the presence of my wife." —*Brooklyn Eagle*.

Taps From the Old Chief's Hammer



"OH, Tom," called the Old Chief from the doorway of his office. "Step in here a minute, will you?"

"What's up, Chief?" inquired the younger man as the boss thumbed through a file of papers on his desk.

"Here's a home office engineering department report covering the last year and a half's inspection of concealed mud drum heads by the company's departments," the old man explained. "I want you to go through it and get out a letter to all our field men."

Preble, scanned the totals at the foot of the sheet. "This is interesting," he said finally. "I've been looking for these figures ever since you sent in the report for our department, as I was rather curious to learn how our findings would compare with the combined record for all sections of the country. Let's see. All in all, 4,732 heads have been uncovered and examined. Roughly one-fifth, or 889, were found more or less seriously corroded, and of that number forty-seven were in such bad shape that the owners either replaced them or scrapped the boilers. That means that just about one out of every hundred heads examined would almost certainly have caused an accident if we hadn't been able to induce the owner to dig away the brick work so we could have a look at it. Isn't that so?"

"Absolutely," averred the old man. "And that being the case it will help our men a lot to have these figures when they bump into the occasional owner who objects to the inconvenience of having brick work dug from his buried drum head so that the inspector can examine it."

"By the way, Chief, ever since I've had anything to do with this work, the matter of getting buried heads uncovered for inspection has been one of our most difficult problems. Has it always been that way?"

"As far back as I can remember, it has," the old man assured him. "And the surprising thing about it is that although during all that time concealed drum heads have been exploding with what might almost be called monotonous regularity, some boiler owners are still hard to convince that a bricked-in drum must be uncovered and looked at from time to time. Nowadays, with higher pressures and boilers of larger capacity in general use, it is more important than ever to keep track of such things, for corrosion can play hob even with drums of the best material and design if it is given half a chance."

"I guess the whole matter is summed up in the old saying that an effective inspection requires not only a good inspector but also an owner who lends full cooperation," observed Preble.

"That's absolutely correct," the Chief agreed. "And now that you've brought up that point I'll tell you of an experience I had a few years ago. This will illustrate how even the most careful inspection can be valueless if the owner neglects to do his part.

"One of the installations on my route was in a steel mill where, among several others, they had one battery nicknamed the 'Klondike'. This consisted of four boilers, all joined by a common mud drum that ran crosswise underneath them. The drum was so placed that parts of it were almost continuously in contact with ashes, and as a consequence it corroded. Part of my job at every inspection was to see that the deterioration had not progressed so far as to render the drum unsafe.

"Well, there finally came a year to two of slow business in the steel industry and during that time the mill shut down its 'Klondike' battery and canceled insurance on it. When things picked up we were notified that insurance was again desired, so I went down to the mill to look the boilers over. I had in mind that I'd find the mud drum considerably more corroded than when I last saw it, so I insisted on having the ashes cleaned away for a thorough examination. Sure enough, the bottom of the shell was in bad shape, being very little thicker than paper in some spots.

"Under the circumstances, I looked up both the boiler foreman and the plant superintendent and told them that before firing up the battery they would have to install a new drum. They promised to do so, and I therefore did not suspend the insurance, as I ought to have done to secure compliance with my directions and thus properly protect life and property. I heard no more about it until one morning a week later the superintendent called me by telephone and said they had had a 'little accident'. Something seemed to tell me that the 'little accident' was the explosion of that mud drum and when I asked pointblank if that was the case the superintendent admitted that it was. He said that they had planned to install the new drum just as soon as they could, but that as they were anxious to get the plant under maximum production they yielded to the temptation to use the boilers while the drum was being obtained. He told me later that he was sitting in his office that morning in the very act of reading our inspection report when he heard the sound of the explosion. Luckily no one was killed or injured, but the boiler house was so tangled up that part of the plant was shut down until temporary steam lines could be erected.

"The point I want to make, Tom," the old fellow concluded, "is that it is to the boiler owner's advantage not only to make the boiler accessible for a thorough inspection, but to be guided by what that inspection discloses. The owner who falls down on either of those points is unknowingly cheating himself out of something that may mean thousands of dollars to him."

IT WAS DELAYED

"Band Concert Possponed" was the way the sign read at the entrance to Bryant Park the other day. An hour or two later we happened to be walking by, and were agreeably surprised to find that someone had corrected the matter. "Band Concert Posponed," the sign said.

So subtly fascinating did the sign become to us that we couldn't stay away. We were, later, again rewarded. "Band Concert," corrected the harassed but tireless committee, "Post-Poned."—*New Yorker.*

IT'S HANUARY NOW IN SAN HOSAY

New Resident—"I stopt over in San Juan and"—

Old Resident—"Pardon me, but you should say San Huan. In California we pronounce our J's like H's."

New Resident—"Well you'll have to give me time. You see, I've been in the State only through Hune and Huly."—*El Padre (San Jose, Calif.)*

RUBBING IT IN

After the fall of the Herriot Government, an American, registered at a de luxe Paris hotel, approached the boniface with his bill in his hand and asked:

"Am I on the American or European plan?"

"On the European plan, of course," the hotel man replied.

The American smiled and commented, "Then I don't pay, eh!"—*New York Evening Post.*

Rudolph G. Spreckels was once registering at a fashionable California hotel. The clerk, upon seeing the signature, said:

"Oh, Mr. Spreckels, you will want the Rose Suite, I am sure."

Mr. Spreckels replied that he desired something less expensive.

"But, Mr. Spreckels," protested the clerk, "your son always occupies the Rose Suite when he is here."

"My son," said Mr. Spreckels, "has a rich dad. I am not so fortunate."—Contributed by S. K. Austin, Chicago, Ill.—*Readers Digest.*

The absent-minded professor called his biology class to order shortly after the lunch hour. "Our special work this afternoon," he said, "will be cutting up and inspecting the inward workings of a frog. I have a frog in my pocket here to be used as a specimen."

He reached into his pocket and pulled out a paper sack, shook its contents on the table, and out rolled a nice looking sandwich. The professor looked at it, perplexed, scratched his head and muttered: "That's funny, I distinctly remember eating my lunch."—*Winfield's Winner.*

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1931

Capital Stock, - - $3,000,000.00

ASSETS

Cash on hand and in bank		$ 901,554.83
Premiums in course of collection (since October 1, 1931)		1,177,597.98
Interest accrued on mortgage loans		27,546.67
Interest accrued on bonds		124,122.94
Loaned on bonds and mortgages		986,760.15
Real estate		462,799.10
Agents' ledger balances		10,742.54
Miscellaneous assets		2,014.13
		$3,693,138.34
Bonds and Stocks:		
Book value	$15,576,111.24	
Convention value over book value	790,997.40	
Total value as fixed by The National Convention of Insurance Commissioners	$16,367,108.64	
Deduction to adjust security holdings to true value as of December 31, 1931, as required by Connecticut Insurance Dept.	1,147,046.25	
		15,220,062.39
TOTAL ASSETS		$18,913,200.73

LIABILITIES

Premium reserve		$ 8,609,354.91
Losses unadjusted		329,660.26
Commissions and brokerage		235,519.60
Other liabilities (taxes accrued, etc.)		611,642.21
Special depreciation reserve		2,000,000.00
Capital stock	$ 3,000,000.00	
Surplus over all liabilities	4,127,023.75	
Surplus to Policyholders,		**$7,127,023.75**
		$18,913,200.73

WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 — Charter Perpetual

Department	Representatives
ATLANTA, Ga., Citizens & So. Nat. Bk. Bldg.	W. M. FRANCIS, Manager. C. R. SUMMERS, Chief Inspector.
BALTIMORE, Md., 5 South Street	JAMES P. KERRIGAN, Manager. P. E. TERROY, Chief Inspector.
BOSTON, Mass., 87 Kilby Street	WARD I. CORNELL, Manager. W. A. BAYLISS, Chief Inspector.
BRIDGEPORT, Conn., City Savings Bank Building	W. G. LINEBURGH & SON, General Agents. A. E. BONNET, Chief Inspector.
CHICAGO, Ill., 175 West Jackson Boulevard	P. M. MURRAY, Manager. C. W. ZIMMER, Chief Inspector.
CINCINNATI, Ohio, First National Bank Building	F. L. HOWER, Manager. W. E. GLENNON, Chief Inspector
CLEVELAND, Ohio, Leader Building	A. PAUL GRAHAM, Manager. J. F. HUNT, Chief Inspector.
DENVER, Colo., Gas & Electric Building	J. H. CHESNUTT, Mgr. and Chief Inspector. F. G. PARKER, Ass't Chief Inspector.
DETROIT, Mich., First National Bank Building	L. L. COATES, Manager. THOMAS P. HETU, Chief Inspector.
HARTFORD, Conn., 56 Prospect Street	F. H. KENYON, Manager. A. E. BONNET, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Building	R. T. BURWELL, Manager and Chief Inspector.
NEW YORK, N. Y., 90 John Street	C. C. GARDINER, Vice-President. E. MASON PARRY, Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut Street	A. S. WICKHAM, Manager. S. B. ADAMS, Chief Inspector.
PITTSBURGH, Pa., Arrott Building	GEORGE S. REYNOLDS, Manager. J. A. SNYDER, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth Street	CHAS. D. ASHCROFT, Manager. EUGENE WEBB, Chief Inspector.
SAN FRANCISCO, Cal., 114 Sansome Street	C. B. PADDOCK, Manager. L. E. GRUNDELL, Chief Inspector.
SEATTLE, Wash., Arctic Building	E. G. WATSON, Manager. and Chief Inspector.
TORONTO, Ont., Canada, Federal Building	H. N. ROBERTS, President The Boiler Inspection and Insurance Company of Canada.

Where Lives Depend on Standards

PAINSTAKINGLY, slowly, the welder builds up the seam of a pressure vessel. He must make it as reliable as the steel plate itself, for lives as well as property depend on the quality of the weld.

A safe weld involves many factors—metallurgical composition of the welding material and the plates joined by it, creation and application of a proper electric arc or gas flame, and the knowledge, skill and experience of the welder.

Some shops early achieved good welding. Others did not; and as welded vessels increased in number, with relatively frequent accidents, it became apparent that standards would have to be established by which welders and welding processes could be judged. In the interest of industries insured by it, the Hartford Steam Boiler Inspection and Insurance Company undertook this, just as years before it had set up and secured acceptance of standards for riveted joints.

Welding presents a difficult problem. Neither appearance nor the ordinary tests can be relied on to reveal weaknesses which may cause disastrous explosions. After much research, with the cooperation of leading welding plants and welding equipment manufacturers, the characteristics of a good weld were determined. Standards for safe welding were established, and many of them are now in the national code, generally accepted and followed.

Vol. XXXIX No. 6 April 1933

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

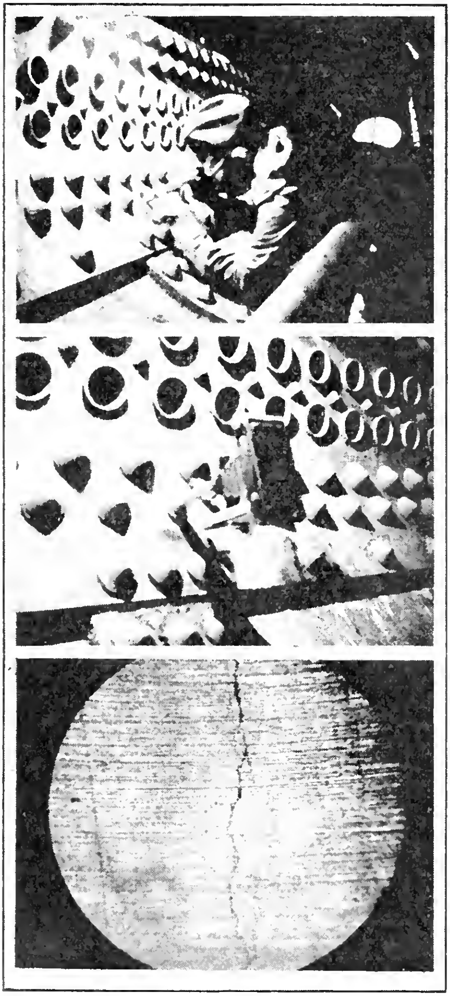
Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

An Improved Means of Studying Plate Embrittlement

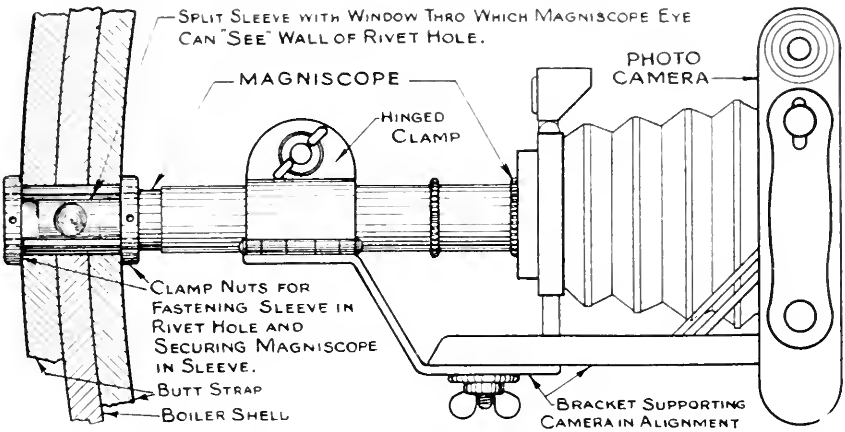
By J. P. Morrison, *Asst. Chief Engineer, Boiler Division*

AT ONE time plate embrittlement caused little worry to boiler owners outside of the relatively few areas where natural feed water is of the "embrittling" sort, but that condition has changed. Higher boiler pressures have necessitated intensive feed water treatment, which under some conditions can result in water having unsatisfactory carbonate-sulphate ratios. The result is that embrittlement is now being found in areas hitherto not subject to the trouble. Consequently the matter is one to which this Company is continuing to devote careful study, and which all engineers responsible for boilers should understand.



Top—*Locating a crack.*
Center—*Micro-photographing.*
Bottom—*The photograph.*

Several years ago the Hartford Steam Boiler Inspection and Insurance Company developed what is now known as the Hartford rivet hole magniscope, a sort of magnifying periscope that was described in detail in The Locomotive of July, 1930. This instrument has been found extremely useful by the experienced inspector in examining the walls of rivet holes for the microscopic indications of embrittlement in its early stages. However, adeptness in focusing the magniscope and in holding it steady while looking through it can be gained only by practice. In many cases the inspector has found difficulty in showing plant engineers and officials the fissures which, to his experienced eye, were clearly visible. It was not until recently that the Company succeeded in overcoming the difficulty by the development of a device which, when used in conjunction with the magniscope, permits making micro-photographs of the walls of rivet holes. The device is shown in accompanying illustrations.



This diagram shows how the Hartford magniscope is rigidly mounted in a rivet hole by means of a threaded sleeve and clamp nuts. The sleeve has an aperture through which the eye of the magniscope sees the surface of the hole. The camera rests on a bracket which affords accurate alignment.

Caustic distress, that is, fissures caused by disintegration of the binder between steel crystals, is, like cancer, slow forming and insidious. In its early stages it impairs the strength of the boiler very little, and if detected in time a boiler may sometimes be saved from retirement by reaming the rivet holes and driving over-size rivets. However, if allowed to progress, the fissures can gradually weaken the boiler, make it unsafe to operate and even result in an explosion.

The efforts of the Company's engineering staff have been directed toward training its inspectors to detect plate embrittlement as soon as the first symptoms make their appearance. The finding of definite symptoms calls for a thorough investigation to determine the extent to which the disease has progressed, and it is not uncommon for an inspector to spend several hours, or days in some cases, standing, kneeling, and lying in cramped quarters, exploring with minute care for further evidence of the trouble. After the inspector has satisfied himself as to how far the embrittlement has progressed, he reports the matter to plant officials. The micro-photograph apparatus is most useful at this stage of the investigation, as plant men can almost always gain a better understanding of the trouble from pictures of the cracks, magnified so as to be clearly distinguishable, than they can by crawling into the boiler drum to look through the magniscope.

The photographing is made possible by means of a device which, after the magniscope has been focused on the crack, clamps the instrument securely in position. It also includes a bracket on which a camera can be mounted so as to focus on the eyepiece of the magniscope. The surface to be photographed may be lighted either by means of a small electric lamp fixed in the end of the magniscope, or by a larger lamp so placed as to illuminate the rivet hole.

Micro-photographing a head seam

The skepticism of some engineers about plate embrittlement was recently illustrated in two cases where large high pressure boilers gave evidence of the trouble. Applications for insurance had been made and "Hartford Steam Boiler" inspectors proceeded to make the initial inspections.

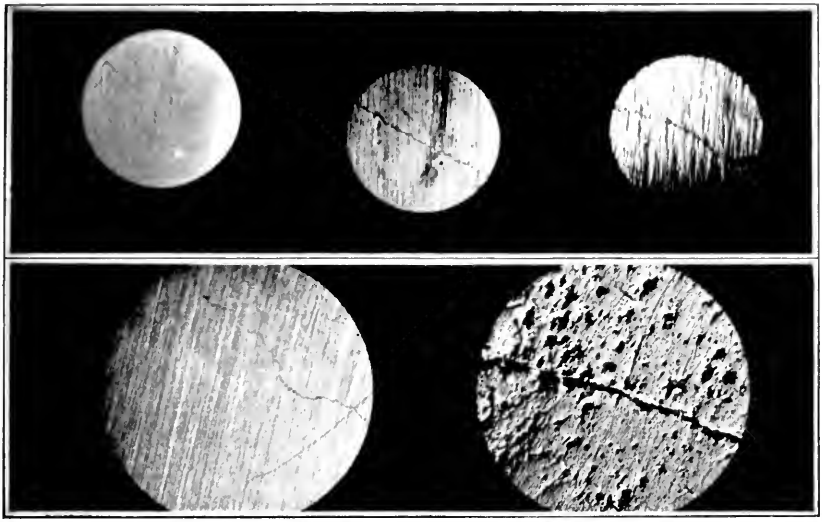
In one boiler the inspector found four rivet heads cracked off. He questioned the operators and found that leakage had occurred and that repeated caulking had not eliminated the trouble. He immediately communicated with the engineer of the plant and also with his chief inspector.

The report that rivet heads had failed brought a comment from the engineer to this effect, "Well, what of it? We'll replace the rivets and go ahead."

It required a great deal of argument to persuade the engineer to cut out not only the faulty rivets but also others along the same seam so that the walls of the rivet holes could be examined. When this was done it did not require a magniscope for him to see the cracks. In this case the embrittlement had advanced to the stage where a new boiler was necessary.

In the other instance, where only a small amount of the metal had become "diseased," careful reaming of the rivet holes and the use of larger rivets made it possible to continue the boiler in service.

It is generally understood that the caustic to which embrittlement



How the microscopic caustic embrittlement cracks look through the eye of the camera connected to the Hartford magniscope. It is important to remember that these tiny hair cracks, while they develop slowly at first, may weaken the plate to a point where the boiler explodes. The upper three photographs were made with 20 magnifications and the lower two with 40 magnifications.

is attributed enters the boiler as sodium carbonate and changes into a form of caustic soda in the boiler. A concentration sufficient to attack steel is never found in water that is fed into the boiler. If a concentration anywhere near that amount existed in the boiler, excessive priming and foaming would result. However, with these harmful ingredients in the water, even in small amounts, the theory is that a concentration does build up between the straps at seams, where it is somewhat segregated from the main body of water in the drum.

In tracing the development of embrittlement our experience of late has shown that even when feed water has been corrected after finding it faulty, the embrittlement action may continue, due to old deposits of the caustic in the seams.

It should be emphasized that by no means are all of the cracks which occur in boilers under high stresses due to caustic embrittlement. It requires trained men to diagnose this difficulty, the chief symptoms of which are detached rivet heads, leakage which repeated caulking does not stop, and evidence of soda near the seams. The trouble usually occurs below the water line and in the inaccessible portion of the plate beneath the strap at a seam, but there are cases of affected tube ends.

Another characteristic is that embrittlement usually starts at a rivet hole and progresses into the plate in the direction of another rivet hole.

There is no definite length of time required for caustic embrittlement to get in its destructive work. New boilers have been found to be ruined after approximately a year's use. In other cases the phenomenon has not manifested itself until after several years of service. When this kind of trouble is suspected, it is best to call in authoritative counsel at once. There is too much at stake to permit any dependence on luck to keep high pressure steam "harnessed" under questionable conditions.

Famous Engine-Building Firm 100 Years Old

ALTHOUGH today the Corliss engine produces but a small percentage of the total power used by industry, there was a time when this famous prime mover was the power source for a majority of mills. The engines of this type built by Charles and Elias Cooper were among the best, so we are sure many of our readers will find particular interest in the following account in which *Time* recently noted the company's one hundredth anniversary:

"Andrew Jackson was President when the Brothers Cooper, Charles and Elias, went into business at Mt. Vernon, Ohio, with a pair of horses as capital. They traded the off horse for equipment to build a small cupola iron foundry, kept the near horse to hoist ore to the top of the cupola. The iron was made into heavy castings for carding machinery, sawmills, farm implements. Last week Cooper-Bessemer Corp., direct descendant of the Coopers' cupola foundry, celebrated its centenary.

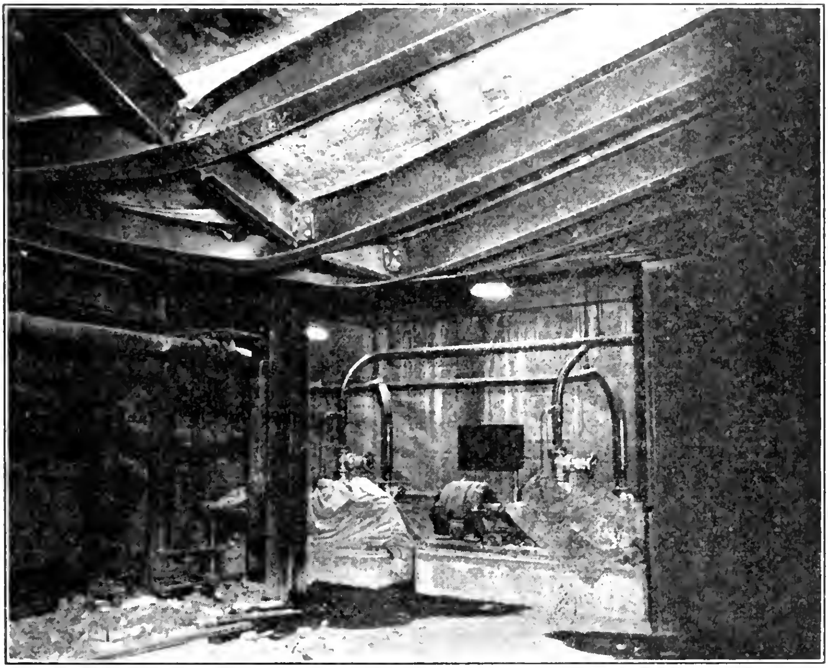
"Nearly submerged in the panic of 1837, the Coopers were prospering in the early 1840's. Ten years later they sold to Baltimore & Ohio R. R. the first locomotive built west of the Alleghenies. But not until they obtained the rights to manufacture the famed Corliss stationary steam engine did Charles and Elias Cooper hit their stride. In 1929 the company was merged with Bessemer Gas Engine Company and Hope Forge Company as $11,000,000 Cooper-Bessemer Corp., makers of marine Diesels, oil and gas pipe line equipment. A few old employes still on Cooper-Bessemer's payroll can remember the time, during a money panic 50 years ago, when the Brothers Cooper paid wages in scrip, then passing in wide areas of Ohio."

Judge: Prisoner, the jury finds you guilty.

Prisoner: That's all right, judge. I know you're too intelligent to be influenced by what they say.

Natural Gas Furnace Explosion at Colorado Springs

ONE man was killed and three others were injured by a terrific explosion of natural gas in the furnace of a boiler at the municipal plant of Colorado Springs on the morning of January 31. Occurring with such force as to destroy the brickwork of the boiler setting and bend the heavy 12-inch I-beam supports as though



they were putty, the blast endangered the lives of between 20 and 25 workmen engaged in putting the finishing touches on the new plant.

The boiler, a large one of the cross-drum, straight-tube type, had been put in place, and men were about to boil it out to prepare it for an acceptance test when a torch thrust into the combustion chamber ignited a charge of gas that had accumulated there. The resultant explosion not only rocked the boiler almost loose from its support but burst out the metal framework of windows in the building and did considerable damage to the brick walls of the setting and the power house.

The man killed was covering the steam piping from the boiler to the main header. He was hurled into the basement and buried under debris. Two others who were directly in front of the boiler were badly injured. A third who was with them had a narrow escape, being hurled across the room but striking the wall in a way that did not injure him. A truly miraculous escape from almost certain death was experienced by a painter who, at work up under the roof, was jarred loose from his perch 75 feet above the floor of the room. By the sheerest chance his arm caught over the hand rail around the upper boiler platform as he fell and he was able to haul himself to safety.

The city of Colorado Springs obtains a portion of its power from a water wheel generator driven by a Pelton wheel that takes water from Pike's Peak and operates under a head of 1000 lbs. per square inch. The steam plant augments this source of power and is depended upon particularly in the dry season. The accident came at a time when work was being rushed on an additional unit for the steam plant in anticipation of a need for more steam capacity to make up for a shrinkage of the water supply. The new unit would have been ready to go on the line in about two weeks, and city officials had planned to hold on "open house" in connection with its formal start.

Although the building was considerably damaged, the chief destruction was to the boiler setting and boiler appliances. The four main supporting columns, which were 12 x 12 x ¾ inch "I" beams, were so seriously twisted and sprung that replacement was necessary. This damage is not apparent in the illustration shown here, but it can readily be seen how the other heavy "I" beams comprising the cross members between the main supports were crushed downward. The top row of tubes on the lower tube deck was sprung down until these tubes touched the tubes below them, and the drum was shifted to the rear about 3 inches. Fortunately, however, the tubes were not loosened either from the drum or from the headers.

Heads of Air Tanks Fail With Disastrous Effect

THE presence of ice in an air tank was given as a contributing cause of one of four recent air tank explosions, the ice interfering with the escape of the air by the safety valve. Two other explosions were believed to have been caused by sticking of the relief valves and a fourth by defective welding.

In the first case, at Williamstown, Pa., the air tank was kept outside of a machine shop in an "L" of the building. It had been out of service for some time and had become partly full of water which froze over the opening of a pipe to which the safety valve was attached. When pressure was built up by means of a motor driven compressor, one of the cast iron heads gave way and hurled the rest of the tank into the machine shop, killing one man and seriously injuring another. The vessel was 34" in diameter and 19'9" in length. It had originally been a boiler, and when converted had been fitted with flat, cast iron heads.

An air tank which rested on the third floor of a wooden garage building in New Orleans exploded in such a way that the bottom head blew out of the shell to which it was welded and damaged an automobile on the floor below. The tank was projected upward like a skyrocket, crashed through the ceiling and fell back on the roof. An inspection of the tank revealed the probable cause of the accident as defective welding where the head was joined to the shell. In fact, it appeared that at least one-third of the circumference of the head was not welded at all. The tank was of fusion welded construction throughout, all horizontal seams being butt welded and the head seams welded in the usual manner. It was 20" in diameter by 6' in height with a plate thickness of 3/16". Both heads were convex.

When a contractor's portable air tank used in connection with Charlottesville, Va., street work exploded in the midst of a gang of 80 men, one was killed and two others injured. The tank traveled approximately 185 feet along a residential street. The man who was killed and one of those injured were standing some 100 feet away from the tank and were knocked down by the detached head. The other injured man was sitting on the tank when it exploded. Failure of the relief valve was given as the cause of the accident.

In an oil station near Carthage, Missouri, a motor-driven compressor and tank went through the roof when the tank exploded. The building was badly damaged, but no one was injured. Again, the accident was attributed to a defective relief valve.

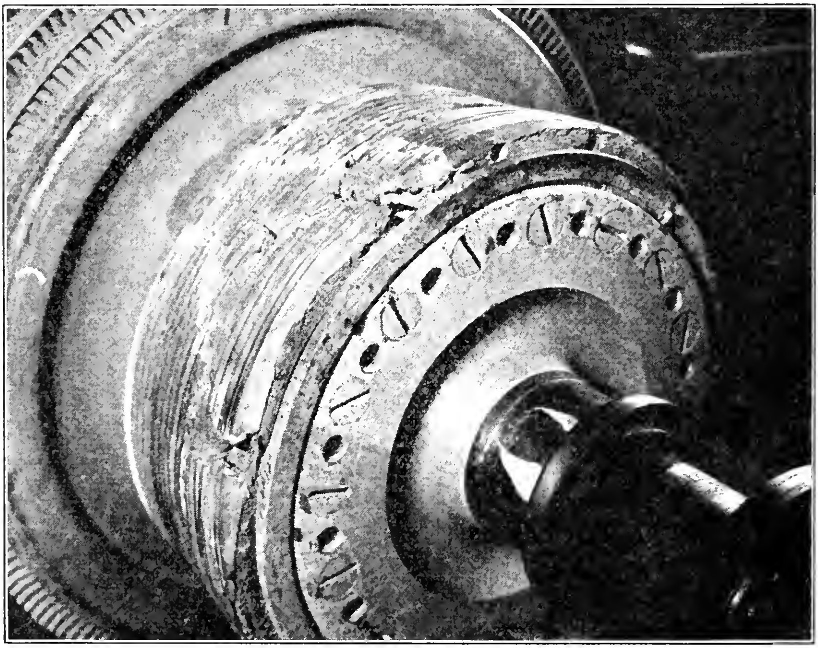
The Mississippi Keeps Its Secret

There was excitement at a Mississippi river lumber mill in Louisiana one morning in March for two Negroes who happened to be the only human beings at the scene. A mess boy on a boat tied to the bank said he heard a loud report and some moments later was mystified by a splash as of a log landing in the river. The other Negro came running from a shelter nearby and found that a vertical boiler used for power to pull mahogany logs from the river to a storage pond was gone. There had been an explosion, it was plainly evident to investigators who visited the scene later, for a concrete slab on which the boiler had rested was cracked, the wooden roof which had been above it was torn away and there were other evidences of destruction. A thorough search was made for the boiler but it was not found. The conclusion was that the mess boy's "log" in reality was a vertical boiler whose own excess steam pressure had rocketed it in one final unappreciated dive.

Accidents to Reaction Type Turbines

THREE recent accidents to turbines of the reaction type, all involving costly damage to blading, illustrate the need for ample insurance coverage against breakdown.

An accident to a 3750 kva turbine at Charleston, West Virginia, the basic cause of which was undetermined, manifested itself in a breaking of the rotating dummy ring (see illustration), rubbing of



and injury to blades, and a distortion of the spindle. Because of reports of smoke between the oil tank and the turbine casing, prior to the failure, and indications at several places of excessive heat, the theory was advanced that the burning of confined oil in the asbestos lagging caused sufficient heat to warp the casing, thus causing the stationary and the movable dummy ring to rub, leading to a chain of events which brought about serious damage. Repair costs in connection with this accident exceeded $15,000. Restoration of the turbine's usefulness involved repairs to the spindle, replacement of blading, and replacement of the spindle and cylinder dummy rings, gland runners, gland cases, primary nozzle block, governor stand and some other parts.

Repairs to the bearing bracket were required, with a general inspection and repair of the entire mechanism.

A 3125 kva steam turbine used in a textile mill near Providence, Rhode Island, sustained approximately $8,500 damage when an accident necessitated the replacement of all the blading. The probable cause of blade breakdown was thought to be excessive moisture conditions in a bleeder pipe from which steam was taken in fluctuating amounts. Conditions were such as to permit water or very wet steam to rise into the turbine with subsequent possible injury to the blading. It was recommended that this hazard be reduced by installation of a suitable non-return valve close to the turbine to avoid the return of wet steam to the lower stages of the unit.

In the third case, in New Jersey, a turbine erector was wearing in some packing strips of the blading and dummy rings. In doing so, according to reports of the accident, he made an adjustment of the spindle which brought about an unexpected and heavy friction between the rotating and stationary parts. Subsequent damage involved a fusion of the blades, a ruptured oil line caused by severe vibration and finally fire in the released oil. It was estimated that the damage to the turbine alone and not counting fire damage, would amount to approximately $130,000.

While the causes in each of these accidents were obviously different, the resulting damage was similar, and the chief item of repair was the replacement of damaged blades, either ruined through excessive friction or knocked from their positions by moving parts or by other blades which were loose within the turbine.

Recent Power Boiler Explosions Involving Loss of Life

POWER boiler explosions resulting in serious loss of life and injury to persons have occurred with what appears to be unusual frequency during recent months. From among them we have selected the following as typical:

Back in the Russell county mountains of Virginia on a Saturday in February the hill men-folk had collected at a meal grinding mill as was their custom. It was a sort of social event to meet and "josh" each other and exchange views while their corn was being ground. Because of near-zero weather, men and boys were gathered close to the locomotive-type boiler, one youth being perched on a board on top of it. An explosion sent the youth out through the metal roof of the mill.

He was found on a stack of lumber 50 feet from the mill, injured severely but not fatally.

Three men were killed instantly and eleven others were injured by flying parts or steam. Care of the injured was complicated by the extreme cold, their removal to a hospital some 20 miles distant involving precarious travel over icy roads.

The boiler failed in the crown sheet while an attendant was raising steam to operating pressure, preparatory to starting the mill engine.

Three men were killed and two injured in a similar accident in upper Colleton County, South Carolina, when a violent explosion of an uninsured boiler hurled the shell approximately 450 feet and parts as far as 850 feet. The men who were killed or injured were 40 or 50 feet from the boiler room.

A heavy piece of the boiler passed through the roof of a house 300 feet away and smashed through a dining table which had been set for the noon meal. The housewife had gone to another part of the house and was sewing when the accident occurred.

At a coal mine near Marseilles, Illinois, a 10 horsepower boiler used to operate mine machinery blew up and wrecked the engine room, killing one man and injuring another so that he died later in a hospital. The injured man's clothing, including his heavy boots, were entirely blown off by the explosion.

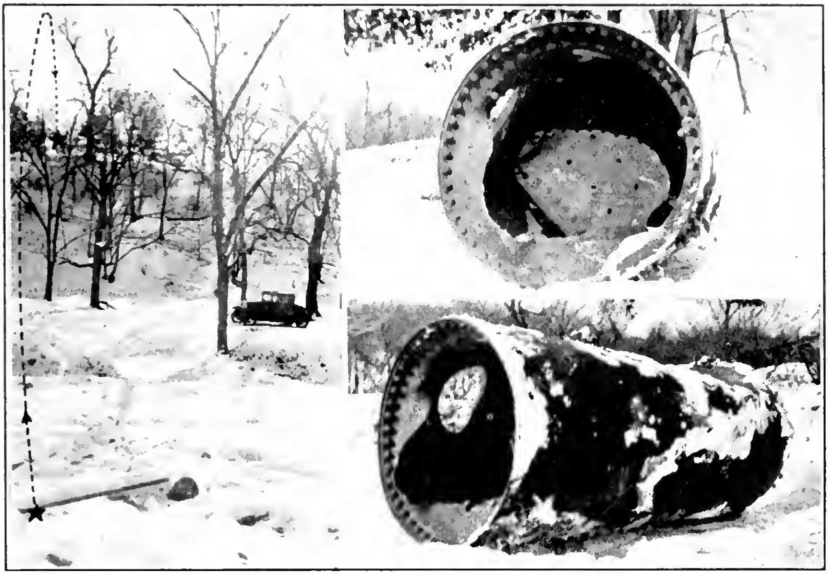
The boiler was of the vertical tubular type, 36″ in diameter and 6′ in length. The men were raising steam pressure in order to pump water out of the mine when the explosion rocketed the boiler 700 feet over a hill and out of sight. An idea of the boiler's "flight" and the damage done to it will be gained from the picture accompanying this article. Because there was no path through the snow to the place where the shell landed, it was not found for two days.

Reports of two explosions resulting in death to persons came recently from the Texas oil fields. A boiler operated at an oil test near Nueces exploded and killed two men. At a well near Edom one man was injured and one was killed when boilers there exploded. The man who died was thrown more than 100 feet by the force of the explosion. The other was hit by a piece of derrick. One of the boilers crashed through the derrick, tearing it down, but a group of men working on the derrick floor escaped injury.

The boiler in a sawmill at Milton, Delaware, exploded with such violence as to demolish the mill and injure three men seriously. One of the setting bricks passed through the front and rear walls of a home

75 feet from the mill and another tore through the wall of a house about 300 feet away.

The vessel was a horizontal tubular boiler about 10 years old, 40″ in diameter and 10′ long. The thickness of shell was ¼″, the longitudinal joint of the double riveted lap type, the rivets ¾″ in diameter and the pitch 3″. The shell was found badly pitted at the longitudinal



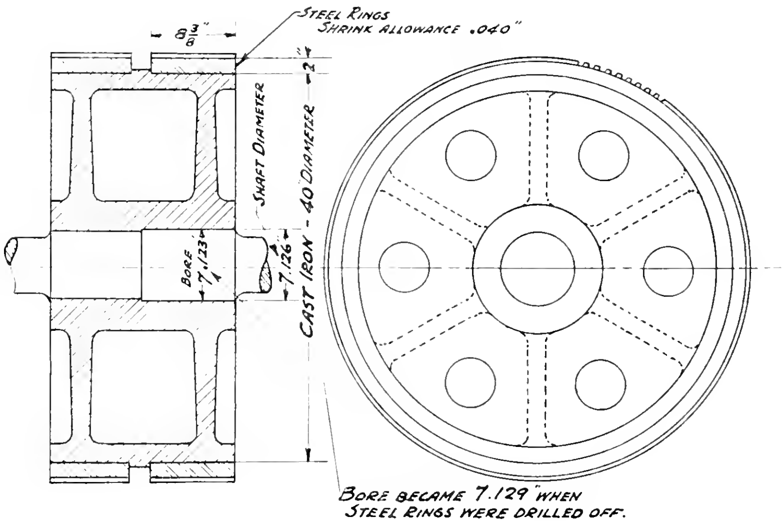
After the explosion—the boiler and where it went. The view at the left will give a good idea of the path of the Marseilles, Illinois, mine boiler. It followed approximately the path indicated by the broken line, passing upward over the trees and hill to a resting place 700 feet distant. The pictures at the right show end and side views of the boiler, the former revealing how the firebox was forced up against the tubes, and the latter showing the firebox opening and the dent caused when the boiler landed.

seam on the water side. At a point 30″ from the rear head the shell had deteriorated from the original thickness of ¼″ to a thickness of 1/16″. It is believed that the rupture occurred at the weak point and extended along the entire length of the longitudinal seam, tearing the sheet from the front and rear heads by shearing the rivets for a distance of three-fourths of the circumference.

At Jasonville, Indiana, a boiler explosion and a subsequent fire in a cleaning plant wrecked the building and shattered windows in homes surrounding the plant. The boiler went through the roof of the building.

Elasticity of Cast Iron Under Compression

CAST iron is well known to have a high compressive strength as compared with its tensile strength, the ratio being about 5 or 6 to 1. It is usual to assume that cast iron has no elasticity, that is to say, when a tension test is made a permanent set is produced in cast iron at comparatively small loads per square inch and the deforma-



tion increases at a more rapid rate than the applied stresses, there being no observable elastic limit or yield point as with steel.

Under compression, however, the elasticity in cast iron is quite appreciable. Test data on the latter property is very scarce and it is rare that a practical example of it becomes available. An opportunity to observe this was recently afforded in a cast iron spider of a high speed reduction gear with a cross section as shown above. As will be noted there were two steel rings shrunk on this spider and the gear teeth were cut in these steel rings. The outside diameter of the spider was approximately 40 inches and the shrink allowance of the steel rings was .040 inches. At the time the gear was manufactured, the shaft was forced into the bore of the spider under a load of approximately 40 tons and this pressing in of the shaft was done after the gear rings had been shrunk on the spider. As shown in the sketch, the force fit of the shaft had a shoulder midway for the purpose of simplifying the assembly. The shaft, which was approximately 7 inches in diameter, was only .003 inches oversize.

Because of failure of the teeth the spider was sent to a shop for the installation of new steel rings. The spider was set on a large drill press with the shaft in a vertical position and the rings loosened for removal by drilling a large hole in the edge of each. To the surprise of every one present, the shaft suddenly dropped out of the spider when the second ring had been drilled off.

When the bore was measured, it was observed that it had increased about .006 inches above the original bore at the time the shaft was pressed in. There was some apprehension that a new shaft might be required but this proved to be unwarranted, for when the new rings were shrunk on the old spider, it was found that the bore of the hub was slightly smaller than the original bore so that the same shaft could be pressed in with approximately the same load as was used originally.

This property of cast iron, as evidenced by this instance wherein the bore changed after the spider had been subjected to a high compressive load for approximately four years, suggests other possible similar application on objects constructed of cast iron. For example, a shrink band correctly applied to a loose engine crank disk will actually make the disk tight on the shaft. This has been done successfully in a number of cases. There may also be other applications for the use of the elastic quality of cast iron when subjected to compression.

Accidents to Heating and Hot Water Supply Equipment

THE executive mansion of West Virginia, a Baptist parsonage and homes, apartments, stores and manufacturing buildings in widely separated parts of the country were damaged in recent months by accidents to heating boilers and hot water tanks and heaters. Fatalities resulted in two explosions and in most of the accidents persons were injured.

When water froze in both the supply and return lines of a small cast iron boiler and a fire was started, the resultant overpressure caused an explosion which killed two men, hurt five others and caused serious property damage. The boiler was used at a Berkeley Heights, New Jersey, brickyard to reduce the viscosity of fuel oil for power boilers operated on the premises. Normally the boiler carried no more than five pounds pressure, but the freezing of the water in the pipes made it a closed vessel.

Freezing pipes also were given as the cause of an explosion in a bottling plant in Cincinnati which injured two men and resulted in some $2,500 property damage. The boiler was being fired up when the accident occurred.

A furnace gas explosion in the basement of Governor William G. Conley's executive mansion at Charleston, West Virginia, nearly resulted in the death of West Virginia's first citizen. Becoming chilly on a Sunday night and knowing that servants were away he went personally to the basement to determine why the gas burner in the furnace was not functioning. Cautiously he opened the furnace door with a stick and an

explosion of terrific violence occurred almost immediately. Governor Conley was burned about the face, but he was able to shut off the gas and avert further trouble. The cause of the accident was attributed to ignition of the gas and air in the furnace by a pilot of a nearby hot water heater. Damage to the mansion was estimated at $1,000.

Rev. William W. Barker of Woonsocket, Rhode Island, was in the kitchen of the parsonage early on a Sunday morning in December when an explosion shook the house, broke windows, upset furniture and damaged valuable antiques. The living room was a mass of debris (see illustration) and the house was jarred from its foundation. A heating boiler had exploded and the top section had crashed through a 12-inch beam. It was reported a non-operating safety valve had led to the explosion. The pastor, his wife and a roomer all escaped injury.

An oil fired, fusion welded hot water heater, used in a New Orleans apartment house, exploded early in February, reduced the basement to a mass of debris and seriously scalded the attendant.

A combination of hot coals from a nearby boiler, "green" soft coal and a closed damper is believed to have caused the furnace explosion which destroyed the hot water heater in a Dorchester, Massachusetts, apartment. No one was injured, but tenants were inconvenienced because of gas, vapor and smoke in the hallways.

Investigation of an explosion in an automobile sales building in Philadelphia brought reports of clogged supply lines, which, coupled with the fact that there were no safety appliances or devices, resulted in an explosion due to over-pressure. Because the boiler was in a confined room in the basement the explosion did little damage.

Lack of relief valves and an improperly welded repair were factors in the explosion of a barber shop towel heater in East Providence, Rhode Island. As the explosion occurred after the shop had closed for the day, loss was confined to property damage.

Other explosions brought tragedy to families. Near Greenville, Texas, a woman died of injuries and a 2-year-old boy suffered a broken ear drum when a water heater burst. At St. Louis a man and his wife were badly scalded when their boiler exploded as they were standing near it. Pipes connected to a water tank in a stove at Rock Hill, Illinois, froze, causing the tank to burst, and scald a mother and her two children who were in the kitchen. An exploding hot water tank in a residence at Danielson, Connecticut, tore loose one side of the house, bulged another side and loosened the foundation in several places. The burner had been lighted and not turned out when the family retired. At 2 a. m. the tank exploded. It was reported there was no relief valve. An accident at a hotel in Riverside, New Jersey, caused property damage when an attendant shut the valve between the heating unit and a storage tank when he thought he was opening the valve.

Seek to Make By-Product from Fly Ash

If experiments being carried on at a plant of the Detroit Edison Company are successful, declares "The Business Week", fly ash resulting from the burning of pulverized coal will become a new raw material. The plan is to use fly ash in making bricks, slabs, hollow tile and various building shapes.

Ammonia Compressor Demolished

IN THE LOCOMOTIVE of October, 1921, was described a severe explosion in the crankcase of a vertical, two-cylinder single acting ammonia compressor, for which a definite cause could not be determined. In some respects that accident was duplicated a few weeks ago at a bakery where the crankcase of a similar small unit, on which there was no insurance, was torn to pieces while the machine was working under what seemed to the operator to be normal conditions.

The base of the machine was destroyed and even the flywheel was broken, the rim coming away from the spokes and the hub leaving the shaft. Other property damage consisted of the wrecking of a dough-mixing machine, breaking of a wall, and shattering of windows. Four men sustained injuries that required hospital treatment, one having bones broken in both feet.

Between the compressor and the discharge valve was an over-pressure relief valve that discharged into the suction line from which an equalizing pipe ran to the crankcase. The manufacturers of the machine were of the opinion that the operator failed to open the discharge valve when starting the compressor and that during the five hours the machine was running the churning of ammonia gas through the relief valve generated enough heat to cause detonation of oil vapor in the crankcase.

This explanation presupposes the presence of air in the crankcase, of course, as there could not have been a detonation of the oil vapor without the support of oxygen. However, as the crankcase was subjected to the pressure of the suction line, usually about 10 or 15 pounds per square inch, it is not apparent how air could have entered it. Another explanation of what occurred is that the heat generated by the churning may have been sufficient not only to raise the pressure in the suction line somewhat above normal but also to distort the pistons and cause them to seize. The stresses thus set up in the crankcase might have caused it to fracture, releasing the ammonia gas that was under pressure and thus giving the accident the appearance of an explosion.

"Open" Tank Explodes

An explosion in a tank which normally was open to the atmosphere illustrates how accidents can occur sometimes to vessels that are supposedly free from the hazard of overpressure. At Omaha, Nebraska, a welded steam tank with heads described as "very flat" was being used as a receiver for traps from parts of a steam system. It left its moorings when the vent of the tank became clogged, permitting pressure to build up and causing a head to fail. There was no safety valve. The tank was 24" in diameter, 48" long and 3/16" thick.

Generating Steam by Electricity

A RECENT compilation by the Dominion Engineering Works to show the increased use of electric heat for steam generators in Canada reveals that there are 126 such generators of 50 kw or more now being operated with a total capacity of 1,105,770 kw. The largest users are paper mills with 822,300 kw.

One of the newest installations is at Thorold, Ontario, where the Ontario Paper Company on March 10 began operation using surplus electric power which was available at that location. The steam generating equipment consists of three three-phase electric steam generators of 30,000 kilowatts capacity each. The change eliminates a coal-fired boiler plant with a daily consumption of 300 tons of coal.

The Hydro-Electric Power Commission of Ontario made the electrical energy available in proper form by expenditure of some $325,000, according to newspaper accounts. Revenue was estimated at $250,000 to $300,000 annually from the newsprint manufacturer. The mills at Thorold have a capacity of 325 tons of paper daily.

Units such as the ones at Thorold are in use in several parts of Ontario and Quebec where there is surplus electric power available at extremely low rates. Such power is available, according to the Ontario commission, only after all other demands for it have been satisfied.

Speaking of this development in a recent issue, *"Electrical World"* points out that to compete with fuel at $10 per ton on a steam-cost basis alone, electric power has to be available at no more than 2 mills per kilowatt hour. However, several advantages would offset a higher ratio of electric power to fuel cost, namely, low first cost, cleanliness, small space, flexibility of location, no fuel storage or ash disposal, and ability to start quickly. Some companies are using electric steam boilers to make better utilization of their demand charges.

The source of this information is a report by B. A. Malkin, Chief engineer, paper machinery department, Dominion Engineering Works.

Canadian power companies in some cases own the electric steam generators and work on an agreement whereby they may interrupt the current supply to satisfy other needs, provided notice is given far enough ahead to get up steam on coal-fired equipment. The fact that the steam from such electric installations is sold to the consumer at a little less than the cost of producing it by coal makes such a plan possible.

Pioneering the Youngstown steel industry, James and Daniel Heaton built the first charcoal blast furnace west of the Allegheny River in 1803 on Yellow Creek near Struthers, Ohio. The furnace will be preserved for its historical interest.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., April, 1933

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.

Vice President Berry's 25th Anniversary

Mr. E. Sidney Berry, vice president and general counsel, on April 1st received the hearty congratulations of executives and staff on the event of his twenty-fifth anniversary with the Company. He was presented with the official gold medal marking a quarter century of service with the Company. Floral tributes from friends indicated the widespread recognition of his achievement.

Mr. Berry's experience in the legal work of insurance companies began in the head office of the Employers Liability Assurance Corporation, Ltd., in Boston in 1890, soon after it initiated the business of liability insurance in the country. In 1903 he went to New York as the Ætna Life Insurance Company's attorney for that city and vicinity, when the Ætna liability department was established.

He came with the "Hartford Steam Boiler" on April 1, 1908, as counsel. In 1917 he was advanced to the position of assistant secretary and counsel, on March 1, 1922, was elected second vice president and general counsel and on Feb. 8, 1927, became vice president and general counsel.

Vice President E. Sidney Berry

J. P. Kerrigan Heads Cincinnati Department

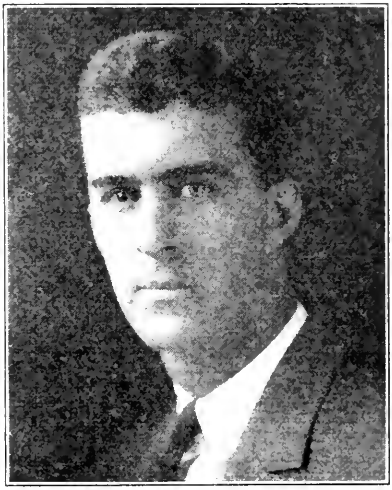
After nearly three years as manager of the Baltimore Department, Mr. James P. Kerrigan, was on February 1 appointed to a similar position at the Company's Cincinnati headquarters. He succeeded Mr. Frank L. Hower, whose retirement was occasioned by continued ill health. Mr. Kerrigan's experience with the Company has been broad in scope, and his advancement to a position of greater responsibility was a logical outcome of his years of application.

Coming with the Philadelphia Department of the Company two decades ago, Mr. Kerrigan began as an inspector. From this start in 1913 he served continuously until 1922 with the Philadelphia Department, except for an emergency of short duration when he occupied the post of acting chief inspector at Baltimore. His experience afforded him a broad knowledge of the application of engineering insurance, and his work during the years as chief adjuster emphasized qualities which brought him success as manager at Baltimore.

From June, 1922, until his appointment as manager of the Baltimore Department he was at the Home Office at Hartford. He served as an adjuster until January 1, 1927, at which time he was promoted to the position of chief adjuster.

The Cincinnati Department is an important part of the Company's national network of offices. It serves progressive sections of the Ohio River valley, including southern and western Ohio, and most of Indiana and Kentucky. Mr. Kerrigan's appointment brings to this territory the

J. P. Kerrigan



D. W. Little

benefits of his extensive knowledge of boiler and machinery insurance, and permits a wider field for the exercise of the executive ability he has so ably demonstrated.

The Company feels that a continuance of cordial relationships and the advancement of efficient service in the territory are assured.

Drummond W. Little New Manager at Baltimore

Mr. Drummond W. Little, for four years assistant superintendent of agencies, was appointed on February 11 to succeed Mr. Kerrigan as manager at Baltimore. More than 13 years of service with the Company equipped Mr. Little with a fund of experience directly in line with his new duties, for with the exception of a few months of activity as a clerk at Hartford beginning in October, 1919, Mr. Little's time was devoted to the Company's relations with its representatives and clients.

In September, 1920, Mr. Little was assigned to the Cincinnati Department as special agent, his territory comprising a large part of Indiana, including the Indianapolis section. In June, 1926, he was transferred to the Boston Department, as a special agent in Rhode Island and southeastern Massachusetts.

Rapid development of his territories and the commendation of those he served revealed an intensive application and study with regard to the requirements of the Company in the field, so a broader opportunity was offered him in October, 1928, when he was promoted to the position of assistant superintendent of agencies. Constructive assistance to special agents was his particular assignment, and his work took him into every section of the country. His duties included also the conducting of intensive courses of training for special agents of the Company, a work for which he was admirably fitted.

His assignment to the Baltimore Department, which comprises the states of Virginia and Maryland, and parts of West Virginia and North Carolina, is expected to preserve and increase the friendly relationships between the Company and those it serves in that territory.

Some General Principles of Natural Gas Control

Increasing use of natural gas as fuel has been accompanied by a considerable number of violent furnace explosions. For attendants in charge of such installations the following general principles may serve as useful guides, although it is realized that each plant has its own combination of arrangements and appliances that influence the exact procedure of lighting off.

1. The pipe to each burner should be provided with a straight way plug cock and a rising spindle gate valve or some equivalent device which indicates positively whether the valve is open or closed, and that can be seen from a distance.
2. Before opening any valves or introducing a torch of any kind into the furnace, the gas passages should be thoroughly ventilated. If there are both forced and induced draft fans, both should be run at normal speed for at least five minutes prior to lighting off. If a high chimney is depended upon for draft and there is a forced draft fan, the damper to the stack should be wide open and the forced draft fan run for at least five minutes. If there is an induced draft fan, but no forced draft, the induced draft fan should be run at normal speed for about five minutes with the air inlet openings to the furnace wide open. If there are no fans

whatsoever, the chimney being depended upon to provide all the necessary draft, the stack damper should be left wide open and all air inlets wide open for at least 10 minutes before lighting off.

3. Each individual burner should be lighted with a torch which should be introduced prior to opening the gas valve which latter should be opened slowly until ignition takes place. If it does not light promptly, the gas should be shut off and the reason for the failure to light determined. A lighted burner should not be depended upon to serve as the source of ignition for other burners.
4. When lighting off with forced draft it is usually necessary to reduce the speed of the fan in order to avoid blowing out the torch and possibly also the lighted gas before being fully turned on. If this occurs after the gas has been turned on, or if the flame goes out for any other reason, the furnace and gas passages should be again ventilated.
5. The use of natural gas, or any other gas for that matter, requires constant vigilance, and there should always be a suspicion that there is free gas and an explosive mixture somewhere in the gas passages that must be cleared away beyond any doubt before introducing a torch.

Inspector Has Narrow Escape

Although in the course of his work a boiler inspector frequently crawls into spaces so restricted that he is called on to exercise all the tricks of a contortionist, it is not often that an experienced man needs aid to emerge from the boiler. However, such occasions do arise now and then to call attention to the hazards inherent in boiler inspecting.

An inspector for another insurance company nearly lost his life in Pittsburgh a few weeks ago when he crawled through the manhole of a horizontal tubular boiler that had not been properly ventilated. Boiler room hands found him there after he had been overcome by suffocation. They attempted to drag him out, but his foot was caught among the tubes in such a way that they could not do so. An oxygen inhalator had to be used to keep him alive while workmen with acetylene torches cut through the boiler plate to release him.

Explosions in Paris and Shanghai

Two boiler explosions of the catastrophe type occurred in foreign lands during February. At Shanghai, China, 17 persons, 15 of them girls, were killed and 30 persons injured at the Yunghao Rubber Factory in the Chinese section. The week before in another Shanghai rubber factory two gasoline vulcanizers exploded killing 81 persons.

The second boiler explosion was on February 6 at the Renault Automobile Works in Billancourt, a suburb of Paris. The accident caused at least eight deaths and more than 100 persons were injured, about 50 of them seriously. The fact that the roof of a building collapsed, trapping workmen beneath it, accounted for the large number of injuries.

Aluminum Bromide Discussed for Turbine Use

WHILE amazing progress has come out of modern engineering thought, the engineering mind continues its undying restlessness and no sooner has one plan been tested and found practical than along comes another with new possibilities of economy and safety.

Anhydrous aluminum bromide is offered in place of mercury for use in binary-cycle power generation by H. Barjot, writing in *Le Génie Civil.* He presents for consideration the following characteristics and facts concerning anhydrous aluminum bromide (Al_2Br_6): Melting point 200 deg. F., boiling point 500 deg. F., non-poisonous, ability to moisten iron, giving off a visible vapor, density double that of mercury (permitting low rotary speeds of the turbine), a lower cost than mercury, and unlimited reserves of the basic constituents. The writer points out that the cost of the liquid would be about $2 per kilowatt of capacity and says that 22 pounds are required in generation of this quantity of power.

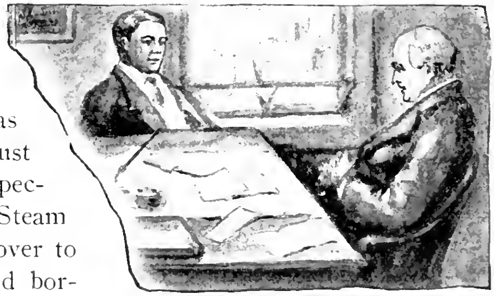
A cycle of operation generally similar to that in the mercury turbine would be required, M. Barjot states. Special care in the construction of the condenser boiler, which would reduce the vapor to a liquid after it leaves the turbine, is emphasized because of the affinity of anhydrous aluminum bromide for water.

Government Specifies "Largest" X-Ray Weld Test

THE giant sections of the Hoover Dam penstocks, which are to be welded both circumferentially and longitudinally, are to be tested throughout their length by the X-ray method, according to the specifications to the Babcock & Wilcox Company of Barberton, Ohio, to whom the contract for this work has been awarded. The undertaking is discussed in *Electrical World* as the largest industrial X-ray job to have been let to date. It is estimated a minimum of 159,000 separate exposures will be necessary, calling for the use of more than 24,000,000 sq. in. of X-ray film.

The size of the undertaking required the construction of a new type of X-ray apparatus, rated at 300,000 volts and 10 milliamperes, and capable of producing radiographs on a continuous operation basis of welded steel plate up to 4″ thickness. The penstock sections range from 8½′ to 30′ in diameter and the steel is 3″ thick in many places. The specifications require that every inch of steel (the total length is about 75 miles) be subjected to careful analysis.

Taps From the Old Chief's Hammer



CRAWLING from the combustion chamber of the big water tube boiler and beating off as much as he could of the dust that clung thickly to his inspector's suit, the "Hartford Steam Boiler's" Old Chief walked over to the boiler room foreman and borrowed a match.

"How much longer do you suppose it will be before the chief engineer gets here?" he asked.

"In a very few minutes now, I should say," replied the foreman. "The plane he was scheduled to take should have reached the airport half an hour ago and it seldom takes long for one of those taxi drivers to come out here."

The plant was a subsidiary of a large corporation that had recently placed its engineering insurance with the Old Chief's company, and as its water tube boilers were fairly new, the management had been somewhat disturbed when, at that company's first examination, its inspector found evidence of a serious defect in the longitudinal seam of a mud drum, and refused to sanction putting the boiler back on the line. In order that there might be no misunderstanding as to just what was involved, the Old Chief had had his inspector submit a detailed report and had then arranged for a meeting at the plant with its chief engineer who had originally planned to come down on the over-night train from Chicago so that he and the Old Chief could get together early in the morning. But he changed his plans and was leaving by plane in the morning. As a result, the Old Chief had finished his examination of the affected drum and was enjoying a cigar in the foreman's office when the chief engineer walked in.

"What is all this business I have been hearing about a mud drum being cracked?" he asked with a smile after he and the Old Chief had been introduced. "None of these boilers are old enough to be going to pieces that way."

"Well," said the chief, "the best way to find out what it is all about is to get on a suit of overalls and crawl inside with me for a look."

Attired in overalls borrowed from the foreman's locker, the younger man slipped through the manhole after the Chief and crouched along toward a spot near the farther end where the old fellow knelt down and focused a sort of magnifying periscope on the wall of a rivet hole from which the rivet shank had been removed. "There," said the Chief after a time, holding the magniscope steady and inviting the other to look through the eyepiece, "see that crack?"

"Yes," finally replied the other. "It seems to run through the whole plate, but it must be pretty narrow to appear so fine under a magnifying glass."

"Sure," agreed the Chief, "but a separation of any width weakens the plate just the same. Even if it goes only part way through, it means that the plate is not holding together with the same strength as formerly. You take a seam that has these cracks running out from every rivet hole and you have a condition wherein the original strength is greatly reduced. As a matter of fact I have found cracks just about like that one in each of the 10 rivet holes I have examined in this particular drum."

"Well, that's that," exclaimed the chief engineer, after looking through the magniscope at several of the other rivet holes. "The only thing to do, I suppose, is to cut out this drum and put in a new one."

"That would cost you plenty," pointed out the older man. "It wouldn't mean only a new drum, you know. You might have to put in a complete set of tubes as well."

"That's a fact," said the other thoughtfully, "but we haven't much choice. The boiler must be repaired, and how else can we do it?"

"I think there is a way," laughed the Old Chief. "At least I figured out a way of doing it this morning before you got here. All I want to do now is to check over my dimensions again and we will see if we can't manage to repair this drum without disturbing either the tubes or the tube sheet section either."

The drum was made up of two sheets. The Chief's plan was to replace just the lower sheet and the two heads, leaving undisturbed the upper portion of the drum into which tubes were fastened, so as to save the owners the expense of retubing. Around the rivet holes in both head seams the metal in the heads and in the lower sheet was weakened, but the upper sheet was unaffected except at the first three rivet holes. Fortunately the upper sheet extended beyond the tube holes far enough to leave room for a new seam after cropping the sheet back to sound metal. Thus the repair would consist of putting in new heads, new butt straps, and a new lower sheet somewhat larger than the old one, the installation of these parts to be accomplished without removing the tube sheet from the tubes.

Mr. Braintree studied with keen interest the dimensioned working drawing that the Old Chief made for him on the back of a report form.

"Well," he finally said as he folded and pocketed the paper, "this ought to save the plant a few thousand dollars. But I'm not quite able to figure out why you go to all the trouble of planning how we can repair this drum when it wouldn't cost your Company anything to insist on our putting in a new one. I should think that to get the best risk you can you would be inclined at least to argue the desirability of new parts."

"Let's get washed up and find some lunch," smiled the Chief. "My stomach tells me it's noon."

"Yes, but you haven't answered my question," pursued the other good-naturedly. "I really want to know."

"It's this way," explained the old man, pausing in his vigorous scrubbing of face and neck to reach for the soap. "My Company has specialized in this business a great many years and we have come to value the confidence that engineers, such as yourself, have in our knowledge of plant equipment. The folks expect me to use that knowledge to our clients' advantage whenever I can, for we believe that to be a good business principle. Furthermore, we seek to avoid economic waste, so when passing judgment on a boiler we weigh its value and expense of repair as compared to the cost and benefit of installing a new boiler or a new part. Sometimes the value of an old piece of power plant equipment doesn't justify any repair expense.

"As a matter of fact, I guess our effort to present the facts just as they are and to save the owner money whenever we can, accounts in part for the 'Hartford Steam Boiler' being entrusted with about half of all the boiler insurance in the country."

New Jersey Mercury Shipment Sets Record

Sealed in 3,553 flasks, each containing 76 lbs., the nearly 135 tons of mercury for the new 20,000 kw mercury-vapor boiler of Public Service Electric and Gas Company, at Kearney Station, New Jersey, is said to be the largest single shipment of quicksilver ever received in this country. It was obtained from the Almaden mines in Spain, the richest source of mercury in the world. These deposits of the fluid metal were known as early as 553 B. C. and have been supplying mercury ever since.

So heavy is mercury that the 135 tons for the new boiler could be poured into a container less than 7′ on a side.

Young Wife—"Now, Bill, I want you to go around to the minister and arrange for having the baby christened."

Bill (shipyard worker)—"You mean to say you are going to let somebody hit that little thing over the head with a bottle?"—*Farm Journal.*

Caught in the Separator

"Jawdge Ain't Done Bus No Boiler"

The Inspector called at the premises in Harlem to ascertain whether a check valve had been installed in the return line of a cast iron boiler as called for in a previous report of inspection. On arriving in the boiler room, he found the colored attendant, George, entertaining three of his friends, and the following conversation ensued:

Inspector: "Good morning."

George: "Mawnin, who is yo?"

Inspector: "The Hartford Steam Boiler Inspector."

George: "Oh yeah, yeah, I membas yo, bin heyah thee fo times, ain't yuh?"

Inspector: "That's right."

George: "Yo'all wanted some kinda valve on this hyah boiler, didn' yuh?"

Inspector: "Right again, a check valve in the return line. It was supposed to be done this morning. Has the steamfitter been here?"

George: "Dunno nothin bout no steamfitter nor no valve neither."

At this point, one of George's friends nosed in to ask if a check valve were necessary and, when informed in the affirmative, said he, "Never seed no good boiler thout a check valve".

George: "Guess so, mebbe so, I dunno; mebbe if she'd had one las December she wouldn't a busted. Yo'all know how this hyah boiler busted? I'll tell yuh: Plumber he say Jawdge busted the boiler. Jawdge didn' bust no boiler; Jawdge jest done whut he was tol. Plumber he come hyah to put in a new radiator in the front room. See that big wheel up dere? (pointing to main stop valve). Wallsuh, he done spun er aroun and aroun en shut her tight and went to cut his pipe. Ah was sittin hyah in ma chair an fust thing ah knowed, bippety blam, blam, ol boiler begun bangin. Ah holler for de plumber, en he comes a-runnin; ah says somethin wrong hyah, boss. He say 'Open dat valve an give her a lil water; she's too hot.' So, ah opens de feed valve. See dat clock? (steam gage). She was way up to der top; ah opens de valve, ah did, an Lawdy; bing, bang, blippety blam; ah looks at de boiler an hones she was a rockin on her base like a ship on de ocean. Ah says, dis ain gonna work, so ah shets de valve again quick."

One of George's friends: "Yo knows where ah'd a bin when she stopped rockin?"

George: "Whur at wud yuh a bin?"

Friend: "Bout fo blocks up 8th Avenue."

George: "Wall, AH had nerve nuf to stick hya an shet er down."

Friend: "Nerve? Man, you was jes dumb."

George: "Wall, ne'mine, de clock she drapped right back an everythin got quiet when ah shet de valve. Plumber he goes back to work an ah sits me dahn in ma chair; in about five minutes, whang! bam! She starts again. Ah yells fer de plumber and tells him dis boiler sure done somethin to herself thet time. Plumber he run in, yanks open de fire door; he say, 'She's too hot, git some water.' So he open dis facet wide an fills dis tub, grabs a bucket and bails water onta de fire as fast as he can. Time he gits her all out an when de smoke an steam cleared out, boy, was she a mess? Thet's how come dis boiler gits busted. No suh, Jawdge ain't done bus no boiler."

Saw All, Heard All

Fresh from an inspection trip through one of the large locomotive works, a young lady undertook to describe to her friends how a locomotive is made. This was her version of it:

"You pour a lot of sand into a lot of boxes," she explained, "and you throw old stove lids and things into a furnace, and then you empty the molten stream into a hole in the sand, and everybody yells and swears. Then you pour it out and let it cool and pound it. Then you screw it together, and paint it, and put steam in it, and it goes splendidly; and they take it to a drafting room and make a blue print of it. But one thing I forgot—they have to make a boiler. One man gets inside and one remains outside, and they pound frightfully; and then they tie it to the other thing, and you ought to see it go!"

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1932

Capital Stock, - - $3,000,000.00

ASSETS

Cash on hand and in banks		$ 782,202.90
Premiums in course of collection (since October 1, 1932)		973,590.37
Interest accrued on mortgage loans		40,081.96
Interest accrued on bonds		114,256.73
Loaned on bonds and mortgages		948,517.17
Home Office real estate		437,474.66
Other real estate		212,746.88
Agents' ledger balances		4,159.04
Bonds on an amortized basis	$8,823,376.79	
Stocks at "Convention Values"	7,178,230.12	
		16,001,606.91
TOTAL		$19,514,636.62

LIABILITIES

Premium reserve		$7,142,070.04
Losses unadjusted		317,337.64
Commissions and brokerage		194,718.07
Other liabilities (taxes incurred, etc.)		566,977.68
Contingency Reserve		3,600,000.00
LIABILITIES OTHER THAN CAPITAL AND SURPLUS		$11,821,103.43
Capital Stock	$3,000,000.00	
Surplus over all liabilities	4,693,533.19	
Surplus to Policyholders,		**$7,693,533.19**
TOTAL		$19,514,636.62

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Incorporated 1866 Charter Perpetual

Department	Representatives
ATLANTA, Ga., Citizens & So. Nat. Bk. Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 704-9 Garrett Building	D. W. Little, Manager. P. E. Terroy, Chief Inspector.
BOSTON, Mass., 87 Kilby Street	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., City Savings Bank Building	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 175 West Jackson Boulevard	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio, First National Bank Building	F. L. Hower, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, Leader Building	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER, Colo., Gas & Electric Building	J. H. Chesnutt, Mgr. and Chief Inspector. F. G. Parker, Ass't Chief Inspector.
DETROIT, Mich., First National Bank Building	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., 56 Prospect Street	F. H. Kenyon, Manager. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., Hibernia Bank Building	R. T. Burwell, Manager and Chief Inspector.
NEW YORK, N. Y., 90 John Street	C. C. Gardiner, Vice-President. E. Mason Parry, Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut Street	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., Arrott Building	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth Street	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., 114 Sansome Street	C. B. Paddock, Manager. L. E. Grundell, Chief Inspector.
SEATTLE, Wash., Arctic Building	E. G. Watson, Manager. and Chief Inspector.
TORONTO, Ont., Canada, Federal Building	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.

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The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Provisions for Wear in Vessels with Stirring Devices

AMONG the great variety of pressure vessels used in manufacturing processes, there is a class which employs stirring devices of some kind. These stirring devices not infrequently get out of line or otherwise become misadjusted so that the moving parts rub on the walls of the container. Furthermore, there are many substances that, in

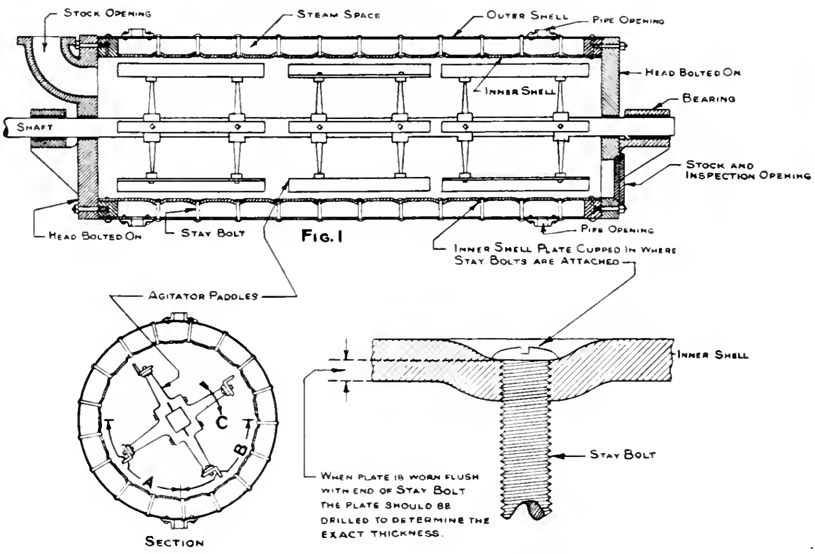


Fig. 1

Section
Fig. 2

Fig. 3

themselves, are of an abrasive nature and, when kept in almost constant motion, will cause a scouring action on the metal with which they come in contact. In this class of vessels are the driers used in the meat packing industry. These are usually jacketed vessels of large size constructed with staybolts to support the inner shell (Figure 1).

To lengthen the life of his apparatus, one large user of these vessels has developed a method that is ingenious enough to warrant a detailed description.

The accompanying sketches show the general construction of one of the types of fertilizer driers used by the concern. As illustrated in the cross-sectional view, Figure 2, experience has shown that the greatest wear in the inner shell will usually be in the area marked "A", provided the paddles revolve in the direction shown by the arrow. The drier is continued in service with the paddles operating in this direction until, by inspection, it is determined that the inner shell in the area "A" has been worn to its minimum safe thickness. The driving motor is then reversed and the agitator paddles made to revolve in the opposite direction. The inner shell then wears at area "B".

When area "B" has worn to its minimum safe thickness, the drier heads are removed, the steam and condensate pipes are disconnected, and the drier shell is turned 180°, thus placing the unworn portion on the bottom. This turning of the shell is made possible by the fact that the stock openings are placed in the heads and that duplicate pipe connections are provided.

The heads and pipes are replaced and the drier is continued in service until the two quarters of the lower portion of the inner shell are worn to the minimum safe thickness as in the portions marked "A" and "B".

As a reminder to operators and maintenance men an arrow is attached to the driving gear of the agitator paddles, to indicate the direction in which the paddles are to turn. When the rotation is changed the arrow on the gear is reversed.

By this procedure the inner shell is worn or wasted over practically its entire surface, thus obtaining the maximum length of service from it.

Another desirable feature of this drier is that the inner shell is cupped inward where the staybolts are attached. This feature allows the staybolts to retain the proper number of threads in the plate while the inner shell is being worn to its minimum safe thickness. When the staybolts are installed in this manner (Figure 3) they also act as an indicator as to the approximate amount which the inner shell is worn.

In the July, 1916, issue of The Locomotive will be found an article on "Driers" which discusses more in detail the points in connection with this staybolt arrangement.

Two Men Injured After Steam Valve Failure

Two men were scalded, one seriously, when a steam valve recently failed at a North Carolina finishing mill. The steam was used to heat water in an open tank of about 300 gallons capacity. Preceding the accident, the water in the tank was near the boiling point, and the stripping of threads on the valve stems, said to have been caused by the application of excessive force every time the valve was closed, permitted steam at 90 lbs. pressure to enter the tank, throwing the scalding water in all directions.

Ford Motor Company, England, plans to employ hot gases from incinerators used to handle refuse from the City of London, to operate one of three power units, each rated at 200,000 lbs. of steam per hour at 1,200 lbs. pressure and 725° F. final steam temperature.—*Steam Plant Engineering.*

Photographic Investigation of Caustic Embrittlement

By J. P. Morrison, *Assistant Chief Engineer, Boiler Division*

PHOTOGRAPHING the walls of rivet holes in a boiler drum through the Hartford magniscope, thereby combining the principles of the periscope, the microscope and the camera, was described in an article in The Locomotive for April dealing with developments in the detection of caustic embrittlement. The interest aroused in America and abroad by the reference to the Hartford Steam Boiler Inspection and Insurance Co.'s work on the subject appears to justify publication of further detail.

The difficulties of photographing evidences of caustic embrittlement are in themselves an interesting subject and form a logical supplementary article to that in the prior issue. The accompanying photographs, explained in detail later in the article, clearly illustrate the problems involved.

Prior to the development of the Hartford magniscope, our inspectors, by the use of small magnifying glasses, had become proficient in the discovery of cracks in boiler seams in spite of the difficulties encountered even in the comparatively small rivet holes in thin plate. Under the operating conditions of a few years ago, involving low rates of evaporation, the fissures were comparatively slow in development, requiring, in many cases, a number of years' operation with boiler water of high sodium carbonate alkalinity and low sulphate content, before the disease progressed through the plate a sufficient distance to impair the safety of the boiler. During that time, the defect in the wall of a rivet hole may have developed until visible to the eye. Not infrequently, one boiler became affected to a dangerous degree a considerable time before it appeared in other boilers operated under identical conditions. The seam of one boiler of which we have record was examined at intervals of two weeks for six years between the time the first evidences of caustic embrittlement were discovered and the time the development reached the danger stage.

However, with the higher rates of combustion and furnace temperatures now generally used, make-up water treatment is an absolute necessity, even where the boiler supply is principally condensate. The boilers of great capacity, designed for the higher ranges of pressure, have thick shellplates, and larger, longer rivets, and so have correspondingly greater areas to be affected by caustic embrittlement. If the distress is discovered in one boiler, it is probable that all boilers in the plant are affected to a greater or lesser extent. The development instead of requiring a number of years may be the cause of an explosion within a year or less after the boiler is first placed in service.

Before the Hartford magniscope was developed, if no crack could be seen by the naked eye or under a small magnifying glass, the true condition of the seam could not be determined. The boiler was continued in service until greater development brought the defect into the range of visibility, but made the caustic embrittlement fissures visible at a stage too far advanced to permit salvaging the investment. The situation made it evident that some better method of investigating rivet holes would have to be devised, if the disease were to be diagnosed in time to prevent the scrapping of expensive installations.

The Hartford magniscope with its periscope principle of inserting a mirror into the rivet hole, was devised to solve this problem. The original instrument, of 6 magnifications (little more than that obtainable with a reading glass) gave way to one of 12-power, which in turn was replaced by a magniscope of 20-power. We are now successfully using lenses giving approximately 100 magnifications of the surface being investigated. Etching the polished rivet hole enables us to bring out with this magnification, the grain boundaries of the steel showing the intercrystalline path of the fracture. This, we believe, has not been done previously except in a metallurgical laboratory.

The work of polishing and etching the rivet hole in the boiler violated many of the traditions and practices of such work. While the laboratory method of having a small specimen polished to a perfectly smooth, plane surface is recognized as the ideal working condition, we are not able to change the shape of the wall of a rivet hole, which is curved and frequently not over an inch in diameter. Furthermore, a caustic embrittlement fissure seldom develops in a straight line, so not only is the area to be polished, etched and photographed curved, but the problem of focusing is complicated by the fact that the defect in which we are interested usually crosses that curved surface at an angle. The difficulties in establishing a perfect focus with any sort of a magnifying instrument may be easily imagined.

Customary laboratory instructions for micro-photographing steel read about as follows: "After etching a sufficient length of time with acid, dip the specimen in ethyl alcohol to neutralize the acid, drying quickly in moving air to prevent rusting". This laboratory instruction is not so easily followed when the specimen is part of a boiler drum 54″ in diameter by 30′ in length and weighing 25 tons.

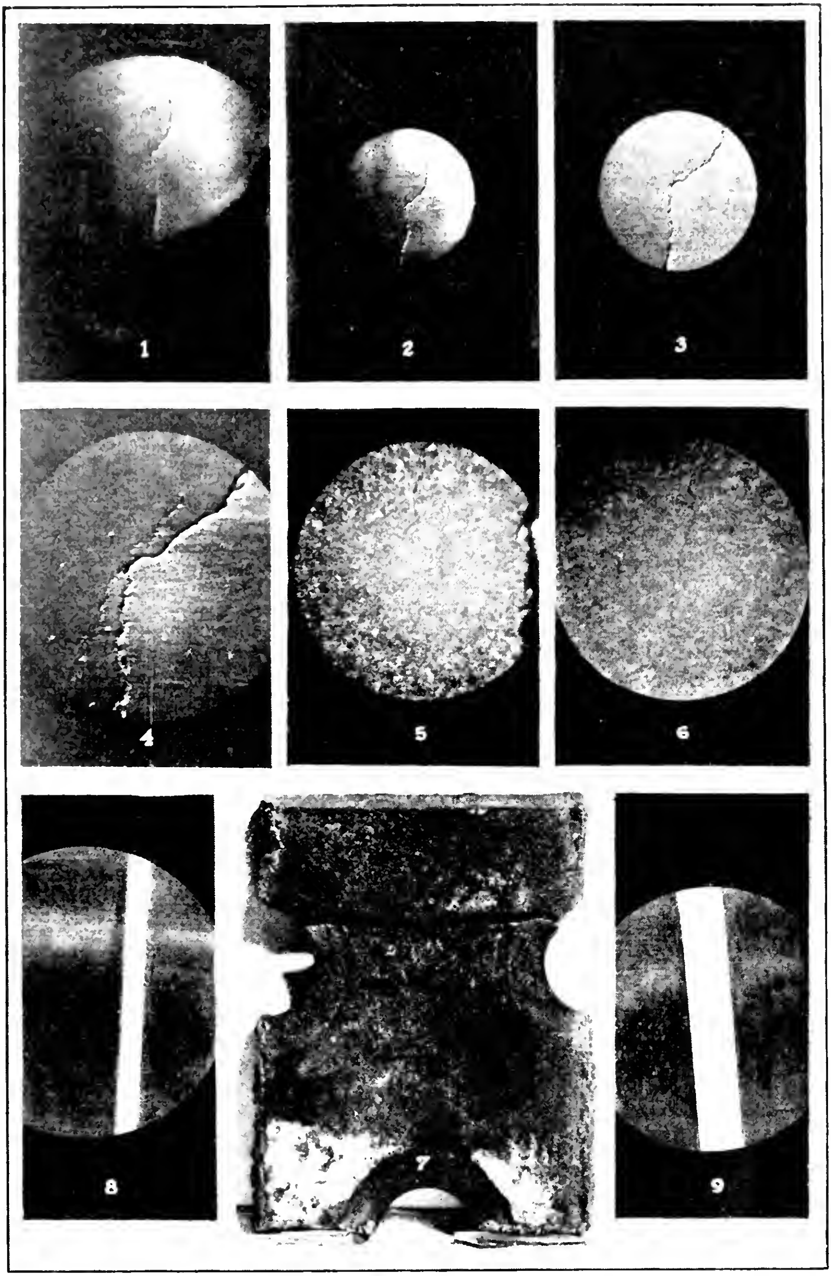
It was pointed out in The Locomotive article previously referred to that the surface to be magnified and photographed may be lighted either by means of a small electric lamp affixed to the end of the magniscope, or by a larger lamp so placed as to illuminate the rivet hole. Neither of these methods provides what might be termed a perfect light for as irregular a surface as the wall of a rivet hole which is being examined in detail for microscopic cracks. Because of the curvature of the surface to be photographed, the angles of the light rays upon the area within the range of the reflecting prism, as used in the magniscope of latest design, lead to diffusion in some zones and concentration in others. These particular difficulties of focusing are still a problem and we have not been able to overcome this trouble entirely. In taking the photographs accompanying this article it was sought to correct this condition as much as possible by getting the important part of the picture into the best focus and by throwing sufficient light on the part of the plate to be brought out in the photograph. In these cases, of course, the important part of the picture is the section of the rivet hole through which the embrittlement fissure passes. This explains why the center portion of some of the pictures is in sharper focus than is the outer portion.

Recently symptoms of caustic embrittlement were found in a plant containing five boilers. For the purpose of comparing the older methods with the newer, photographs made during the investigation are now reproduced as a matter of general interest.

Photograph No. 1 was taken through the original Hartford magniscope, using the camera attachment. The defect was faintly visible without the aid of magnification after the surface had been polished and the location of the defect had been determined.

Photograph No. 2 is of the same defect through an instrument similar to the original magniscope except that the reflecting mirror had been replaced with an optical prism.

Photograph No. 3, taken with the magniscope and camera attachment of the latest design, is of the same defect at about 20 magnifications. In this photograph the true nature of the embrittlement defect becomes clearer. What is seen in the photograph is not a large fissure with branches, but rather the junction of two large fissures, the one progressing upward in the photograph and the other downward. Thus the complete defect, which extends the full width of the boiler plate, was formed by the joining of two independent fissures, each progressing from the surface of the plate. Further investigation, after the plates forming the butt strapped seam had been separated, brought to light the fact that each of the two lines of cleavage, while appearing to unite at the wall of the rivet hole really extended independently of each other



How caustic embrittlement cracks appear through the magniscope.

through the material of the plate in the direction of an adjacent rivet hole. These two fissures progressing from one rivet hole to another tended to make a section of the plate between them a sort of island cut off from the rest of the plate.

Photograph No. 4 is of the same defect magnified about 40 diameters and gives a better illustration of the grapevine path of the smaller fissure shown in the lower part of the photograph.

Photograph No. 5 is a part of the fissure at the lower left of photograph No. 4 which was not visible in the pictures of smaller magnification. The larger defect which can be seen in photographs Nos. 1 and 2 appears as a large irregular gouge along the righthand side of this picture, which is of approximately 100 magnifications.

Photograph No. 6 is of the same defect as No. 5 except that the rivet hole wall had been etched. It is of approximately 100 magnifications and shows the path of the crack between the grains of the steel.

Photograph No. 8 shows the poles of a micrometer set at .005″ and magnified about 40 times. If any part of the defect illustrated in photograph No. 4 were .005″ in width it would be of the same width as the gap shown in photograph No. 8.

Photograph No. 9 shows the micrometer poles set at .005″ and magnified 100 times. Thus if the hairline defect shown in photographs Nos. 5 and 6 were .005″ in width, it would be as wide as the space shown in photograph No. 9. These two photographs (Nos. 8 and 9) are shown merely to give an idea of the minuteness of embrittlement cracks in their early stages.

The final stage of caustic embrittlement development is illustrated in photograph No. 7. This piece of metal came from the butt strap of a boiler which embrittlement had ruined. When the strap was removed, it fell apart under a very slight hammer blow.

Frequently, the fact that a caustic defect is not visible to the naked eye is used as the basis for an opinion that it is of minor importance and has not extended a distance sufficient to weaken the boiler materially. However, experience has taught us the impossibility of determining from its appearance across the wall of the rivet hole what distance the crack extends into the plate on a line parallel to the longitudinal axis of the drum.

This uncertainty has led to the perfection of an inspecting technique to ascertain with more accuracy the depth of a defect at a particular rivet hole or group of them. After the presence of the disease has been discovered in the wall of a rivet hole, it is known to a certainty only that the cracks are present in the surface of the hole. It is not known how far they extend into the plate, whether 1/8", 1/4" or the entire distance to the next rivet hole. To determine whether the embrittlement has eaten only a short distance or whether it is more serious, a hole (see Figure 10-A) is routed into the side of the rivet hole where the crack was found by means of the magniscope. A dental drill or burr has been used with some success in excavating a cavity to a depth of 3/16" into the plate, but an especially designed combination of motor, flexible shaft and milling tool was used in exploring the particular defect shown in the photographs. With this tool a cavity 1/4" wide was milled into the steel plate to a depth of 1/4". This exploration revealed conclusively that the fissures extended more than 1/4" into the plate, and further investigation showed that they extended practically from rivet hole to rivet hole. Exploration in other rivet holes revealed a veritable network of cracks developing simultaneously through the plate. Had the cracks penetrated to a depth of only 1/8" the progress of the disease might have been checked by reaming the rivet holes oversize and reriveting the seam.

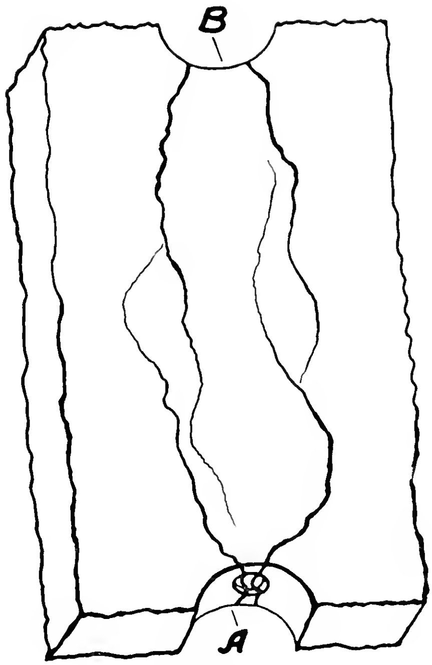


Fig. 10.

The case used in illustrating this article had progressed to a point where a dangerous weakening of the boiler plate and butt straps had taken place, so the drums were removed. One of the butt straps was cut, and the condition shown in photograph No. 7 was revealed. In another piece of the strap, with rivet holes into which cavities had been drilled in the sides, a condition similar to that illustrated in Figure 10 was brought to light. It is shown here because it emphasizes the network of fissures which are often present in an advanced case of caustic embrittlement.

Figure 10 is a drawing of a section of plate cut from a scrapped drum. In the case in point the development of fissures from two adjacent rivet holes was studied and charted. Two of the fissures passed through the cavity milled in the wall of the rivet hole A and then proceeded about halfway to the next rivet hole B. Two other fissures had started at the rivet hole B and had proceeded to a point where they merged with the two fissures developing at A. Thus in this case four separate fissures had contributed to the disintegration of the plate. These and other fissures had ruined the boiler drum beyond repair.

Power Boiler Accidents

WHEN a 72″ horizontal tubular boiler, used in a battery of three at a Wisconsin dairy, bulged and ruptured on March 16, the accident cut off the plant's entire steam supply, and resulted in the death of one man and serious injury to another.

The rupture occurred with considerable violence in the center boiler, and resulted in serious damage not only to it, but also to the adjacent boilers, and to the steam piping, the stoker equipment and the building itself. The boilers were insured by the Hartford Steam Boiler Inspection and Insurance Company, which paid the direct damage loss, $6,564.88.

It was evident, from examination following the accident, that the water in the boiler had been low. Investigation showed that the bottom of the front course had the characteristic discoloration caused by burning, and the course appeared to have been increased in circumference by about 20″, due to the bulge caused by overheating. The tear, which was 32″ across at its widest part, extended in the bottom of the first course from the girth seam to the front head seam, and then through the front head seam into the manhole opening in the front head. Witnesses said that the pressure on the boiler at the time of the rupture was about 60 lbs. This was sufficient, however, to force the boiler upward out of its place in the brickwork so that it struck and bent the 12″ steel beams which supported two of the boilers.

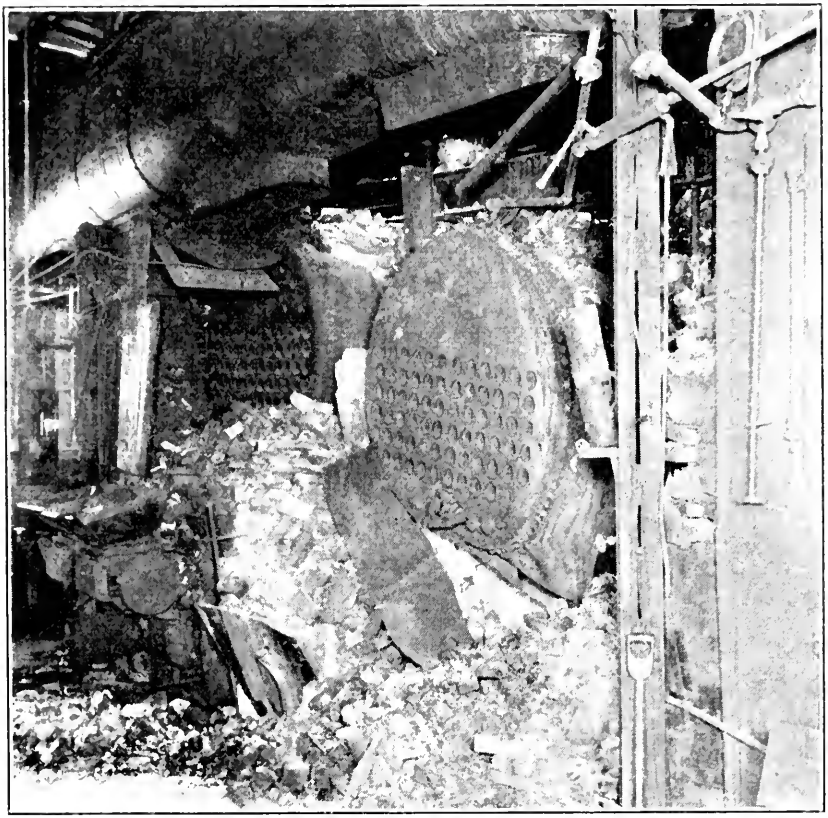
Besides causing major loss to the exploding boiler, the accident destroyed the settings of the whole battery, damaged the stokers, mangled the fronts of the other two boilers, and broke attachments, steam pipes, water lines, supporting beams and breeching. There was also damage to walls and roof.

At the time of the accident, three men were completing the installation of a stoker for the center boiler, and had started the stoker to test its operation with the boiler under steam. A helper who was working on top of the boiler was killed; an erecting engineer who was superintending the installation was hurt seriously; and a third man sustained minor injuries.

The blow-off valve, examined after the explosion, indicated that the water had probably escaped from the boiler by this outlet.

Other recent power boiler accidents also took their toll in deaths and injuries to persons and damage to property:

Two men were scalded to death and two others injured when a tube ruptured in a boiler used by a Kentucky brick company.



After dairy boiler bulged and ruptured

The failure of a tube on a boiler used in connection with an oil well development near Bradford, Pennsylvania, caused the death of the owner of the lease, who happened to be in the path of the escaping steam.

As preparations were being made for a hydrostatic test on the main boilers at the Madison, Indiana, shipyards, an auxiliary boiler which was used to supply steam to a feed pump, exploded and killed the engineer instantly. He was crouched over, stoking the fire under the boiler, when the blast occurred. His body was blown about 50 feet. Because the boiler was somewhat removed from other machinery, little damage was done, except to the boiler and its attendant.

The body of the watchman at a Chicago laundry was removed from beneath tons of debris following a boiler explosion which completely wrecked the two-story plant. The explosion hurled bricks and flying metal into neighboring private garages, damaging four automobiles.

An explosion at an Illinois coal mine destroyed the boiler house, and seriously injured the night engineer, the only man on duty at the time. The boiler, a horizontal tubular design, 72″ in diameter and 18′ long, was used to heat water for the washroom and to generate steam to operate large air fans. The boiler itself was catapulted through a wall and into a nearby pond. The building was demolished and a brick and concrete smoke stack about 5 feet square and 35 feet high was snapped off. The engineer was injured by flying cinders, hot water and falling debris. Bricks and concrete were scattered within a radius of 100 yards.

At a Texas oil development the explosion of a boiler used to supply steam for drilling ripped the boiler from its foundation and parked it 200 feet from its setting. One man was seriously injured. This boiler was the second to explode at this location within the year.

The explosion of a boiler used in a Jasonville, Indiana, cleaning plant caused considerable excitement. The boiler was thrown about 200 feet into a neighboring yard. No one was injured, the employees being out-of the building at the time. The plant was being started up preparatory to regular operation.

At a brick yard, in New Jersey, two men were killed and four others injured, two of them seriously, when a stoppage of the steam outlet led to an explosion of a cast iron boiler used to heat oil. All of the injured men were in the boiler room at the time of the accident.

Safety Valve Proves Too Small for Tank

The inadequate capacity of a safety valve used on a hot water tank connected to a boiler in an Arkansas garage, led recently to the explosion of the tank and damage to heating equipment and automobiles. The vessel was made of 1/8″ steel with welded head seams and a welded longitudinal seam. It was 24″ in diameter and the theoretical bursting pressure was 473 lbs. The tank ruptured along a line about 6″ from the welded longitudinal seam and parallel with it.

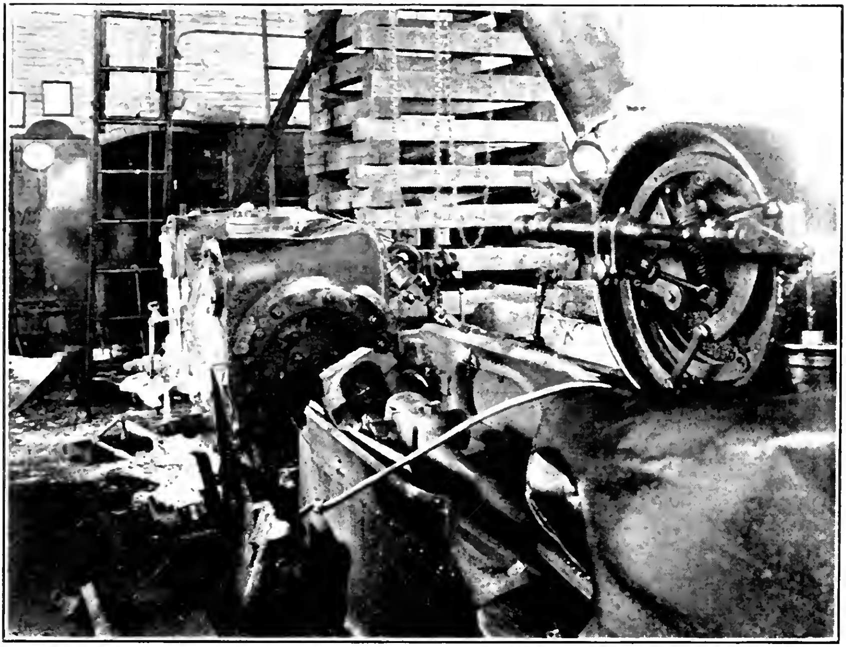
M. M.: "Did I bring your pipe wrench back last month?"
C. E.: "No, you certainly did not."
M. M.: "Now what am I going to do? I wanted to borrow it again."

—*Powerfax.*

Drains on Steam Engine Piping

By H. J. Vander Eb, *Assistant Chief Engineer, Turbine and Engine Division*

IT IS well known that if slugs of water enter the cylinder of a steam engine in motion, the reciprocating parts or the cylinder or both will be damaged. In some cases the immediate result is a disastrous breakdown, but in others there may be merely the weakening of some of the parts, and the actual breakdown may not



When the piston tried to compress water and the crosshead failed under the strain.

occur for months or years. The degree of damage depends on the quantity of water, the size of the clearance space and the speed of the engine. The damage may be only a slight straining or possibly a surface fracture in a normally concealed part of a connecting rod strap or a crosshead, or in the threads of the piston rod or in the flat surfaces of the piston. The initial weakness may then progress gradually during a long period of operation until the affected part ultimately fails. When a break occurs and there is no evidence that water has entered the cylinder at that time, the operator usually expresses surprise. He overlooks the fact that the initial damage may have started long before the failure took place, but was not readily manifest then.

Although drains for steam pipes, receivers and exhaust pipes have been the subject of much discussion, the importance of adequate automatic drainage equipment is not always fully appreciated. There are a number of different conditions under which water may enter a steam engine cylinder. The principal ones are:

Serious priming of the boiler causing large quantities of water to go over into the engine cylinder, even though there is a steam separator in the steam line. On a compound engine the moisture in the live steam may not seriously affect the high pressure cylinder, but may, in the absence of an effective drain, accumulate in the receiver between the high and the low pressure cylinders and eventually be carried over into the low pressure cylinder.

Failure to provide a proper automatic drain in the receiver between the cylinders of a compound engine. If a trap is provided, it frequently is one which will operate only while the pressure in the receiver is above atmospheric pressure. This arrangement may work out all right for certain engines which always operate at full load, because the receiver is then always subject to pressure above atmospheric except during the short time of starting when a slight vacuum may occur. Thus, if the receiver is amply large so that it can safely store a considerable quantity of water, the use of a pressure trap may be permissible. If, on the other hand, the receiver is small and it is likely that the engine may operate for long periods under light loads, it is to be expected that a dangerous accumulation of water in the receiver will result. This water eventually would go over into the low pressure cylinder. Operators frequently misunderstand the true function of a pressure trap and they assume that it will act as a check valve. This, of course, is not true. Should the outlet from a pressure trap be under water, the vacuum would tend to draw water through the trap into the receiver. The outlet pipe from any trap should always be open-ended and must never be submerged in water.

Pockets in the steam pipe, due either to improper design or fitting up of the piping, or to a sag in the middle of a long run of pipe. (See Figure 1.) The water which is certain to accumulate in such pockets will be carried over into the engine cylinder when a sudden increased flow of steam occurs due to increase in load.

Presence of a large quantity of water in the live steam pipe, particularly in the vertical leg leading to the engine throttle. Operators occasionally fail to drain off this water properly at starting time with the result that at the first few strokes of the piston this water gets into the cylinder and causes serious overstresses in the reciprocating parts.

Water backing into the steam cylinder of a non-condensing engine from an atmospheric exhaust pipe. As a rule the exhaust pipe extends down from the engine, making a U-turn or loop and then leads to the atmosphere (Figure 1). It is very important that such a loop be properly drained at all times and the best arrangement is an open drain pipe leading down to a sump without any valves or traps. The open end of this drain should never be submerged in water. This is a frequently neglected feature because it is not generally understood that there is a

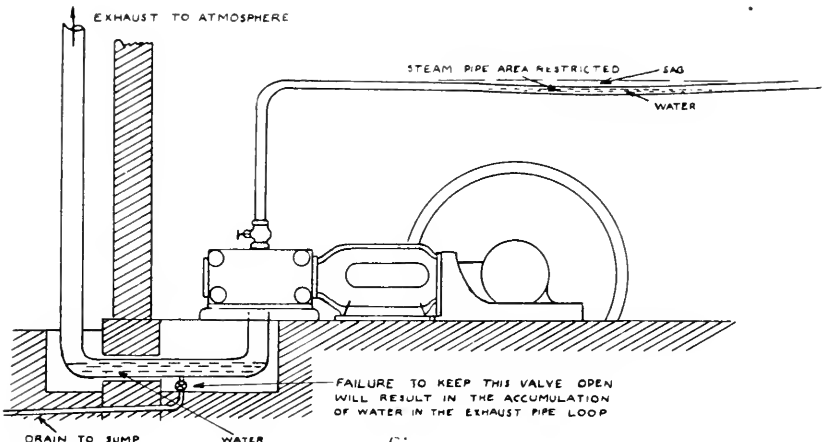


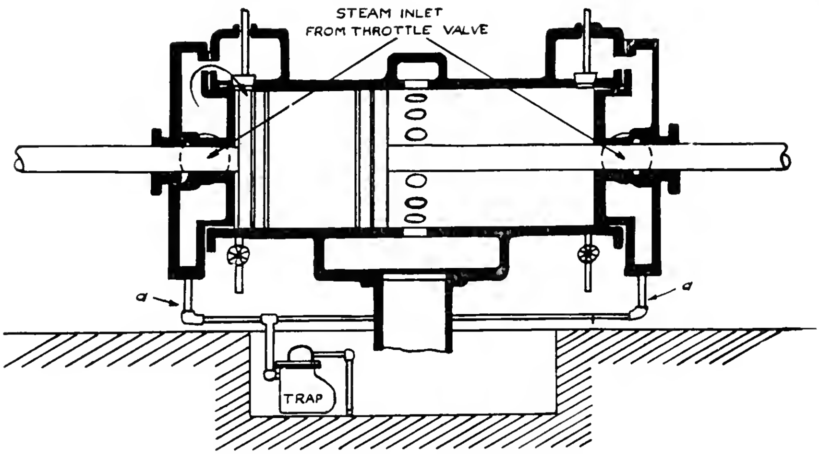
Fig. 1.

slight suction in any atmospheric exhaust pipe during a certain brief portion of the piston stroke. Furthermore, the low temperature of the outdoor part of the exhaust pipe causes it to function somewhat as a condenser, particularly during cold weather. The resulting condensate accumulates in the exhaust pipe loop unless there is an open drain at the bottom of the loop.

If considerable water is permitted to accumulate in the loop while the engine is operating, the exhaust steam has to force itself past or through this water. Even when there is a good load on the engine with the resulting large volume of exhaust steam, a slight amount of water may be drawn into the cylinder at the end of each stroke by the suction mentioned above. This water may be sufficient to cause slight over-stress in the reciprocating parts. The condition is usually manifested by a thumping noise and possibly by movement of the cylinder, or movement of the whole engine on its foundation.

The breakdown of reciprocating parts is, in most cases, a result of the development of a progressive crack. If such a crack exists it would be continually aggravated by the constantly recurring small doses of water pulled back from an exhaust pipe loop.

There are a number of cases on record where the backing up of water from an undrained atmospheric exhaust pipe loop caused the complete wrecking of the reciprocating parts of an engine or the failure of its cylinder head. In many of these cases the engine had been operating under a very light load or a friction load and during this time the exhaust pipe loop became nearly full of water. When under these con-



AUTOMATIC DRAINS FOR UNIFLOW CYLINDER HEADS

Fig. 2.

ditions the throttle was suddenly closed, the pressure drop throughout the cylinder was such that momentarily a pressure below that of the atmosphere existed and the water in the exhaust pipe was drawn back into the cylinder while the engine was still turning over due to the momentum of the flywheel.

Improper drainage facilities on uniflow engine cylinder heads. The cylinder heads of a uniflow engine are as a rule steam-jacketed, that is, all the steam used by the engine enters through the cylinder heads. By the use of a baffle the steam then makes a complete sweep through the heads and finally enters the cylinder by way of the poppet valves. Since cylinder heads of this description necessarily form pockets (in the lower half) in which water can collect it is essential that suitable drains (See a-a Figure 2) be provided at the bottom of the heads.

A number of costly accidents to uniflow engines were caused by neglect of this drainage feature. In these cases it was ascertained that water had accumulated in the bottom of the cylinder heads while the engine was running under a friction load. When suddenly an appreciable load was put on the engine the greatly increased flow of steam through the heads carried this water into the cylinder with disastrous results.

The proper safeguard against this condition is the continuous drainage of the cylinder heads by means of a steam trap. Preferably there should be no valves in the drain lines from the cylinder heads to the trap as these valves might be inadvertently closed. In some cases the operators have mistaken the drain valves on the cylinder heads for cylinder drains and have closed them.

Of course, if it so happens that an engine of this description never operates at friction load or at very low load for any appreciable length of time, but is always under full load, a disastrous accident as described, may never occur. However, in any installation the time interval during which the engine runs at friction load, after having been started from cold condition and before the load is put on the engine, may on some occasion be sufficiently long to cause dangerous water accumulation in the cylinder heads, unless properly drained, and a serious breakdown may then occur.

Failure of Lubrication Supply on Turbine

THE loss of lubricating oil due to the draining of the oil reservoir on a 12,500 kw turbine resulted recently in a property loss of $6,905.09 covered by "Hartford Steam Boiler" insurance. The accident illustrates how an apparently efficient lubrication system can fail with costly results.

In this case there was an oil supply tank in the basement from which oil could be pumped to the oil reservoir at the turbine. The discharge line from this pump had a branch running to the turbine reservoir and also a branch returning to the oil supply tank. Each of these branch lines was provided with a valve and the connection to the oil reservoir was made near the bottom.

Just prior to the accident, the turbine operator, finding that additional oil was required in the reservoir, telephoned to the basement asking that the oil pump be started. Upon being informed that the pump was running, the turbine operator opened the valve in the supply line to the reservoir and then occupied himself with other duties before ascertaining definitely that oil was being delivered to the reservoir. It so happened that the valve in the discharge line between the pump and the supply tank had been left open and the pump was simply returning the oil to that tank. The oil in the reservoir was also drained into the supply tank through the same line as the discharge from the pump.

The loss of the oil pressure tripped the emergency stop, but before the machine came to rest the three main bearings and the exciter bearing were worn down, permitting the rotor to be lowered sufficiently to damage seriously the shaft packings at the diaphragm and the water seal impellers, the oil deflectors at the main bearings, and the shaft seals at the generator end bells. The thrust bearing also was overheated and partly worn away. The auxiliary oil pump automatically went into operation with the lowering of oil pressure and its turbine wheels and shaft suffered major damage also due to lack of lubrication. The exciter received such injury as to require extensive repairs. Because of the large radial clearances between the ends of the buckets and the casing on this particular type of turbine, the wheels and buckets showed no evidence of rubbing.

To prevent a recurrence of such an accidental draining of the oil reservoir, the pipe connection was removed from a point near the bottom of the oil reservoir and a new inlet oil connection was made near the top above the normal operating oil level. This is a form of protection of the oil supply recommended for similar installations.

If there is a glass oil gage on the outside of a turbine oil reservoir, it should be carefully protected so that its accidental breakage would not cause the loss of oil from the reservoir. Better yet, gage glasses of all kinds on the oil reservoir should be avoided and mechanical pneumatic, or electrical indicators provided.

Fire Follows Ammonia Equipment Accidents

When a 16-ton ammonia condenser slipped as it was being loaded in a New York brewery early in July, it crashed against the basement wall, pinching and breaking an ammonia main. Fumes immediately filled the basement, the mixture of air and ammonia gas caught fire and the ammonia tanks exploded.

The explosion of an ammonia tank in the wax house of a West Virginia refining company's plant on June 23, resulted in the death of one man, who was overcome by fumes and burned by subsequent fire. Other workmen were able to leave the plant without injury.

"Engines are called 'she'," according to W. S. Scarboro of St. Albans, Vt., road foreman of engines for the Central Vermont Railway, "because they wear jackets, with yokes, pins, shields and stays. They have aprons, pumps and hose, and even drag trains behind them."

How Oil, Scale and Soot Insulate Boiler Plate

An idea of the insulating effect of a thin film of oil on the heating surface of a boiler is given in an account by *National Engineer* of recent tests in which fire temperatures ranging from 2,190 to 2,500° F. were used on an iron vessel ½ in. thick. With the surface clean and the vessel containing pure water the temperature of the metal was 280° F. A mixture of 5 percent mineral oil was then used and the temperature rose to 310° F. It was found that a coating of grease 3/64 in. thick on the bottom of the vessel resulted in a temperature of 518° F.

While lubricating oil is a common menace to the efficiency of boilers, there are two other hazards of a similar nature which should be emphasized from the standpoints of safety and economy. A coating of scale inside the drums or tubes or a coating of soot outside may not at once manifest any evidence of retarding the boiler's efficiency, until the relationship between fuel consumed and steam generated is noted. As soot or scale or oil on boiler plate accumulates, a higher furnace temperature is needed to effect the required heat transfer necessary to keep the boiler steaming.

Machinery Lowered by Ice Blocks

The new freezing vat at the Mueller Ice Company, Commerce, Texas, is in position after an interesting engineering feat. The vat came from the factory in steel sheets with rivet holes accurately punched, and was fabricated on cribbing about 18″ above the foundation on which it was to rest.

The finished tank weighed approximately 16,000 pounds, and the problem confronting the engineers was to take out the supporting blocks and lower the tank without straining the riveted seams in such a way that leakage would ensue. To meet the difficulty 1,200 pounds of ice was purchased and sawed into 100-pound blocks. After the blocks were placed under the eight tons of metal, the wooden cribbing was removed, and as the ice melted the tank settled gently into position.

—*Ice and Refrigeration.*

Steam Supply Pipe Ruptures Under Street

Steam and water vapor rose to a height of twenty stories when a supply pipe beneath Park Avenue, New York City, ruptured a few weeks ago. The pipe supplied steam to buildings along one block of the thoroughfare. It was necessary to divert traffic to other streets while workmen repaired the break.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., July, 1933

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THE LOCOMOTIVE *of* THE HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO.

William G. Lineburgh Represents Company 50 Years

William G. Lineburgh and Son, Inc., of Bridgeport, Conn., this year observed the fiftieth anniversary of the firm's initial connection with the Hartford Steam Boiler Inspection and Insurance Company. The late William G. Lineburgh was appointed General Agent for Southern Connecticut in February, 1871, by the late President J. M. Allen. In 1883, the present William G. Lineburgh, Sr., head of the agency, entered the business and has continued from that date. William G. Lineburgh, the founder of the business, died in November, 1903, after representing the "Hartford Steam Boiler" for 32 years.

The firm at present is made up of Mr. Lineburgh, John J. Caraher who has been connected with Mr. Lineburgh and the business for 40 years and W. Gerald Lineburgh, son of Mr. Lineburgh, grandson of the first William G. Lineburgh—the third generation of Lineburghs to represent the "Hartford Steam Boiler". The present head of the agency remembers that when the Bridgeport office was first opened there was only one inspector located there and that all letters were written in pen and ink and all policies written in the same manner.

Two Chief Inspectors Are Appointed

The many policyholders of the Hartford Steam Boiler Inspection and Insurance Company in Northern Ohio and Pennsylvania who have known John L. Scott while he was an inspector, adjuster and directing inspector for the Company in the Cleveland departmental office, will be pleased to learn of his advancement to the post of chief inspector in

John L. Scott

Frank G. Parker

the New Orleans Department, which includes Louisiana, Mississippi and Southern Texas. The promotion became effective May 16, 1933.

Mr. Scott entered the employ of the Company as an inspector in the Cleveland Department on May 16, 1923. Two years later he became the adjuster for that department and in March, 1929, was made directing inspector under Chief Inspector J. F. Hunt. With this varied experience he is admirably fitted for the new responsibilities he is to assume at New Orleans.

The promotion was announced also of Frank G. Parker to the chief inspectorship of the Denver Department which includes Colorado, Wyoming, Montana, New Mexico, Utah and parts of Nebraska and South Dakota. Mr. Parker had been assistant chief inspector of this department for two years. He started with the Company July 1, 1925, as a field inspector in the St. Louis Department. On February 1, 1928, he became assistant to the chief inspector at that office and continued in that capacity until he was appointed assistant chief inspector of the Denver Department on January 1, 1931. His experience in two of the Company's middle western departments well equips Mr. Parker for the increased responsibilities in connection with his new position.

The new appointments made possible an enlarged scope of work at the New Orleans and Denver Departments where Managers R. T. Burwell and J. H. Chesnutt had handled the work usually assigned to chief inspectors in addition to the duties as managers.

Bigelow Company One Hundred Years Old

A veteran among the steam boiler manufacturers in New England is what is now known as the Bigelow Company of New Haven, Connecticut, which this year celebrates its one hundredth anniversary. In 1833 Mr. Cyprian Wilcox started a foundry and machine shop in New Haven, and with the development of the demand for power machinery went into the manufacture of water wheels, engines and boilers. In 1860 this plant became the Bigelow Company which gradually concentrated its work on the manufacture of boilers. Until 1905 the Bigelow horizontal return tubular and the Bigelow-Manning were the principal types of boilers manufactured, but the plant had also been making steam drums for several prominent water tube boiler manufacturers.

After it became evident that the water tube design was more suitable for larger units and higher pressures than the fire tube, the Bigelow Company in 1905 obtained from the Richard-Hornsby Company of Grantham, England, the rights for the manufacture of the Hornsby water tube boiler. The original was redesigned and the Bigelow-Hornsby water tube boiler became one of the New Haven company's products. Since that time other types of water tube boilers and steam generating equipment have been added to the line.

Soviet Develops Power Plants in Arctic

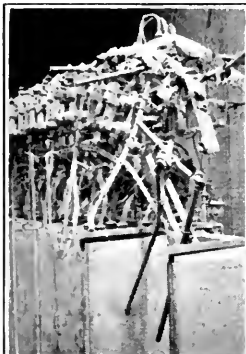
A program of power development is being rapidly expanded in Soviet possessions north of the Arctic Circle in spite of extreme cold, blizzards, and ice conditions the greater part of the year. One such undertaking between Lake Imandra and the White Sea will result in the production of 150,000 kw if the total contemplated output of three stations is realized. One station of 60,000 kw is nearing completion. The three will operate under heads of 50, 120, and 255 feet to utilize the 425-foot fall from Lake Imandra to the sea.

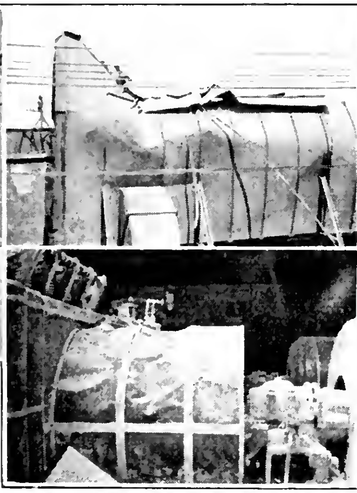
This power is to be employed in mining the extensive deposits of apatite in the region. Apatite, that is, calcium phosphate with calcium fluoride or chloride, furnishes phosphoric acid and aluminum. Phosphates from the deposits are useful as fertilizer. The deposits on Kola Peninsula near the White Sea are extremely rich, being at least 650 feet deep in places and capable of an output of 4,000,000 tons of apatite a year.

Collapsing Brick Stack Damages Power Plant

RESIDENTS of International Falls, Minnesota, at about 8:05 p. m., on Saturday, May, 12, heard a terrific rumble, looked in its direction and saw a familiar part of their skyline drop out of sight. One of the smokestacks at the Minnesota and Ontario Paper Co. powerhouse had collapsed.

Instead of a majestic stack, there was a great pile of bricks, cement, bits of iron and steel. All but about 20 feet of the chimney fell. Much





Above—*Damaged sections of bus structure;* Top Center—*Section of breeching above boiler room.*

Above—*View through hole in turbine room roof;* Lower Center—*Damaged generator casing.*

Scenes after the collapse of 150′ smokestack. Brick and debris have been cleared away.

of the debris went through the roof of the turbine room and was lying in a disorderly heap, covering a 4,000 kw turbo-generator which supplied the plant with part of its electrical power. Another similar unit and the switchboard were partly buried.

The stack, which had been 150′ high and 19′ in diameter at the base, was scattered over an irregular area of about 50′ radius. The falling bricks had damaged much costly equipment, had crushed steel supported roofs; and a shower of brick and mortar dust covered everything.

After the first excitement was past and workmen had had a chance to clean away some of the debris, it was estimated the property damage would be approximately $35,000. No one was hurt. The cause of the collapse has not been determined.

The wrecked smokestack served the six boilers in one of the plant's two batteries. The stack and its ash removal system were a total loss. The large breeching on top of the boiler room connecting the six boilers to the stack was damaged, as were the boiler house roof, an 8″ steam line, a 10″ steam header and the boiler settings.

The roofs of the turbine room and boiler house were crushed and some of the 10″ steel I beams bent. Three-inch I beams, also supporting the roof, were torn loose. A pent house containing lightning arresters, and a ventilator suffered some damage. Falling bricks put out of service a tie line to the hydro electric plant, affecting 1500 feet of overhead cable, fifty 20,000-volt suspension type insulators and two wood cable structures 12′ high. A 15 kw 2300-220 volt transformer used in connection with the lighting of the turbine room was a total loss. One end wall of the boiler room was cracked and part of the boiler house steel structure was slightly twisted.

At the time of the accident No. 1 turbine was idle. Falling debris damaged external parts of both the turbine and the generator. Injury to the other turbine, which was operating, was not severe. When the attendant saw the stack falling, he had the presence of mind to push the electric control button to cut off the steam supply to the turbine and stop it.

The main switchboard was put out of operation. Falling I beams and debris pulled the panel structure loose from the bus structure. Such instruments as were not damaged beyond repair needed cleaning and calibrating. Some of the panel frames were twisted and wiring was damaged. Seven of the 11 sections of the bus supporting structure mounted over concrete oil switch cabinets required rebuilding. Several sets of 600 ampere disconnect switches and insulators were beyond repair.

Miscellaneous damage included the pressure gauge panel near No. 1 turbine, a steam flow meter and 6600-volt feeders to substations in the mill yard, the breaking of windows, twisting of a fire escape, damage to small water and steam connections and some other minor breakage.

An Explanation of Unusual Air Preheating Efficiency

The efficiency of some air preheaters applied to boiler firing, where the air actually absorbs more heat than is available in the hot gases used in preheating (weight and specific heat taken into consideration), is discussed in *Engineering and Boiler House Review*, England. According to the article, the explanation is that there is a certain amount of slow combustion in the gas due to suspended carbon particles which combine with oxygen and liberate heat in addition to that actually in the gas itself.

Tube Rupture Causes Two Deaths

AN ACCIDENT to a new water tube boiler, built to carry 250 lbs. pressure and installed in connection with a municipal pumping plant, recently directed attention to the fact that hazards exist in new installations as well as in old.

Examination of the boiler following the accident revealed that a tube had ruptured in such a way as to admit steam at more than 200 lbs. pressure to the furnace, blowing open the fire door and scattering a mixture of steam and fire, live coals, smoke and hot ashes throughout the boiler room. Two men died as the result of burns, two others were injured by fire or steam and the lives of several other workmen who ran from the boiler room were menaced.

What was described by a witness as a dull "plop" preceded the explosion from the furnace. Men scurried from the boiler room, one diving through an open window to safety. An engineer, who subsequently died from burns, told of his experience when he was interviewed at a hospital. He said he was standing in front of the boiler when there was a roar, and flame and dust came pouring out of the firebox. He ran from the building, his clothing on fire, and rolled on the ground in puddles of rain water, putting out the flames. The other injured men were near the firebox in the path of the fire and steam.

The recording chart showed that pressure rose quickly from about 75 lbs. to 225 lbs. immediately preceding the time of the accident. This would seem to indicate that the metal surfaces had been overheated because of an abnormally low water level, thus causing a rise in pressure that bulged and ruptured the softened tube. The tube itself was of paper thickness surrounding the break.

An examination showed that aside from the ruptured tube and damage to two other tubes which had been pulled out of the headers, the direct property damage was not serious. The boiler was not insured.

Outdoor Steam Generating Plant Has Dual Use

An outdoor steam generating plant coordinating the needs of utility and industrial power has been developed by the General Electric Company at Schenectady.

The unused electrical output from a 20,000 kw mercury turbine and a 6,000 kw turbo-generator will be fed into the commercial system of the New York Power and Light Company, and the steam output, 650,000 lbs. of steam per hour, will be used in the works of the General Electric Company.

Besides the turbine units, equipment at the outdoor plant consists of a steam boiler capable of producing 325,000 lbs. of steam per hour, the mercury boiler, and the mercury condenser, also capable of supplying 325,000 lbs. of steam per hour.

Boiler Explosions at Illicit Distilleries

Three recent explosions of boilers in illicit whiskey distilleries, one of which involved a fatality, support the old contention that boilers are dangerous objects when lacking either competent attendants or periodic inspections. It is probable that the men who had these particular vessels in charge were more skilled as distillers than in handling boilers; and it is a certainty that the boilers themselves had the benefit of neither insurance company nor state inspections.

A South Carolina "sawmill" was found by federal officers to be an alleged whiskey distillery after a boiler explosion had killed one man and injured another.

It was learned after the explosion of a boiler operated in connection with a still in the Oklahoma mountains that one of the "operators" had attempted to hold a wooden plug in the side of the boiler. Steam blew out the plug and the following explosion blew the man part way up a hillside. Several arrests followed the accident.

Sheriff's deputies found evidence of distilling operations after a boiler explosion in a house at Pontiac, Michigan. The boiler tore through the first floor ceiling, into a second floor bedroom and then on through the roof to a spot 350 feet from the house.

Steam-Made Power Twice Usable Water Power

That water power today furnishes only slightly more than 30 percent of the electricity for industrial business and home consumption is indicated by a compilation of the sources of electrical power in 1931 in the United States.

The Department of the Interior, which collected this information from a wide variety of sources, estimates that of a total of 91,729,000,000 kilowatt-hours of electricity used in that year, 67 percent was produced by the use of fuels and the remainder by the use of water power.

The amount produced by fuels was 61,124,000,000 kilowatt-hours, and the fuel consumed in generating this amount of electricity was: Coal, 38,717,000 tons; oil, 8,114,000 barrels; gas, 139,350,000,000 cubic feet; and wood, the equivalent of about 270,000 tons of coal.

Of the fuel-generated electricity 82 percent was produced by coal, 4 percent by oil, 14 percent by gas, and less than 1 percent by wood.

"Are the fish biting?"

"I don't know," replied the weary angler. "If they are, they are biting each other".—*Union Electric Magazine*.

Taps From the Old Chief's Hammer

THE OLD CHIEF inspector sat musing after the close of business over a late afternoon issue of his favorite newspaper.

"Tom," he said to his assistant who had just finished writing a report, "here is another article about a plant which has been ordered by the State to stop dumping its waste into the river. The fish and game conservationists seem to be unusually active. Incidentally their work is sometimes a boon to boiler users."

"How's that, Chief?" Tom Preble asked.

"Didn't I ever tell you about what we ran into a few years ago in searching for the cause of corrosion in the boilers of the big utility plant up the river?"

"I don't believe so, Chief."

The older man's face lighted up, he got his pipe going, and was off on one of his favorite hobbies, the telling of true stories from his wide experience.

"While Inspector Corbin was making his regular inspection visit to the big plant," the Old Chief began, "he noticed that grooving was developing in the upper drums of several boilers, and in addition there was pitting in both the shell plates and tubes. He was surprised, for the condition had developed since his last visit, and had all the earmarks of some sort of corrosive action. The thing was puzzling, though, because as far as he knew there had been no change in a feed water treatment that had been apparently satisfactory in the past. So he mentioned the trouble to the boiler room foreman.

"'I don't understand how that could be,' exclaimed the foreman, after listening to Corbin's description of the symptoms. 'At the rate the grooving is taking place it would most likely mean acid in the water, wouldn't it? Our boiler water always has tested alkaline?' Once inside the drum, however, it took but a glance to convince the foreman that they were up against a condition which, if allowed to continue, would ruin the boilers.

"When they told the plant superintendent, his first reaction was that there must be some mistake. He had been checking the feed water over a considerable period and in that time the analysis had consistently shown the water to be alkaline. But the signs of corrosion were plainly evident and he was too keen an engineer to waste time arguing the point.

" 'There's certainly something wrong,' he agreed. 'The question is what.'

" 'How often have you folks been analyzing the feed water?" asked Corbin.

" 'Twice a day,' was the reply, 'at 7 a. m. and 6 p. m.'

" 'Even at that,' exclaimed Corbin, 'my hunch is that something in the water is at the root of the trouble. We've got to go into this thing thoroughly and find out, for at the rate the corrosion is developing you folks will have a serious condition on your hands if the cause isn't found and corrected pronto.'

" 'I'm with you up to that point,' smiled the superintendent, 'but in view of the fact that in all our checking of the feed water we've never had any suggestion that it might be acid, I don't quite see what the next step is to be.'

" 'Who does the checking?' Corbin wanted to know.

" 'Our own chemist, right upstairs,' was the answer.

" 'Well then,' said Corbin, 'let's get him to start now making hourly tests. I'm curious to find out what's happening to that feed water during the middle part of the day. If his analysis doesn't give us a clue to what's wrong, I'll want you to send samples taken hourly to our home office laboratory in Hartford. But in the meantime let's see if we can't solve the problem right here.'

"The superintendent agreed to the experiment and called in his chemist while Corbin was there.

"The next morning the plant had me on long distance, wanting Corbin or me or both of us up there right away. They had discovered a strong acidity in the feed water on the 7 p. m. test the night before, an hour after what had been their regular time of testing, and while the 7 a. m. test was alkaline the 8 a. m. results showed the acid condition again. As Corbin was busy in another town, I went to the plant myself.

"There they reported at 9 a. m. a condition of excess acidity. After that the water seemed normal. However, the excess acid present at 8 and 9 a. m. and 7 p. m. was amply sufficient to have caused the trouble in the boiler.

"I figured that to be found with such regularity, the acid must have been dumped into the river. Finding out by whom wasn't so hard when we knew what we were looking for, as across and a little way up the river was a process mill. From there, because of a bend, the current swept to the opposite side of the stream and along the shore in front of the big plant.

"A call at the process mill justified my suspicions as well as the findings based on the hourly water tests. By a coincidence the process mill emptied its vats of waste acid into the river at times which happened to be only a few minutes after the big plant's regular times for testing its feed water.

"The big plant had been taking in necessary makeup water shortly after the tests so that a portion of this acid found its way into the boiler and ate away at the shell plates and tubes to its heart's content.

"By the time of the next feed water test, however, the current had carried sufficient of the acid out of that part of the river so that the water showed alkaline after the usual regular feed water treatments had been made.

"The condition was improved by arranging to have the up river plant put the acid into the river continuously, instead of releasing it in large quantities. The treatment of the feed water at the big plant was then altered to prevent further corrosive action taking place in the boilers.

"Since that time, in keeping with the policy so widely in effect on the part of large power plants, they have, of course, set up a system of feed water testing that is practically continuous, and the last time I was talking to the superintendent he told me that the saving from having clean boilers has justified many times the cost of frequent testing.

"It would be very unlikely for corrosive action due to a high acid content of the feed water to develop at that plant now at any time of day. The continuous testing would detect any change at once and give the signal for a variation in water treatment."

Foreman (to small son of one of his workmen who has met with an accident)—"When will your dad be fit for work again?"

Boy—Can't say for certain, but it will be a long time."

Foreman—"Oh, what makes you think that?"

Boy—"'Cause compensation's set in."

"Why not try Allen's 'Kentucky Cardinal'?" the salesman suggested. "That's a highly popular book."

"No," said the lady, "I don't care for theological stories."

"But the Cardinal was a bird."

"I am not interested in the scandals of his private life," said the woman as she walked out.—*The Kalends.*

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1932

Capital Stock - - $3,000,000.00

ASSETS

Cash on hand and in banks		$ 782,202.90
Premiums in course of collection (since October 1, 1932)		973,590.37
Interest accrued on mortgage loans		40,081.96
Interest accrued on bonds		114,256.73
Loaned on bonds and mortgages		948,517.17
Home Office real estate		437,474.66
Other real estate		212,746.88
Agents' ledger balances		4,159.04
Bonds on an amortized basis	$8,823,376.79	
Stocks at "Convention Values"	7,178,230.12	
		16,001,606.91
TOTAL		$19,514,636.62

LIABILITIES

Premium reserve		$7,142,070.04
Losses unadjusted		317,337.64
Commissions and brokerage		194,718.07
Other liabilities (taxes incurred, etc.)		566,977.68
Contingency Reserve		3,600,000.00
LIABILITIES OTHER THAN CAPITAL AND SURPLUS		$11,821,103.43
Capital Stock	$3,000,000.00	
Surplus over all liabilities	4,693,533.19	
Surplus to Policyholders		**$7,693,533.19**
TOTAL		$19,514,636.62

WILLIAM R. C. CORSON, President and Treasurer

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Incorporated 1866 | Charter Perpetual

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Vol. XXXIX No. 8 October 1933

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

Published continuously since 1867
by The Hartford Steam Boiler
Inspection and Insurance
Company

Please show to your Engineer

Preventing Dangerous Corrosion of Drum Ends

IN THE older installations of bent tube boilers the mud drums are usually in low positions, and like other covered parts of boilers the ends of these mud drums can be badly weakened by external corrosion before the danger is discovered, as they are not ordinarily accessible for inspection. The narrow spaces between the ends of the drums and the settings of such boilers gradually fill with soot and ashes which, in the presence of moisture, are extremely corrosive to metal. If allowed to progress, this corrosion can lead to very serious consequences, for the plate may waste away until not enough metal remains to withstand the working pressure.

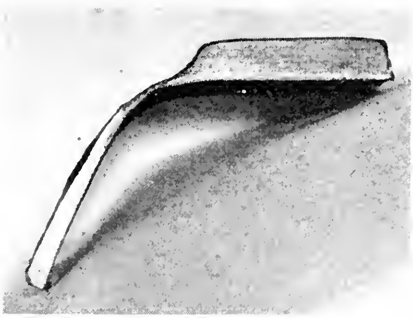


Figure 1—Cross section of "blind" head showing corrosion.

In a special checkup conducted during the past two years, this Company found that, of all bent tube boilers of which the mud drums were uncovered for inspection, the drum heads of about ten percent were affected by corrosion to such an extent that expensive repairs would soon be necessary. About one percent were in such dangerous condition that the boilers could no longer be operated without immediate repairs or, in some cases, replacement of the drum.

Figure 1 illustrates how serious this thinning down can become. This piece was cut from the mud drum head of a boiler which evidently could not have held together much longer under its working pressure of 150 pounds per square inch. At the bottom of the drum, and for some distance up each side, the sound metal at and near the turn of the head flange was not much thicker than a piece of heavy cardboard. In addition, the ends of the shell plate and rivet heads were very seriously eaten away. Because that portion of the head forming the skirt was protected by the end of the shell from contact with the ashes, it did not corrode. The head was originally of the same thickness throughout, so the illustration shows clearly the extent to which the half-inch plate was wasted. Over a considerable proportion of the circumference of the head at the turn of the flange about one-sixteenth inch of sound metal remained.

When drum ends are closely encased in brickwork, there is no

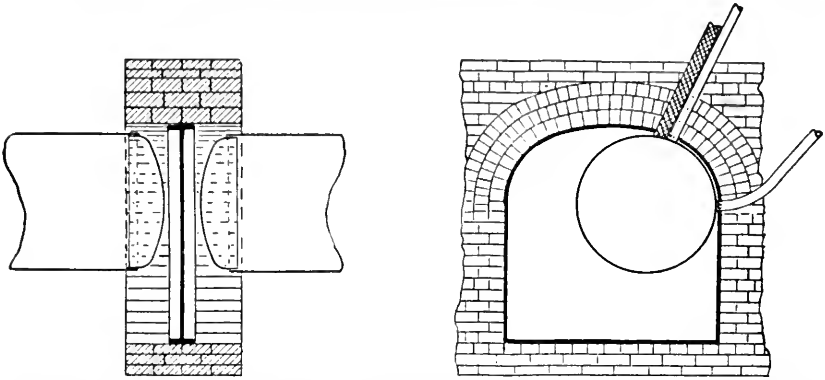


Figure 2—Ideal arrangement for blank heads of mud drums in battery setting.

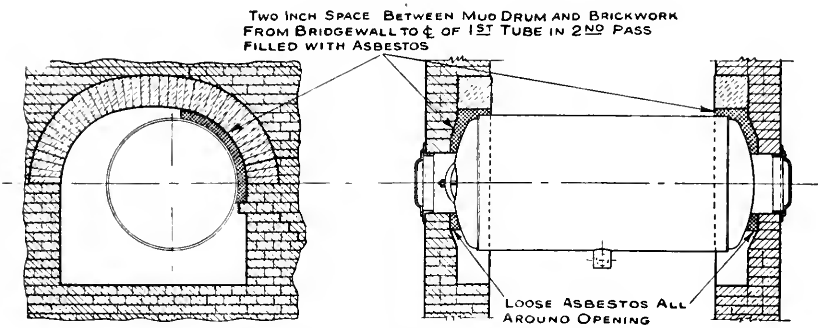


Figure 3—Ideal arrangement for ends of bricked in drums.

way in which the outside surface can be examined except by tearing out some of the bricks. In some cases an inspector can detect the presence of serious external corrosion by tapping with his hammer inside the drum. However, this test can not be depended upon entirely, for the ashes and rust growth sometimes become packed so tightly between the outside of the head and the setting that the head will feel or sound "solid" under the hammer blow. For this reason it is important that provision be made for the regular inspection of the outside surface, and it is more satisfactory if some provision be made whereby inspection does not necessitate taking down brickwork.

Two such suggested arrangements are illustrated herewith. Both have the advantage not only of permitting easy access for inspection, but of avoiding pockets where soot and ashes can accumulate and pack up against the ends of the drum.

Figure 2 shows a division wall arrangement for boilers set in battery. The division plate may be made of either steel or cast iron built solidly into the brickwork. This sketch was originally published in the July 1931 issue of THE LOCOMOTIVE, and since then many boiler users have adopted the plan for their boilers. With such a plate in position, the inspector can reach those parts of the head that are likely to corrode.

Figure 3 shows a plan that may be used for the outside ends of boilers set in battery, and for both ends of boilers set singly. The arrangement is not difficult or expensive to install at the time a boiler is set, or to apply to boilers that now have drum heads embedded in masonry which must be taken down when the drum ends are to be inspected. The slight additional expense in either case is fully justified in the interest of safety.

Violent Accident to Oil Circuit Breakers

ALTHOUGH costly in direct property damage as well as in the matter of plant interruption, electrical equipment accidents are not as uniformly spectacular as are boiler explosions or turbine overspeed wrecks. However, some of them do occur with great violence, and of this variety was a recent accident to oil circuit breakers used in connection with very large capacitors at a steel mill.

Housed in a small brick sub-station from which the incoming power was distributed to various departments of the mill, the capacitors were in charge of an attendant who cut them on to the line whenever it became necessary to correct an unfavorable power factor. He had just closed the circuit breaker on one of the capacitors when there was a flash and a light "pop" or puffing noise which caused him instinctively to drop to the floor. Before he could crawl away the oil tank of the breaker was ripped open by a violent explosion.

Two other employees who were seated in a nearby yard office said afterwards that the noise of the explosion was similar to the detonation of dynamite. They found the capacitor building afire inside and as they opened the door the attendant, his clothes ablaze, staggered out and collapsed. While the two men were extinguishing the fire in their colleague's clothing, the oil tank of the second circuit breaker exploded.

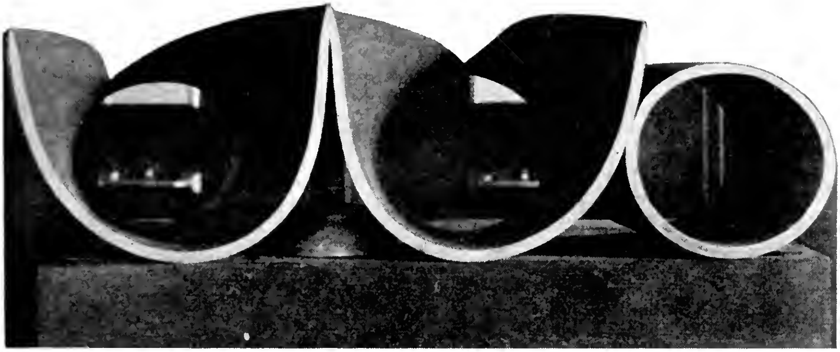
So much of the electrical equipment was destroyed by fire and by the violence of the explosions, that it was impossible to determine which of several probable causes was accountable for the failure. Property damage amounted to about $8,000.

The Protection of Water Wall Tubes

By E. R. Fish, *Chief Engineer, Boiler Division*

ALTHOUGH water-wall tubes do not fail as frequently as do main boiler tubes, failures are by no means uncommon, and the illustration shows a typical case that recently occurred. Such accidents, the result of overheating, can be looked for unless preventive means are considered both in the installation and in the operation of the boiler.

The use of water walls grew out of rapid advancement in the design and sizes of steam turbines which imposed on boiler makers the necessity of finding means of increasing the capacities of their steam producers with a minimum of investment. To accomplish this, rates of combustion were stepped up, and the efficiency with which the fuel was burned was also increased to the point where very little excess air was needed to obtain complete combustion. The result was greatly increased furnace temperatures. These temperatures, coupled with the fluxing effect of the fused ash on the furnace wall refractories, very quickly brought trouble in maintaining the interiors of furnaces. The fire brick lining gradually melted away under the influence of the heat and the fused ash, leading to frequent shutdowns and increased overhead expense for idle equipment, and necessitating extensive and expensive repairs.



Examples of failure in water wall tubes.

The answer to this problem was the evolution of the water-cooled furnace, which in the past ten years has been developed to a high degree of perfection.

"Water walls" as they are now generally known are almost universally made up of vertical tubes which discharge in various ways into the steam spaces of the boiler and which are supplied with water from the circulatory system of the boiler. They are, therefore, essentially a part of the boiler and contribute in a large measure to the steam making capacity of the unit.

Manufacturers have found only by expensive experience that unrestricted circulation in the water wall tubes is of paramount importance to avoid overheating and that this free circulation must be maintained in all the tubes which are exposed to furnace temperature. The water supply connections must be so distributed that all tubes receive the necessary quantity of water with substantially the same facility, and in the tubes there must be the least possible resistance to the free escape of steam.

In large installations, it is common practice to burn fuel so as to give a heat release of about 30,000 Btu per cubic foot of furnace volume per hour with furnace temperatures of 2500° or 3000° F. Under conditions such as these, the rate of heat absorption by water wall tubes may be on the order of 75,000 Btu per square foot per hour or more.

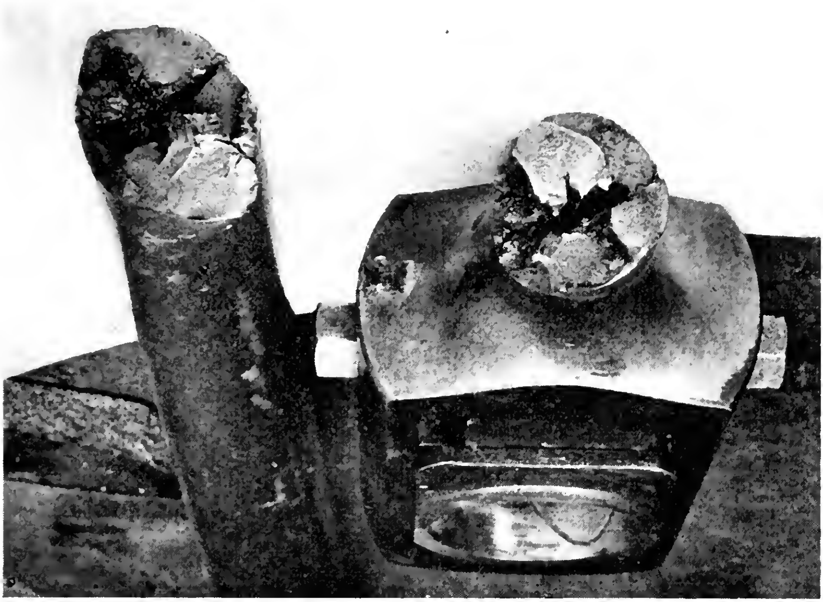
In order for these rates to be maintained without overheating the metal of the tubes, it is imperative that the absorption of heat be continuous and uninterrupted. This can be attained only if the inside surfaces of the tubes are kept free from accumulations of every sort. It has been found that with some kinds of scale a thickness of less than 1/100 of an inch is sufficient to cause overheating. This kind of trouble grows with increased steam pressure. Sluggish circulation, whereby the steam bubbles are not carried away with sufficient rapidity, likewise causes overheating because of the relative slowness with which steam absorbs heat.

There have been many cases, too, where overheating has been due to the direct impingement of very high temperature gases on restricted areas of the water wall surfaces. It is important, therefore, that the burners through which pulverized fuel, gas or oil is introduced into the furnace be so arranged that there is no direct impingement of the burning fuel on the walls.

In general, the secret of avoiding trouble with water walls may be said to consist of designing and installing the system in such a way that it will have free circulation of water and will not be subjected to direct impingement of flame, and of treating the feed water so that scale is prevented. The proper conditioning of the feed water is a matter of very serious importance if boilers equipped with water walls are to be run continuously at high ratings without tube failures.

The manufacturer must necessarily be depended on to design properly the tube and burner arrangements. Once installed it is indeed difficult and costly to make changes. But granting that the installation is correct mechanically, its correct operation is the responsibility of the attendants.

A FLAW INFREQUENTLY ENCOUNTERED



THE illustration shows the unusual forging flaw to which a recent serious engine accident was attributed. The large cross-compound engine went to pieces, damaging itself to the extent of more than $4,400.

A special inspection on account of the accident revealed that this connecting rod (on the low pressure side) had broken in two near the cross-head end where there was an internal flaw, evidently caused by slag inclusion. It was found that this flaw extended lengthwise 8½ in. along the center axis of the rod.

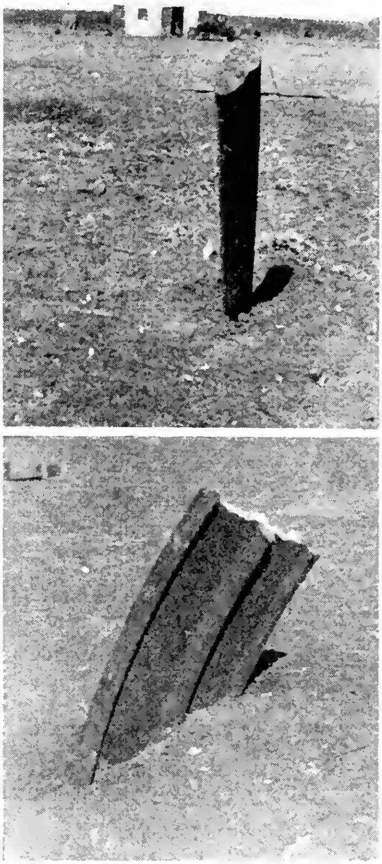
In addition to breaking the low pressure side cross-head, cylinder heads, and piston spider, the accident bent the piston rod and cracked the 36 in. cylinder. The engine was operating prior to the accident at 120 rpm with 160 lbs. steam at the throttle and was developing approximately 700 hp.

When a motor truck backed into a guy wire for the smokestack at an Illinois cheese factory, the steel smokestack fell, breaking the plant's main steam line. Several thousand gallons of milk were lost because the plant was temporarily shut down.

Accidents to Wheels Cause Death and Injury

Occurrences, insignificant in themselves, may bring about catastrophic losses. Last February, in a cotton gin in the Texas Panhandle, the weakening of a gasket of a blow-off valve of a 72″ horizontal tubular boiler caused leakage which was blamed for a severe engine accident.

When the attendant first noticed the leaking blow-off valve, he did not think it would be necessary to shut down the plant. Very shortly thereafter, the engine started to overspeed and the attendant attempted to close its throttle valve. Before he succeeded, however, the wheel went to pieces and he was killed.

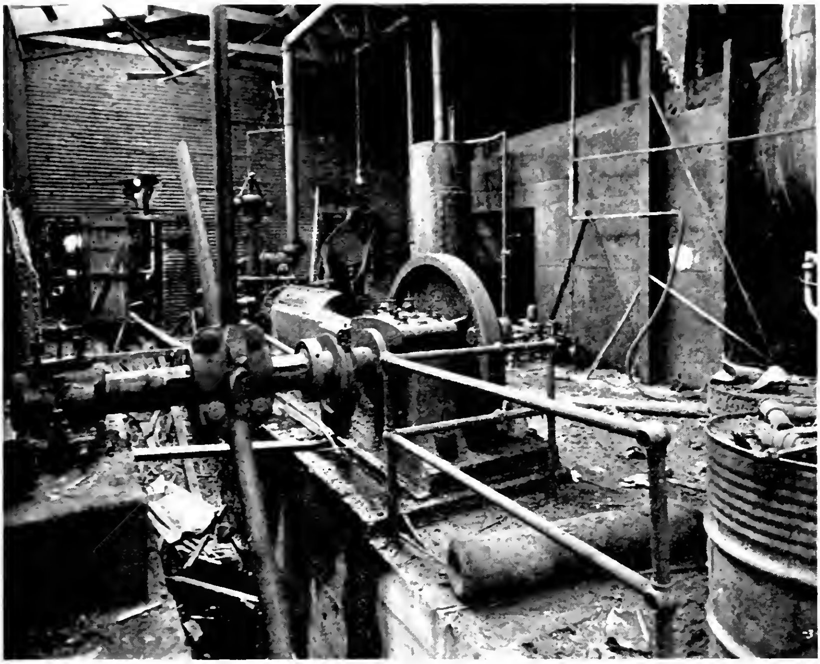


Above—An arm of the wheel "javelin-minded".
Below—Piece of rim 200 yds. from the engine.

One theory was that the water leaking from the blow-off valve filled the wheel pit to such a level that the main driving belt lost its traction, and that this resulted in an alternate slipping and grabbing of sufficient severity to break the belt. There was some evidence to support the belief also that while this was occurring the governor belt slipped off either from the erratic behavior of the engine or because of becoming wet by water splashed up from the belt wheel. This governor belt had slipped off on previous occasions, attendants said, but this time the safety cams on the engine valve gear were not in proper position. The result was that the stopping of the governor failed to cut off steam from the engine, as it should have done. As the engine had been relieved of its load by the breaking of the main belt, overspeed developed quickly.

Besides killing the attendant,

flying fragments of the wheel also badly injured one of the members of the firm who was in the doorway to the engine room, and some parts of the wheel were found six hundred feet away. The flywheel was of cast iron, 14 feet in diameter with a rim 25″ wide and 2″ thick.



Engine room after the shattering of the flywheel. All that remains of the wheel is the hub and three spokes.

It had 8 arms, was in two sections and weighed about 7 tons. The engine was not insured.

The devastating energy of bursting flywheels also was illustrated recently by several accidents to small installations.

At Tolland, Connecticut, a 30″ cast iron flywheel on a gasoline engine exploded with sufficient violence to cause the entire wheel to be hurled in small fragments far from the scene of the accident. The wheel was used in connection with a portable saw mill and had been operating about ten minutes when the accident occurred. When sawing a large stick, the engine slowed down and one of the two men operating the saw went to the engine to adjust the carburetor while the other introduced the next stick, which happened to be small.

The engine speeded up and the flywheel burst with a report like that of a gun. The man near the saw was struck by a piece of the wheel and died instantly. There was no property damage except to the wheel, only one small piece of which was located.

Other flywheel accidents resulting in personal injuries and destruction of property occurred to a cream separator, an emery wheel and a motor truck. The accident to the flywheel on the separator occurred at a Montrose, Missouri, farm, one piece of the wheel hitting the farmer who was turning the separator.

At Jeffersonville, Indiana, a man who was sharpening a plough on an emery wheel was killed when the emery wheel he was operating exploded and a fragment struck him in the chest.

A "freak" flywheel accident occurred to a heavily loaded truck caught on a hill at Akron, Ohio. According to his own account, the operator of the truck had not shifted to second gear at the top of the hill and on the way down he burned out both service and emergency brakes. As the truck gained speed the flywheel of the truck exploded, sending pieces of steel through the metal dash board and tearing the floor boards to pieces. The operator's right leg was broken and his face and body severely cut. He clung to the steering wheel, however, and guided the truck half way up the slope of another hill and brought it to a stop by "jack-knifing" the trailer into the curb.

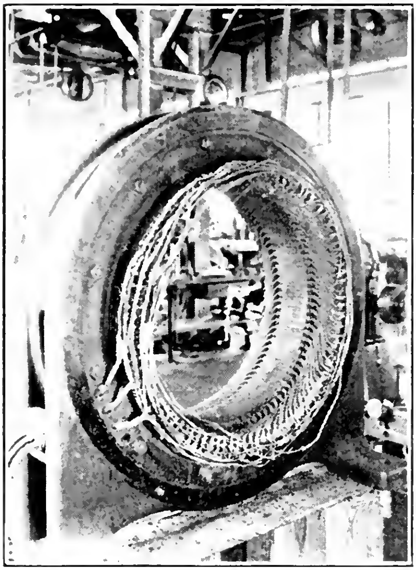
Two Ammonia Compressor Accidents

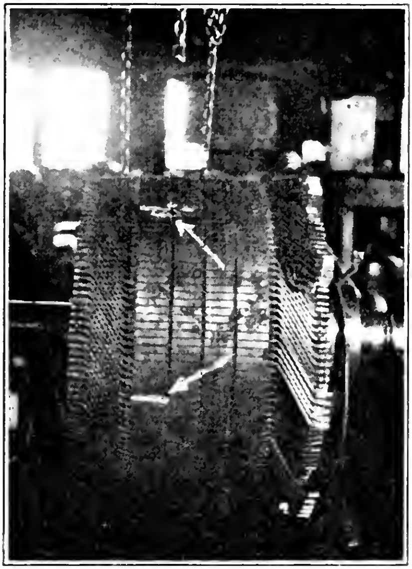
When the cylinder head of a vertical ammonia compressor at a Southern creamery blew out, early in September, the president of the establishment was the only person injured, although several employes barely escaped from the building before the ammonia fumes reached the room in which they were working. The explosion broke off the eight ¾" bolts holding down the cylinder head and sent the head up through the roof. The concussion knocked down the two men and escaping ammonia gas overcame the president.

At another creamery, also in the south and on the same day, a man sustained a broken leg and severe burns as the result of one of two explosions. From newspaper accounts, it was determined that there was a compressor explosion followed in about three minutes by an explosion of ammonia fumes.

Some Recent Accidents to Electric Motors

THERE is probably no machine more useful to industry than the electric motor, and its usefulness has increased greatly in recent years because of developments in design which permit its adaptation to a great variety of purposes. But for all its usefulness, the motor is subject to accidents which not only involve heavy repair expense but cause costly interruptions of plant operation.





Left—Complete burnout of the stator windings. Right—Wound rotor of an induction motor showing damaged sections in the laminated core resulting from an insulation failure in the slots.

There are many kinds of accidents to motors. Some result from a misapplication of the motor to the job. Others can be attributed directly to lack of proper attention to the motor and its control equipment, to carelessness of the operator in starting and stopping, and to failure to protect windings against the harmful effects of moisture while the motor is out of service. Still others are due to causes arising outside of the motor, such as lightning, line surges, or single-phasing resulting either from line failure or the failure of a fuse in the motor circuit.

Periodic inspections by experienced men who are familiar with up-to-date design and operating practices, tend greatly to cut down the number and frequency of motor accidents, but in spite of such precautions the factors cited above cannot in all cases be prevented from causing failures, as the accounts of recent accidents given below will illustrate. Insurance protection provides funds with which to meet the direct damage losses for such accidents as may occur.

The grounding of a coil in a motor at an Ohio coal mine led to severe electric arcing. An accumulation of oil on the coils caught fire and all of the insulation burned off of one end of the machine. Failure to keep this motor clean greatly increased the severity of the accident.

At another coal mine in Missouri, eight coils of a hoist motor armature burned out because of repeated overloads. Melted copper was thrown about by the rotating armature, and lodged between coils of the stator windings. It was necessary to rewind the entire machine.

Dampness absorbed due to intermittent operation of an air compressor motor in a cotton seed oil mill in Texas led to grounding of the windings. The grounds in the machine and system caused one fuse to blow, but the machine continued to operate single phase and as a result the stator winding burned out.

The burning out of all the field coils in a 150 hp motor at a Virginia flour mill came about through the short circuiting of the turns of one field coil. This initial accident caused an excessive field current to flow through the remaining coils, overheating and breaking down their insulation.

Two motors operating coal pulverizers in the boiler room of an Ohio food products plant were damaged recently from a cause that could not have been foreseen. A heavy piece of slag dropped from the sidewall of one of the boiler furnaces, ruptured a tube, and shot a jet of steam and water on the windings of both motors, resulting in short circuiting of the coils.

When connections between collector rings and rotor winding broke loose from their fastenings and bent outward, the stator windings of a 300 hp pump motor at a municipal water supply plant were cut so badly that a complete rewind was necessary.

Failure of rotor bars in a 50 hp motor at another municipal pumping plant resulted in the short circuiting and burning of the conductors in one stator coil. In all, fourteen of the high resistance rotor bars were broken. Because of the design of the motor these bars moved slightly each time the motor started and stopped. This was believed to have caused eventually a crystallization and breaking of the bars near the end rings where the bars were welded.

Loosening of the end shield bolts of a 200 hp motor driving a machine in a rubber manufacturing plant led to the failure of both rotor and stator windings. The end shield slipped out of place, thus permitting the rotor to rub against the stator, damaging both the stator and rotor windings as well as the laminations.

Dirt or foreign material accumulating in the bearing oil reservoirs of a 100 hp motor used in a West Virginia silica works for sand pulverizing, caused the bearings to heat up to such a degree that the bearing metal "ran". This allowed the rotor to rub against the stator with consequent damage to insulation. Accidents of this kind show the absolute necessity of properly sealing bearing housings against the entrance of dirt and foreign material.

Bearing burnout was the cause of a failure in a motor used to pump asphalt in a New Orleans roofing manufacturing plant. The bearing on the pulley end failed and the resulting strain on the other bearing caused it to overheat and wipe. In another case excessive belt tension caused the pulley end bearing to overheat and "freeze", putting the motor out of service on its owner's California farm.

In a California pumping station the motor insulation became very brittle due to age. This deterioration caused a short circuit between phases, necessitating a complete rewind.

Abuse of a motor in a state training school by careless reversing of the machine resulted in the shorting of the armature coils and the commutator segments.

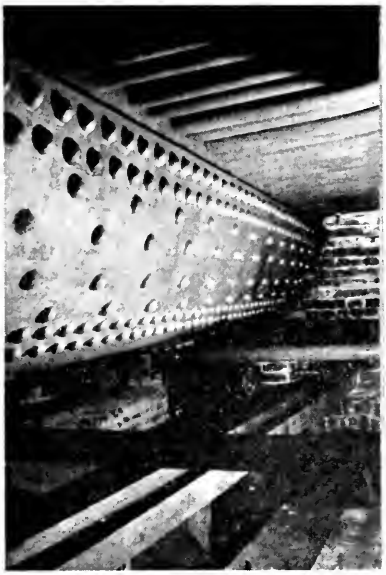
Two accidents from lightning damaged a 700 hp motor used in a southern cotton seed oil mill. The first accident took out fourteen coils and other insulation to an extent which made a rewind necessary. In the second accident three coils were grounded. The periodic inspection of lightning arrestor equipment and its grounds is very important to reduce accidents of this sort. Such equipment can become practically inoperative if neglected, and high resistance grounds can materially affect its functioning.

A line surge was responsible for the damaging of a synchronous motor used to drive a generator at a West Virginia coal mine. In this case the supply line for the motor was installed below and parallel to a 22,000-volt transmission line. From all indications it appeared that disturbances on the high tension line induced surges in the motor supply circuit, resulting in the burning out of the motor windings.

The frequency of motor accidents, their great variety, and the number of outside hazards which threaten such equipment make advisable competent periodic inspections, as well as insurance to indemnify the owner for such accidents as are bound to occur.

Repairing Drums Weakened by Embrittlement

THE expedient of applying wider butt straps as a repair of a seam that had been weakened by caustic embrittlement, was made use of recently on batteries of water tube boilers at two different locations in southern states. This form of repair is limited, of course, to cases where the embrittlement is in an early stage, and where the design of the boiler does not prevent the use of wider straps; but in the cases about to be described it was successfully used in adding



Exterior and interior views of boiler drum repaired with extra-wide straps to overcome weakness caused by caustic embrittlement.

several years of life to boilers that otherwise seemed destined for a quick retirement. All the boilers were of the bent tube type, and embrittlement had affected only the longitudinal seams in their lower drums.

An unusually intense water softening procedure seems to have led to the trouble discovered in the boilers at Plant A, a large lumber mill. The mill was the only industry of the town, and had undertaken to provide the water supply for the small group of homes and a hotel that comprised the village. Because the water was "hard" at some seasons of the year the plant officials installed a base exchange softener, and in doing so had in mind the softening of the water for general use in the village rather than in the boilers. Previous to the installation of this base exchange process, the boiler room foreman had been using a boiler compound largely made up of soda ash. He made no change in his method of treatment after the base exchange process was installed, so that thereafter the raw water not only passed through the base exchange process but was later treated with soda ash. As a result, the sulphate to carbonate ratio in the boiler water was extremely low.

The first symptoms of the probable presence of embrittlement were discovered at a regular inspection by one of this company's men, and his subsequent exploration of walls of rivet holes from which the rivet shanks had been drilled brought to light such conclusive evidence of cracking that the butt straps were removed. It was then readily seen that the shell plate in the riveted area had also been weakened. The four straps on the two seams of the mud drum were disintegrated too badly to be used again, but repair of the drums was possible by the installation of new straps, enough wider than the original straps to permit riveting through the sound part of the drum beyond the old rows of rivets. Two other boilers of the same battery were found to be similarly affected and were likewise repaired. The accompanying photographs show the new inside and outside straps on one of the repaired seams.

Lack of regulation in the use of the base exchange process for water softening was blamed for the trouble in the Plant B. This plant used deep well water high in calcium carbonate, a material forming very hard scale, and as the water was practically free of the sulphates which are necessary as embrittlement inhibitants when sodium carbonate is present in large quantities, the changing of the calcium carbonate into sodium carbonate by the base exchange method produced a water of the embrittling kind.

Here, again, the discovery of embrittlement symptoms was made by an inspector who then explored the seams of the several boilers in the battery until he was satisfied that embrittlement defects were present. The repair was similar to the repair described above. Three boilers were in the battery.

When a pipe ruptured on a donkey engine boiler used in connection with a Pacific coast lumber operation, the attendant was severely scalded and died as a result of the burns. The engine was used to lift logs at the booms. The unfortunate man was oiling the engine and happened to be standing close to the pipe which failed.

Stream Pollution Leads to Boiler Accident

TEMPORARY diversion of the contents of a 24″ sanitary sewer into a small stream from which a southern cotton mill was taking boiler feed water, was blamed for a recent tube accident that not only damaged the boiler in which the accident occurred but, for a time, put a companion boiler out of service and curtailed plant production.

Some days prior to the accident power plant attendants began to have trouble with the boilers foaming and priming. An investigation disclosed that in order to make a sewer available for repair, workmen had diverted sewage into the stream from which the plant obtained its boiler water supply. As soon as this was discovered a temporary connection was arranged so that feed water could be taken from the city main, but the water from the contaminated brook had already left enough solid matter in the boiler tubes to cause overheating.

A fireman had just blown down the water column and was standing directly in front of the boiler when the tube burst, showering around him a quantity of bricks blown from the upper part of the setting. He was fortunate enough to escape injury, but the debris broke the feed line between a stop valve and the feed water heater so that the damaged boiler rapidly emptied itself and there was no way to feed water either to it or to its companion boiler. Therefore, the plant was entirely without power during the two hours that it took to repair the feed line and put the undamaged unit back into service.

The bursting tube pulled out of the top drum, whipped around and struck other tubes and superheater elements with sufficient force to damage them. However, the greater part of the damage sustained by the boiler resulted from the overheating to which it was subjected after the loss of water. It was necessary to replace 96 tubes, reroll most of the others, and repair the damaged setting and superheater.

The product of the mill was cotton cloth, which was woven from yarn spun on the premises. At the time of the accident production was being pushed to fill a large rush order, and the management was extremely anxious to have the full producing capacity restored as quickly as possible.

Besides the two large water tube boilers comprising the main battery, the plant had also a third, smaller boiler which was regarded as an emergency standby unit. This boiler was immediately fired up and put on the line with the undamaged unit, but their combined steam capacity was not sufficient to maintain full production. As a consequence the plant output was seriously curtailed. This was a sufficient reason for rushing repairs, but another good reason was the fear that the larger of the remaining boilers might at any time sustain a similar accident. It, too, had used the contaminated feed water and although it had probably accumulated an equal quantity of solid material, it could not be spared then for a cleaning. Were it to go "down", production would cease, for the standby boiler was too small by far to keep even the looms running.

Fortunately, the boiler held out. By working steadily, several shifts of repairmen succeeded in retubing the damaged boiler without further mishap. To obtain and expedite the shipment of new tubes "Hartford Steam Boiler" had made available the services of a representative in a distant city and the tubes had come through promptly. The local "Hartford Steam Boiler" inspector remained on the job continuously for a stretch of 48 hours while the repairs were under way.

Gas Furnace Explosion Causes Great Damage

A FURNACE explosion on July 9 at a southern industrial power plant resulted in damage estimated at more than $10,000 to a boiler setting and other power house equipment. The front, side and rear walls of the gas fired bent tube type boiler in which the explosion occurred were blown out and the accident left a large hole in the upper front corner of the division wall between this boiler and one adjacent to it. The steel supporting column at one corner of the boiler was bent outward about 12″ and the "I" beam upon which the right-hand end of the three steam drums rested was slightly twisted. The central supporting column at the front between this boiler and one adjacent was also twisted. (See accompanying pictures.)

It was learned that there was a steam pressure of 150 lb. on the boiler at the time of the furnace explosion, but that the explosion, apparently, did not injure the boiler. During repairs the boiler was blocked up to permit the installation of new columns and "I" beams where necessary. The furnace was entirely rebuilt.

At the time of the accident the boiler in question was not on the line, although the fireman had lighted several burners to bring the pressure up preparatory to cutting the boiler in. According to his report, he had opened the damper for about five minutes to clear out the setting before lighting the furnace, and then lit each burner separately with a kerosene torch made with asbestos wick on a stick. He said he did not believe any of the burners went out, although he could not be sure, for after lighting the burners he went around to the front of the boiler to check the water level. The investigator reasoned that the gas which detonated had collected in the furnace either because of inadequate draft or as a result of one or more of the burners going out. Following the accident the gas valves were tested. Two of them were found to leak.

Attention is called to the similarity between the results of this accident and those of the one on January 31 at the municipal plant of

Results of furnace explosion. Notice how the large I-beam in the right-hand picture is bent outward.

Colorado Springs where heavy 12″ "I" beam supports were bent in much the same way as the support shown in the accompanying photographs.

Four other furnace explosions under gas-fired boilers have been reported recently in newspapers. All of the accidents involved injury to persons.

At San Jose, California, an auto laundry employe sustained injury to his head when a fragment of a boiler struck him, resulting in a concussion. The fuel explosion occurred when the employe tried to light the burners. Local police reported that they learned gas had been escaping all night from some part of the system and that this was set off when the employe thrust a lighted torch into the furnace.

A similar accident occurred at Exira, Iowa, where a gas furnace explosion blew out the front end of the boiler following an attempt to light the burners. One man was badly burned about the face and chest.

At Bristow, Oklahoma, a negro cleaner turned on the gas under a boiler and struck a match which did not ignite. He left the gas on, according to the newspaper report, and went for another match. The explosion that occurred when he lit the second match not only injured him but resulted in some property damage.

While attempting to light a gas fired water heater in the basement of a hotel at Ligonier, Pennsylvania, a young man received injury to an eye as the result of a detonation.

Other furnace explosion accidents described by the press in various parts of the country occurred in oil-fired boilers.

One man died and another was sent to the hospital with serious injuries as a result of a furnace explosion under an oil-fired boiler operated by a Worcester, Massachusetts, factory. The blast broke the main steam line, filling the room with steam. The injured men were cleaning the flues of the boiler, which had been converted to use oil as fuel. The explosion occurred after a cleaning rod was pushed into a flue, a column of fire striking one of the men squarely and burning the other as he attempted to run from the room. It was the opinion of firemen that the cleaning process dislodged hot soot which, when it came in contact with a pocket of gas, set off the blast.

Several hundred children attending a Saturday afternoon performance in an East Providence, R. I., theatre, were frightened when smoke entered the auditorium through a ventilator following a fuel explosion of an oil-fired boiler. The explosion burst open the heater door, broke windows in the boiler room and burned a theatre employe. Owners of the theatre continued the performance during the confusion and were able to quiet the audience quickly.

About an hour after the congregation had left the auditorium of a Pittsfield, Massachusetts, church, a furnace explosion filled the church with black soot which penetrated to every part of the edifice. Damage was confined to that caused by the smoke and minor damage to the heating plant itself.

At a Long Island City button works, a furnace explosion blast shattered a large boiler and enveloped three workmen in a shower of flaming oil. The men had been installing an oil heating unit on an adjoining boiler.

The Locomotive

A QUARTERLY MAGAZINE
DEVOTED TO POWER PLANT PROTECTION

George H. Prall, *Editor*

HARTFORD, CONN., October, 1933

Single copies may 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.

New Orleans Department in New Offices

Effective September 15, the office of the New Orleans Department of the Hartford Steam Boiler Inspection & Insurance Company moved from the Hibernia Bank Building, and is now located at 333 St. Charles Street. The New Orleans Department comprises Louisiana, Mississippi and Southern Texas.

E. M. Parry Added to Home Office Staff

Mr. E. Mason Parry, who last spring was given a leave of absence for rest and recuperation from a long-continued illness, has returned from a visit to his old home in England much benefited by his vacation. However, supervision of the New York inspection department imposes strenuous obligations on the man at the head of it. The officers of the Company realize this and out of consideration for Mr. Parry have acquiesced in his request to be transferred to a position of less exacting responsibilities by adding him to the Home Office engineering staff. We are happy that he has come back to us here in a position in which his long experience in inspection work and his marked capability as an engineer will be available in the direction of all departments without too great a tax on his strength.

Mr. John M. Gorham, who has been serving as acting chief inspector during Mr. Parry's absence, will continue temporarily in charge of the engineering activities of the New York office.

Veteran Inspector of Baltimore Department Dies

Many officials and engineers of concerns in the parts of Baltimore and Virginia that were served for 34 years by Inspector Thomas Johnson will regret to learn of Mr. Johnson's death on September 19, 1933.

Born in Hull, England, on June 5, 1867, Mr. Johnson served an apprenticeship in the British merchant marine. He had for some years been chief engineer of various vessels when, in 1899, he abandoned the sea to enter the employ of this Company. His early training not only provided him with valuable experience for his duties as an inspector, but imbued him with a desire for thoroughness that was at all times characteristic of his work. The Company felt that it was losing a valued employe when, in June of this year, ill health forced Mr. Johnson's retirement.

Insurance of Enclosed Gear Sets and Deep Well Pumps

Due to the fact that the gears, casing, bearings and other parts of an enclosed gear set are generally regarded as a unit, the Hartford Steam Boiler Inspection and Insurance Company has provided a means for insuring the complete gear set. Hitherto it has not been possible to insure the whole set, and while the gears could be insured individually as wheels, there was no coverage for most of the other parts.

Such sets consist of two or more intermeshing gears or pinions, together with their shafts, bearings and other necessary parts, all mounted in a casing. They are frequently used as auxiliaries to motors or other machines, either to increase or reduce the speed. As heretofore, a set of gears built into a motor housing or into a casing which is *integral* with a part of the motor, is still considered a part of any insured motor and requires no separate coverage.

A similar situation exists in connection with deep well pumps. These are now insurable as a unit which includes the pumps and their driving motors. The motors, of course, can be insured separately, but the pumps themselves are insured only in deep well pump units. Under the former plan of insurance for such apparatus a centrifugal or rotary pump of the deep well type was defined for insurance purposes as "one in which the centrifugal or rotary impellers are mounted in a bowl or housing set at the bottom of a drilled well below the standing water level and connected by means of a shaft extending through a casing to the driving machine at the surface of the ground". This definition did not include reciprocating pumps, or centrifugal pumps used in connection with artesian wells, or centrifugal pumps set at the surface of the ground or in pits below the ground.

Trends in Design of Central Station Turbines

By T. B. Richardson, *Chief Engineer, Turbine and Engine Division*

TRENDS in central station turbine-generator practice since 1920 have involved increases in unit size with resulting gains in kilowatt capacity, greater steam pressures and higher temperatures of the steam at the throttle.

In 1920 the largest unit in use had 60,000 kw capacity and the average unit was 30,000 kw. Today the average size is 80,000 kw, revealing the notable gains in capacity that have been made. The largest units far exceed the average.

A 208,000 kw triple-compound unit was placed in service at State Line Station near Chicago in 1928. The high pressure cylinder, on a shaft with a generator turning out 76,000 kw of electrical power, takes steam at 650 lbs. pressure and 730°F. temperature. It exhausts to two double-flow low pressure units mounted on individual shafts, each with its generator. Exhaust steam from the high pressure cylinder is at about 95 lbs. pressure and 400°F. Before entering the low pressure cylinders the steam is reheated to 500°F. Thus there are one high pressure turbine and two low pressure turbines driving three generators with an initial supply of steam, which is divided, as necessary, during its expansion. This unit has three shafts. Eight vertical condensers, having a total area of 176,000 sq. ft. of cooling surface, are used.

The more recent installations show a tendency toward single shaft units of high capacity. Since 1928, when the 208,000 kw installation was made, large single shaft units as high as 160,000 kw capacity have been placed in service. Two such units of tandem-compound design were installed by the Brooklyn Edison Company. Each has a 15-stage high pressure cylinder, a 4-stage double flow low pressure cylinder and a generator. Steam at 400 lbs. pressure and 750° F. is applied at the high pressure nozzles and continues through both cylinders without reheating. A single condenser having 101,000 sq. ft. of cooling surface takes the exhaust.

The average steam pressure used in 1920 was 300 lbs. gage; today that average is in the neighborhood of 425 lbs. About 1926 a number of turbines were built to utilize steam at 600 lbs. gage pressure, and at nearly the same time there were a few turbines constructed to operate with inlet pressure of between 1200 and 1400 lbs. gage. In 1920 the average temperature of steam at the inlet nozzles was 600°F. Now the average is 750°F. for the lower pressures and 825°F. for the higher pressures. The highest temperature of steam now being used continuously is 1000°F. on a 10,000 kw turbine at Detroit.

In the operation of turbines, steam, if not sufficiently superheated, will contain too high a percentage of moisture at the exhaust for safe and economical operation. This moisture causes excessive blade or bucket maintenance as the result of erosion. When the moisture exceeds 15 per cent at the exhaust, serious erosion can be expected. As a consequence, provision is made to superheat the steam before it enters the high pressure cylinder and often to reheat it between the cylinders. Thus, in the 208,000 kw unit, steam is superheated before entering the high pressure cylinder and is given 100 degrees of reheat, from 400° to 500°F., between the high pressure and low pressure cylinders.

Similarly, in the turbines operating at 600 lbs. gage, steam is reheated before it passes through the lower stages. In the turbines operated at between 1200 and 1400 lbs. the exhaust from the high pressure cylinder is at about 200 lbs. pressure and reheat is necessary before the steam completes its expansion cycle in low pressure condensing turbines.

There are very definite restrictions as to the steam temperature usable in turbines, the chief controlling factor being the materials of which the turbines are made. Until recently such materials would not permit the use of temperatures greater than 750°F. The newest of alloy steels will permit the safe use of 1000°F. At high temperatures metal is subject to "creep" which results in the necessary turbine clearances being reduced. The new steel alloys containing molybdenum and tungsten are found to be less subject to "creep".

The use of high temperatures in modern installations has made it possible to do away with the expense of reheating in some cases. The manner in which increased temperatures work a benefit in this regard is shown by the following theoretical examples. Suppose a turbine can safely be operated at 850°F. If the pressure at the nozzle was 400 lbs., it would be possible to superheat the steam approximately 400 degrees before reaching the total temperature of 850°F. and this steam would pass through the various stages to exhaust with, let us say, only 10 per cent moisture at the end of the steam cycle. This, of course, is less than the 15 per cent limit mentioned above as permissible. However, if instead of 400 lbs. pressure we were to consider the use of 1200 lbs. pressure, it would be found possible to apply only about 280 degrees superheat before the temperature limit of 850°F. was reached. This would be considerably less spread in temperature between the saturated steam temperature from the boiler and the working temperature of 850°F. Thus, with the 1200 lbs. pressure, there might be as much as 20 per cent moisture at the exhaust end of the cycle which would be an undesirable amount. Therefore, to obtain this steam pressure and still keep down the moisture content, reheating would be necessary between stages to maintain the steam at the desired dryness.

The picture would change with the use of 1000°F. steam. At 1200 lbs. pressure, 430 degrees of superheat can be applied before reaching 1000°F. and this will permit the use of the higher pressure without reheat. It should be noted that in this case it is possible to utilize more superheat, restrictions as to maximum temperature considered, than was obtainable when using steam at 400 lbs. pressure and a temperature limit of 850°F. Thus the advantages of high pressure are utilized without the cost of reheating between stages.

Six or seven years ago the practical limit for total temperature of steam was such that in order to maintain a reasonable degree of superheat the pressures could not be greatly increased if reheating was to be avoided. Some of the larger turbines installed at that time were, therefore, constructed to operate at inlet pressures as low as 415 lbs. gage. Originally, turbines which had inlet pressures of 600 lbs. and above required the use of reheat equipment to avoid serious erosion of the lower stage buckets, but because of the development of materials which will withstand high temperatures it is now possible to use higher pressures without reheat. The raising of the inlet temperature to 825°F. makes it possible with a steam pressure of 600 lbs. gage and no reheat to limit the moisture in the steam at the exhaust to the reasonable value of 12.5 per cent. At present there is little activity toward the use of 1200 lbs. to 1400 lbs. pressures because of the necessary reheating, yet one plant is now in operation using a pressure of 700 lbs. 850°F. temperature and no reheat. Large turbine builders declare themselves ready to build equipment for 1000 lbs. pressure and 1000°F. temperature without reheat.

The present tendency in large turbine design is distinctly toward single shaft machines. The two 160,000 kw Brooklyn Edison machines are of this type and a new General Electric 150,000 kw turbine designed for the State Line Station on Lake Michigan is a tandem-compound single generator machine, as is the 105,000 kw Allis Chalmers machine for the same station. A 160,000 kw Westinghouse machine of this construction is now being built for the Philadelphia Electric Company.

Considerable research work is being done on the construction and finishing of blades to decrease their wear due to moisture in the low pressure stages. At present a stellite coating seems to offer the greatest promise of accomplishing this.

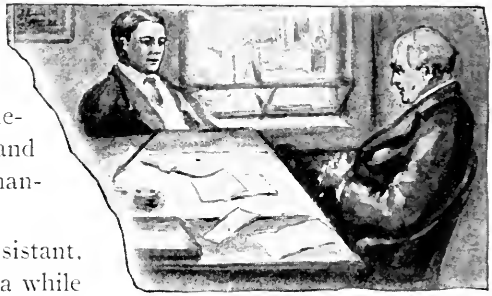
The largest single cylinder 1800 r.p.m. units constructed to date are of 80,000 kw capacity. One manufacturer has proposed to build a single cylinder turbine of 100,000 kw to operate at 1800 r.p.m., 650 lbs. pressure and 825°F. temperature at the throttle.

Quite recently manufacturers have developed fair sized 3600 r.p.m. turbine-generator units. A single cylinder 18,000 kw, 3600 r.p.m. turbine at the Burlington, N. J., station is now the largest unit of this speed. One manufacturer is prepared to build turbines as large as 30,000 kw to operate at 3600 r.p.m. Such a turbine would be a tandem compound unit with double flow of steam in the low pressure element.

There has been a definite trend toward the use of motor drives for turbine plant auxiliaries. A recent development, of interest, in auxiliaries is the use of motor driven boiler-feed pumps of the plunger type.

Some recent outstanding improvements in design detail include the following: The more general use of water-sealed glands at both ends of the turbine for eliminating the leakage of steam from these points into the turbine room and thereby reducing condensation on the ceiling of the turbine room in the winter time; the almost complete elimination of lateral vibration of turbine wheels; the rather extensive use of a vacuum trip attachment on the turbine throttle as a substitute for an atmospheric relief valve on the condenser, and the use of multi-valve construction to provide good light load efficiency on the very large turbines. Incidentally, it is not considered good practice to operate large turbines at less than 20 per cent of their rated capacity.

Taps From the Old Chief's Hammer



THE OLD CHIEF sat working quietly. Item after item of inspection and engineering detail came to his attention and was carefully, but quickly handled.

"Tom," he said to his assistant, "I hope no one comes in for a while until I get my desk clear."

Almost before he had finished speaking, however, his telephone rang. It was Brownell, works manager of the Vandeventer Paint Company, who had called to see the Old Chief.

"Tell Mr. Brownell to come in," the Old Chief told the operator, and turning to Tom Preble, he added, "Tom, I spoke too soon. Here's Brownell and he wasn't expected until tomorrow. I think the matter is as far as we can take it, though. Will you please get me the file and I'll tell him the bad news."

The situation was as follows:

Having need of an additional boiler at one of the plants in another state, the paint company had dismantled No. 1 boiler at its main works preparatory to moving it to the new location. The boiler had been loaded on a flat car preparatory to shipping, when it was decided that an inspection would be wise before taking the boiler any distance. The inspector had reported to the plant superintendent at the time of the inspection that the state in which the boiler was to be located would not accept it. Brownell had come to "Hartford Steam Boiler" to find out the reason, and to see whether he could avoid the extra expense of resetting this boiler and dismantling another. The plant official was inclined to be somewhat brusque regarding the situation.

"Mr. Brownell," quietly drawled the Old Chief, "did you ever own a good dog?"

"I own one now," was the answer in a somewhat mystified tone, "the best bird dog I ever saw."

"Has it a pedigree?" was the Old Chief's next question.

"Yes, . . . but see here, Chief, what has all this got to do with my boiler on a busy morning?"

"Everything," smiled the veteran boiler inspector. "One more question—if your bird dog had no pedigree, would you consider it just as good a dog?"

"It might be, in my opinion, as far as hunting is concerned."

"Exactly, but suppose you wanted to sell it. Could you get as good a price as if you could prove its pedigree?"

"Of course not, but what are you driving at?"

"Just this. The reason you can't use the boiler at the new plant is because it has no pedigree. I know all this sounds strange, but I'll explain."

Leisurely relighting his pipe the Old Chief went into the matter of pedigrees and boilers and the attitude of state boards toward boilers apparently good in every respect except lack of identifying records.

"The whole trouble," the Old Chief began, "is that your boiler has no formal history, no pedigree. We know it is safe to operate, but state boards are state boards and they have good reasons for their strictness. They feel the safety of their public depends on the use of sound boilers and they won't take chances.

"The information we have is as complete as any existing record of the main plant's boilers. In so far as we can determine, when the contract was let for the boilers in 1925, the engineer specified that they were to be built to the requirements of the A. S. M. E. Boiler Code, but did not specify that 'Hartford Steam Boiler' should make the shop inspections required by the code. He may have thought that our shop inspections would be furnished, as a matter of course, However, our inspection organization then had no knowledge of your plans, until called upon by your people to examine the first boiler as it was being unloaded from the car at the main plant.

"Inspector Ramsey could not locate an 'H. S. B.' identification although the boiler was stamped A. S. M. E. Code and, no doubt, was satisfactory in every way. Ramsey suggested to your people that the manufacturer be requested to furnish a 'Hartford Steam Boiler' shop certificate for each of the other five boilers about to be fabricated. The manufacturer, quite naturally, was agreeable to doing so. As a result the other five boilers at the main plant, bear the A. S. M. E. Code symbol and 'H. S. B.' identification. We have on file an original copy of the manufacturer's data signed by our inspector as well as by the manufacturer for five of the boilers. In other words each of them has a registered pedigree except Boiler No. 1."

"All very interesting," Mr. Brownell interrupted, "but that doesn't alter the fact that Boiler No. 1 is just as good a boiler as the other five."

"Possibly," the Old Chief smiled, "but the law of the state into which you wish to ship the boiler requires you to show a pedigree before you can use it there. When he was instructed to ship a boiler to the new location, your superintendent chose No. 1, because it was the easiest to dismantle and ship. The setting and attachments had been removed before any one thought of the advantage of having the boiler reinspected. If you had taken the matter up with us before you dismantled the boiler, we would have explained the pedigree ruling and saved you a lot of trouble.

"The first we knew of the matter was the report of our inspector. He said he had asked your company for a copy of the manufacturer's data for that boiler, but that there was none to be found. He saw the boiler had no 'H. S. B.' or other required official inspection and indentification number and realized the legal restrictions which might prevent its use in the state in which your other plant is located. After we learned of the situation, we tried to obtain a copy of the manufacturer's data record from the boiler manufacturer, but learned that a fire in his office destroyed all of his data records several years ago. We appear to have reached the end of the lane in that direction. There seems no doubt that the boiler was inspected by some one during the process of fabrication, but no record of such inspection of the boiler can be found."

"I see what this pedigree business is all about, Chief, but what am I going to do about it?"

"There seem to be two possible solutions to the difficulty. One is to appeal to the authorities of the state for permission to install the boiler in spite of the present rules. It is possible an appeal to the authorities would be successful but if the whole subject is placed before the board, hearings and meetings will be held before a revision can be made. The delay will cause a loss greater than the expense of dismantling one of the other boilers for shipment."

"What do you mean, that we can't use No. 1 boiler but can use No. 2 which is just like it?"

"Yes, except that No. 2 boiler isn't exactly like it."

"You mean that the state insists on the stamp of the 'Hartford Steam Boiler' or the stamp of some other officially recognized inspection expert."

"What the state insists on is proof that the boiler was inspected during construction by a commissioned inspector. You see a boiler's pedigree is mighty important when it is to be transferred from state to state or changes owners. The laws of different states on the subject are not uniform."

"Well, what do you know about that?" said the now convinced Brownell.

The Old Chief smiled and added, "Mr. Brownell, you can ship any one of the other five boilers. We can supply a pedigree for each of them, giving the original manufacturer's data record for each, as there is an 'H. S. B.' identification. As soon as you decide upon what action to take, we will arrange for a thorough examination of the boiler to be shipped."

"Clear enough, Chief, and thanks for your trouble," Mr. Brownell said as he rose to go. "You're a great one, comparing a boiler to a dog. However, since you seem to be acquainted with the ins and outs of pedigree records, including those of bird dogs, I'll bet you do a bit of hunting now and then. If you'll go, I'd like to take you out with me some time this fall and let you follow that dog of mine."

Tornado Results in Power Interruption

A Mississippi tornado on March 31, 1933, resulted in the complete shutdown of a large manufacturing plant when the storm blew down about four miles of high power transmission lines. It required thirty-four hours of intensive work on the part of the power company to restore service. The plant, which was operating twenty-four hours a day, was protected against such a loss by a power interruption policy in the Hartford Steam Boiler Inspection and Insurance Company which paid the assured $300 per hour for twenty-four of the thirty-four non-operating hours, or $7,200, the limit of insurance under its policy.

Another severe case of power interruption, the cause of which seemed so trivial that distant newspapers carried the story, occurred in Wisconsin on October 10. A $300,000 substation was "knocked out", with three transformers removed from service, because a curious squirrel ventured from his haunts in search of a place to bury or eat a nut. The repair bill was estimated at $5,000.

Sulphite Liquor Evaporated By Submerged Combustion

According to the *Paper Trade Journal*, experiments now indicate that waste sulphite liquor can be evaporated successfully by submerged combustion, that is, by an unprotected flame under the surface of the liquid. The experiments referred to were carried out by Kenneth A. Kabe in the chemical engineering laboratory of the University of Washington. Unneutralized liquor, containing 12 per cent solids, was charged into the boiler where it was heated by a flame formed by a mixture of city gas and air delivered under the liquid surface through a tube.

The Hartford Steam Boiler Inspection and Insurance Company

OF HARTFORD, CONN.

STATEMENT AS OF DECEMBER 31, 1932

Capital Stock - - $3,000,000.00

ASSETS

Cash on hand and in banks		$ 782,202.90
Premiums in course of collection (since October 1, 1932)		973,590.37
Interest accrued on mortgage loans		40,081.96
Interest accrued on bonds		114,256.73
Loaned on bonds and mortgages		948,517.17
Home Office real estate		437,474.66
Other real estate		212,746.88
Agents' ledger balances		4,159.04
Bonds on an amortized basis	$8,823,376.79	
Stocks at "Convention Values"	7,178,230.12	
		16,001,606.91
TOTAL		$19,514,636.62

LIABILITIES

Premium reserve		$7,142,070.04
Losses unadjusted		317,337.64
Commissions and brokerage		194,718.07
Other liabilities (taxes incurred, etc.)		566,977.68
Contingency Reserve		3,600,000.00
LIABILITIES OTHER THAN CAPITAL AND SURPLUS		$11,821,103.43
Capital Stock	$3,000,000.00	
Surplus over all liabilities	4,693,533.19	
Surplus to Policyholders		**$7,693,533.19**
TOTAL		$19,514,636.62

WILLIAM R. C. CORSON, President and Treasurer

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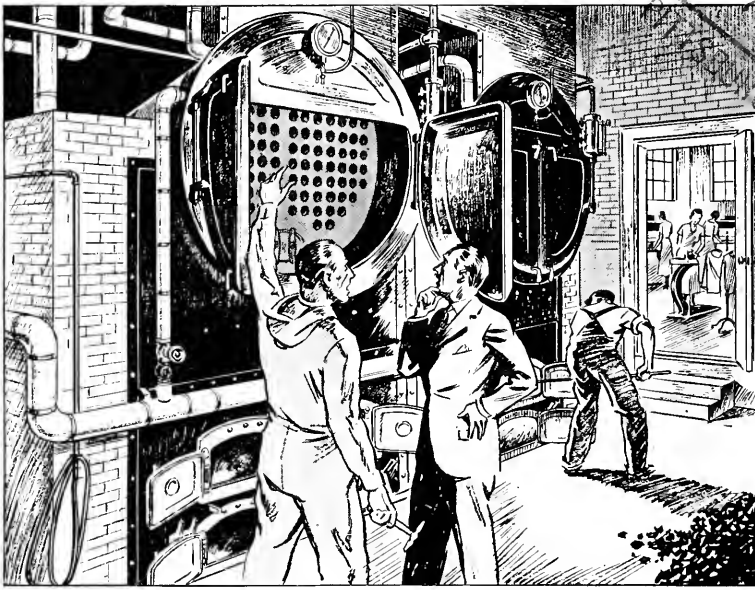
Incorporated 1866 — Charter Perpetual

Department	Representatives
ATLANTA, Ga., Citizens & So. Nat. Bk. Bldg.	W. M. Francis, Manager. C. R. Summers, Chief Inspector.
BALTIMORE, Md., 704-9 Garrett Building	D. W. Little, Manager. P. E. Terroy, Chief Inspector.
BOSTON, Mass., 87 Kilby Street	Ward I. Cornell, Manager. W. A. Bayliss, Chief Inspector.
BRIDGEPORT, Conn., City Savings Bank Building	W. G. Lineburgh & Son, General Agents. A. E. Bonnet, Chief Inspector.
CHICAGO, Ill., 175 West Jackson Boulevard	P. M. Murray, Manager. C. W. Zimmer, Chief Inspector.
CINCINNATI, Ohio, First National Bank Building	James P. Kerrigan, Manager. W. E. Glennon, Chief Inspector.
CLEVELAND, Ohio, Leader Building	A. Paul Graham, Manager. J. F. Hunt, Chief Inspector.
DENVER Colo., Gas & Electric Building	J. H. Chesnutt, Manager. F. G. Parker, Chief Inspector.
DETROIT, Mich., First National Bank Building	L. L. Coates, Manager. Thomas P. Hetu, Chief Inspector.
HARTFORD, Conn., 56 Prospect Street	F. H. Kenyon, Manager. A. E. Bonnet, Chief Inspector.
NEW ORLEANS, La., 333 St. Charles Street	R. T. Burwell, Manager. John L. Scott, Chief Inspector.
NEW YORK, N. Y., 90 John Street	C. C. Gardiner, Vice-President. J. M. Gorham, Acting Chief Inspector.
PHILADELPHIA, Pa., 429 Walnut Street	A. S. Wickham, Manager. S. B. Adams, Chief Inspector.
PITTSBURGH, Pa., Arrott Building	George S. Reynolds, Manager. J. A. Snyder, Chief Inspector.
ST. LOUIS, Mo., 319 North Fourth Street	Chas. D. Ashcroft, Manager. Eugene Webb, Chief Inspector.
SAN FRANCISCO, Cal., 114 Sansome Street	C. B. Paddock, Manager. L. E. Grundell, Chief Inspector.
SEATTLE, Wash., Arctic Building	E. G. Watson, Manager and Chief Inspector.
TORONTO, Ont., Canada, Federal Building	H. N. Roberts, President The Boiler Inspection and Insurance Company of Canada.



His Insight *prevented* an EXPLOSION

"Would the boiler have exploded?" the laundry owner asked.

"I'm afraid so," replied the 'Hartford Steam Boiler' inspector. "The shell was weakened by a hidden lap seam crack, which might have let go at any time under regular steam pressure. The hydrostatic test shows that the boiler is cracked for 27 inches.

"It is lucky that the steel plate was torn open by the test, rather than by a steam explosion. That might have killed or injured many of those women working in the next room. I know of a case where 30 persons were killed and 35 injured by a lap seam explosion."

The hydrostatic pressure test was requested by the inspector when he discovered a small, discolored spot on the plate adjacent to the lap riveted seam. His experience and training caused him to regard the inconspicuous spot as evidence of leakage, and as a clue to serious trouble—probably a long crack, concealed by the overlapping at the joint, and piercing the plate where the discoloration was found.

The water test proved that his diagnosis was correct, and that the boiler was unsafe. The owner agreed and ordered the boiler replaced. Again a 'Hartford Steam Boiler' inspector had discovered potential danger before lives and property were destroyed.